Periodontal Surgery

A Clinical Atlas

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To my wife, Akiko; son, Kimihiko; daughter, Yuka;
and parents, Keisuke and Yoko Sato for their support.

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Foreword

When I reviewed Dr Sato's first book on periodontal-restorative interrelationships in 1993, 1 was most impressed, and regretted that it was not available in English. Upon seeing the Japanese edition of this second book, Periodontal Surgery: A Clinical Atlas, in 1997, I was convinced that it needed to be translated into English. Fortunately, Quintessence has now done just that.

I first met Dr Sato in 1977, just after he finished his postdoctoral training at the University of Iowa. He then came to the University of Pennsylvania for a brief period to study with Dr D. Walter Cohen and myself. From that time on I followed the amazing career of Dr Sato as he became one of Japan's most outstanding clinicians. It was fascinating to watch him practicing in apparent geographic isolation-become so knowledgeable and clinically expert. Dr Sato has already influenced many dentists in Japan; it is only fair that we in the English-speaking world should have access to the writings of this outstanding clinician.

Periodontal diseases, including dental caries, are chronic in nature and acute in their ramifications, but they are also capable of creating deformities that in turn become important propagating factors in the progression of the disease. Dr Sato clearly recognizes this and knows that the best approach is early recognition of disease in the susceptible patient. He emphasizes the importance of selective differential diagnosis in his approach to periodontal surgery and, whenever possible, directs his efforts toward regeneration in restoring and maintaining form, function, and esthetics in the masticatory system. He takes us through basic periodontal surgical procedures, from curettage, to osseous plastic and resective surgery, to crown lengthening in all its various manifestations, but he also covers more advanced procedures-including mucogingival, periodontal, and osseous regenerative techniques, as well as the preparation and various applications of osseointegrated implants in the same detailed manner.

The atlas format of this book, illustrating treatment through case by case study, is an excellent approach to learning and teaching. The photographic plates and illustrative drawings are beautiful, and the step-by-step method takes the reader through a clear, concise, and well-referenced discussion of the various subjects. This book is a must-read for the periodontist and the general practitioner and mandatory for the postdoctoral student.

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Preface

Today, the objective of dentistry is not only to eliminate oral disease, but to improve function and esthetics; thus, patients' quality of life can be assured through oral health. In treating patients with periodontal disease, dentists should seek optimal results, including the regeneration of periodontal tissue lost through disease, the establishment of a functional and stable dentition, the creation of an easily maintained periodontal environment, and esthetic enhancement. This book was written to demonstrate how regenerative procedures, combined with fundamental periodontal surgery techniques, can achieve these goals and enhance the clinical outcome.

With step-by-step explanations, this text elucidates clinically effective procedures, each of which was evaluated and their clinical results compared with those of other studies. Abundant photographs and illustrations support the clear and concise descriptions of the procedures, and highlighted key points throughout each chapter enable the reader to conveniently integrate knowledge.

Clinical wisdom is achieved only by rigorous and candid evaluation of each case and its outcomes. I hope you, the reader, will learn as much as I did from the cases presented in this book.

I extend many thanks to Professor Kazuyuki Ueno (periodontal department of Iwate Medical University); Dr Haruhiko Abe (Abe Complete Denture Clinic); Dr Phillip A. Lainson (head of the department of periodontics at the University of Iowa College of Dentistry); Dr Norimasa Endo in Iwate; and Dr Hitoshi Shirahama, Dr Yoshiro-Hattori, and the staff at Tokyo Gas Clinic. Their support and guidance have encouraged me through years of research.

I also gratefully acknowledge Mr Ikko Sasaki, president of Quintessence Tokyo, for publishing the Japanese edition of' this book, and Mr Hidetoshi Akimoto (Aki Editorial Company) for editing the drafts and for offering helpful suggestions regarding the clinical photographs and illustrations.

My special thanks to Dr Gissela Anderson, who kindly checked the English translation.

1 Objectives and Techniques of Periodontal Surgery

Objectives and Methods of Periodontal Surgery

Objectives of Periodontal Surgery

Periodontal surgery comprises initial treatment, in which the original cause of periodontal disease is eliminated, and definitive surgery, in which an environment conducive to long-term health and maintenance is achieved.

Procedures to eliminate the etiogenic factors of periodontal disease are closed curettage and flap curettage, which entail debridement and the elimination of lesions. While shallow pockets can be eliminated by such procedures, in advanced periodontal disease recurrence is frequent. Additionally, esthetic problems may occur due to loss of attachment or irregular bone morphology even after the resolution of infection. In such cases, periodontal surgery is required to improve the periodontal environment, in addition to eliminating the original factors and lesions (Table 1-1 and Table 1-2).

The elimination of periodontal pockets enables a good environment to be maintained during therapy. If periodontal pockets of more than 4 mm remain postoperatively, however, maintenance is very difficult and the outcome unfavorable.[1]

Periodontal disease is intimately related to the anatomic factors of affected teeth, including tooth surface and position. Furthermore, the results of treatment rely on patient adherence to hygiene and sometimes on chance. In severe periodontal disease, it is often difficult to devise a treatment plan that is readily accepted by the patient.

Table 1-1 Objectives of Periodontal Surgery

1. Accessibility of instruments to root surface.
2. Elimination of inflammation.
3. Creation of an oral environment conducive to plaque control.
   a. Establish gingival sulcus for easy periodontal disease control (elimination of pocket).
   b. Correct abnormal gingiva and alveolar bone morphologic characteristics that interfere with plaque control.
   c. Perform root-sectioning procedures or treatments to improve morphology for easier oral hygiene maintenance.
   d. Create an easy to clean and proper embrasure space.
4. Regeneration of periodontal apparatus destroyed by periodontal disease.
5. Resolution of gingiva-alveolar mucosa problems.
6. Preparation of periodontal environment suitable to restorative and prosthodontic treatment. Periodontal surgery serves as the therapy prior to prosthodontic treatment.
7. Esthetic improvement.

Table 1-2 Methods of Periodontal Surgery

1. Closed curettage
2. Gingivectomy
3. Flap surgery
   a. Flap curettage
   b. Osseous resection
      - osteoplasty
      - ostectomy
   c. Bone graft
   d. GTR (guided tissue regeneration)
      - GTR with bone grafts
      - GTR without bone grafts
4. Mucogingival surgery
   a. Attached gingiva augmentation
      - Free autogenous gingival grafts
      - Pedicle gingival grafts
      - Apically positioned flap surgery
   b. Root coverage
      - Pedicle gingival grafts
      - Semilunar coronally positioned flaps
      - Free autogenous gingival grafts
      - Subepithelial connective tissue grafts
      - GTR (guided tissue regeneration)
   c. Frenum operation
5. Combination of various periodontal surgical approaches

In a case like that shown in Fig 1-1, where closed curettage is performed only on single-rooted teeth, it is possible to achieve a relatively stable condition. However, closed curettage is an unwise first choice of treatment due to its lack of predictability in bone regeneration and attachment gain. Clinically, flexibility is required in considering various treatment modalities, but decision-making must not be based on exceptional or incidental treatment outcomes.

Therefore, while it is important to eliminate inflammation immediately, it is also necessary to consider factors influencing long-term prognosis, including the maximum pocket reduction suitable for the site in regard to bone defect, gingiva-alveolar morphology, and gingival attachment.

Resective Procedures and Regenerative Procedures

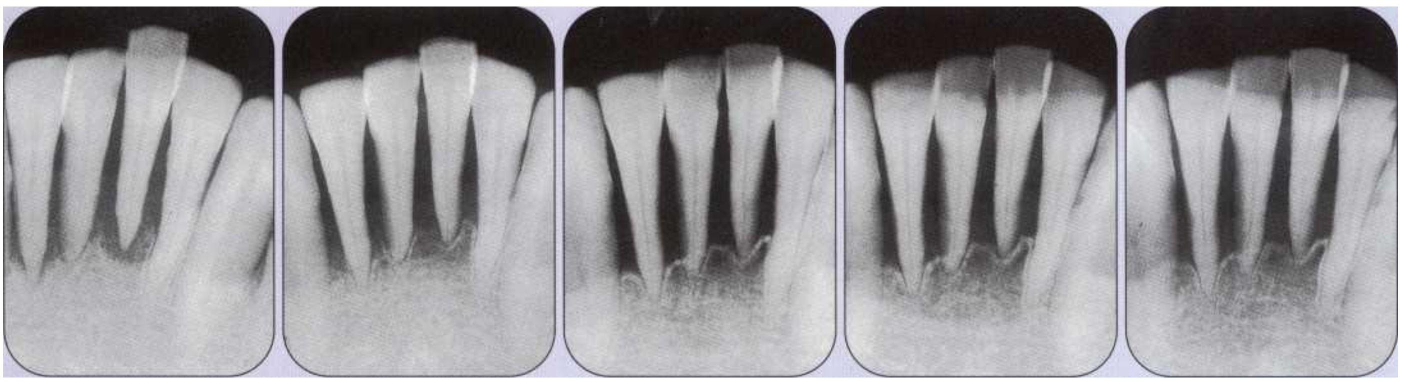
With shallow bony defects or moderate periodontitis with moderate periodontal pockets (5-6 mm), resectioe procedures such as apically positioned flap surgery with or without osseous resection help to create a shallow gingival sulcus and physiologic morphology in which bone and gingiva are in harmony so that an easy-to-maintain periodontal environment is achieved.[3,4]

Fig 1-1 Resolution of advanced periodontal disease by closed curettage.

a. Thirty-seven-year-old man. The probing depth is 7-10 mm, and marked bleeding and drainage are detected on probing. Pathologic tooth mobility is Class II-III. After splinting and occlusal adjustment, closed curettage is performed several times with local anesthesia.

b. One year and 2 months after surgery. Note the extensive gingival shrinkage caused by closed curettage.

c. Six years and 5 months after surgery. Probing depths are within 2-3 mm, and there is no bleeding on probing. The patient is recalled every other month for teeth cleaning.



d. Preoperative radiograph shows remarkable bone resorption on 23, 24, 25, and 26.

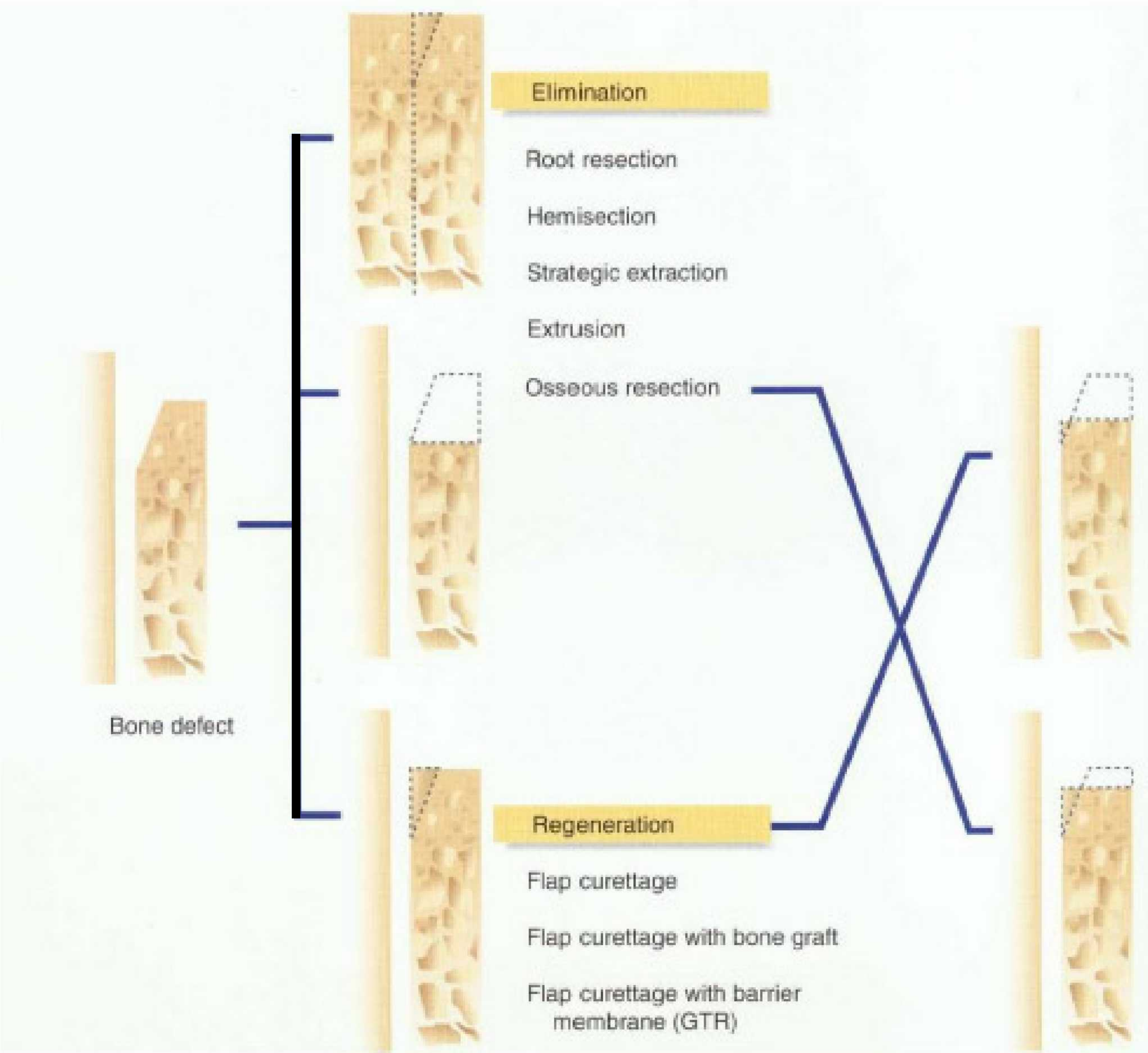
e. One year after closed curettage.

f. Two years and 5 months later. The linea alba is clearly seen.

g. Three years and 4 months later.

h. Six years and 5 months after surgery. The height of the alveolar crest is maintained.

Fig 1-2 Elimination of intrabony defect.



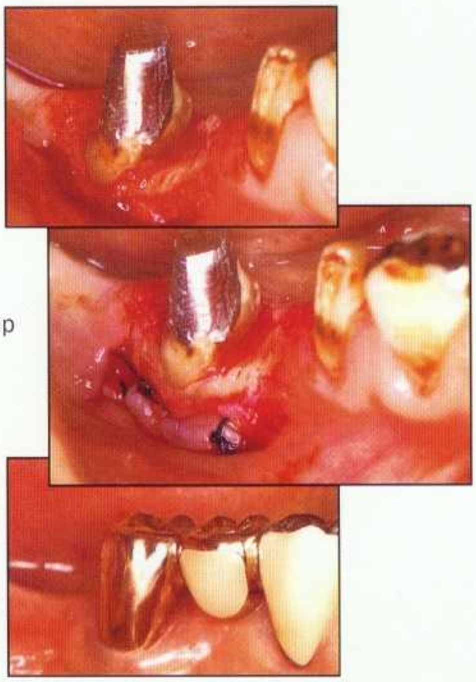
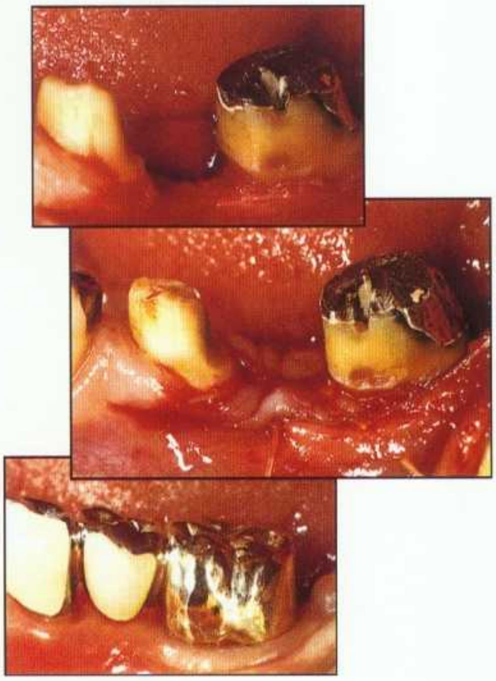
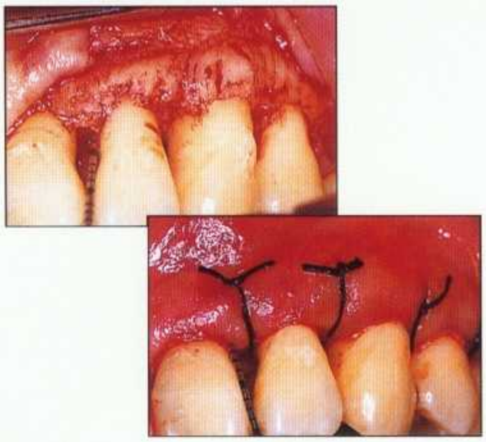
However, with deep intrabony defects, resectioe procedures may result in considerable bone resection and reduction of supporting tissues. Conversely, if surgical principles are compromised, deep periodontal pockets may remain and make maintenance difficult. Various regenerative procedures have been developed, but no clinical method can address all cases. The treatment of periodontal pockets requires a decision on the approach: 1) resective.procedure; 2) regenerative procedure; or 3) combination of resectioe and regenerative procedures (Fig 1-2).

Apically Positioned Flap Surgery in Resective Procedures

Variety of Flaps

The two basic flaps in periodontal surgery are determined by whether the flap includes periosteum (full thickness) or not (split thickness). Flaps are also described by their placement. With the apically positioned flap, the flap is displaced apically from the original position. With the replaced flap, the flap is displaced to the original or intimate (close) position. The apically positioned flap is used in resective procedures, while the replaced flap is used in surgical procedures for tissue regeneration.

Table 1-3 Basic Flaps in Periodontal Surgery

Position of displaced flap	Reflected tissue: Full-thickness flap (mucoperiosteal flap)	Reflected tissue: Partial-thickness flap (split-thickness flap) (mucosal flap)
Apically positioned flap		
Replaced flap		

Apically Positioned Flap Surgery

The apically positioned flap is one of the most widely used techniques for eliminating periodontal pockets. A flap made by an internal bevel incision is displaced apically from the original position, and the suture is made on the alveolar crest or in a slightly coronal position.'

The position of the flap displacement varies depending on the:

1. Thickness of alveolar margin in operating area
2. Width of attached gingiva
3. Clinical crown length necessary for an abutment

There are variations of the above depending on how much reduction of the periodontal pocket is achieved and the expected result.

Apically positioned flap surgery is used widely to eliminate periodontal pockets, to increase the width of the attached gingiva, to lengthen the clinical crown for prosthetic treatment, and to improve gingival and gingival-alveolar bone morphology (Table 1-4). It is not, however, suitable for severe periodontal disease or for the esthetic zone.

Full-Thickness Flap Surgery

Flaps may be full thickness or partial thickness. A full-thickness flap is used to expose the root surface while a partial-thickness flap is used to keep the periosteum-connective tissue on the bone surface. Even in a full-thickness flap, the periosteum is not removed histologically; rather the bone surface is exposed clinically. For clinical purposes, these two procedures entail suturing of the flap to the periosteum, prevention of bone resorption, and alleviation of swelling. Because partial-thickness flaps enable flaps to suture and fix to tissues and periosteum, flaps are displaced in the correct position.'

Table 1-4 Apically Positioned Flap Surgery

Advantages	Disadvantages
1. Eliminates periodontal pocket	1. May cause esthetic problems due to root exposure
2. Preserves attached gingiva and increases its width	2. May cause attachment loss due to surgery
3. Establishes gingival morphology facilitating good hygiene	3. May cause hypersensitivity
4. Ensures healthy root surface necessary for the biologic width on alveolar margin and lengthened clinical crown	4. May increase the risk of root caries
	5. Unsuitable for treatment of deep periodontal pockets
	6. Possibility of exposure of furcations and roots, which complicates postoperative supragingival plaque control

Table 1-5 Contraindications for Apically Positioned Flap Surgery

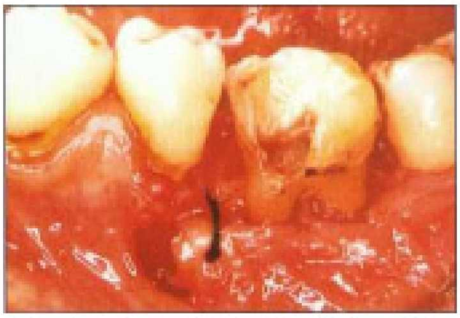
1. Periodontal pockets in severe periodontal disease
2. Periodontal pockets in areas where esthetics is critical
3. Deep intrabony defects
4. Patient at high risk for caries
5. Severe hypersensitivity
6. Tooth with marked mobility and severe attachment loss
7. Tooth with extremely unfavorable clinical crown/root ratio

Fig 1-3 Apically positioned flap surgery for *subgingival* caries.

Buccal partial-thickness apically positioned flap

a. In this case, there are 4-6 mm periodontal pockets on teeth 30 and 31. Note the subgingival caries on the mesiobuccal surface of 30.

c. Preparation of buccal partial-thickness flap.

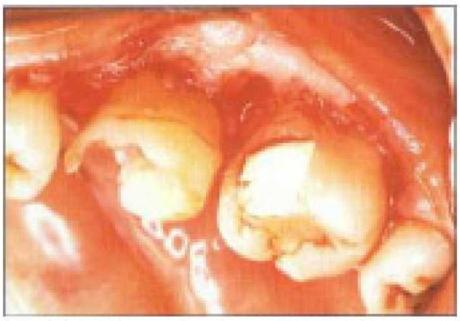


e. The flap is displaced apically and a periosteal suture made.

g. Three years after the placement of a gold crown. A shallow gingival sulcus (less than 2 mm) was maintained by apically positioned flap surgery.

Palatal full-thickness apically positioned flap

b. Note the subgingival caries on the mesiopalatal aspect of tooth 15.



d. Full-thickness flaps are reflected on the palatal aspect. Osseous resection is performed to gain biologic width and to lengthen the clinical crown.

f. The palatal full-thickness flap is displaced apically by a continuous suspensory sling suture.

h. Three years after the placement of a gold crown.

Partial-thickness flaps are especially useful for augmentation of the attached gingiva. This is done by positioning the flap apically or laterally. However, the partial-thickness flap is a difficult technique and causes much discomfort because of postoperative swelling (Table 1-7).

In reality, there are few partial thickness flap cases (see Chapter 2). The partial-thickness flap is favorable in augmentation of attached gingiva with thin bone; however, if the flaps cover the alveolar crest and are sutured firmly, full thickness flaps also can reduce the amount of bone loss that is clinically acceptable. Currently, the partial-thickness flap is used to thin flaps with thick gingiva. Later the periosteum-connective tissue is removed to make a full-thickness flap (partial and full-thickness flap).

The full-thickness flap can be used to reduce or eliminate periodontal pockets, but there must be a sufficient band of attached gingiva and sufficient alveolar crest width to achieve this (Fig 1-4).

As a modified method of the apically positioned full-thickness flap, a combination of full thickness and partial thickness may be employed. Namely, a full-thickness flap may be made in the area where osseous resection is required and a partial-thickness flap made apical of the flap.'

Flaps are displaced apically to the position where the alveolar margin is slightly covered and the partial-thickness flap and periosteum-connective tissue base fixed with a periosteal suture. The alveolar crest is covered by a sufficient full-thickness flap. This procedure works for both full-thickness and partial-thickness flaps (Fig 1-5).

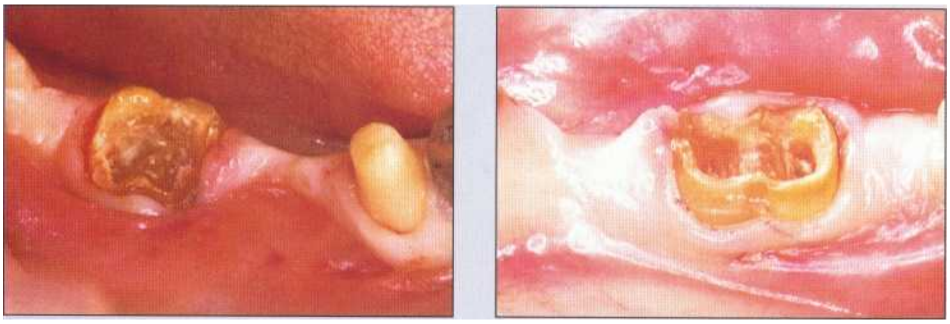
Table 1-6 Contraindications for the Full-Thickness Flap

1. Area where treatment for osseous defect with mucogingival problem is not required
2. Thin periodontal tissue with probable osseous dehiscence and osseous fenestration
3. Area where alveolar bone is thin

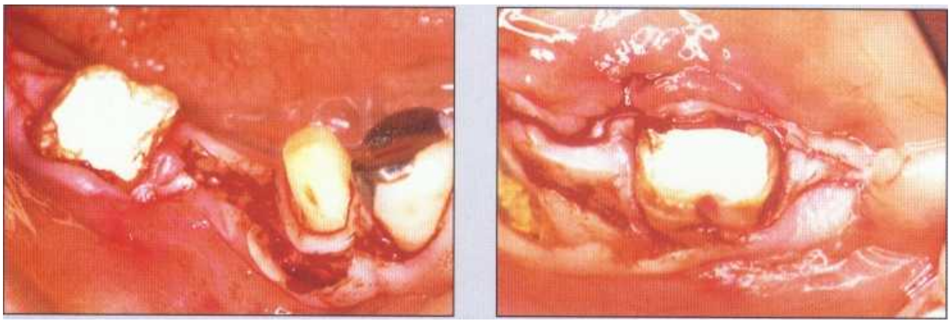
Table 1-7 Comparison of Full-Thickness Flap and Partial-Thickness Flap

	Full Thickness	Partial Thickness
Healing	Primary healing	Secondary healing
Technical difficulty	Relatively easy	Difficult
Bone defect treatment	Possible	Difficult
Blood supply to flaps	Sufficient	Decrease
Elimination or reduction of periodontal pocket	Possible	Possible
Use with mucogingival surgery	Impossible	Possible
Bleeding	Less	Much
Postoperative swelling	Less	Severe
Postoperative pain and discomfort	Less	Much
Fixation of flaps	–	Firm fixation with periosteal suture
Possibility of flap penetration	Less	Much
Thin flap preparation by primary incision	Difficult	Easy
Augmentation of the band of attached gingiva	Possible	Possible

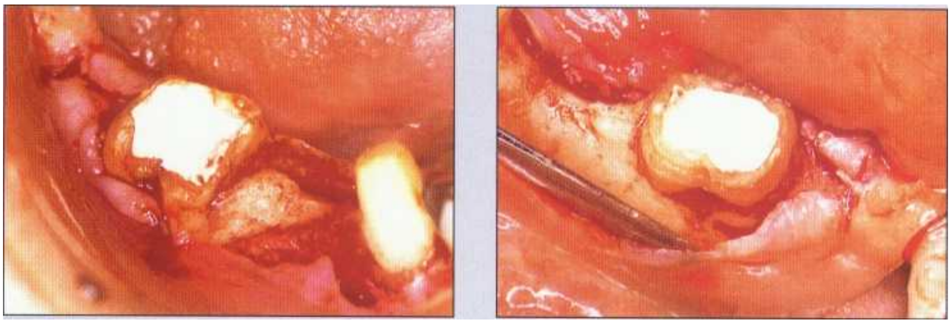
Fig 1-4 Solution of periodontal problems by apically positioned flap surgery.



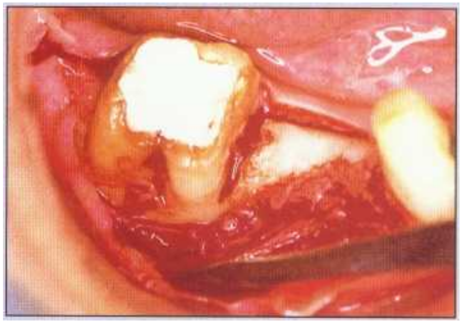
a. Note the collapse of the crown of tooth 31, subgingival caries, Class I furcation involvement on the buccal aspect, a narrow band of attached gingiva, and a 5-6 mm periodontal pocket on the distal aspect. The mucosa is mobile over the edentulous ridge of 30. Apically positioned flap surgery is performed for the elimination of the periodontal pocket, augmentation of the band of attached gingiva, and clinical crown lengthening to ensure adequate healthy tooth structure supragingivally.



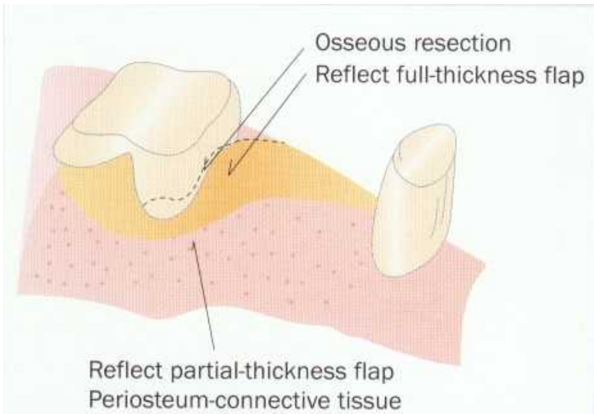
b. A wedge operation incision is made to the mesial and distal alveolar ridge of 31.



c. Flap reflection before osseous resection.

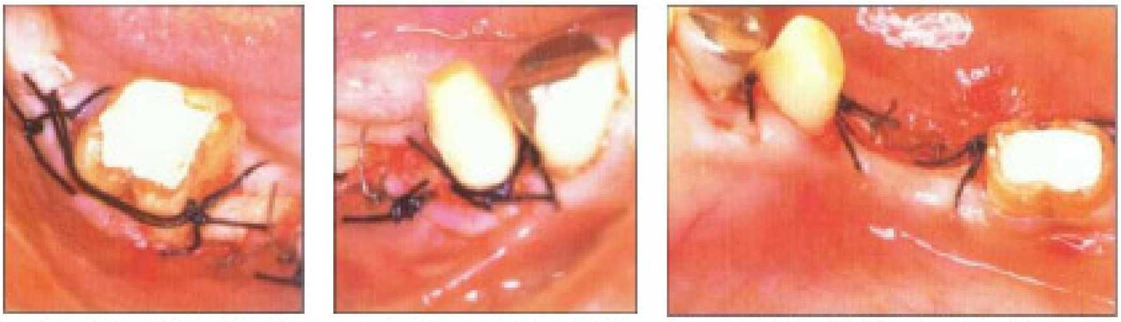


d. The clinical crown is lengthened by osseous resection. Consideration is given to the biologic width.



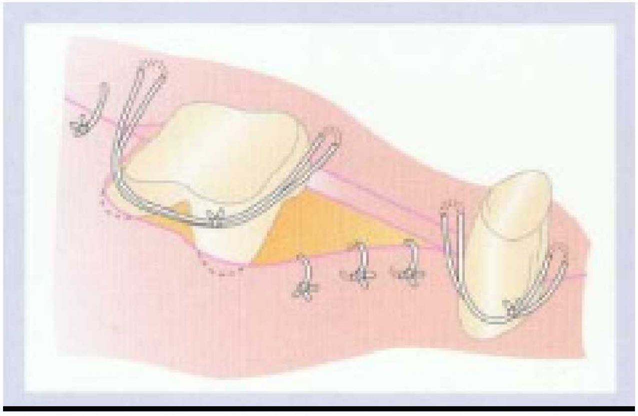
Make a partial-thickness flap to the apical area where osseous resection is indicated on the alveolar ridge of 30 and the buccal aspect of 31 to enable apical migration of the flap and firm fixation by periosteal suture.

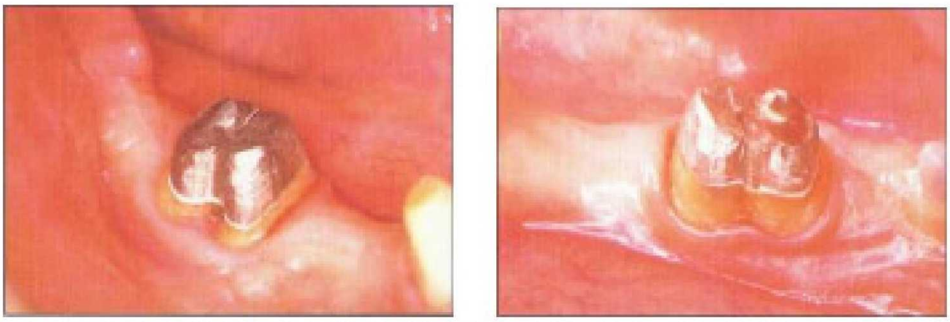
Fig 1-4 (continued) Solution of periodontal problems by apically positioned flap surgery.



e. The buccal flap is fixed apically with a periosteal suture on the alveolar ridge of 30. A suspensory sling suture of the lingual flap is made.

The root surface on the alveolar ridge of 30 is partially exposed to increase nonmobile keratinized mucosa.

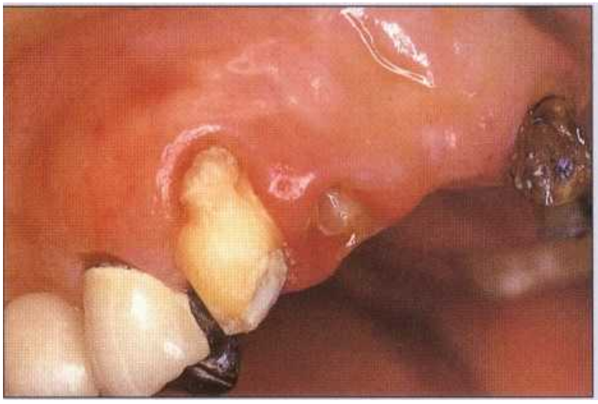




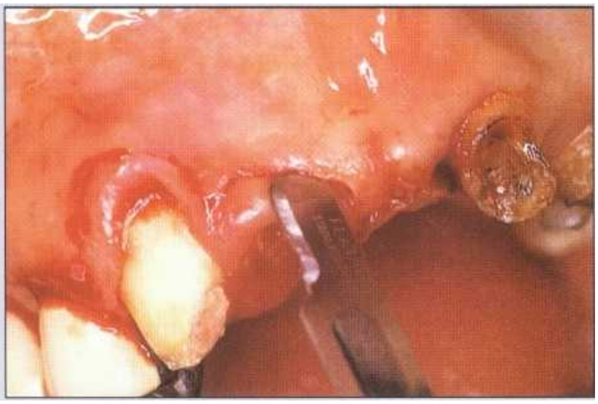
f. Three months after surgery. Note the elimination of the periodontal pocket, augmentation of attached gingiva, morphologic correction of the edentulous ridge, and improvement of the furcation lesion. Also, sufficient clinical crown length has been achieved for restorative treatment.

g. Five years after restoration placement.

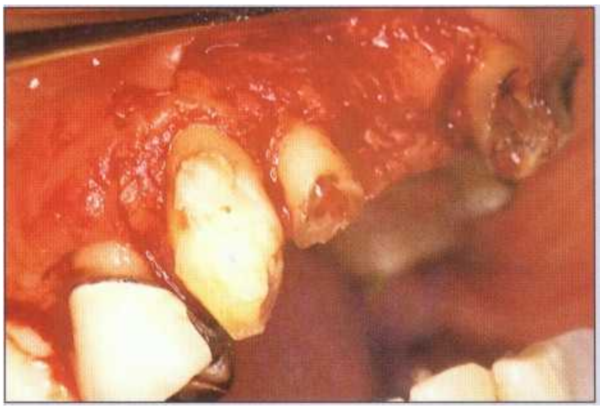
Fig 1-5 Apically positioned flap by combination flap.



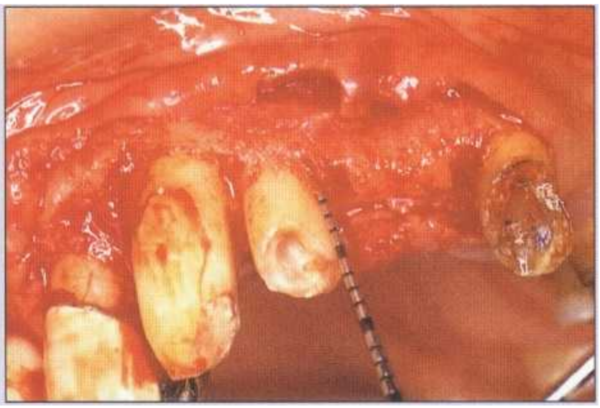
a. 62-year-old woman. Clinical crown lengthening is necessary because of a crown fracture and subgingival caries.



b. An internal bevel incision apical to the gingival margin is made to gain sufficient clinical crown length supragingivally.

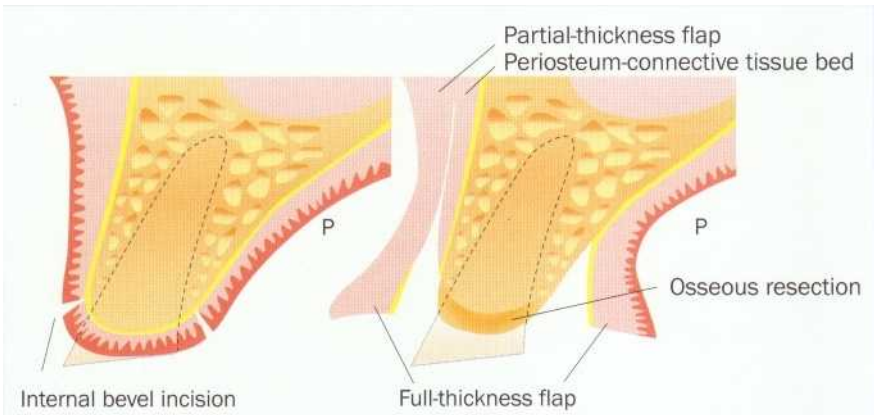


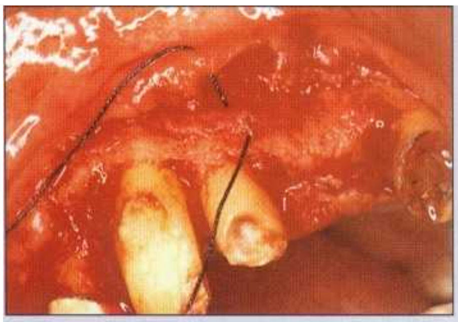
c. On full-thickness flap reflection. Note the extreme root proximity of 6 and 7.



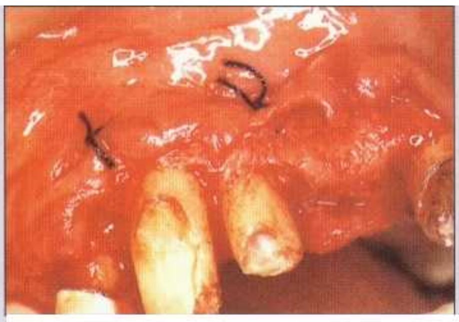
d. After osseous resection, more than 5 mm of the tooth structure from alveolar crest is exposed. The interdental space is enlarged between 6 and 7 by morphologic correction from crown to root.

On the coronal portion of the buccal flap, a full-thickness flap is made to expose the bone surface as far as osseous resection is required. A partial-thickness flap is made on the apical aspect. A full-thickness flap is made on the palatal aspect.

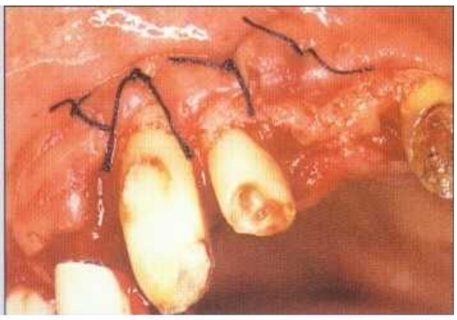




e. A periosteum suture is made with a vertical mattress suture at the base of the mesial flap of 7.



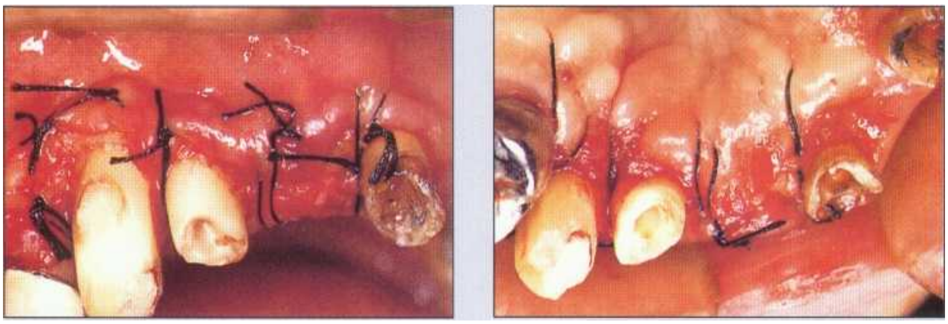
f. A periosteal suture is made atthe distal aspect of the flap of 6.



g. The flaps are displaced apically and fixed at the appropriate positions by a periosteal suture with four vertical mattress sutures.

Fig 1-5 (continued) Apically positioned flap by combination flap.

After osseous resection, displace the buccal flap edges apically to cover the alveolar margin. Make a periosteal suture at the base of the flap and periosteum-connective tissue with a vertical mattress suture for flap fixation. Then join the buccal flap margin and palatal flap with a vertical mattress suture and adapt the flap closely to the alveolar crest.



h. The alveolar crest is covered and protected with a sufficient full-thickness flap. At the same time, the flaps are displaced apically and adequate tooth structure is preserved for restorative treatment.

i. One month after surgery.

j. Six months after surgery.

k. Seven months after surgery. Copings are placed.

l. Six months after placement of the final restorations.

Resective Procedures and Regenerative Procedures

in advanced periodontal disease, the surgical procedures that eliminate or reduce the periodontal pocket and improve the morphology of the alveolar bone may be resective or regenerative. These procedures have different objectives and indications.

For recovering periodontal tissue, regenerative procedures are superior to resective procedures. However, not all periodontal problems can be solved by regenerative procedures alone. Generally, these procedures are less predictable than resective procedures. Also, regenerative procedures are more technically demanding. For this reason, resective procedures are more reliable for most practitioners. Additionally, it takes longer to achieve postoperative results, with regenerative procedures (approximately one year) than with resective procedures (a few months). With regenerative procedures a second surgery is often necessary to eliminate remaining periodontal pockets and osseous defects (Fig 1-6).

Schallhorn[9] described resective and regenerative procedures and their contraindications. He recommended against these procedures for patients with inadequate plaque control or poor compliance to periodical maintenance therapy. Resective procedures are especially contraindicated in the presence of insufficient support tissue or a deep, vertical osseous defect that may compromise the adjacent supporting tissue or esthetics. Because it is difficult to predict the outcome of regenerative procedures, it is best to await the results of healing before creating a final treatment plan.

Fig 1-6 Osseous defect therapy.

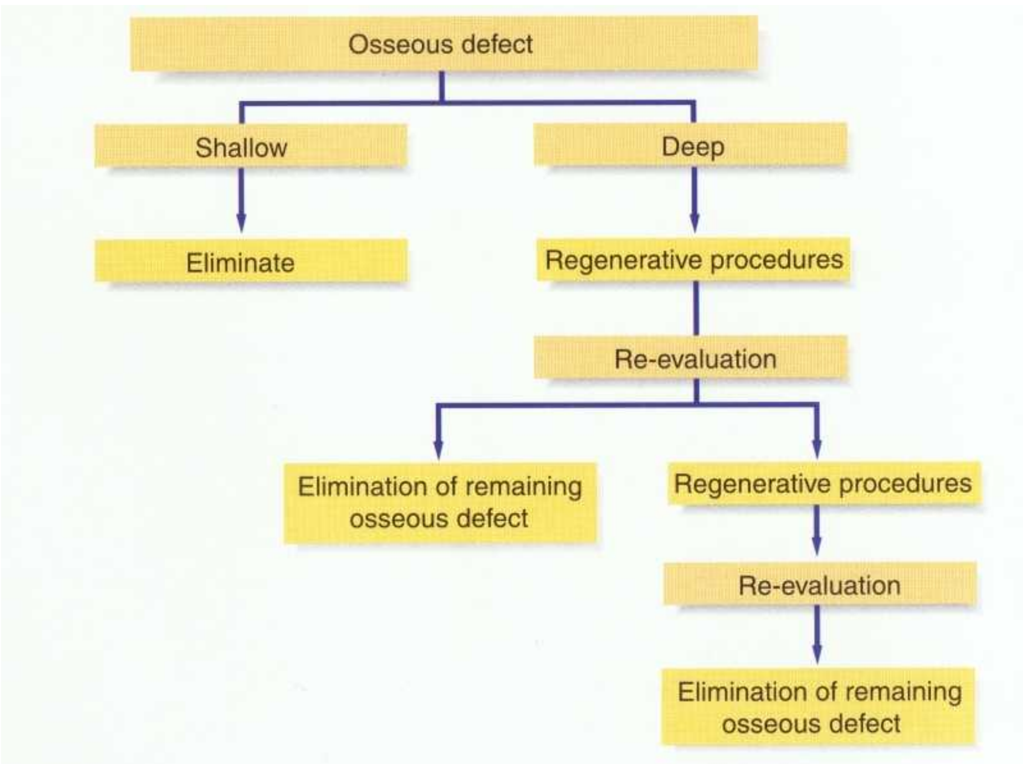


Fig 1-7 Methods of resective procedures and regenerative procedures.

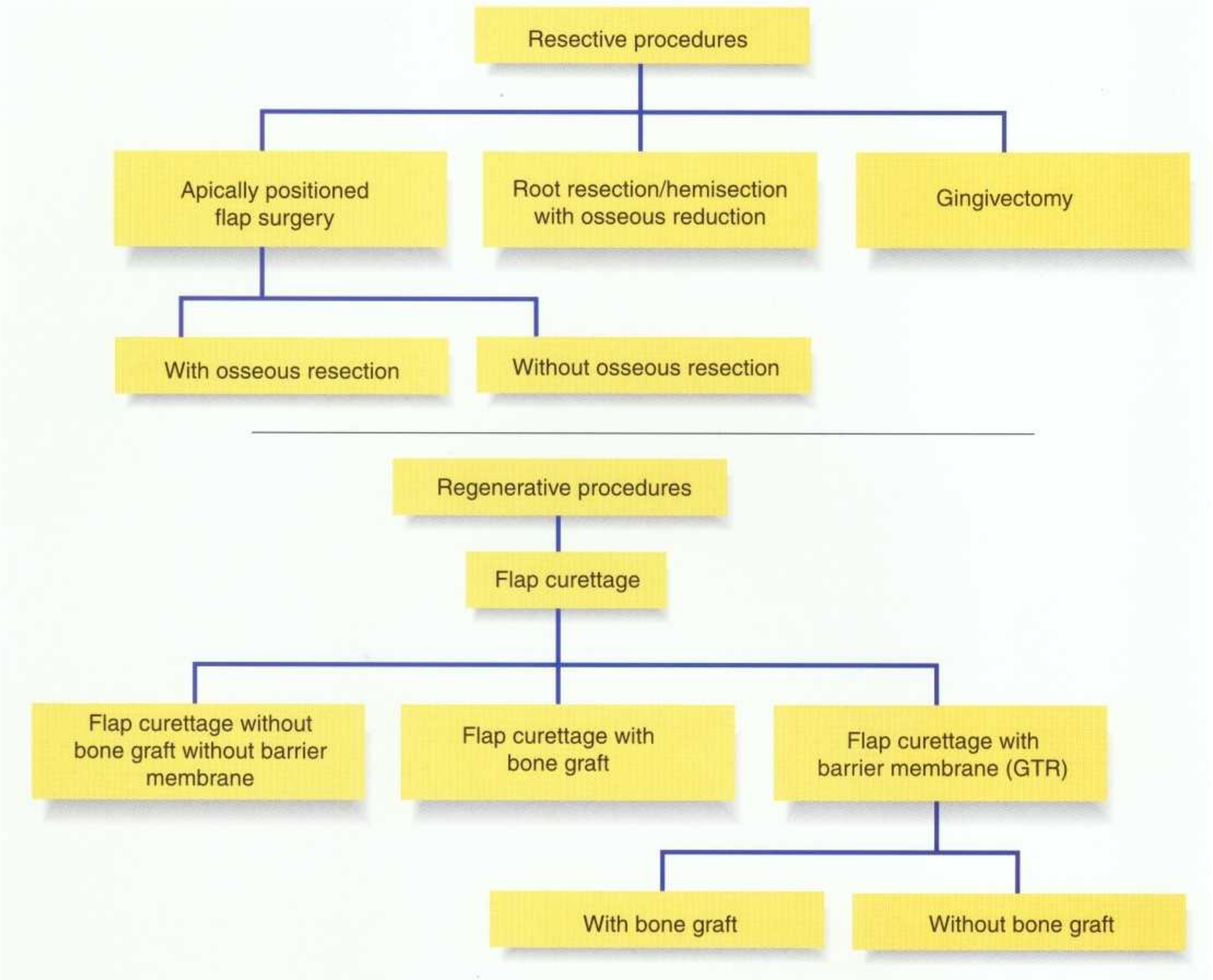


Table 1-8 Advantages and Disadvantages of Resective Procedures

Advantages	Disadvantages
1. Reliable 2. Short term (8-12 weeks) 3. Obtain gingiva-alveolar bone morphology that facilitates easy maintenance	1. Attachment loss 2. Root exposure, compromising esthetics 3. Strong possibility of hypersensitivity 4. Strong possibility of root surface caries 5. Possibility of phonetic impediment

Table 1-9 Advantages and Disadvantages of Regenerative Procedures

Advantages	Disadvantages
1. Lost periodontal tissues restored. 2. Less gingival recession postoperatively, therefore: • Esthetic • Less possibility of hypersensitivity • Low risk of root surface caries	1. Longer treatment time. 2. Technically demanding. 3. Pre- and postoperative plaque control and maintenance mandatory. 4. Second surgery may be required to eliminate remaining periodontal pocket and osseous defect. 5. Costly.

Basic Techniques of Resective Procedures

Incision Technique

Incision techniques for flap preparation are the coronally directed incision (external bevel incision) and the apically directed incision.[10] The most frequently used and basic incision in periodontal surgery is the apically directed incision. The internal bevel incision is especially important. See Tables 1-10 and 1-11 for descriptions of the sulcular incision and the apically directed internal bevel incision.

Fig 1-8 Incision technique.

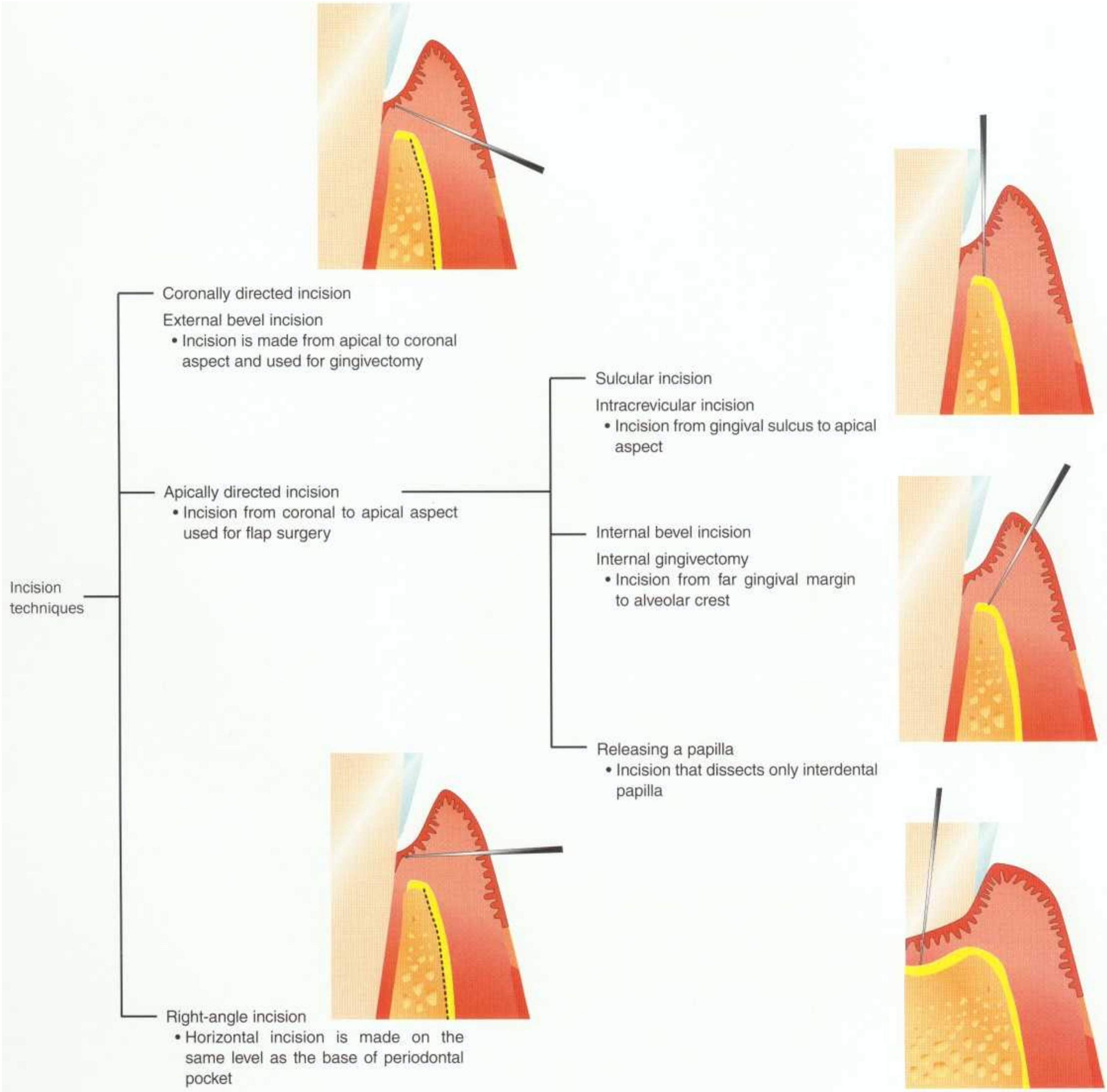


Table 1-10 Indications for the Sulcular Incision

1. Narrow band of attached gingiva
2. Thin gingiva and alveolar process
3. Shallow periodontal pocket
4. Desire to lessen postoperative gingival recession for esthetic reasons in the maxillary anterior region
5. As a secondary incision of usual flap surgery
6. Bone graft or GTR: desire to preserve as much periodontal tissue (especially interdental papilla) as possible to completely cover grafted bone and membrane by flaps

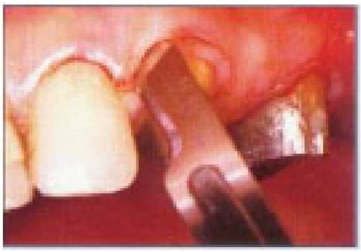
Table 1-11 Indications for the Internal Bevel Incision

1. Primary incision of flap surgery if there is a sufficient band of attached gingiva
2. Desire to correct bone morphology (osteoplasty, osseous resection)
3. Thick gingiva (such as palatal gingiva)
4. Deep periodontal pockets and bone defect
5. Desire to lengthen clinical crown

Incision Process

Three incisions are required for flap surgery. The primary incision dissects the flap from the bone surface, the secondary incision enables the removal of the secondary flap on the cervical aspect for convenience, and the third incision separates the secondary flap (Fig 1-9).

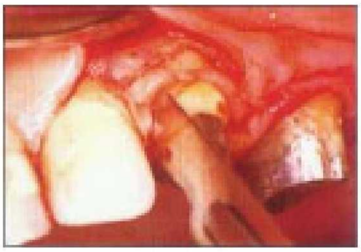
Fig 1-9 Incision process.



Primary incision (initial incision)

The primary incision is an internal bevel incision 1-3 min from the gingival margin inclined toward the alveolar crest. The flap, is reflected to expose underlying bone and root. Important points include:

- Preserve the gingival tissue as inuch as possible.
- Prepare a thin and uniform flap, which can adapt to bone and tooth surface closely.
- For a thick giugiva, thin the flap edge and create a better postoperative gingival morphology.



Secondary incision

The secondary incision is a sulcular incision, which incises the cervical area from the bottom of the, pocket toward the alveolar crest. Its purpose is to facilitate the removal of the inflammatory granulation tissue surrounding the cervical area and the secondary flap of soft tissue walls of the periodontal pocket (after reflecting the primary flap). A no. 12 blade, a small Wedelstadt chisel, and an Ochsenbein chisel are recommended.

Third incision

The third incision is an interdental incision along the alveolar crest and alveolar septum from the buccal to the lingual side. It separates cervical secondary flap from the alveolar crest and interdental bone after reflecting the buccal and lingual flaps. The secondary flap is easily removed as a single piece by the third incision. The Orban interdental knife is recommended for this incision.

An internal bevel incision of a primary incision may be a scalloped incision or a straight incision. To cover the bone properly when replacing a flap, the scalloped incision is mostly used for the primary incision along the gingival edge and to prepare arc shape.

The scalloped primary incision must extend to the interdental area but include sufficient interdental papilla for complete coverage of interdental bone and close adaptation of the buccal and lingual flaps. This is especially important in case of flap curettage and grafts.

The placement of the primary incision is determined by the following factors:

1. Band of attached gingiva
2. Method of periodontal surgery
3. Depth of periodontal pocket
4. Whether osteoplasty and ostectomy are necessary
5. Thickness of the gingiva and alveolar process
6. Esthetics
7. Whether restorative treatment is necessary after periodontal surgery
8. Clinical crown length needed for abutment

In Case 1-l, there is a sufficient band of attached gingiva in the surgical area and a deep periodontal pocket with abutments for restorations necessary after periodontal surgery. Osseous resection is chosen for the elimination of periodontal pocket.

Also, the crown lengthening procedure is necessary to eliminate the subgingival caries and to preserve the sound tooth structure supragingivally.

There is no interdental papilla between 8 and 9, but the patient chose tooth preservation over esthetics.

Because the gingiva is thick in this case, the primary incision is prepared far from the gingival margin to allow for thin flap edges for better flap adaptation. This approach also creates better postoperative gingival morphology. Therefore, as a primary incision, a scalloped internal bevel incision 2-3 mm from the gingival margin toward alveolar crest was made.

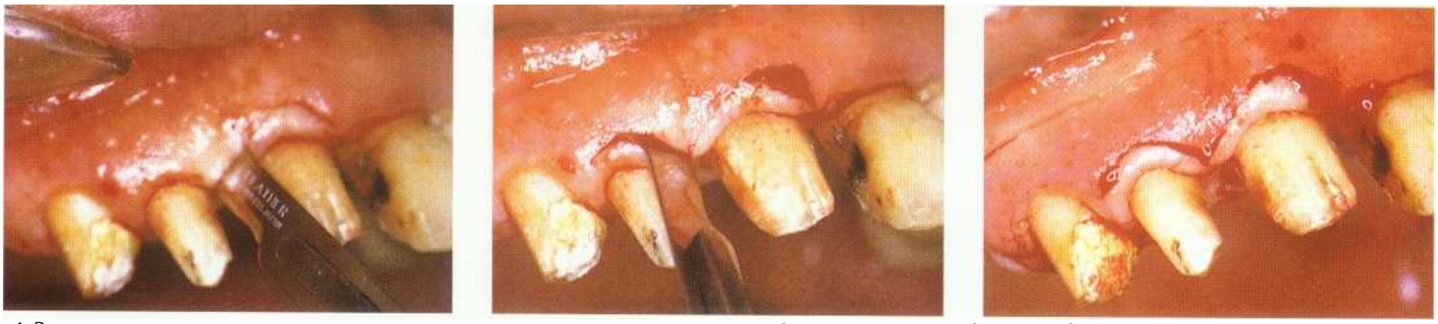
Case 1-1 Surgical crown lengthening in the maxillary anterior region

c1-1 Indication for surgical crown lengthening. 67-year-old-man 4 months after initial visit. Gingival inflammation has resolved with initial therapy, but 6-8 mm periodontal pockets remain. There is bleeding on probing, suppuration, a gingival crater between 7 and 8, subgingival caries on 6, and root proximity of 6 and 7. Clinical crown lengthening and the elimination of periodontal pockets are required to make abutments for a fixed partial denture.

c1-2 Primary incision. A no. 15 blade is I held parallel to the long axis of the tooth. The blade is held firmly with the tip the aiveoiar crest. Extending the incision one or two teeth mesiodistally from the envelope flap area without a vertical incision provides better blood supply to flaps (unless flap displacement is unnecessary).

Key point

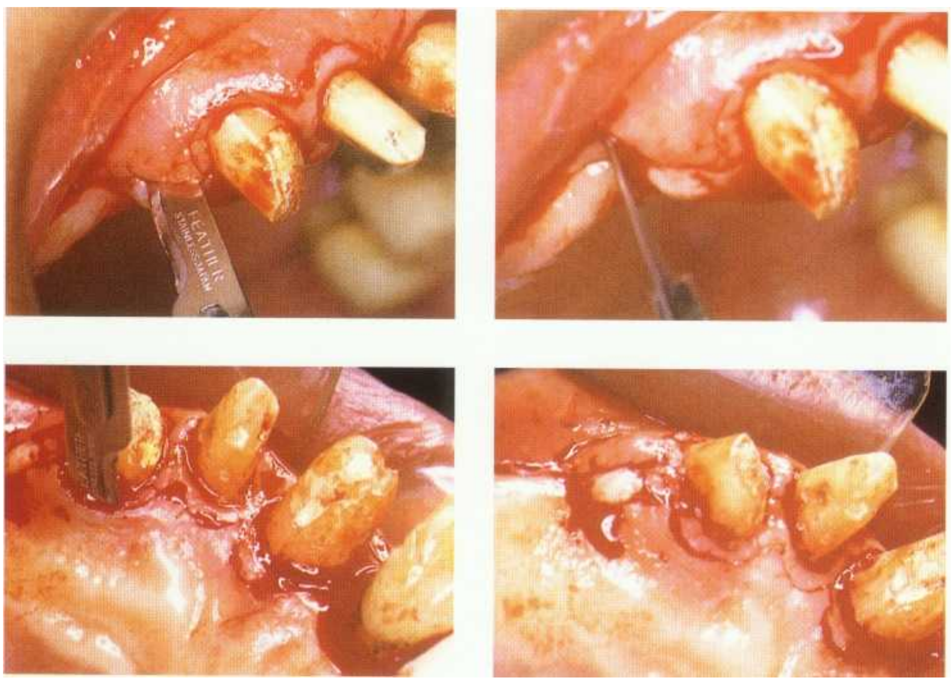
Use the anterior, straight part (2-3 mm) of the no. 15 blade to prevent indentation of the tissue. Hold the blade tip parallel to the gingival surface to make a thin and uniform flap. The thickness of the primary (or initial flap) flap is about 1.5 mm. If the flap is too thin, there will be insufficient connective tissue support. Consequently, because of insufficient blood supply necrosis of the flap will occur.



c1-3 Primary incision (interdental papilla). The interdental papilla is gently lifted with the side of the tip of the blade. The tip is held parallel to the gingiva and a thin portion of the papilla is dissected.

Key point

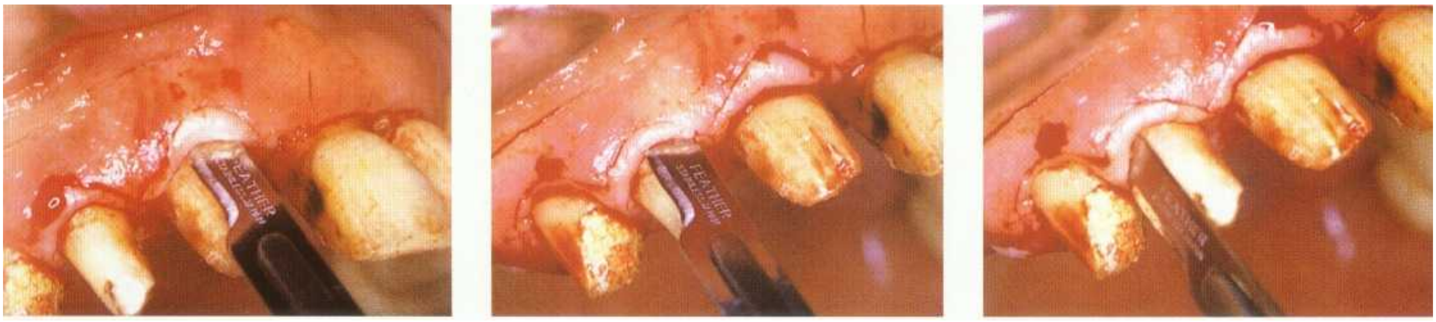
Directing the blade tip distally in the distal half of the interdental papilla and mesially in the mesial half enables the preparation of a primary flap with uniform thickness.



c1-4 Wedge procedure and incision on the palatal aspect.

a. For a wedge procedure incision on the distal aspect of 6, a square incision is made (two parallel horizontal incisions and a single vertical incision).

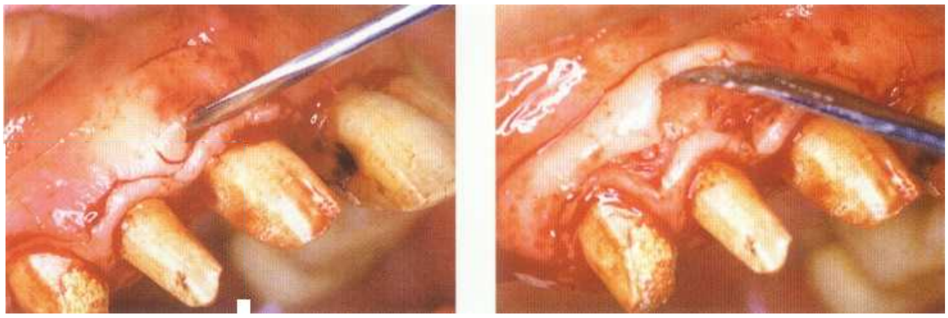
b. For an internal bevel incision, the thick gingiva is thinly sliced on the palatal and wedge area.



c1-5 Secondary incision. A secondary incision (sulcular incision) is made from the bottom of the periodontal pocket toward the alveolar crest with a no. 15 blade. The secondary flap is dissected.

Key point

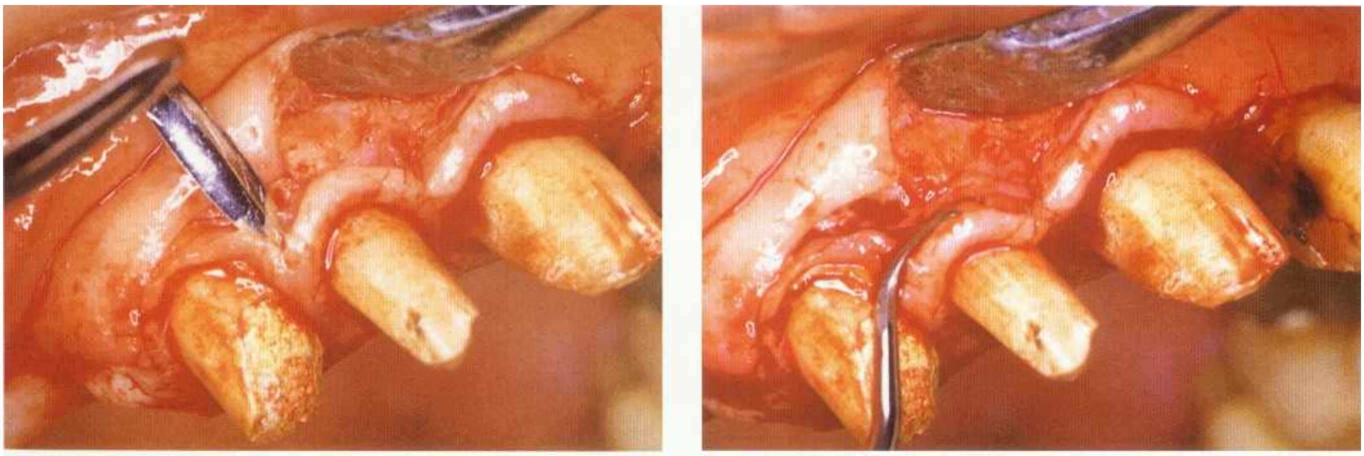
The objective of the secondary incision is to facilitate the removal of the secondary flap.
Avoid touching the root from the bottom of the pocket.



c1-6 Reflection of primary flap. At an obtuse angle, a full-thickness primary flap is reflected apically. Caution must be taken not to perforate it. The bone surface is exposed with a small periosteal elevator. The flap must be reflected to allow access to and visibility of the alveolar bone.

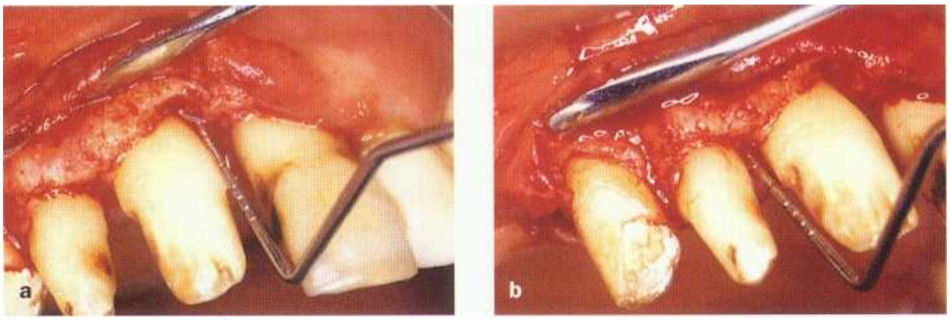
Key point

To prevent the bone from drying, leave the flap on the bone surface after reflecting.



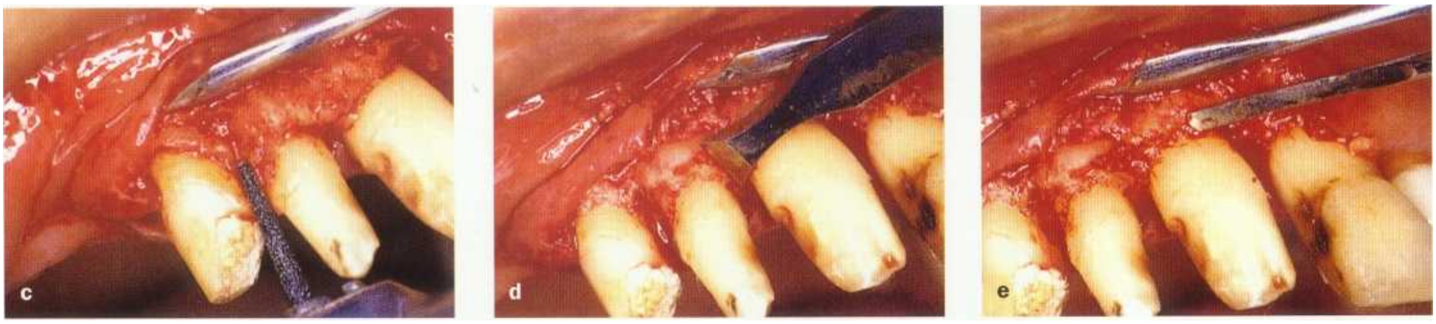
c1-7 Third incision. The flaps are reflected with a periosteal elevator. The third incision is made with an Orban interdental knife 1/2 along the alveolar crest and alveolar septum, from the buccal and palatal, to separate the secondary flap around the cervical area, from the bone crest and interdental bone. The third incision facilitates secondary flap removal as a single piece. Care must be taken to not damage the root surface with the knife during the third incision. The secondary flap is removed with a curette.

c1-8 Debridement. After the secondary flap and wedge tissue are removed, granulation tissue on the root and bone surface is thoroughly and carefully removed with a curette. Root planing is then performed.

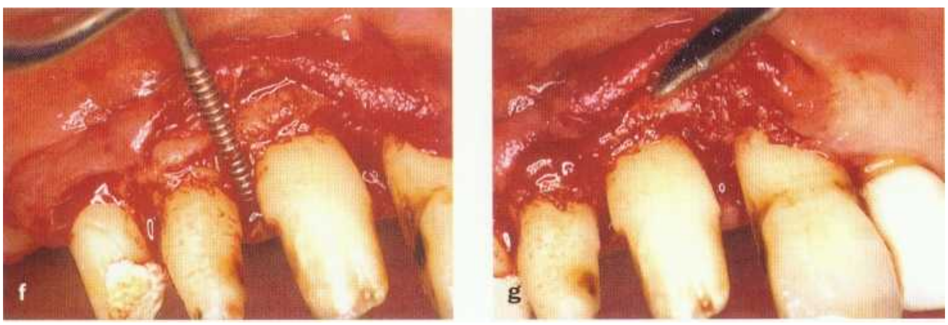


c1-9 Osseous resection.

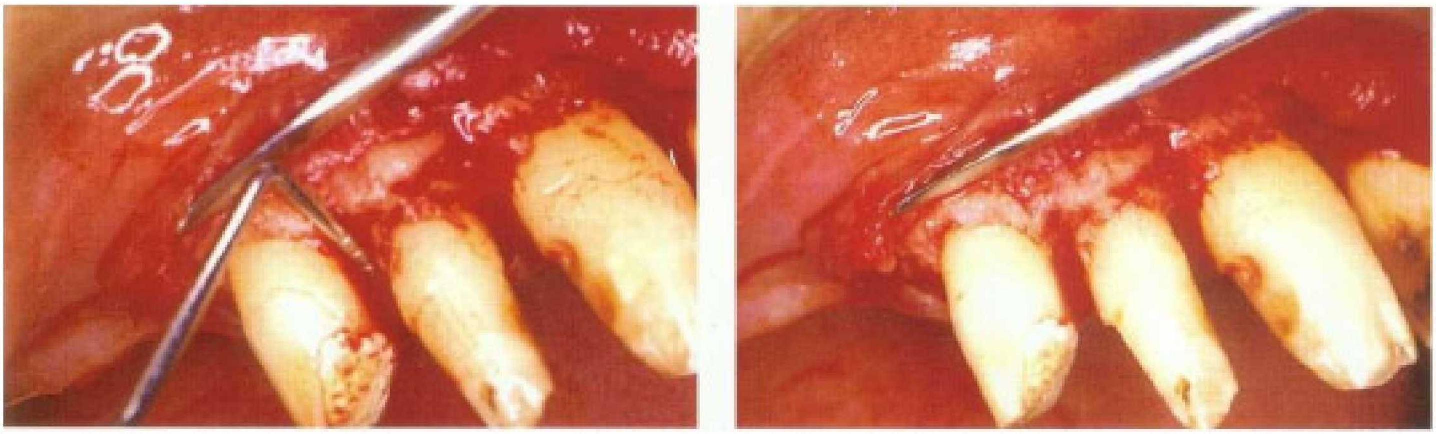
a, b. Teeth 6, 7, and 8 are suitable for osseous resection because of long, thick, roots and sufficient periodontal support. Note the craterlike osseous defect in the interdental areas. Also note the intrabony defect on the mesial aspect of 9 and the root proximity of 6 and 7.



The buccal and palatal walls of the iterdental crater removed with a turbine bur extending as far down to the osseous defect as possible (c). Osseous resection of the mesial (bone) wall of 8 and marginal bone of 6, 7, and 8 is performed. Osteoplasty is performed with an Ochsenbein chisel (d) and a Wedelstadt chisel (e) to create physiologic bone morphology (positive architecture).



The bone defect is flattened (or leveled) with a Sugarman file (f) to avoid a concave interdental area buccopalatally at the terminal stage. At the same time, a bevel incision is made on the buccal and palatal aspects of the alveolar crest for close adaptation of flaps (g).



c1-10 Enlargement of the interdental space. The interdental space is enlarged by morphologic correction from crown to root. The problem of root proximity of 6 and 7 is managed. Osseous resection is required to lengthen the crown due to subgingival caries on the mesial aspect of 6. It also enables preservation of approximately 5 mm of sound tooth structure on the alveolar crest. After osseous resection, the osseous defect is eliminated and the bone reshaped.

c1-11 Flap suture. A figure-eight suture is made on each tooth with 3.0 silk thread. Note how closely the flaps adapt to the root surface.

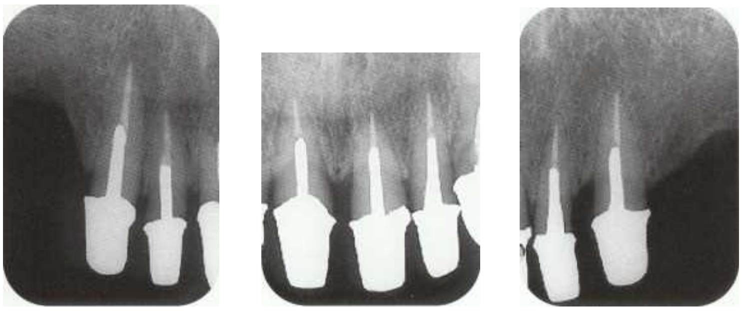
Key point

After suturing, make a ligature with pressure such that there is resistance on probing from the flap edge. If the surrounding tissue blanches, however, the suture is too tight, which may cause necrosis because of poor vascularization.

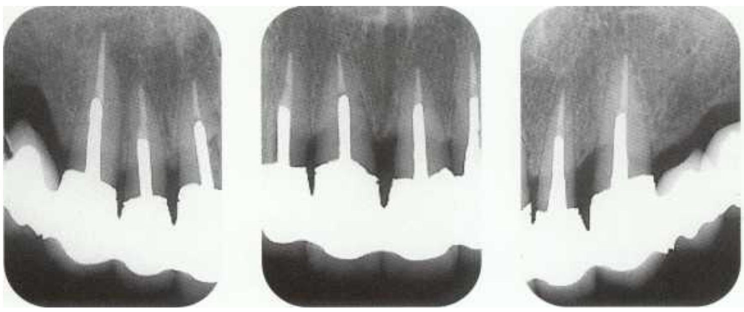
c1-12 Postoperative status. Six months after the elimination of the periodontal pocket on the right side, and 4 months after the elimination of the periodontal pocket on tooth 11.

Radiographic evaluation.

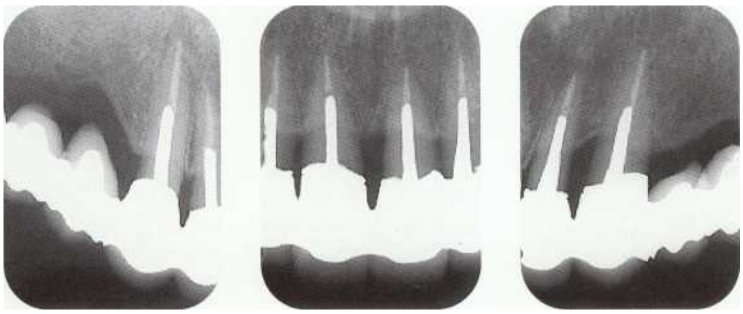
a. Initial examination.



b. At placement of copings. Seven-month postoperative radiograph on right and 5-month postoperative radiograph on the left.



c. Four years after initial examination.



d. Nine and one half years after initial examination, 9 years after periodontal surgery, and 8.5 years after the placement of final restorations.

Crown Lengthening in Periodontal Surgery

While much is written on regenerative procedures and esthetic enhancement, resective surgery is still the basic form of periodontal surgery. Regenerative procedures combined with resective procedures yield excellent clinical results.

Objectives and Methods of Clinical Crown Lengthening

Periodontal surgery to extend the clinical crown apically, namely by crown lengthening, is the most frequently used and valuable periodontal surgical procedure related to restorative treatment.11–14

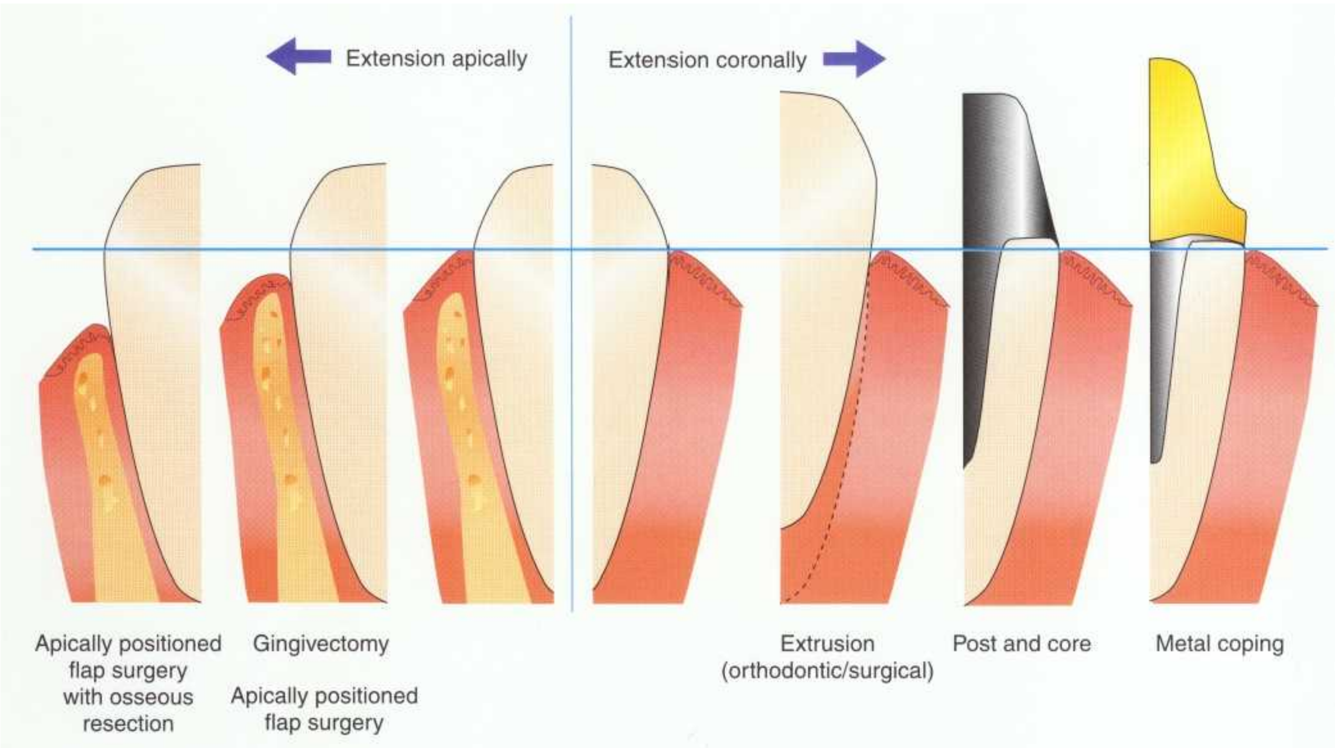
In the presence of periodontal disease, subgingival caries, or missing teeth, extending the crown length by means of periodontal tissue resection can improve maintenance, restorative prognosis, occlusal harmony, and esthetics.

Objectives of clinical crown lengthening include:

1. Removal of subgingival caries
2. Increase and preservation of maintenance of restorations
3. Cosmetic improvement
4. Enabling restorative treatment without impinging on biologic width
5. Correction of occlusal plane
6. Facilitation of improved oral hygiene

In crown lengthening, there are two methods, coronal extension and apical extension (Fig 1-10). Apical extension of the crown is achieved by surgery such as gingivectomy and apically positioned flap surgery with and without osseous resection.

Fig 1-10 Method of clinical crown lengthening.



Indications for the Crown Lengthening Procedure

The crown lengthening procedure, in which periodontal tissue is resected and the clinical crown lengthened apically, assumes intentional attachment loss. For this reason, possible risks and outcomes should be carefully considered. There are limitations to lengthening the clinical crown.

Diagnostic considerations include:

1. Importance of the tooth in the dental arch (whether it is key to occlusion or not)
2. Subgingival caries and the degree of extension of the clinical crown fracture apically
3. Whether the clinical crown/root ratio after restorative treatment may be unfavorable
4. Root length and root morphology
5. Residual amount of supporting bone after crown lengthening (especially osseous resection)
6. The degree of periodontal support lost from the adjacent tooth
7. The possibility of furcation exposure as well as unfavorable exposure of root surface (including grooves), which may complicate maintenance
8. Increasing tooth mobility due to diminished supporting tissue and its influence on occlusion
9. Possible esthetic and speech defects
10. Whether proper plaque control can be maintained after the placement of restorations

The crown lengthening procedure depends mainly on the band of attached gingiva and the thickness of the marginal alveolar bone.[13]

Other reasons for lengthening include subgingival caries and fractures beyond the gingival margin. However, if there is not more than 3 mm of sound tooth structure coronally from the alveolar crest, resection of the marginal bone is required to preserve sufficient sound tooth structure (Fig 1-11).

Fig 1-11 Width of attached gingiva, thickness of marginal bone, and indications for the crown lengthening procedure.

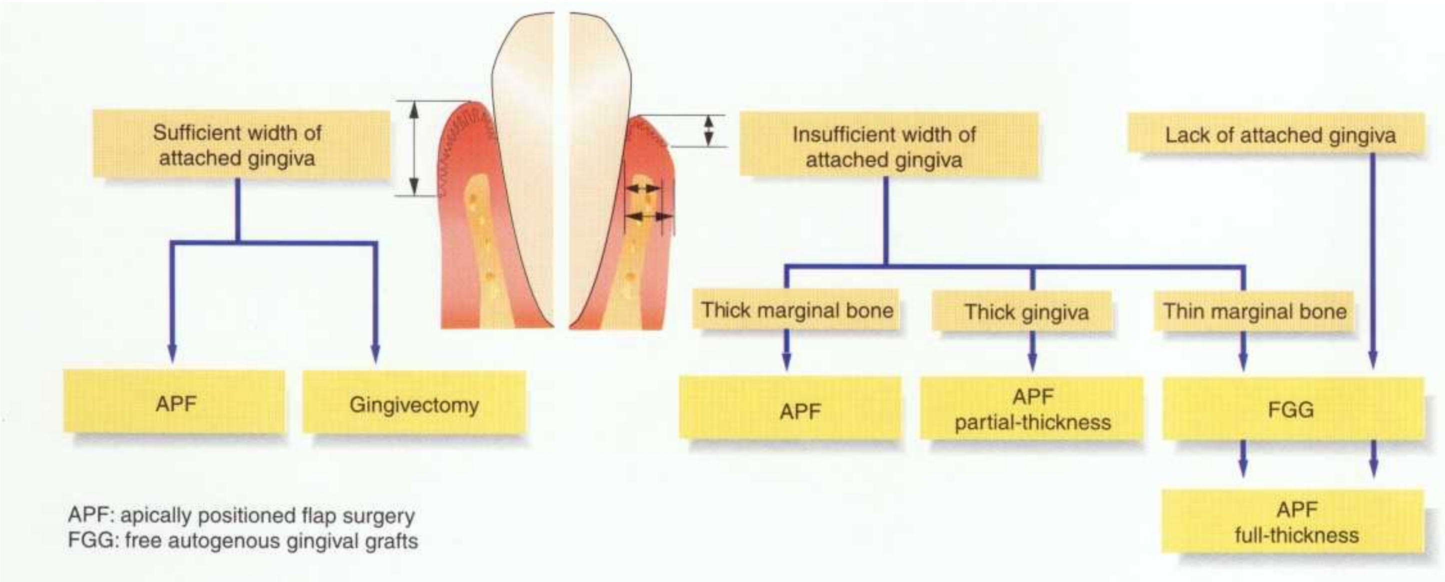
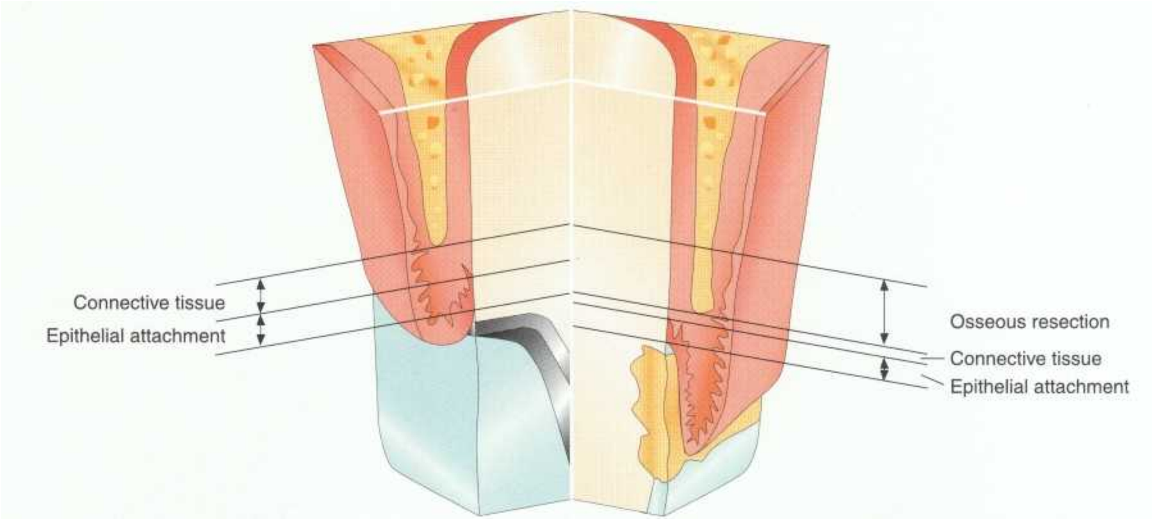


Fig 1-12 Consideration of biologic width in crown lengthening procedures.



If there is a sufficient band of attached gingiva and thick gingival tissue on the marginal bone, the soft tissue is removed. No excess epithelial attachment should remain postoperatively. However, if the band of attached gingiva is in sufficient, there may be gingiva-alveolar mucosa problems postoperatively. The apically positioned flap is used to avoid this problem.

Partial-thickness flap can be used only if there is sufficient gingiva and bone thickness.

To maintain healthy periodontal tissue, the attached gingiva and biologic width must be considered. Biologic width is measured from the bottom of the gingival sulcus to the alveolar crest and is maintained by homeostasis.", 15 This width consists of the epithelial attachment which is against the tooth surface and its connective tissues. The average width is 2.04 mm (the average epithelial attachment is 0.71-1.35 mm and the average connective tissue is 1.06-1.08 mm) (Fig 1-12).

Sound tooth structure in addition to this width on the alveolar crest is necessary. Impinging biologic width may cause periodontal tissue destruction. Therefore, in crown lengthening, the position of the margin is important.

1. If the margin of the restoration is placed within the gingival sulcus, at least 3 mm of the sound tooth structure coronal from the alveolar crest along the tooth circumference (1-2-mm sound tooth- structure for biologic width plus restorative treatment) should be preserved.
2. If the margin of the restoration is at the gingival margin, it is important to preserve 4 mm of sound tooth structure on the alveolar crest along the tooth circumference. The alveolar bone may be removed if necessary because it is important to maintain the relation with the alveolar crest.

Additionally, the margin of the provisional restoration should not hinder healing before the biologic width is established by surgical procedures. Therefore, a restorative treatment should be initiated after 4-6 months.

Preoperative Treatment and Pre-evaluation in the Crown Lengthening Procedure

Preoperative requirements in the crown lengthening procedure are:

1. *Provisional restoration*

Evaluate caries and the amount of residual tooth structure, remove restorations to assess surgical possibilities, and make provisional restorations.

2. *Determination of occlusal plane*

Where active occlusal treatment is required and where occlusal reduction is required because of remarkable extrusion posteriorly, occlusal diagnosis should be done before surgery and a desired occlusal plane determined (the author uses Abe's Shilla system)' (Case 1-2). Provisional restorations and a treatment denture may then be fabricated. This approach enables practitioners to determine how much additional clinical crown length is necessary (Fig 1-14).

3. *Esthetic evaluation*

For crown lengthening in the maxillary anterior region, it is important to consider the relation of the upper lip line to the exposed teeth and gingiva, the relation between the smile line and the position of the incisal edges of the upper anterior teeth, and the relation of the teeth and exposed gingiva from an esthetic view. It is useful to examine the symmetry of the right and left aspects based on median sagittal plane analysis with the Shilla system.

4. *Evaluation of gingival morphology*

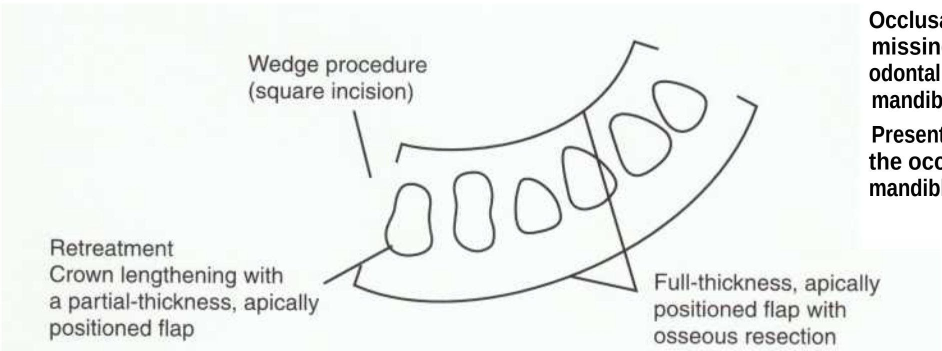
In crown lengthening by osseous resection, the existing gingival morphology (scalloped or flat) must be considered because gingiva tends to return to its original shape.

Case 1-2 Occlusal reconstruction by surgical crown lengthening

Described is a 56-year-old woman whose chief complaint is a problem with chewing.

Occlusal function is compromised because of multiple missing teeth, root caries of residual teeth, and periodontal disease. For occlusal reconstruction, all residual mandibular teeth require crown lengthening.

Presented is a series of treatments: the determination of the occlusal plane to occlusal reconstruction of the mandible by crown lengthening.

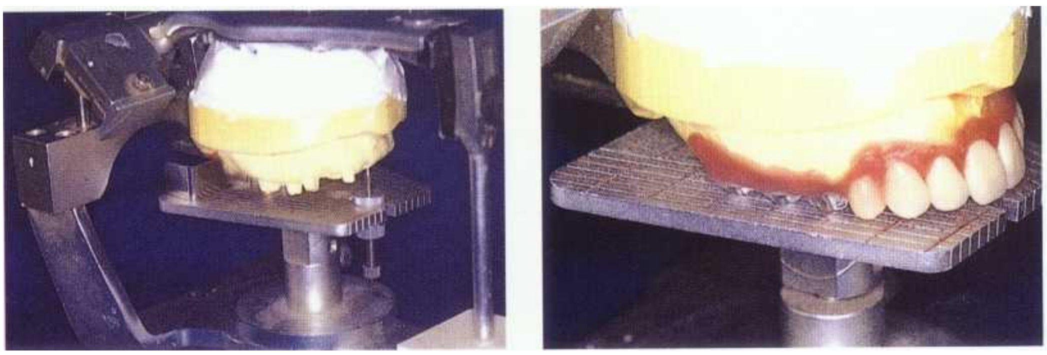


Initial examination

c2-1 Initial examination. Note the thick gingival tissue, gingival redness, swelling, remarkable plaque and calculus deposition, caries under the restorations, and extensive root surface caries. There is bleeding and drainage on probing, the probing depth is 4-6 mm, and there is widespread loss of interdental alveolar bone and numerous apical lesions. There is also prominent extrusion of residual teeth and occlusion disorders including an unfavorable occlusal relationship and a decrease of the vertical dimension. Consequently, occlusal function is severely compromised.

Initial therapy

c2-2 Determination of the occlusal plane. In cases where there are multiple missing teeth, it is important to control inflammatory factors and ensure masticatory function during treatment. It is also impor-tant to control occlusal trauma. An occlusal plane is determined using Abe's occlusal diagnosis and Shilla II devices. Following that, a treatment denture and provisional restorations are fabricated.

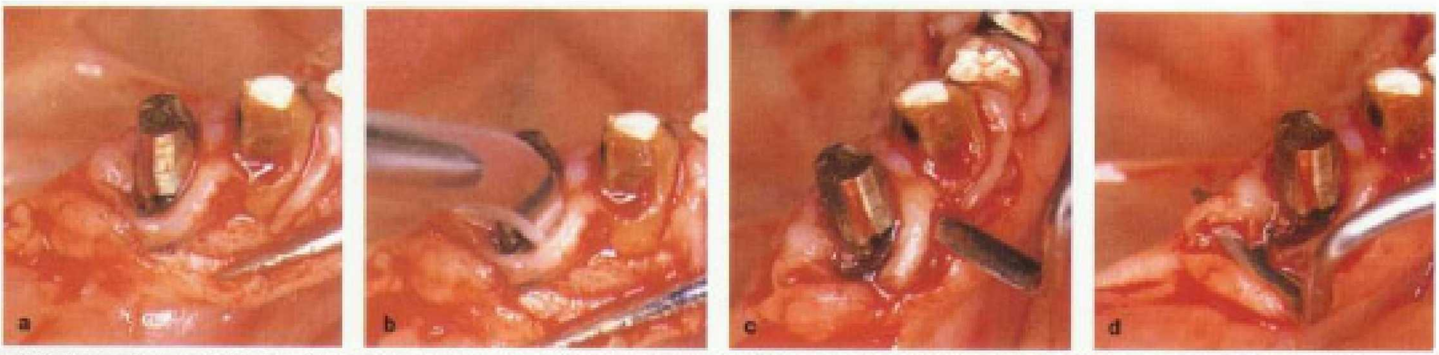


c2-3 **Treatment denture.** Four months after initial examination. An S-A blade is used in the maxillary molars, and a flat table is used in the mandibular molars.

Crown lengthening for teeth 23 to 28

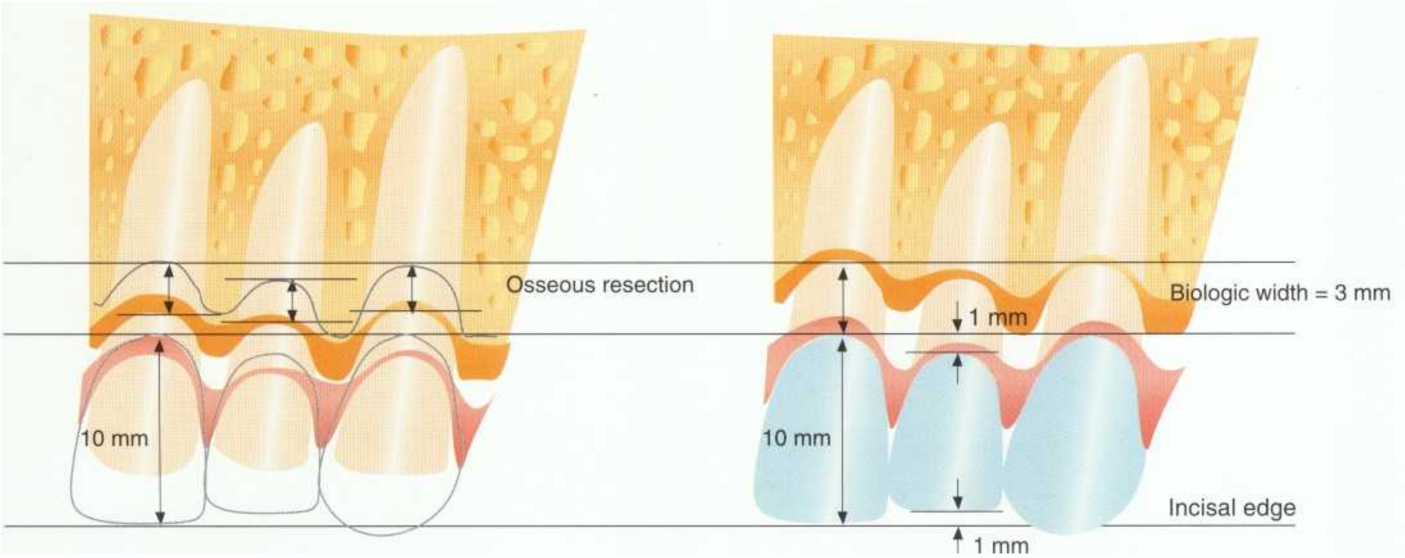
c2-4 **Preoperative status.** Note the residual roots of 25 and 26 and the subgingival caries of 27 and 28. Periodontal pockets and a gingival crater are also recorded.

c2-5 **Primary incision.** A primary incision is made against the alveolar crest. It is displaced from the gingival margin apically to gain sufficient clinical crown supragingivally. A primary flap 1.5-mm thick is prepared using the tip of a no. 15 blade along the gingival surface. The wedge procedure on the distal aspect of 28 is a square incision.



c2-6 **Secondary and third incisions.** After primary flap reflection (a), a no. 12 blade is used to make the secondary incision from the gingival sulcus to the alveolar crest (b). A third incision is made with an Orban interdental knife. The incision follows the morphology of the alveolar crest (c). Wedge tissue is separated from bone, and the remaining collar of tissue and wedge tissue are removed as one mass (d).

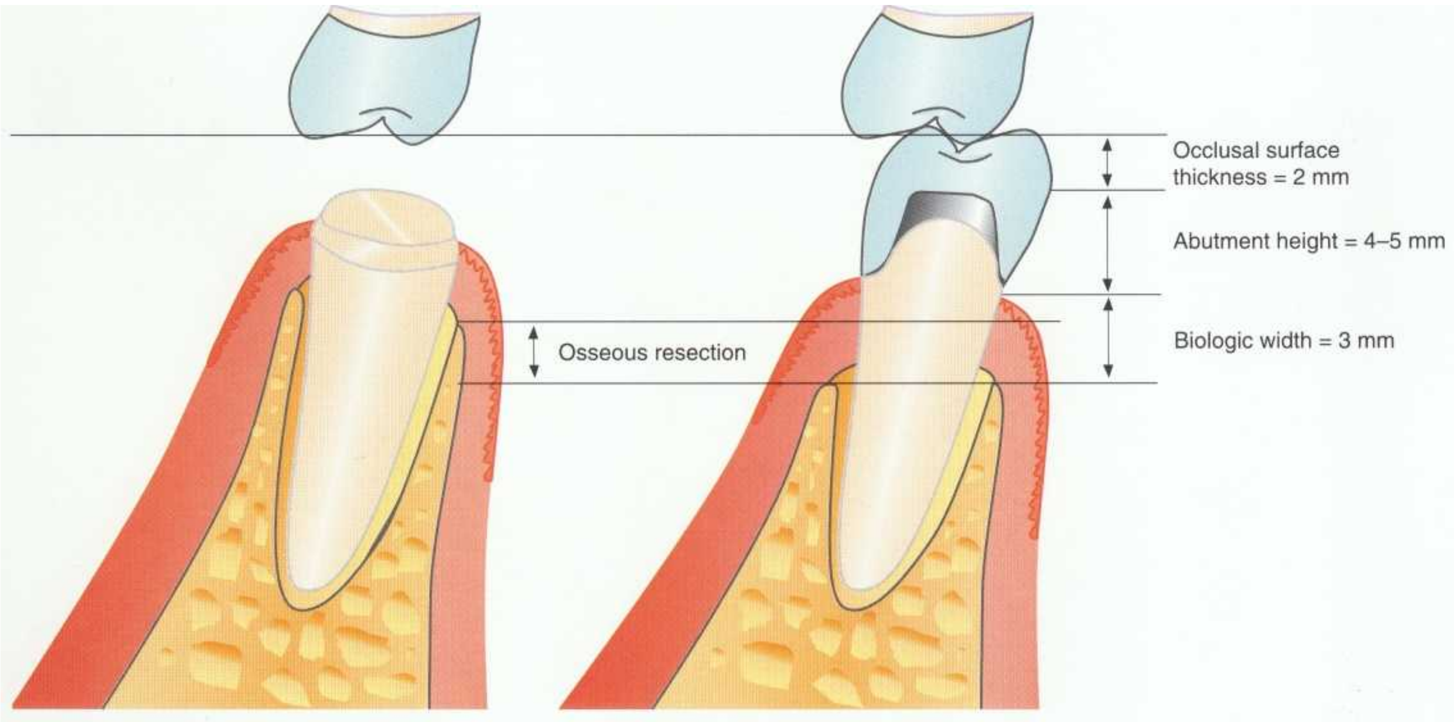
Fig 1-13 Surgical crown lengthening in the maxillary anterior region.



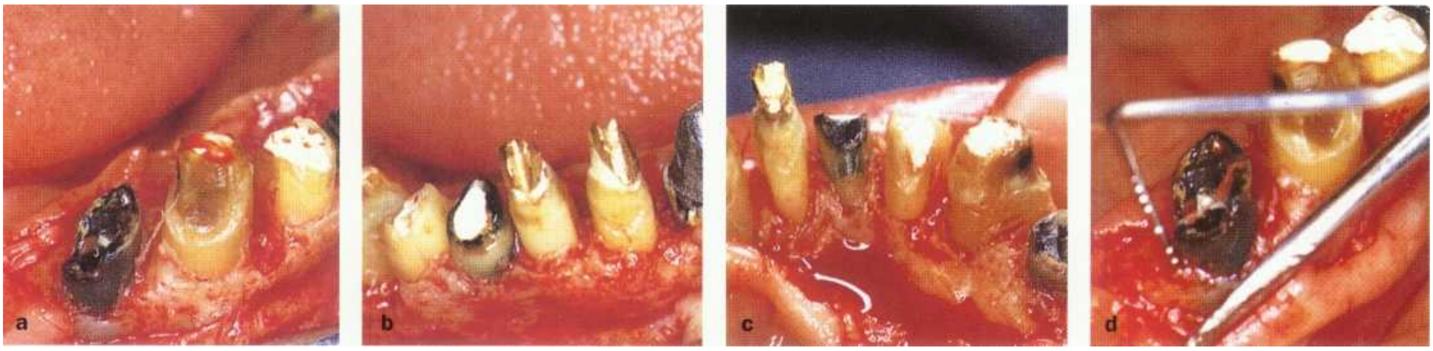
Key points

1. First determine the incisal edge.
2. The incisal edge is determined by the relation of the upper lip line and the exposure of teeth and gingiva, the relation between the smile line and the position of the incisal edges of the anterior teeth, and the curve of the incisal line. The author uses the Shilla svstem and seeks symmetry of the right and left by analysis of the median sagittal plane.
3. Osseous resection should be performed such that the postoperative gingival line will be parallel to the incisal edge line of the anterior teeth and the interpupillary line for esthetic reasons.
4. For osseous resection, there should be a 13-mm distance **from the incisal edge to the alveolar crest to preserve average crown** length in the maxillary anterior teeth (10 mm + 3 mm for biologic width).
5. The right and left anterior teeth should be symmetric. The area of osseous resection should be concave slightly distal from the middle of the root.

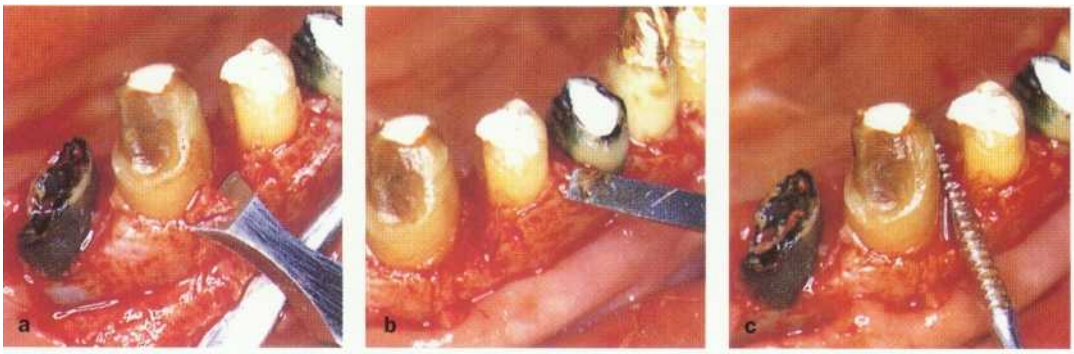
Fig 1-14 Determination of the primary incision position in surgical crown lengthening. The position of the primary incision is determined by: required abutment length + the thickness of the restoration at the incisal edge or occlusal surface + biologic width from predetermined occlusal plane. Preserve at least 9 mm from the occlusal plane to the alveolar crest.



Osseous resection



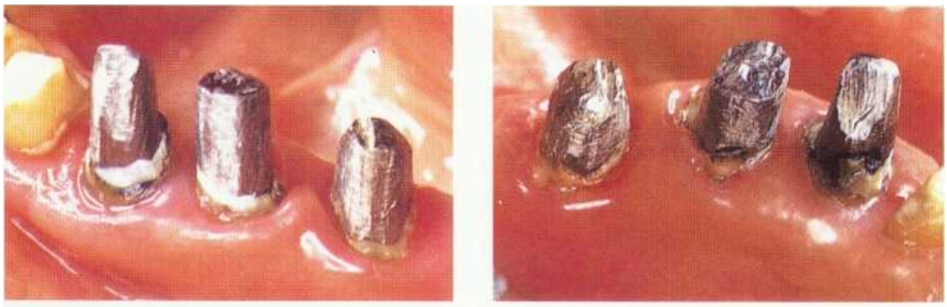
c2-7 Before osseous resection. Note the osseous defect-like interdental crater with an irregular margin after flap dissection (a) and the reverse abnormality of alveolar bone morphology on the mesial aspect of 27(b). The distance between the mesial subgingival caries of 27, 28, and the alveolar bone crest is verv small (c and d).



c2-8 Osseous resection. An Ochsenbein chisel (a), Wedelstadt chisel (b), and Sugarman file (c) are used to correct the alveolar bone morphology. The provisional restorations are used as a guide. In osseous resection, care should be taken to preserve the necessary clinical crown and proper gingival anatomic morphology.

c2-9 After osseous resection. More than 5 mm of tooth along the tooth circumference from the alveolar bone crest is exposed (a: compare with c2-7). Note the reverse bone morphology because of osseous resection with minimal sacrifice of supporting bone due to the thin roots of 23, 24, 25, 26 and insufficient periodontal support.

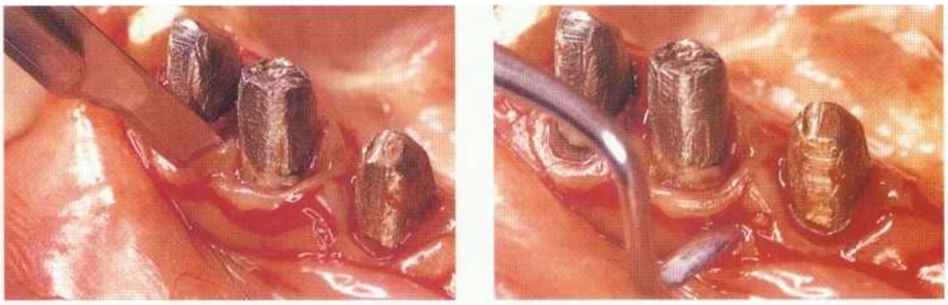
Surgical crown lengthening for teeth 20 to 22



c2-10 Preoperative status. Seven months after initial examination.

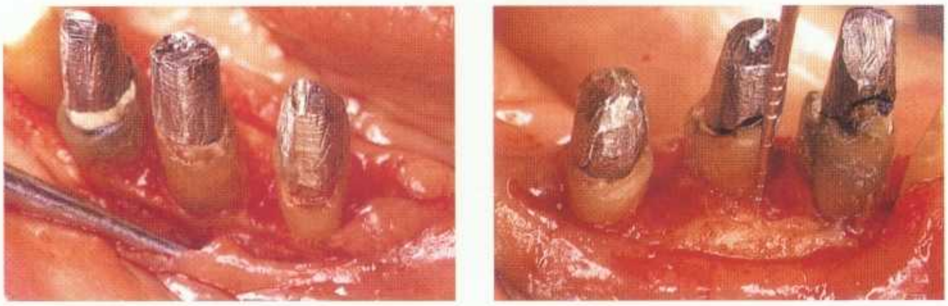
c2-11 Primary incision. A scalloped primary incision (internal bevel incision) apical to the gingival margin is made.

c2-12 **Removal of remaining collar of tissue.** The secondary and third incisions are made to remove remaining collar of tissue.

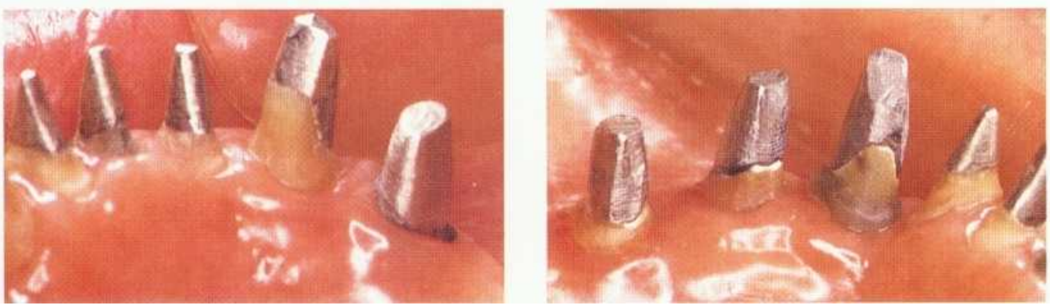


c2-13 **Before osseous resection.** Note the interdental bone craterlike defect.

c2-14 After osseous resection. The osseous defect is eliminated.



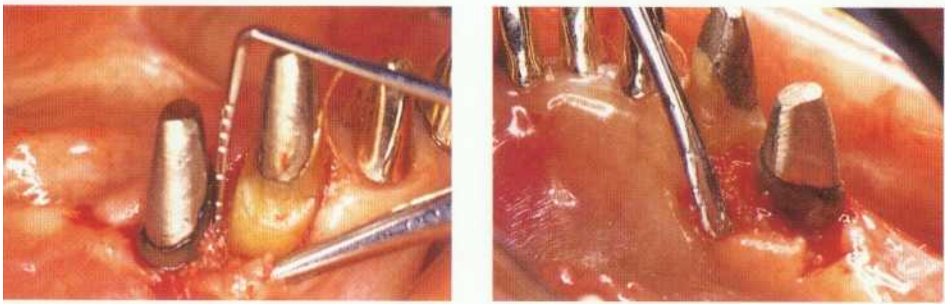
c2-15 Suturing.



c2-16 Postoperative status. Five months after surgery, 23-28, and 2 months after surgery, 20-22.

Surgical crown lengthening with a partial-thickness, apically positioned flap

c2-17 Before retreatment with surgery. Six months after surgery. The margin of the abutment is displaced apically because discolored tooth structure was removed after the surgical crown lengthening procedure on 28. The width of sound tooth structure is, therefore, insufficient.

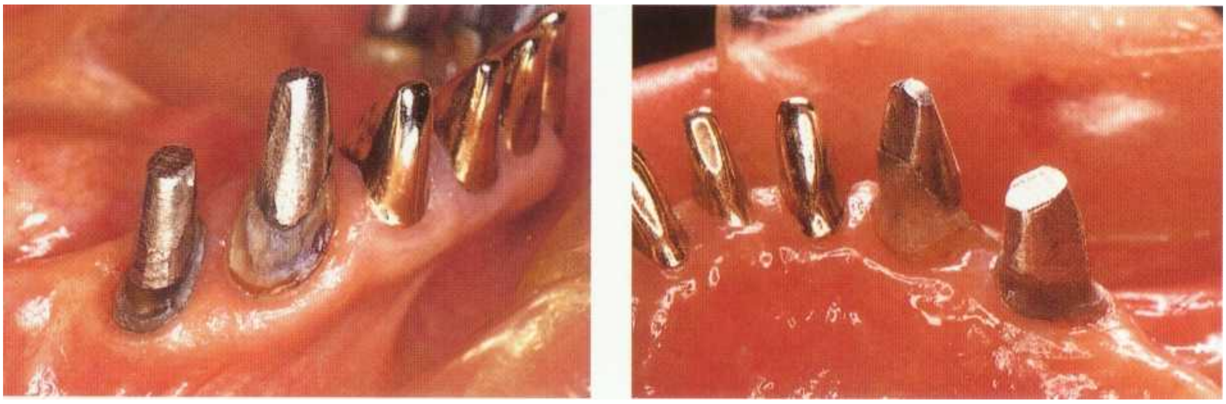


c2-18 Before osseous resection. Flap reflection reveals a distance of only 3 mm from the margin of abutment to the alveolar crest on the mesial aspect. There is insufficient biologic width because of the scalloped, thick gingiva.

c2-19 Suturing.

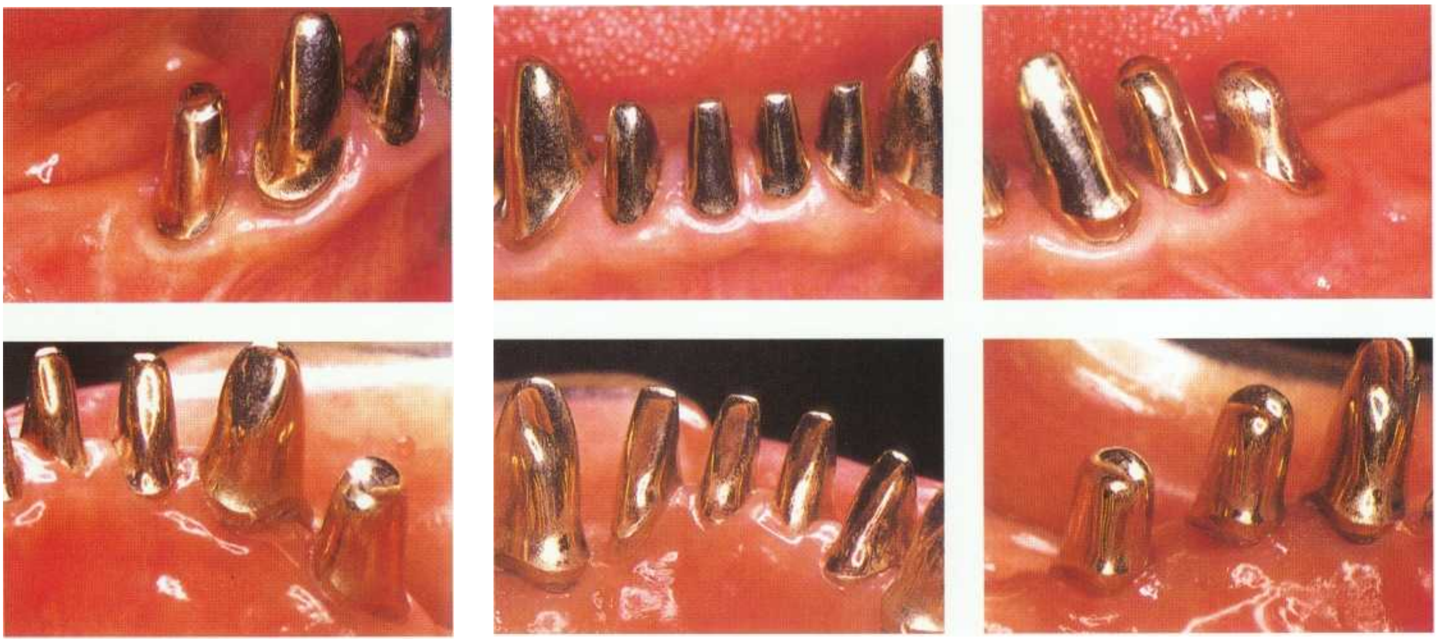
a. Osseous resection is performed, the buccal flap displaced apically, and the periosteal suture secured.

b. Sufficient crown length is gained.



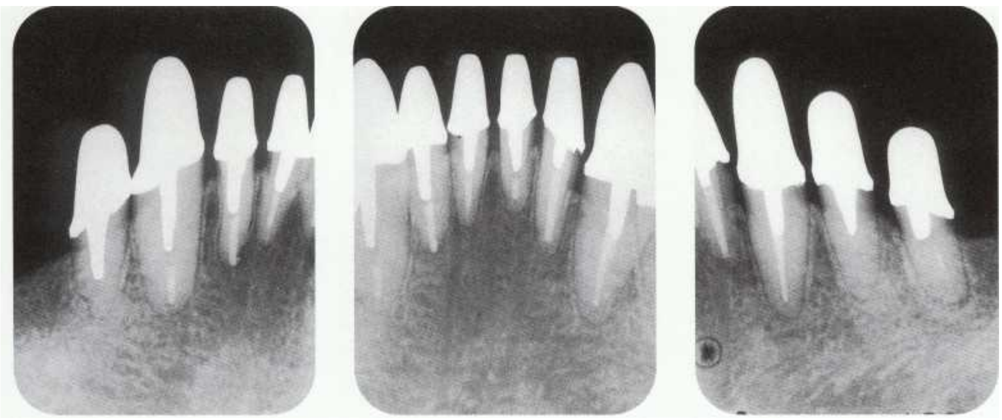
c2-20 Three months after performing surgical crown lengthening again on 28.

Placement of crown-sleeve coping



c2-21 Eleven months after surgical crown lengthening.

Prognosis



c2-22 Five years and 5 months after initial examination, and 3 years and 11 months after the placement of final restorations. Maintenance has been performed at 3-month intervals. While there is bleeding on probing in some areas, the depth of the gingival sulcus is within 3 mm and no enlargement of the periodontal membrane space is evident radiographically. The alveolar bone crest level was maintained, and the lengthened crowns function well as abutments of the partial denture with no advanced mobility.

Palatal Flap Surgery

Anatomic Characteristics of Palatal Tissue

Because of the anatomic characteristics of the palate, palatal flaps require different designs.

It is desirable to remove deep palatal periodontal pockets entirely and establish a shallow physiologic gingival sulcus for the following reasons:

1. Palatal tissue is masticatory mucosa and immobile; it has no elastic fibers and loose connective tissues. Therefore, it is impossible to displace a palatal flap apically.
2. Palatal tissue is thick, keratinized tissue; therefore, accurate close adaptation to the tooth surface and bone margin is difficult, and postoperative gingival morphology may be unfavorable. A gingival crater, a thick shelf-shape that makes toothbrushing difficult, may be created. Such periodontal pockets tend to recur postoperatively.
3. Reduction of the periodontal pocket in a thick gingival wall in the palatal aspect is uncommon because of the minimal gingival shrinkage achieved by initial therapy such as brushing or scaling.
4. Inaccessibility of cleaning instruments may cause inadequate self-care.

If the gingiva is thick in the palatal flap, a partial-thickness internal bevel incision is made, the flaps prepared with thin and uniform thickness, and the flap adapted closely to the tooth surface and alveolar bone. It is necessary to achieve a form that is easy to clean postoperatively.

1. Eliminate the deep periodontal pocket to establish a shallow gingival sulcus. → Prepare a palatal flap at the level of the alveolar bone margin or slightly coronally.
2. Create an easily cleanable gingival form. → Prepare a partial thickness flap of uniform thickness with close adaptation to the tooth surface and alveolar bone.
3. Match the form of the palatal flap with the morphology of the alveolar bone margin. → Accurate flap design with primary incision.

Partial-thickness palatal flap surgery

Partial-Thickness Palatal Flap Surgery

Partial-thickness palatal flap surgery was developed by Staffileno" and improved by Corn et al .z' It is used for the elimination of periodontal pockets where thick palatal tissues occur. This procedure is valuable because it can be used in areas of thick gingival tissues. Advantages include:

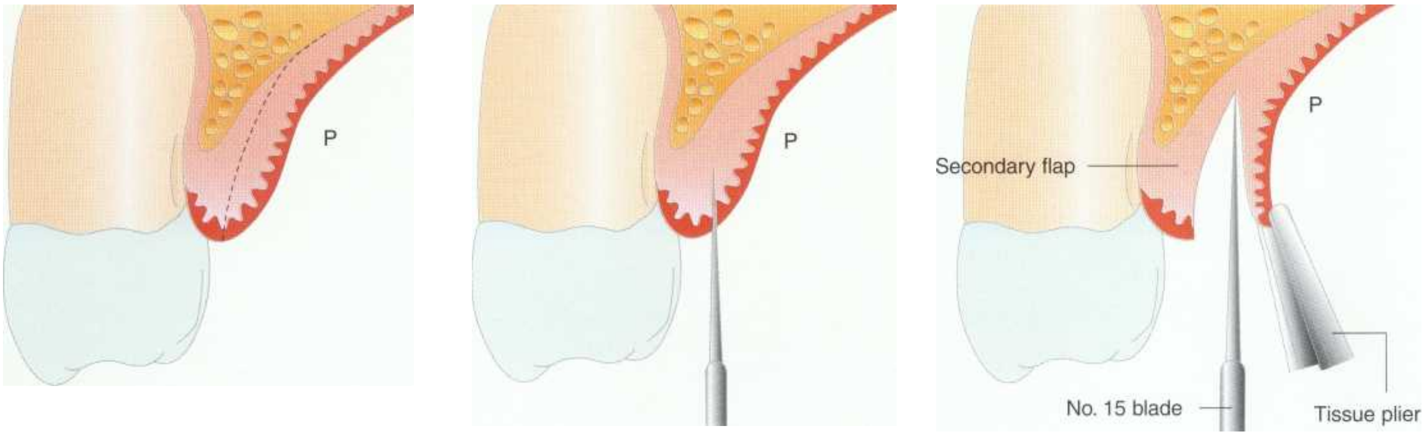
1. Flap thickness may be adjusted.
2. Palatal flap may be adapted to the proper position.
3. Better postoperative gingival morphology is possible with a thin flap design.
4. Treatments may be combined (osseous resection and wedge procedure).
5. Rapid healing.
6. Easy management of palatal tissue.
7. Minimal damage to palatal tissue.

Considerations for determining the position of the primary incision in palatal flap surgery are:

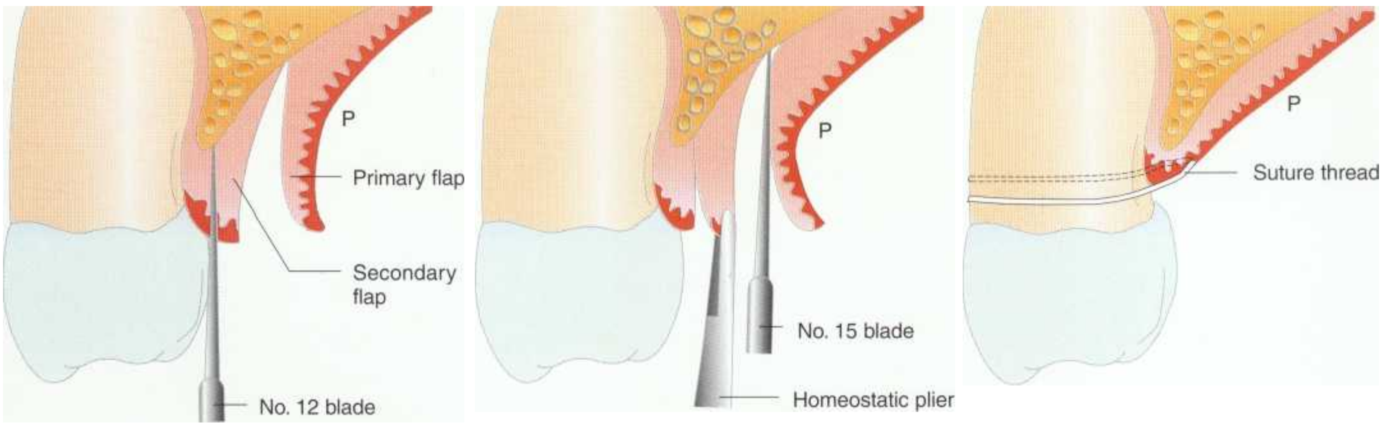
1. Thickness of palatal tissue
2. Depth of periodontal pocket
3. Degree of osseous defect
4. Necessity of osteoplasty and required clinical crown length
5. Surgical methods (or techniques) applied

In general, the thicker the palatal tissue and the further apically it is from the tooth where the primary incision is to be, the better the postoperative gingival morphology.

Fig 1-15 Partial-thickness palatal flap surgery.



a. Outline of primary incision.
b. Primary incision.
c. Thin primary flap preparation.



d. Secondary incision.
e. Secondary flap removal.
f. Suture.

a. Outline of primary incision. The position of the primary incision is determined with consideration for the: 1) thickness of palatal soft tissue; 2) depth of periodontal pocket; 3) necessity for osteoplasty; and 4) clinical crown length required for restorative treatment. The primary incision is a partial-thickness incision to prepare a thin primary flap.

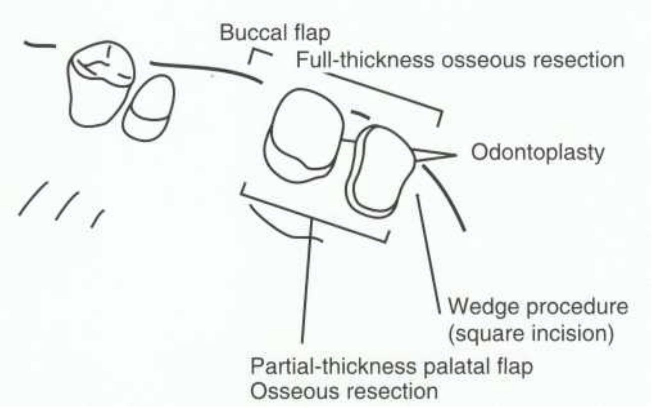
b, c. Advance the blade toward the center of the palate while holding the primary flap margin and holding the blade parallel to the palatal soft tissue to prepare a thin and uniform primary flap (1.5-2.0-mm thickness). Caution must be taken to avoid perforating the flap or making the flap too thin, which will cut off the necessary blood supply.

d. Dissect the secondary flap from the root surface. Move the secondary incision from the bottom of the periodontal pocket toward the alveolar bone to facilitate flap removal as one piece. A no. 12 B blade or Ochsenbein no. 2 chisel is recommended.

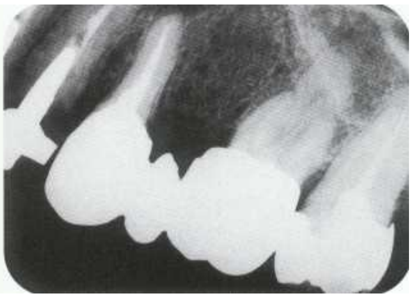
e. Use homeostatic forceps to separate the secondary flap from the tooth. With a no. 15 blade (or a Kirkland 15/16 knife), extend the primary incision toward the bone and separate the secondary flap completely from the primary flap. Remove the flap as one mass. It is easier to manipulate the curette if the flap is removed with a single stroke. It also saves time.

f. Perform osteoplasty only when necessary and then adapt a thinly prepared primary flap close to the bone margin and tooth. If the flap is too long or too thick, adjust the shape. However, adjusting an already dissected flap is very difficult. Suture the flap's edge at the level of the bone margin or slightly cover the alveolar crest (approximately 1-2 mm above the bone margin).

Case 1-3 Palatal flap surgery with osseous resection







c3-1 Initial examination. Thirty-one-year-old woman. Probing depth is 7-9 mm. There is bleeding and drainage on probing, class I-II furcation involvement, secondary caries, subgingival caries, and root proximity of 14 and 15. Total correction of the occlusal plane is necessary.


c3-2 Status after initial therapy. Note the gingival crater between 14 and 15. The thick, shelf-like palatal tissue is related to the deep periodontal pocket.

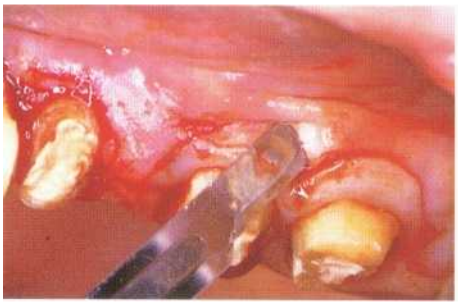
Primary incision

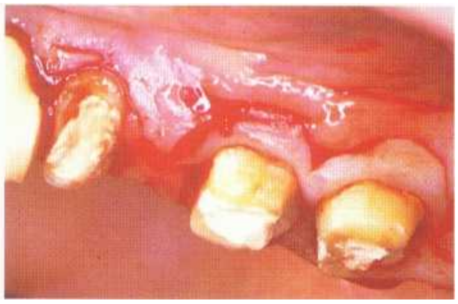
The position of a primary incision is determined by: 1) the thickness of the palatal soft tissue; 2) periodontal pocket depth; 3) necessity of osteoplasty; and 4) required clinical crown length for restorative treatment.

c3-3 Primary flap design. A primary incision is made to prepare the thin, partial-thickness primary flap. The partial-thickness incision is prepared apically with the no. 15 blade held parallel to the palatal soft tissue, with care taken not to penetrate the flap. To preserve the blood supply for the primary flap, a uniform thickness of 1.5-2 mm is sought.

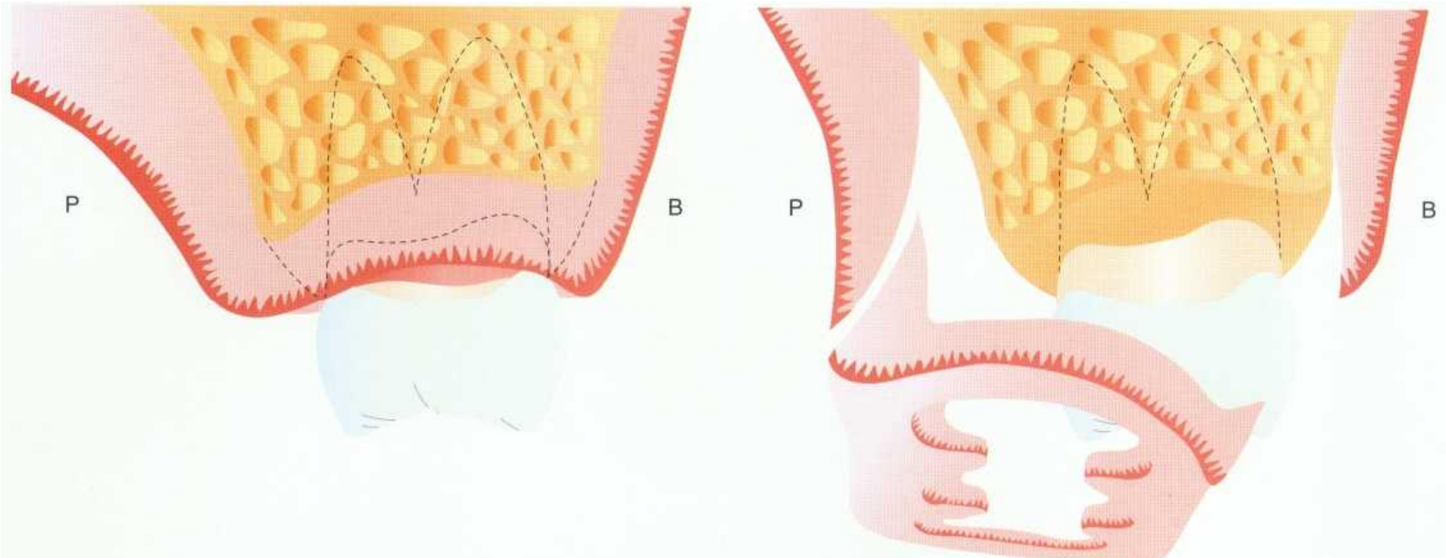

c3-4 Incision of wedge procedure. Because of the soft, thick tissue on the edentulous space distal of 12 and 15, the wedge tissue is removed with a square incision.

c3-5 Preparation of full-thickness flap. On the buccal aspect, a scalloped internal bevel incision is made apical to the gingival margin and a full-thickness flap prepared.

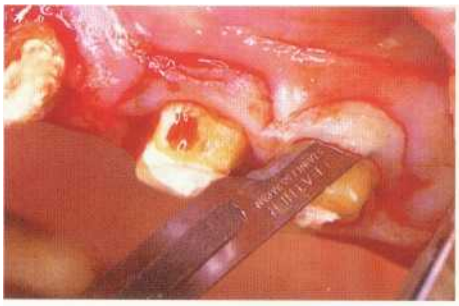


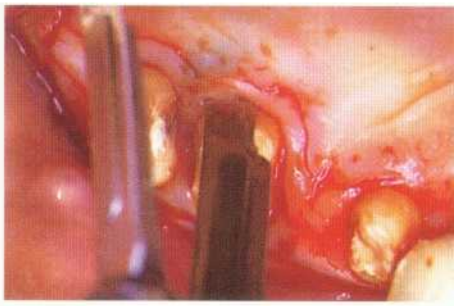


Secondary flap design

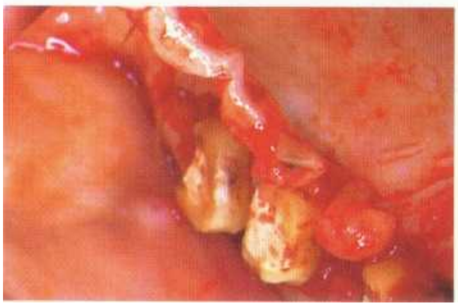


c3-6 Separation of secondary flap. With a no. 15 **blade, the secondary incision (sulcular incision) is made around the cervical area** from the bottom of the pocket toward the alveolar crest. The secondary flap is then moved away from the teeth so that it can be removed as one mass.

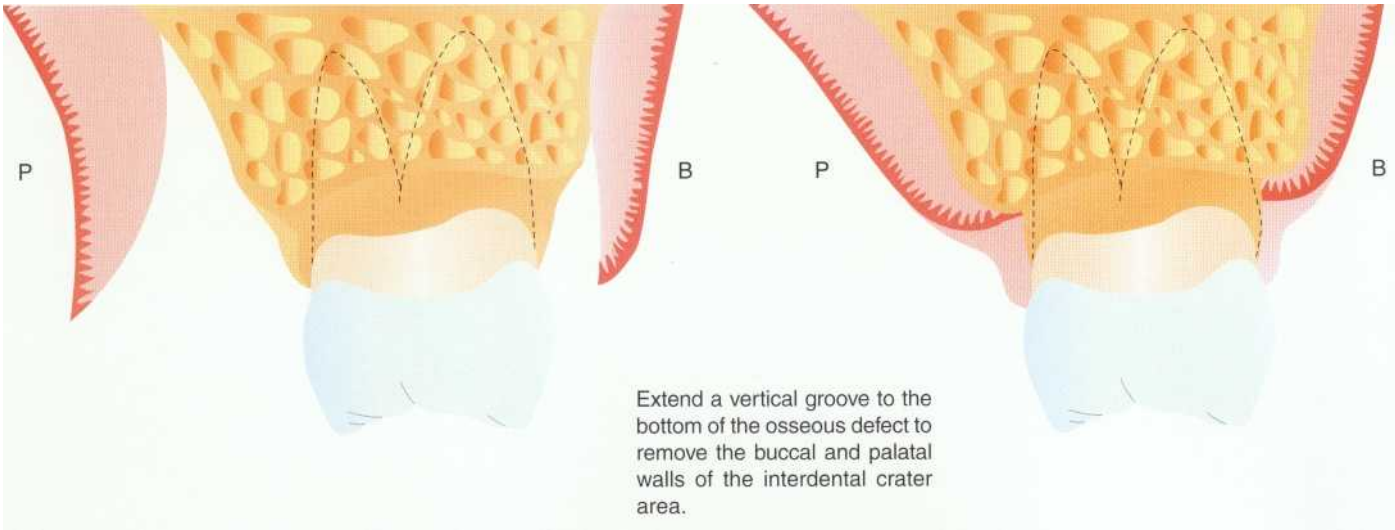


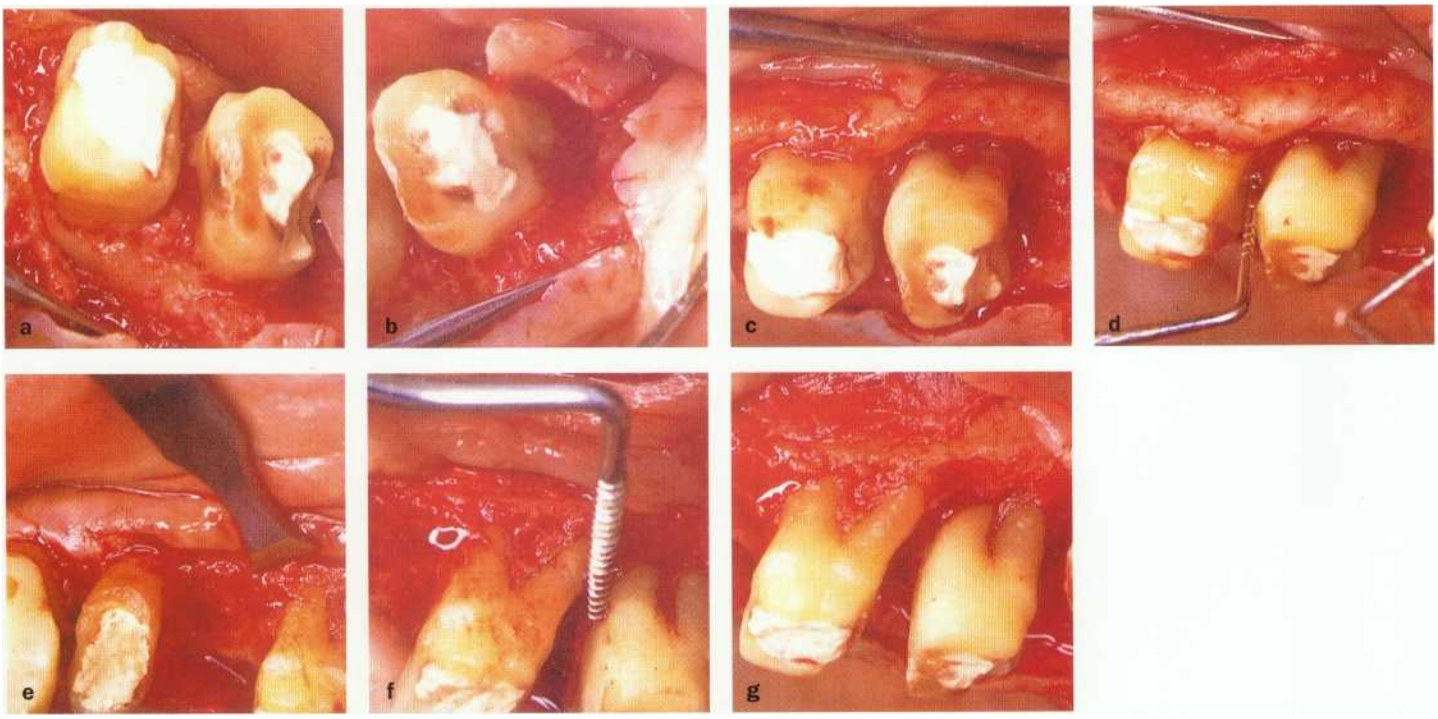


c3-7 Removal of remaining collar of tissue. The **primary incision is extended to the bone, the primary and secondary flap separated completely, and the wedge tissue and secondary flap removed as a mass** while the secondary flap is held with hemostatic forceps. This technique makes curette manipulation easier and reduces surgical time.

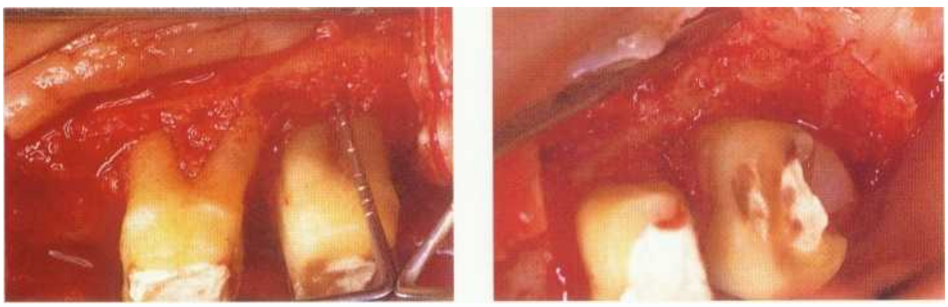


Osseous resection

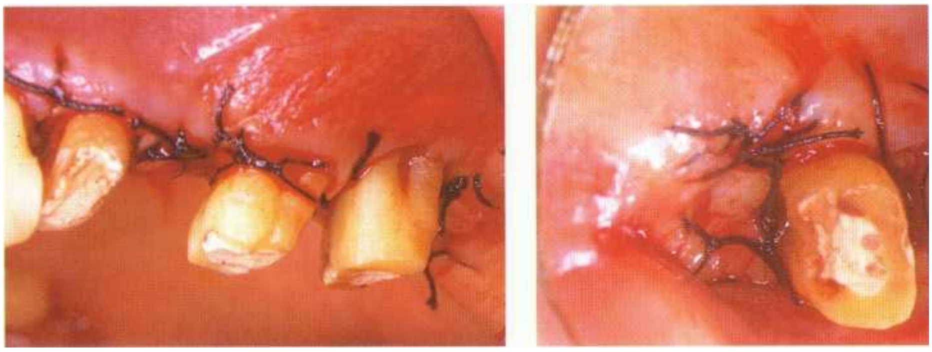




c3-8 Osseous resection. Flap reflection reveals a craterlike bone defect in the interdental area between 14 and 15 (a), Class II furcation involvement on the distal aspect of 15 (b), and the intrabony defect surrounding the thick walls of the alveolar bone, extending from the buccal to the distal area around 15 (c). The depth of the osseous defect is 2-4 mm (d). The osseous defect is removed, the bone morphology corrected, and osteoplasty and osseous resection performed with an Ochsenbein chisel (e) and Sugarman file (f) to extend the clinical crown length. The distance between the roots of 14 and 15 is increased by odontoplasty (g).

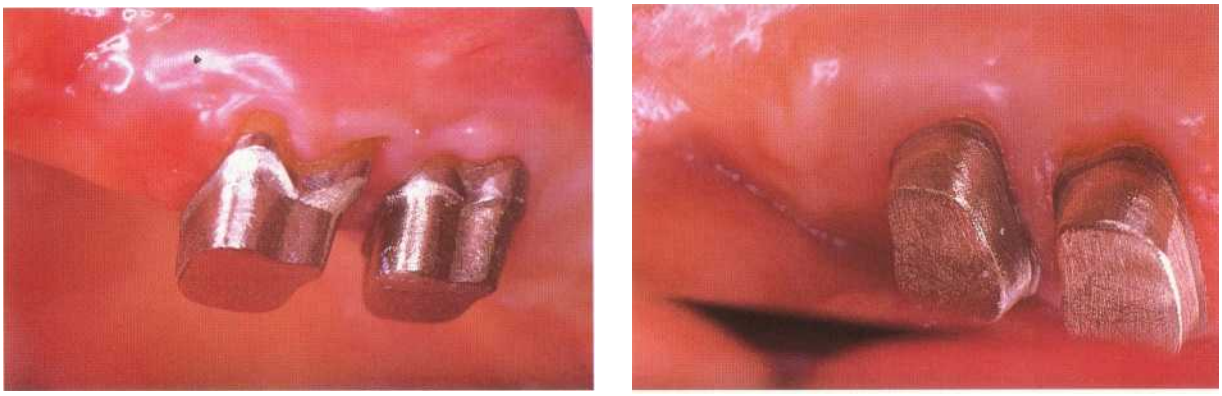


c3-9 After osseous resection.



c3-10 Suturing.

Prognosis



c3-11 **Eight months after surgery.** Copings are placed to preserve the parallel of the fixed partial denture.

c3-12 **Eleven months after surgery.** Placement of final restorations. Note the elimination of the periodontal pockets and the improved gingival shape. An adequate embrasure between 15 and 14 is provided.

c3-13 **Three years and 1 month after the placement of final restorations.**

Osseous Resection

Indications for osseous resection

The objectives of osseous resection are to remove osseous defects, to correct bone morphology, to create a harmonious relation between the gingiva and alveolar bone by eliminating periodontal pockets, and to create a favorable postoperative gingival morphology. The principles and procedures of osseous resection as described by Schluger,3 Friedman," Ochsenbein, and Ochsenbein and Ross have improved technical aspects.

A distinction is made between osteoplasty, which corrects the alveolar bone morphology without removing the supporting bone, and ostectomy, in which the supporting bone is resected to remove the intrabony defect. Indications for osseous resection are described in the following list. Osseous resection with supporting bone resection is limited to points 5-7, which are exceptional clinical therapies.

Indications for osseous resection

1. Shallow intrabony defect around a tooth with sufficient periodontal support (Fig 1-16).
2. Existence of nonsupporting bone that could affect a periodontal pocket or that hinders close adaptation of flap (thick alveolar bone margin, shelflike bone, bony protuberance, exostosis, interdental crater, and thick alveolar bone walls around the intrabony defect).
3. Class I or II furcation involvement (Fig 1-17).
4. Residual osseous defect remaining after regenerative procedures.
5. Irregularity of bone morphology (or osteoplasty) related to hemisection and root amputation (or root resection).
6. Clinical crown requires lengthening before restorative/prosthetic treatment.
7. Deep caries or crown fracture extending subgingivally or to the alveolar bone.

Fig 1-16 Indication for osseous resection of multiple teeth.

Osseous resection for multiple teeth is performed in cases where the bottom of an osseous defect is not beyond the root trunk. Left, before osseous resection. Right, after osseous resection.

Fig 1-17 Osseous resection in furcation area.

Class I or II furcations are indications for osseous resection.

Contraindications for osseous resection

1. Position of the external oblique line in the mandibular molar area and maxillary sinus, which is very close to the osseous defect and root proximity.
2. A periodontal pocket of more than 8 mm exists after initial therapy.
3. The bottom of the osseous defect extends apically against multiple-tooth root trunks.
4. The deep intrabony defect is more than 3–4 mm or the bottom of the osseous defect is more than one half of the root length from the cementoenamel junction.
5. Extended tooth mobility.

As stated, osseous resection is performed on intrabony defects around teeth with long, thick roots. Seibert" stated that an osseous defect that is 3-5 mm from the cementoenamel junction is an indication for osseous resection. Osseous resection should not be performed if it will weaken the supporting bone or expose a furcation without lesions.

Osseous resection is limited in its application because attachment loss occurs with the removal of supporting bone. Also, short and narrow roots (seen commonly in Asians who have less periodontal support compared to Europeans) complicate the procedure. Root separation is limited, and the roots of multiple teeth tend to be fused. Such patients may not be suitable candidates for osseous resection. The principle is to perform osteoplasty or osseous resection only if it is possible to not damage the supporting bone.

Summary of Osseous Resection

Osseous resection is not simply the surgical removal of pathologic tissue. It is used to correct nonphysiologic form, which may be caused by a lesion, and it is, of course, an invasive procedure. Therefore, one must predict how function and morphology would be improved as a result of resection. It is also important that periodontal support not be compromised.

The following must be considered:

- Is the root length and shape adequate?
- Will the amount of residual supporting bone be adequate after osseous resection?
- How much periodontal support might be lost from the adjacent teeth?
- Is there a possibility of increased tooth mobility due to decreased tissue support?

Additional considerations include:

- Are caries a risk? The incidence of root caries is high with root exposure.
- Would furcations and root grooves be exposed, causing maintenance problems?

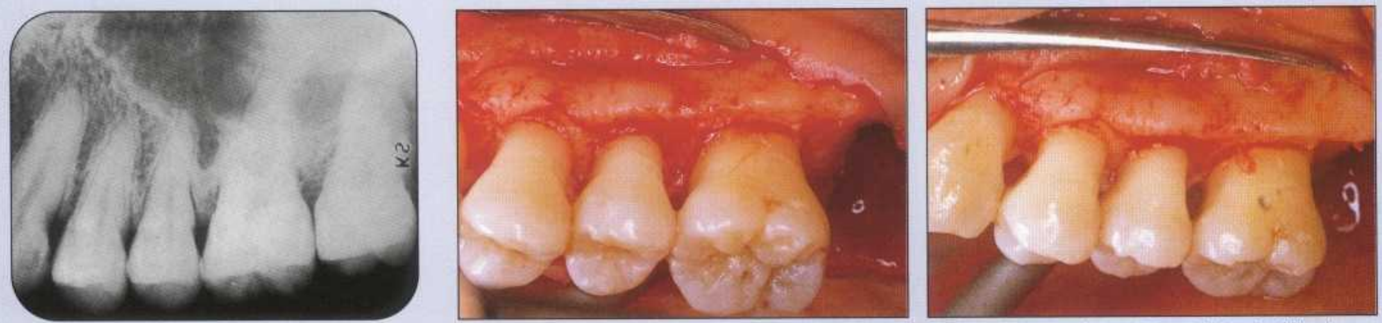
Therefore, practitioners must be judicious concerning the length of the root trunk and furcation involvement. The possibility of marginal bone resorption after surgery must also be considered.

Additional considerations include protrusive teeth and alveolar bone thickness. Anatomic considerations such as the external oblique line, mental foramen, and maxillary sinus, should not be neglected. Finally, if there are foresee able problems in esthetics or phonetics, even if a better periodontal environment is anticipated, osseous resection is not recommended.

Incisions in general have already been discussed. The position of the alveolar bone margin must be determined with a probe before the position of the primary incision is determined, to avoid displacing the flap apically with too little tissue covering the alveolar bone margin.

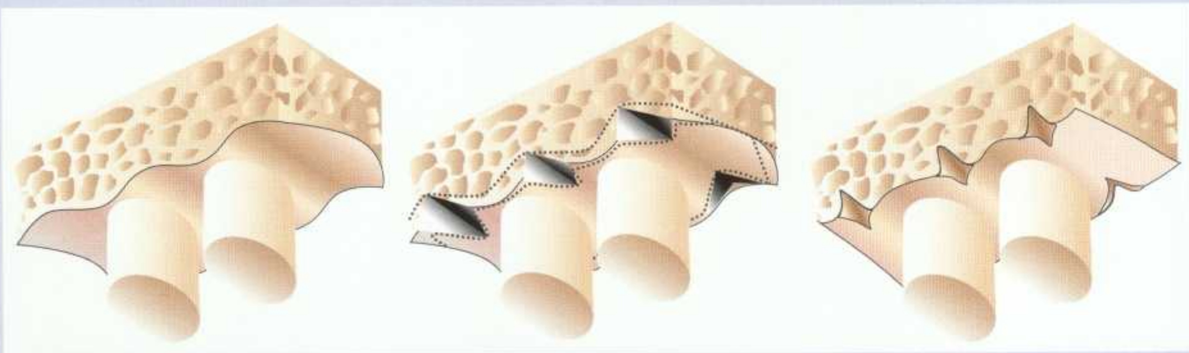
If the palatal gingiva is thick, the primary incision is prepared with the same technique. If the band of attached gingiva in the labial-buccal aspect is sufficient, the incision should be made far from the gingival margin and the flap re flected with full thickness. In osseous resection, the primary flap is reflected past the mucogingival junction with a periosteal elevator. The technique of removing the secondary flap is discussed in the surgical crown lengthening procedure section.

Fig 1-18 *Procedures of osseous resection.*



a. A 36-year-old woman after initial therapy. Note the osseous defect in the interdental area.

b. Postextraction of 15. Note the shallow, craterlike osseous defect with a thick, shelflike bone wall in the interdental area. Bone support is sufficient and the root trunk of 14 is long.



c. A large, round bur is used to prepare a vertical groove on the buccal and palatal walls of 14 in the interdental area.

d. A small, round bur is used to prepare a shallow vertical groove on the buccal supporting bone of 14.

e. Osteoplasty is performed from the bottom of the craterlike osseous defect to the palate on a gradient, and the crater eliminated.

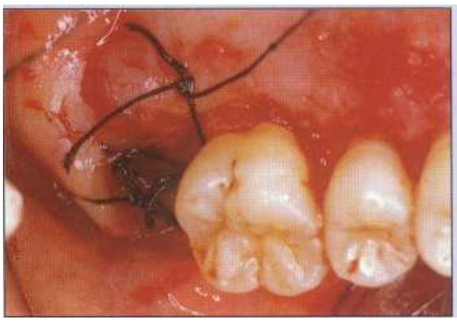
f. The bone shape is corrected and the irregular bone margin resected with an Ochsenbein chisel and a Wedelstadt chisel.

g. The interdental osseous defect is eliminated. The interdental bone becomes scalloped, and its position is coronal to marginal bone.

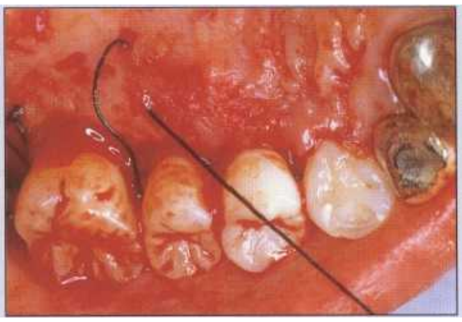
Osseous resection and osteoplasty are performed carefully. The procedure is to flatten the bottom of the concave osseous defect. A round bur and bone chisel are used, but supporting bone is not resected (Fig 1-18). Ideally, the interdental bone has a scalloped form coronal to the marginal bone.

Generally, for a full-thickness apically positioned flap, a continuous suture after apical migration of the flap is used (Fig 1-19).

Fig 1-19 Continuous suture.



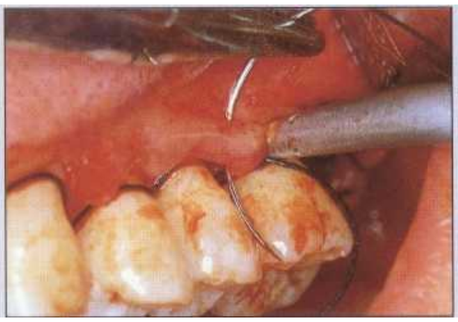
a. A continuous suture is begun from the palatal aspect, starting from the outside of the palatal flap on the distal aspect of 14 and ligature.



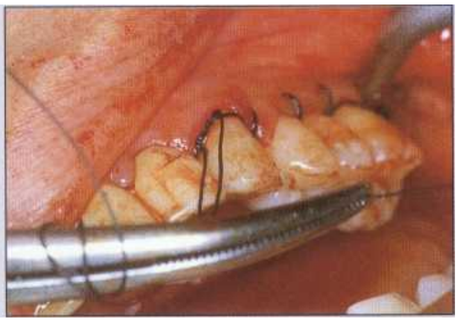
b. The thread is turned around the buccal surface of 14 and brought to the palatal aspect from the mesial interdental area of 14. A vertical mattress suture of the palatal flap is made. The edges of the flap are adapted to the bone tissue.

c. The thread is turned around the buccal tooth surface through the interdental area. This is repeated with the vertical mattress suture on the palatal flaps on the palatal aspect. Note the position of the palatal flap edges (approximately 1 mm coronal to the alveolar crest).

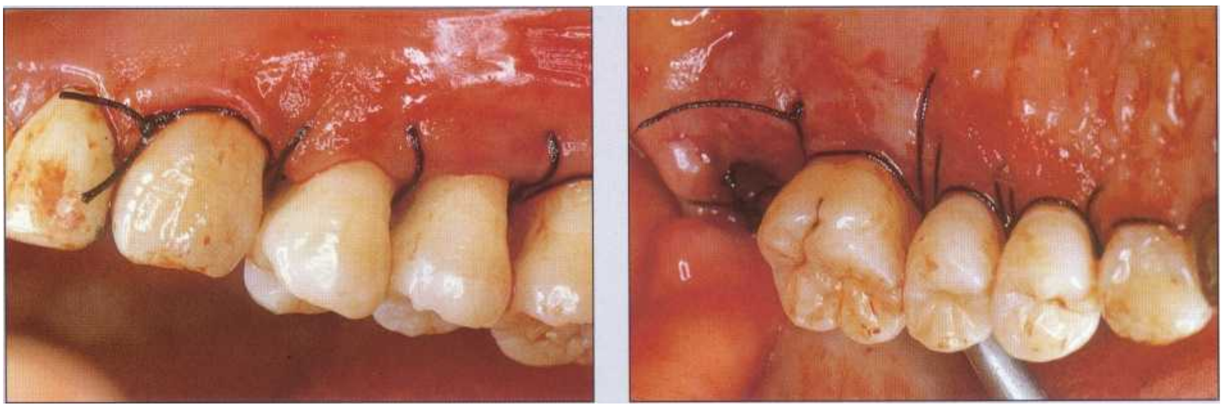
d. A continuous sling suture is made on the buccal aspect.



e. A needle is inserted in the buccal flap on the distal aspect of 14 and ligature, then sutured. The thread is turned around the palatal tooth surface, passed to the buccal aspect through the mesial interdental area, and then inserted on the mesial papilla of the buccal flap from the outside.



f. Another sling suture is made, and a ligature is made of the palatal flap and the end of the continuous sutured thread at mesiobuccal line angle of 11.



g. A loose sling suture of the continuous suture of the buccal flap is made. A periodontal pack maintains the buccal full-thickness flap apically.

The Wedge Procedure in the Edentulous Ridge

Edentulous Space Adjacent to the Abutment Tooth

To maintain healthy periodontal tissue in the edentulous arch, consideration for the edentulous ridge shape adjacent to the abutment tooth is important. The wedge procedure is a method used to eliminate periodontal pockets in edentulous areas. It is also used to recontour periodontal tissues that form on the abutment tooth adjacent to the maxillary tuberosity and the retromolar triangle.[29-32]

An edentulous space adjacent to an abutment tooth tends to form deep periodontal pockets with recurrent periodontal disease after periodontal therapy.

Problems of an edentulous space adjacent to an abutment

1. Plaque hard to control.
2. Effects of initial therapy may be suboptimal because of limited accessibility of instruments during scaling and root planing.
3. Maxillary tuberosity and retromolar triangle are covered with thick gingiva and tend to form deep periodontal pockets. Therefore, advanced furcation involvement is often observed.
4. Abutment adjacent to an edentulous space is a key tooth for occlusion and bears stress in function. Hence, it is at high risk to advance to severe periodontal disease.

Therefore, to maintain a good periodontal environment around the abutment adjacent to the edentulous ridge, periodontal pocket elimination using the wedge procedure is recommended.

Objectives of the wedge procedure

1. Eliminate periodontal pockets
2. Maintain and preserve attached gingiva
3. Make area accessible to instruments
4. Lengthen clinical crown
5. Create easily cleansable gingiva-alveolar form

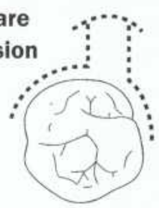
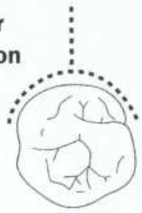
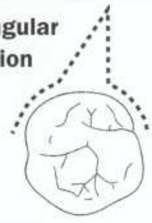
The procedure enables the removal of thick gingival tissue on the edentulous side adjacent to the abutment. If there is an osseous defect, it also corrects the bone morphology by flattening it and the intrabony defect may be elimi nated. The periodontal pocket is eliminated and a shallow gingival sulcus favorable for postoperative maintenance is created.

For a primary closure, a thin flap offers best adaptation to the tooth and bone. This not only ensures the elimination of the periodontal pocket, but alleviates pain and reduces the healing period.

Flap Design of the Wedge Procedure

Four flap designs are used in the wedge procedure: square, linear, triangular, and pedicle (Fig 1-20). A flap design is determined by the size of the edentulous ridge, maxillary tuberosity, and retromolar triangle, and the thickness of the soft tissue.

Fig 1-20 Selection of incision in the wedge procedure.

		Square incision 	Linear incision 	Triangular incision 	Pedicle incision 
Band of attached gingiva	Narrow		○		○
Size of wedge	Big	○			○
	Small			○	
Thickness of soft tissue	Thick	○			○
	Thin		○		
Periodontal pocket in edentulous side	Deep	○		○	○
	Shallow				
Access to osseous defect	Difficult	○			○
	Easy		○	○	
Wound closure	Reliable	○	○		○
Regenerative procedure			○		○

Factors that determine the flap design of a wedge procedure

1. Size and shape
2. Thickness of soft tissue
3. Difficulty of access
4. Band of attached gingiva of the abutment tooth
5. Depth of periodontal pocket and degree of osseous defect on the edentulous side of the abutment
6. Clinical crown length required as an abutment for restorative/prosthetic treatment

For reasons of practicality, the author used the square incision frequently (Fig 1-20).

Indications for the square incision

1. Long and large edentulous ridge, maxillary tuberosity, and retromolar triangle
2. Much tissue to be removed in the wedge area
3. Sufficient existing band of attached gingiva
4. Deep periodontal pockets and osseous defects on the mesial and distal aspects of the abutment

A square incision is made with two parallel internal bevel incisions and one vertical incision. The vertical incision is a release incision to help the flap adapt closer to the source. The amount of wedge tissue to be removed (the distance between the two internal bevel incisions) is determined by a number of factors.

Factors that determine the amount of wedge tissue removed

1. Thickness of the soft tissue
2. Depth of periodontal pocket and osseous defect
3. Amount of bone to be removed (whether by osteoplasty or ostectomy if necessary)
4. Clinical crown length necessary for the abutment
5. Pontic form

Flap designs for the wedge procedure are shown in Fig 1-20.

The pedicle incision is a difficult technique, but it has many advantages.

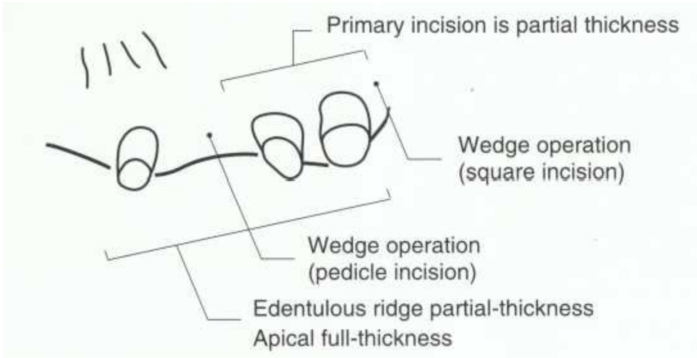
Advantages of the pedicle incision

1. Rapid postoperative healing
2. Less postoperative discomfort
3. Complete coverage of the osseous defect of the wedge area
4. Many indications
5. Reliable access to furcation and osseous defect area
6. Smooth alveolar ridge preparation, easing pontic adaptation
7. No attachment loss

Indications for the pedicle incision

1. Narrow band of attached gingiva.
2. Thick soft tissue.
3. A piece of bone as donor site for bone graft is to be harvested.
4. Osseous defect close to maxillary sinus.
5. Regenerative procedure (bone graft, GTR) indicated due to deep intrabony defect.

Case 1-4 Wedge procedure using a pedicle flap



Described is a wedge procedure performed around the abutment tooth of a fixed partial denture. Note the technique of the flap design and the wedge procedure using a pedicle incision.

Initial therapy

c41 Two months after initial examination, 44-year-old woman.

c42 After initial therapy. Thirteen months after the initial examination; the inflammation of the gingival surface is controlled, but 5-7 mm periodontal pockets remain. Thick gingiva made elimination of periodontal pockets difficult.

Design for wedge operation

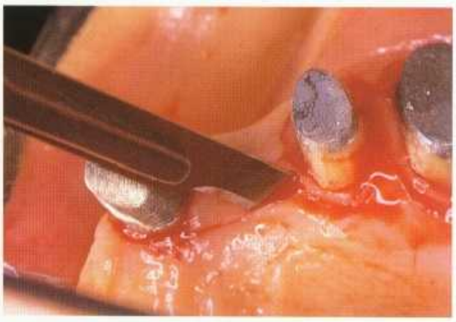
c4-3 Flap design.

a. The wedge procedure is performed using the pedicle incision technique on the alveolar ridge of 12 (left). A square incision consisting of two parallel internal bevel incisions and one vertical incision is made on the distal aspect of 14.

b. A primary partial-thickness incision is made on the palatal aspect of 13 and 14 (right).

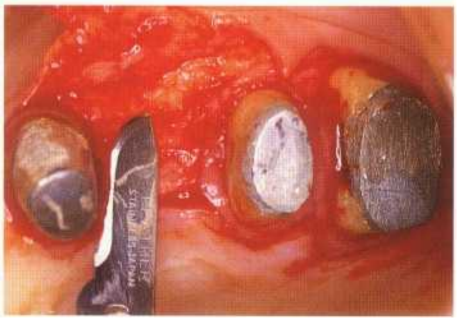
c. An internal bevel incision is made toward **the alveolar crest on the** buccal aspect.

c44 Wedge procedure using a pedicle incision.

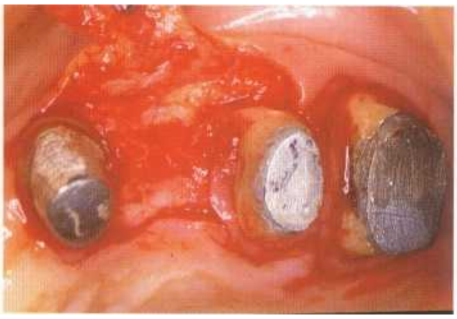


a. A no. 15 blade is used to make a primary incision connecting the distopalatal line angle of 11 and the mesiopalatal line angle of 13.

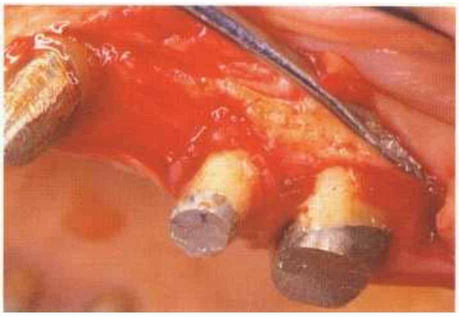
b. The blade is inserted horizontally from the palatal aspect. The flaps are reflected from the underlying connective tissue with approximately 2-mm thickness while the flaps are lifted with the side of the blade.



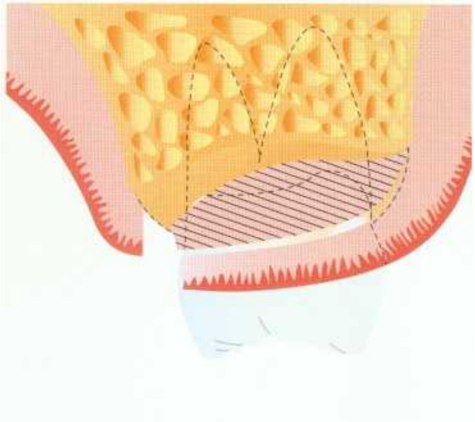
c. The reflected primary flap edge is lifted with tissue pliers and a horizontal partial-thickness incision is made from the palatal aspect toward the buccal aspect.



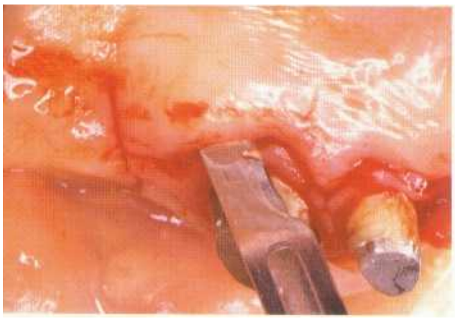
d. During this procedure, the thick soft tissue of the edentulous ridge flap is thinned to approximately 2 mm. The flap should not be penetrated, and the wedge tissue remains on the alveolar ridge.



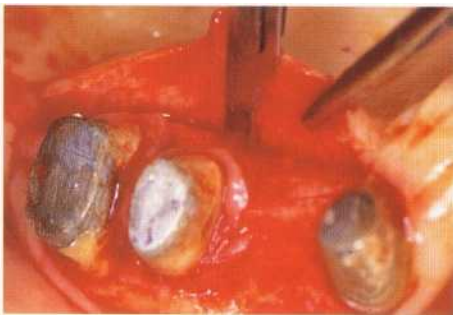
e. A partial-thickness flap is prepared at the mesiobuccal line of 11 and the distobuccal line 13. A full-thickness flap is used apically.



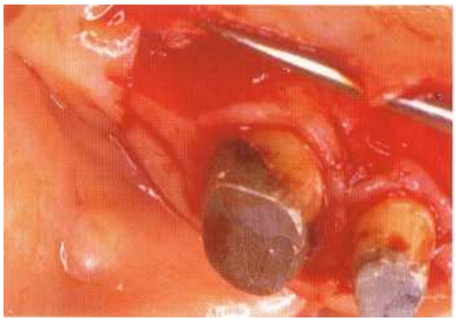
c45 Partial-thickness palatal flap.



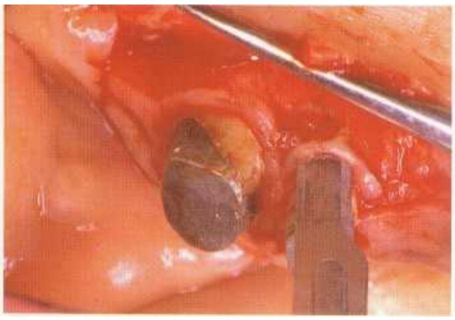
a. A partial-thickness incision is made along the palate to prepare a thin, uniform primary flap.



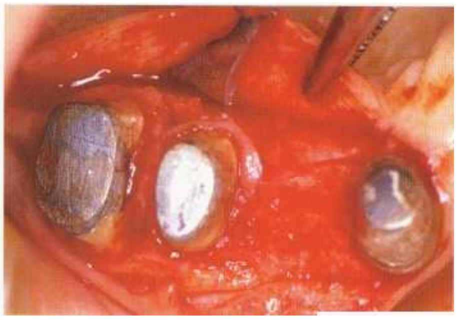
b. The primary flap edges are held and the inside flap undermined while the blade is controlled along the palatal soft tissue with care taken not to penetrate the flap.



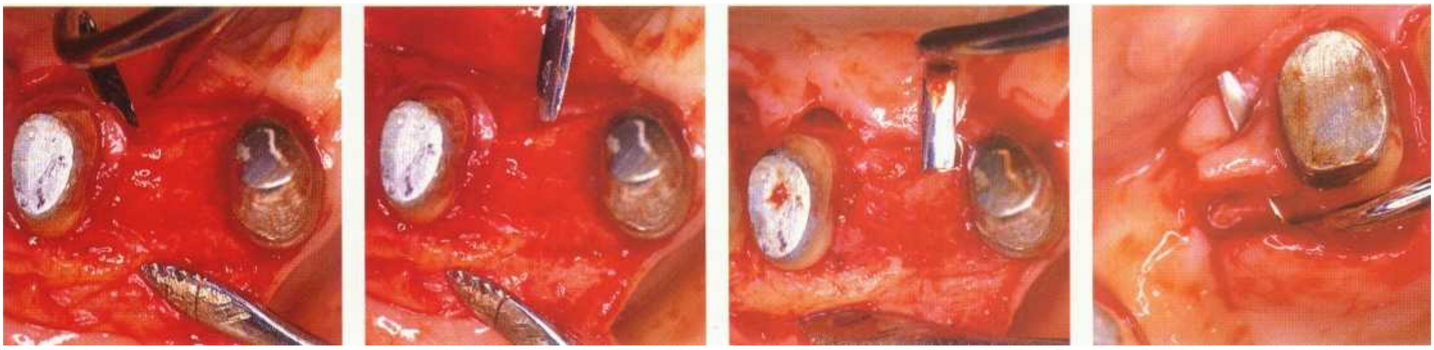
c. A primary flap of 1.5-2.0-mm thickness is prepared.



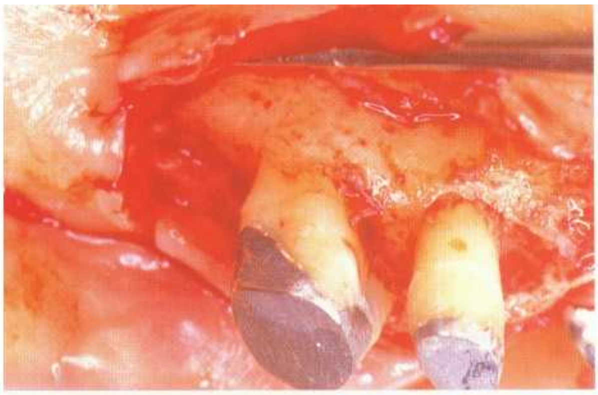
d. The secondary flaps are separated from the teeth after primary flap reflection. A secondary incision is prepared from the bottom of the periodontal pocket toward the alveolar bone so that the flaps can be removed as a mass.



e. The primary incision is extended to the bone with a Kirkland knife 15/16 and the secondary flaps separated from the primary flap completely. The flaps are removed as a mass.

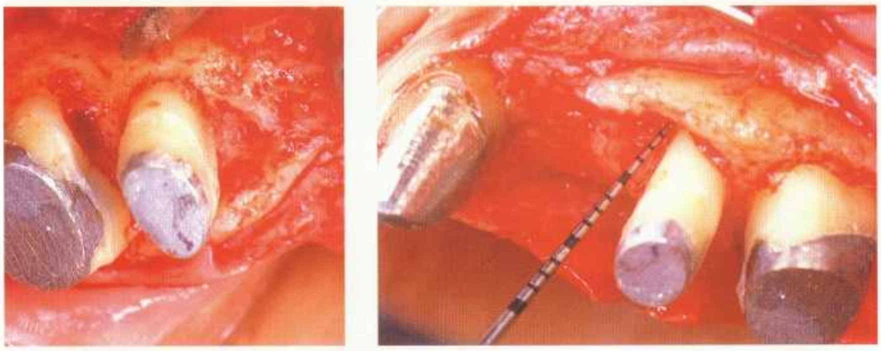


c46 Removal of wedge tissue. Residual wedge tissue of the alveolar ridge is removed. With an Orban interdental knife 1/2, small incisions are made from the palatal to the buccal aspect and from the distal to the mesial aspect while the knife traces the alveolar bone surface. The tissue is separated from the bone surface and removed as a mass by undermining gingivectomy. The wedge tissue is resected with an interdental knife while being held by hemostatic forceps.

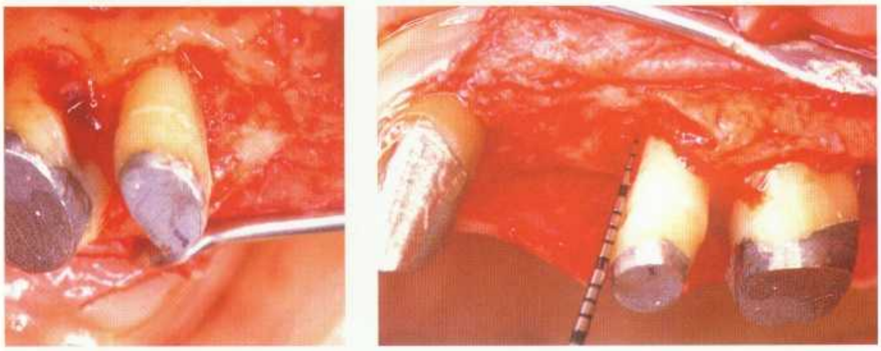


c47 After removal of wedge tissue.

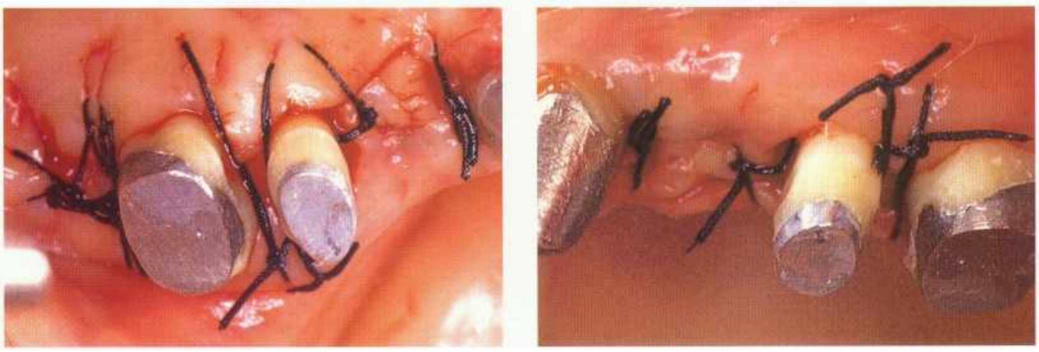
Osseous resection



c48 Before osseous resection. Note the shallow, craterlike osseous defect on the mesial and distal aspects of 14 and the thick, shelflike one-wall intrabony defect on the mesiobuccal aspect of 13.



c49 After osseous resection. The corrected edentulous ridge will enable the placement of a pontic that is easy to clean.



c410 After suturing.

Prognosis

c411 Postoperative status.

a. Two weeks after surgery.

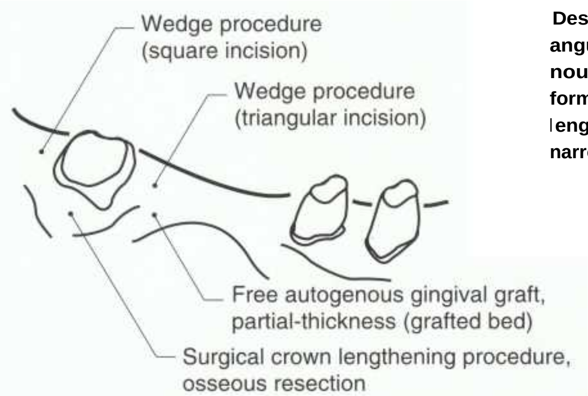
b. Three and one half months after surgery.

c. One year and 5 months after surgery.

d. One year and 8 months after surgery. There is no bleeding on probing, and the periodontal pocket is within 2 mm.

e. Placement of the final restoration 1 year and 9 months after surgery.

Case 1-5 Wedge procedure using two horizontal incisions and one vertical incision



Described is the wedge procedure using square and triangular incisions. A wedge procedure and free autogenous gingival graft with osseous resection were performed on the second molar, for which the clinical crown length was insufficient and the band of attached gingiva narrow.

c5-1 Initial therapy. Sixty-two year-old woman. Left, buccal aspect; right, lingual aspect.

c5-2 After initial therapy. Note the 4-5-mm periodontal pocket depth on 31, bleeding on probing, and insufficient clinical crown length for use as an abutment for a fixed partial denture. There is also a narrow band of attached gingiva mesiobuccally, and the muscle attachment extends to the alveolar crest (left, buccal aspect; right, lingual aspect).

Design of wedge procedure

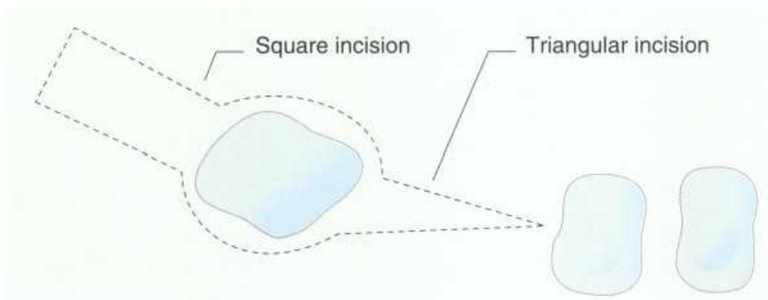
c5-3 Square incision. The wedge procedure on the distal aspect of 31 is begun with a square incision, which consists of two horizontal internal bevel incisions (primary incision) and one vertical incision.

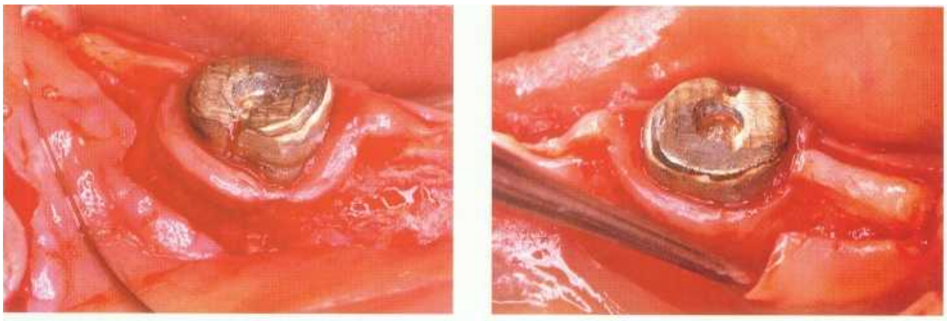
c5-4 Triangular incision. A triangular incision on the mesial aspect of 31 is prepared.

Key point

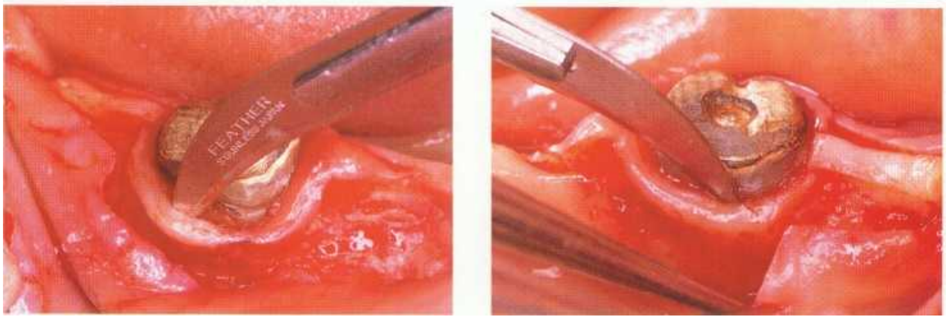
Considerations for the buccolingual width of parallel internal bevel incisions include:

1. Depth of periodontal pocket
2. Thickness of the wedges soft tissue
3. Whether osteoplasty or osseous resection is necessary
4. Clinical crown length required for abutment

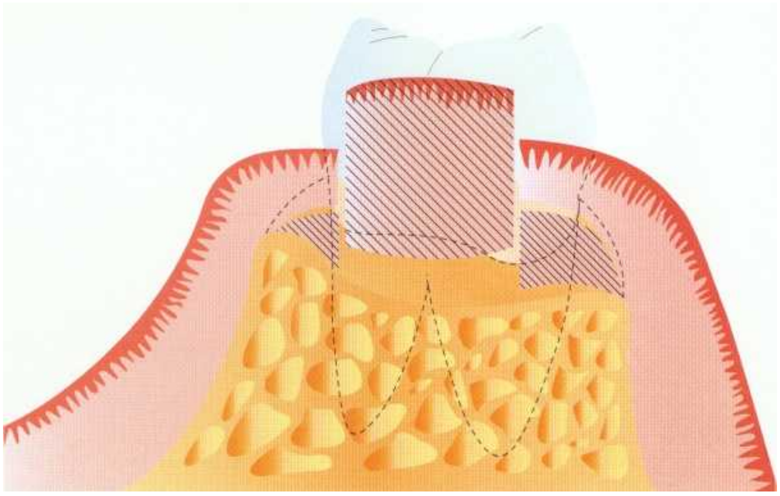




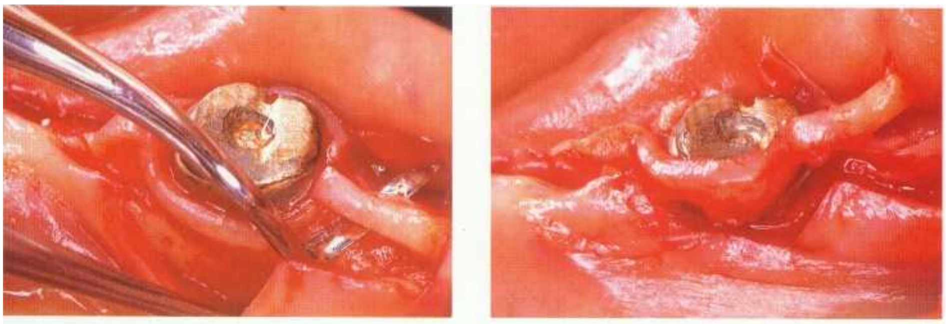
c5-5 After reflecting primary flap with periosteal elevator. Note that the edentulous ridge of 30 is a partial-thickness flap (left, buccal aspect; right, lingual aspect).



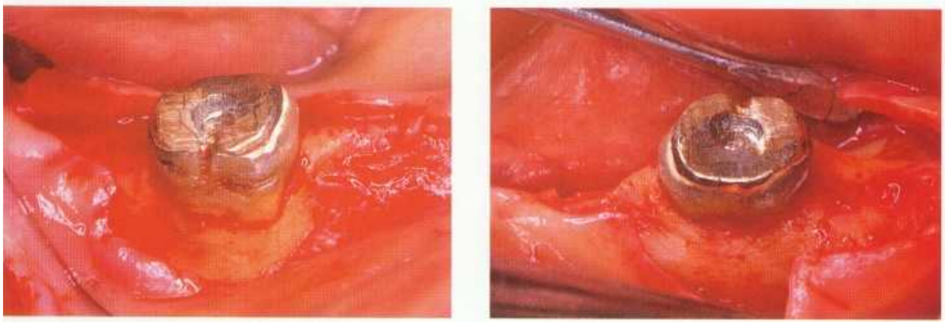
c5-6 Separation of secondary flap. A secondary incision is made from the bottom of the pocket toward the alveolar crest around the cervical area with a no. 12 blade. The secondary flap is separated from the root surface (left, buccal aspect; right, lingual aspect).



c5-7 Wedge tissue removal.



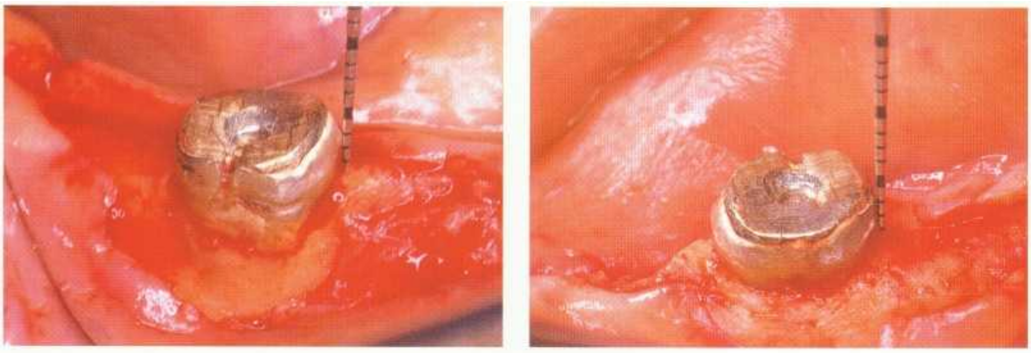
a. With an Orban interdental knife 1/2, the wedge tissue between the two buccal areas and the lingual flap from the bone are removed as a mass.

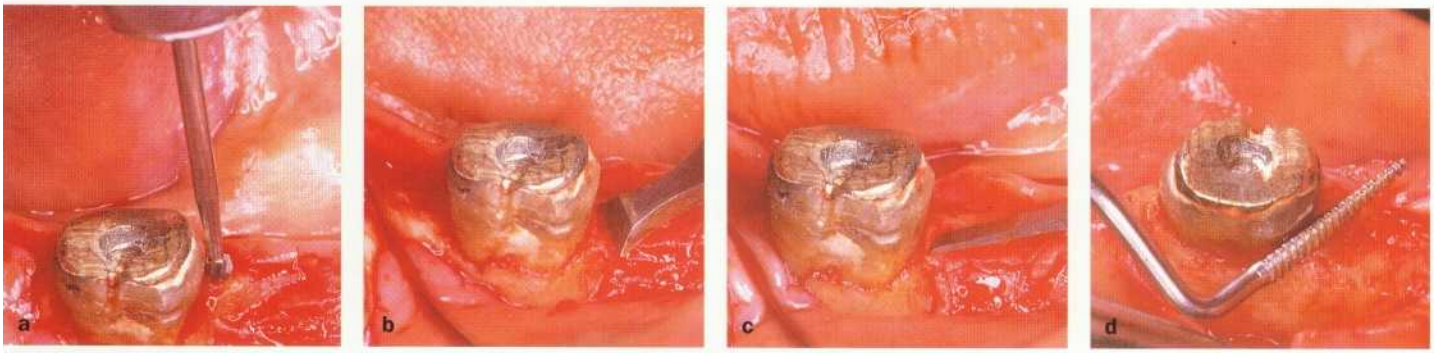


b. After wedge tissue removal (left, buccal aspect; right, lingual aspect).

Correction of the alveolar ridge and surgical crown lengthening with osseous resection

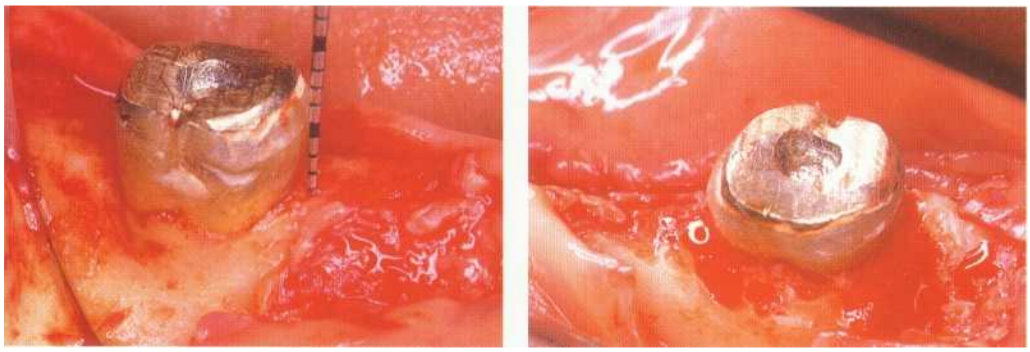
c5-8 Sound root surface to be preserved. The distance from the abutment margin to the alveolar crest on the mesial and distal aspects of 31 is 1 mm. Osseous resection is required to preserve biologic width (left, buccal aspect; right, lingual aspect).





c5-9 Osseous resection. When performing osteoplasty or osseous resection with a turbine bur (a), Ochsenbein chisel (b), Wedelstadt chisel (c), and Sugarman file (d), it is important to avoid exposing the furcation and to extend crown length and create physiologic bone morphology.

c5-10 After osseous resection. The distance from the alveolar crest to the margin of the prepared abutment is 5 mm. Approximately 4 mm of bone is removed. (Compare with c1-5-c1-8. Left, buccal aspect; right, lingual aspect.)



Free autogenous gingival graft to the edentulous ridge

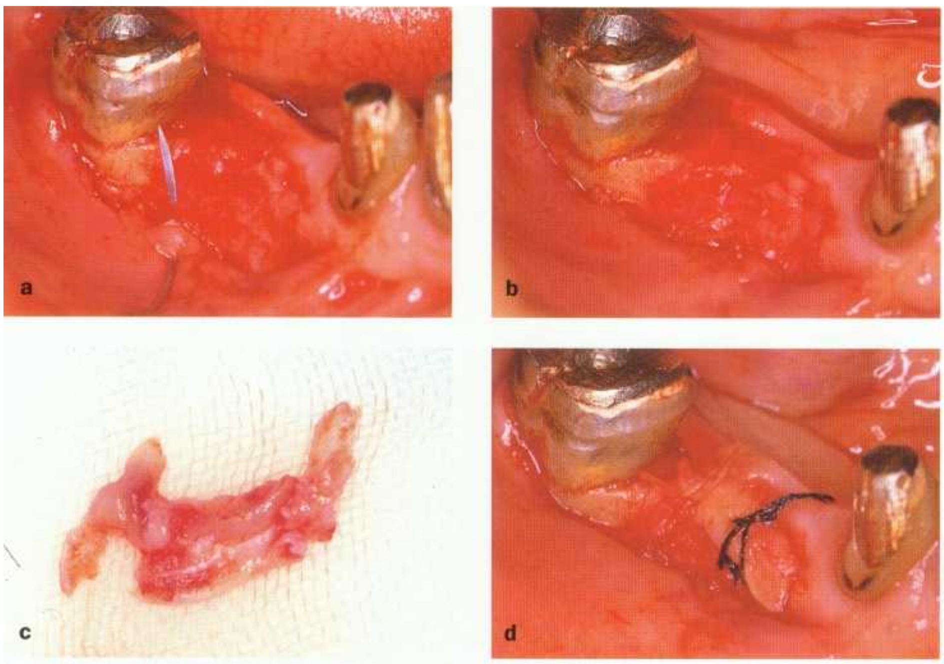
c5-11 Free autogenous gingival graft.

a. Apical migration of flap. A periosteal suture of the partial-thickness flap on 30 is prepared apically because the edentulous ridge on 30 had become mobile alveolar mucosa. A resorbable suture material is used.

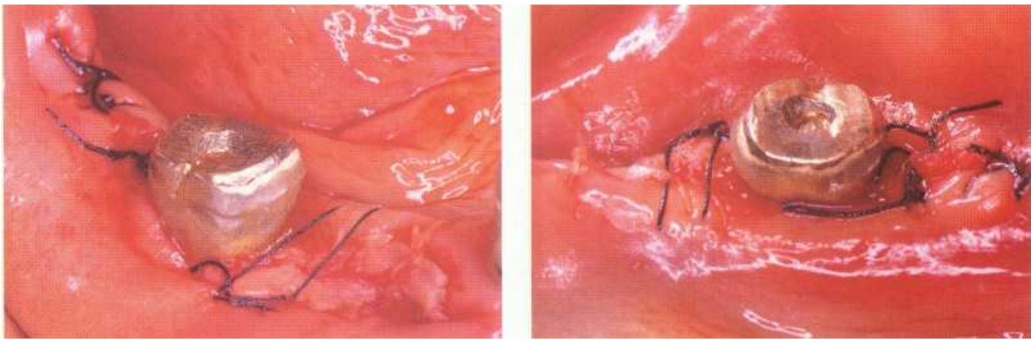
b. Preparation of immobile periosteum-connective tissue bed.

c. Removed wedge tissue is used as donor tissue.

d. Suture of graft on recipient site.



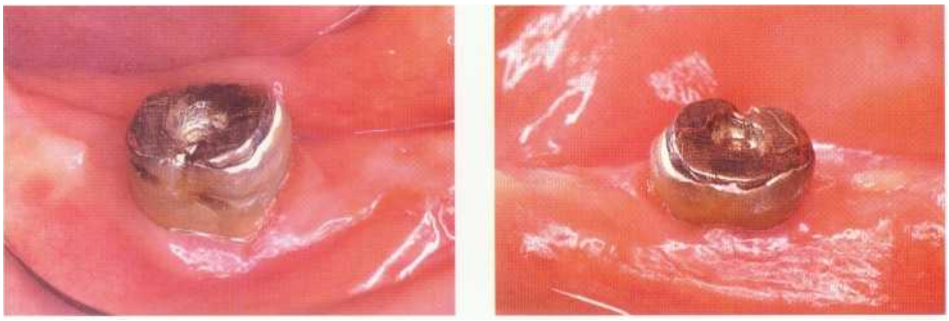
Suture of wedge operation



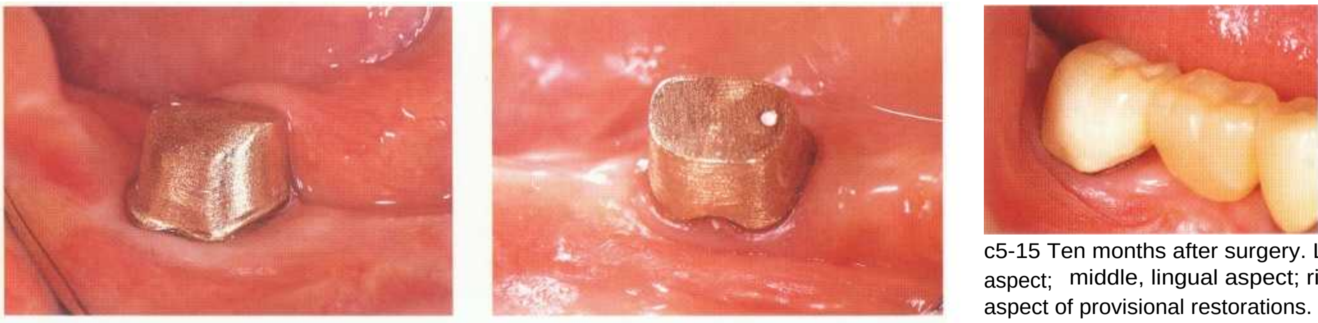
c5-12 Suturing. Exposed bone surface on the mesial and distal aspects of 31 (left, buccal aspect; right, lingual aspect).

Prognosis

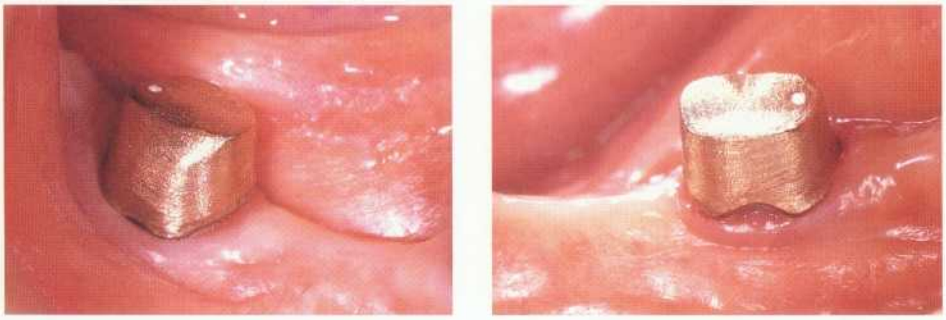
c5-13 Sixteen days after surgery. The area of exposed bone on the mesial line angle of 31 has not completely epithelialized.



c5-14 Two months after surgery. Note the eliminated periodontal pocket of 31 and the sufficient clinical crown length obtained (left, buccal aspect; right, lingual aspect).



c5-15 Ten months after surgery. Left, buccal aspect; middle, lingual aspect; right, buccal aspect of provisional restorations.



c5-16 One year and 11 months after surgery. The depth of the gingival sulcus is within 2 mm (left, buccal aspect; right, lingual aspect).

c5-17 Two years after surgery. Placement of final restorations (left, buccal aspect; right, lingual aspect).

Root Resection and Hemisection

Treatment for Furcation

Treatment for furcation involvement may include reshaping the furcation, preserving and maintaining the osseous defect on the furcation, or seeking new attachment (Fig 1-21). However, in advanced furcation involvement (Degree I1-111), the aforementioned treatments may be limited.

For advanced furcations, root resection or hemisection is performed. As stated in Chapter 4, regenerative procedures are best suited to osseous defects in furcation areas because of the ease in achieving spacemaking and wound clo sure. However, one cannot reliably predict the outcome in regenerative procedures because the prognosis of furcations is influenced by the accessibility of instruments for debridement. Therefore, treatment that eliminates furcations, such as root resection or hemisection, is still widely used.

Fig 1-21 Classification of furcation involvement and concept of treatment.

Classification of furcation involvement (Hamp, Nyman, Lindhe[33])	Degree I	Degree II	Degree III
	Horizontal Osseous defect ≤ 3 mm but within 1/3 of the root width	Horizontal Osseous defect > 3 mm beyond 1/3 of root width but does not extend to the whole furcation area	Through and through
Concept of treatment of furcation involvement (Kalkwarf & Reinhardt,[34] partially modified)			
Maintain furcation	Scaling, root planing Flap curettage	Flap curettage	Flap curettage
Increase access to furcation	Apically positioned flap Odontoplasty Osteoplasty, ostectomy		
Removal of furcation		Root resection Hemisection	Root resection Hemisection
Closure of furcation with new attachment		Flap curettage with barrier membrane (GTR)	Flap curettage with barrier membrane (GTR) Strategic extraction

Root resection or hemisection is indicated when multirooted teeth with Degree II-III furcation involvement are used as abutments of a fixed partial denture. While it is important to attempt to save a tooth affected by periodon tal disease, periodontal therapy should not be performed if the therapies are unduly complicated or endanger the adjacent periodontal tissue.

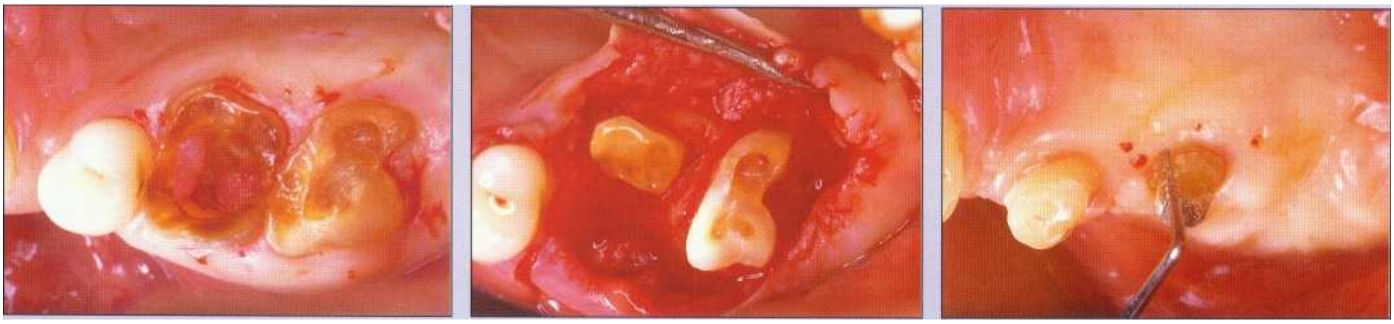
Because periodontal disease involves both the root and the periodontal tissues, strategic extraction is sometimes part of the comprehensive treatment plan. This approach promotes maintenance and recovery of periodontal tissues in the arch, and bone repair in the extraction socket occurs to the height of the adjacent alveolar crest. Root resection or hemisection may also be indicated as part of a strategic extraction of multirooted tooth.[35]

In root resection or hemisection, determining whether a root should be resected or not, or which root and how it can be saved, is even more difficult than the actual resection. Diagnosis of the entire dental arch is needed after fully understanding the indications and contraindications of the procedures.

Objectives of root resection and hemisection

1. To resect the open root furcation area and make possible debridement of the residual root
2. To eliminate the periodontal pocket by removing the furcation
3. To improve the furcation form for dental hygiene
4. To preserve maximum periodontal tissue of the residual root
5. To control interdental space (embrasure) in the area adjacent to the root
6. To treat multirooted teeth where endodontic treatment is impossible
7. To treat teeth with severe caries

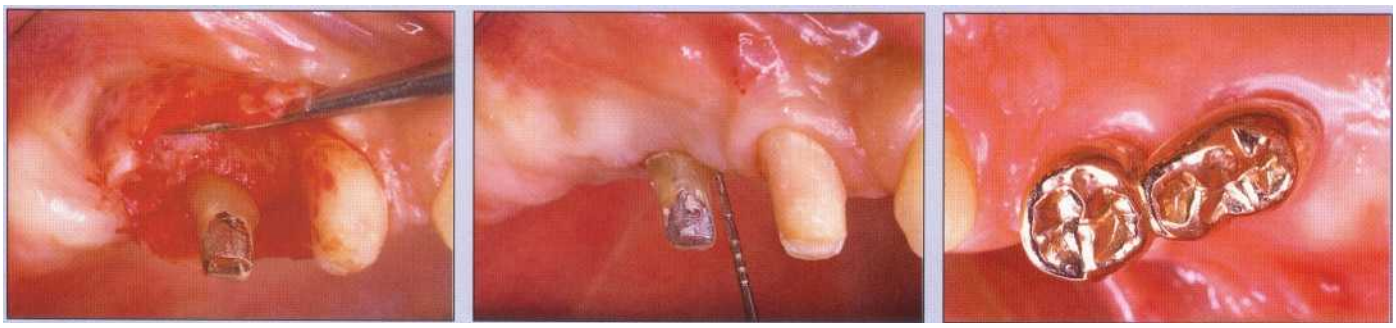
Fig 1-22 Root resection for the preservation of residual multirooted teeth,



a. Note the severe destruction of the crowns of 2 and 3, the perforation of the pulp chamber floor, and a 7-8-mm pathologic pocket.

b. Root resection of two buccal roots of 3 is performed.

c. Six months after root resection.



d. A craterlike osseous defect around the palatal root is removed and osseous resection is performed as a secondary surgical therapy.

e. Five months after osseous resection. Eliminated periodontal pockets and corrected gingival morphology allow for easy plaque control.

f. Ten years and 8 months after initial examination. The depth of the gingival sulcus is within 2 mm, and there is no bleeding on probing nor pathologic mobility.

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42. Newell DH. Current status of the management of teeth with furcation invasions. J Periodontol 1981;52:559,568.

Also, with a fused root or extremely long root trunk, the final decision should be made after flap reflection to ensure that there is sufficient bone support for the saved root.

Even if there is periodontal tissue support, there are situations where the anatomic form cannot be improved to an easy-to-clean state or where endodontic treatment of the residual root is impossible after root resection. There may be insufficient tooth structure after root resection because of decay in the furcation area and because of root resorption. It is also important to consider the residual root morphology to determine whether a post and core or metal core can be delivered or not.

Selection of roots to be saved

When root resection is indicated, it is important to consider, as Hamp and Nyman" stated, not only the amount of residual supporting bone after resection, but the entire arrangement and stability of the occlusal relationship, including the positional relation between the preserved root and the adjacent tooth. Needless to say, the anatomic root morphology and the condition around the apex for endodontic and restorative treatment should be considered.

For prognostication, the following factors should be considered:

Periodontal considerations

1. A long and wide root with a large crown is the ideal form.
2. After root resection or hemisection, the craterlike osseous defect around the residual root is removed by osseous resection and the periodontal pocket eliminated. A form that facilitates plaque control must be achieved.
3. In Class III furcation involvement, a good prognosis is unlikely unless the root morphology is favorable (eg, long and wide root). If a tooth is used as an abutment in an edentulous area, root resection or hemisection at the stage of Class II is best. Bone destruction of the residual root is suppressed and periodontal tissue recovered with a good long-term prognosis is expected.
4. The patient must be capable of thorough hygiene and follow through with scheduled professional care and management.

Endodontic consideration

1. In root canal preparation, excessive enlargement of the root canal must be avoided to reduce the possibility of thin walls.

Restorative considerations

1. A post and core should be used only if the residual tooth structure is fragile and the crown will not adhere. Post and core are the main causes of root fractures.[50]
2. All root resected teeth should be reinforced with copings, if possible. (The author attained 90% success with this approach.)
3. Occlusion should be balanced to avoid a force that might be detrimental to the root resected tooth. If possible, achieve minimal occlusal contact.
4. The restoration form must be easily cleanable for the patient's convenience.

Treatment for Advanced Furcation Involvement

In general, flap curettage is the first treatment choice to save a tooth with advanced furcation involvement (Class 11 deep, Class III). It is a desirable first choice for diagnosis when considering root resection or hemisection. Also, in Class II furcation involvement, regenerative procedures with barrier membranes are frequently used (Fig 1-23).

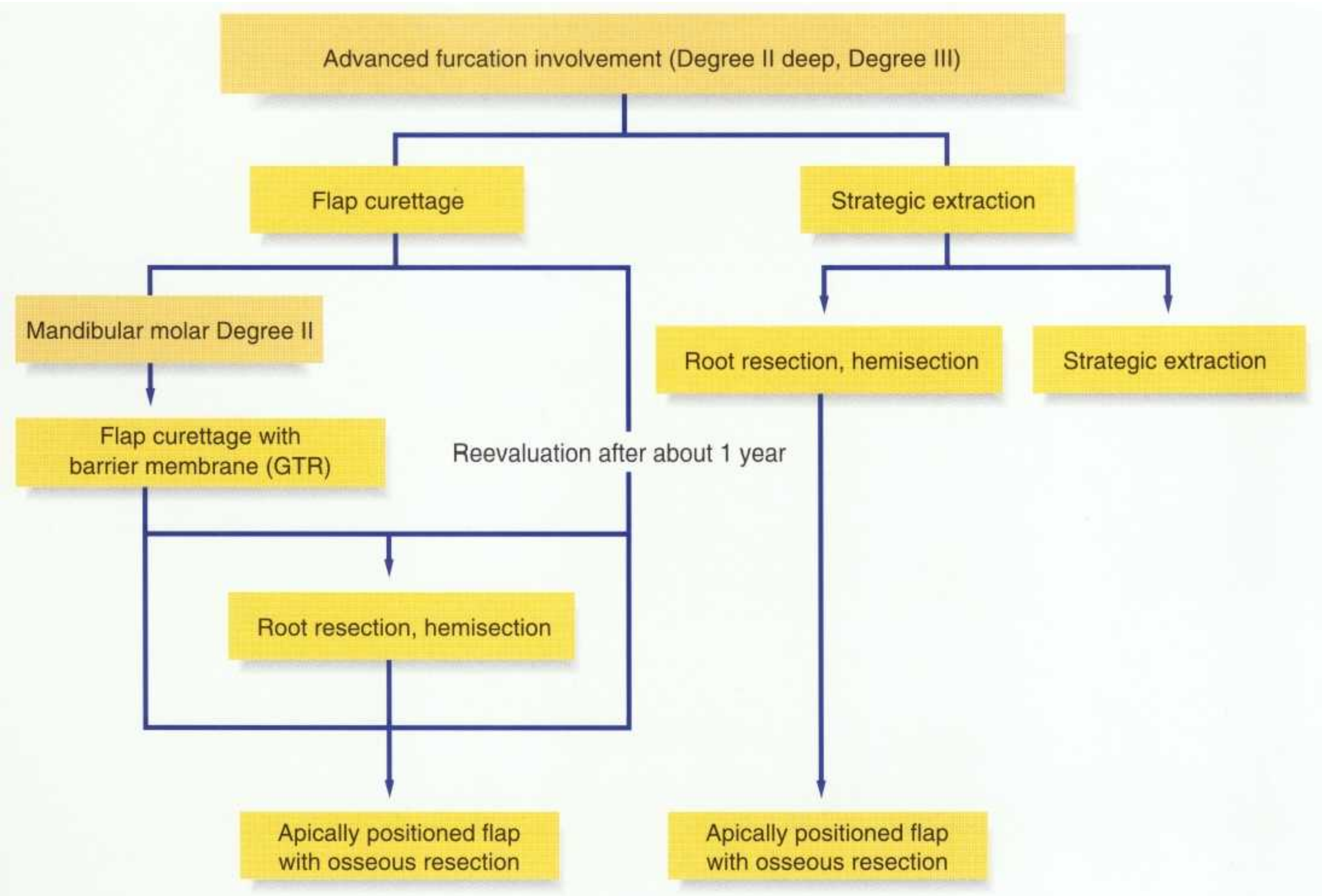
Root resection or hemisection may sometimes be done without flap curettage if a definitive diagnosis can be made by probing or by radiographic examination after initial therapy. However, even in such cases, surgical therapy is re quired to eliminate the craterlike osseous defect around the root and to restore the physiologic gingiva-alveolar bone morphology as the secondary treatment.

Flap curettage as a first treatment

Flap curettage should be done as a first treatment if the periodontal support is extremely minimal, the root is short, and there is mobility (Fig 1-24). Flap curettage can also be used to alleviate inflammation, as a regenerative procedure, and as pretreatment for root resection or hemisection.

Conducting flap curettage makes direct visual examination possible, and root resection or root amputation may be avoided depending on postoperative improvement. Without flap curettage, it is meaningless to evaluate the reaction of advanced furcation involvement to debridement.

Fig 1-23 Management for advanced furcation involvement.



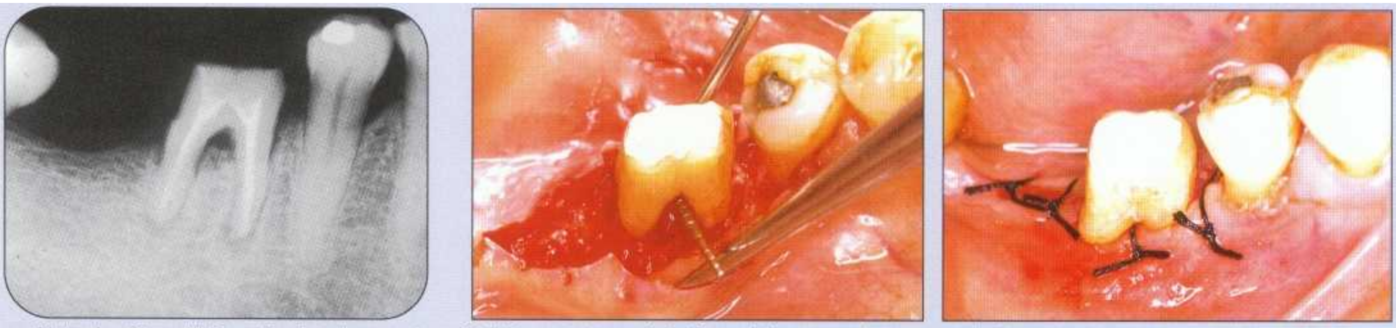
There are many benefits of flap curettage and direct visual examination.

1. Some populations, such as the Japanese, have molars with little root separation (the roots tend to fuse), long root trunks and short roots. Therefore, root resection or hemisection is unfavorable.
2. Improvement of furcation involvement after curettage is not uncommon. Especially with GTR, new attachment can be expected. Flap curettage with a barrier membrane (GTR) is the first choice in Class II furcation involvement in mandibular molars.
3. Judgments about roots to be resected should be made by direct visual examination.
4. It is better to perform resectioe surgery after decreasing the size of the osseous defect in the furcation area. This reduces bleeding during surgery and makes effective root resection or hemisection possible. Also, any residual root mobility is lessened.
5. In flap surgery, wound closure and regeneration are anticipated, unlike with wounds such as extraction sockets. With the latter, not only is postoperative hemostatic management difficult, but discomfort is possible.

Root resection or hemisection as the first choice of treatment

When a reliable diagnosis has been made and the root for strategic extraction can be determined without direct visual examination, root resection or hemisection may be the first choice.

Fig 1-24 Flap curettage as the first choice.



a. Note the Class III furcation involvement on 30. Flap curettage is indicated because the root trunk is extremely short and the roots are separated. The distal root is thin and short.

b. Seven months after surgery. Hemisection performed.

c. Five months after hemisection.

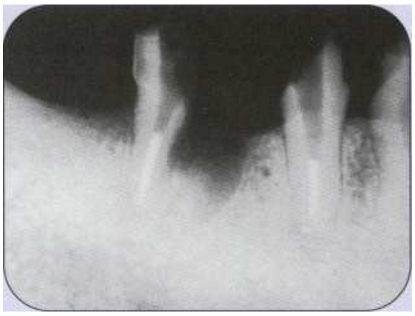
d. Two years and 6 months after flap curettage.

In this procedure, the flap is prepared and the furcation area exposed to avoid damaging the residual root trunk and to avoid leaving an overhang in the furcation area.

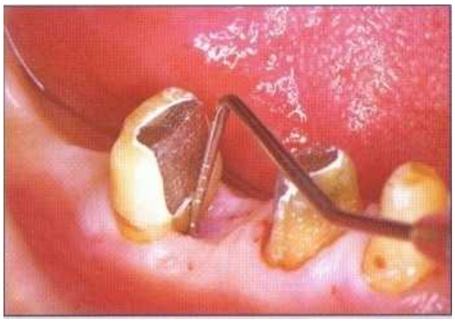
Even in this case, surgical therapy is applied after healing to remove the craterlike osseous defect around the root and to eliminate the periodontal pocket as the secondary treatment (Fig 1-25). This procedure is known as the conventional apically positioned flap with osseous resection.

Fig 1-25 Osseous resection after hemisection.

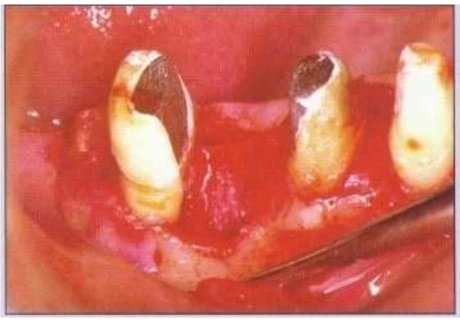
a. Note the Class III furcation involvement on 30. Hemisection is indicated because the root is long and thick and the root separation is significant.



b. One month after surgery.

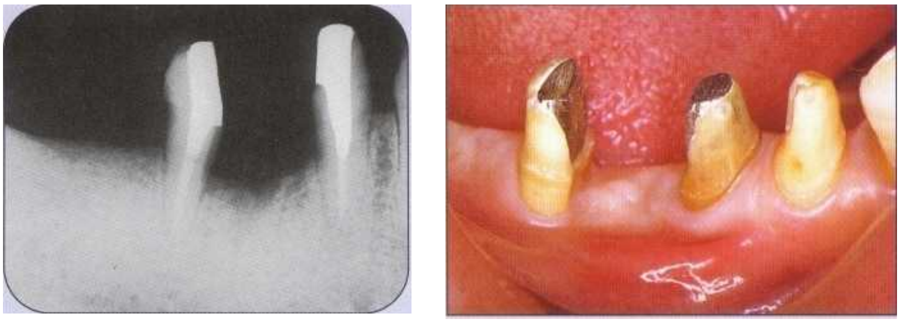


c. Four months after hemisection.

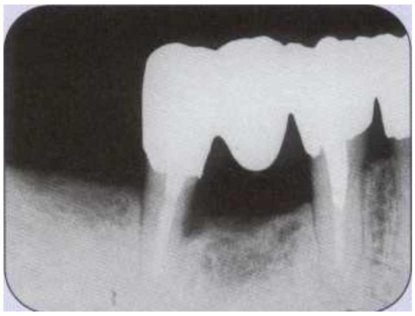


d. Bone surface exposed by a wedge procedure incision (square incision). Note the craterlike osseous defect on the mesial aspect of the distal root of 30.

e. The osseous defect is eliminated with osseous resection and physiologic bone morphology created.

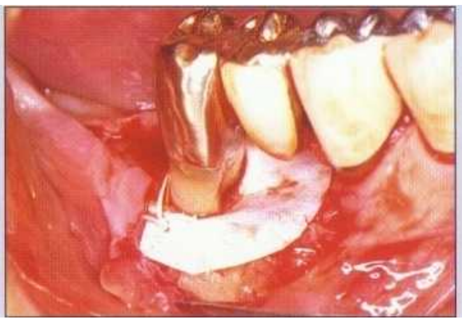


f. Four months after osseous resection, the periodontal pockets of the residual roots are eliminated.



g. Nine years and 10 months after initial ex amination. Note the 5.5-mm periodontal pocket on the mesial aspect of the distal root of 30.

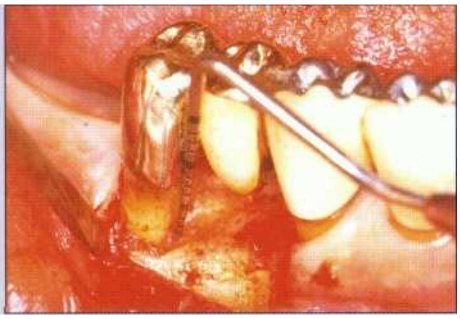
h. Note the deep intrabony defect on flap reflection.



i. A wraparound type barrier membrane (WL Gore) is used after debridement.

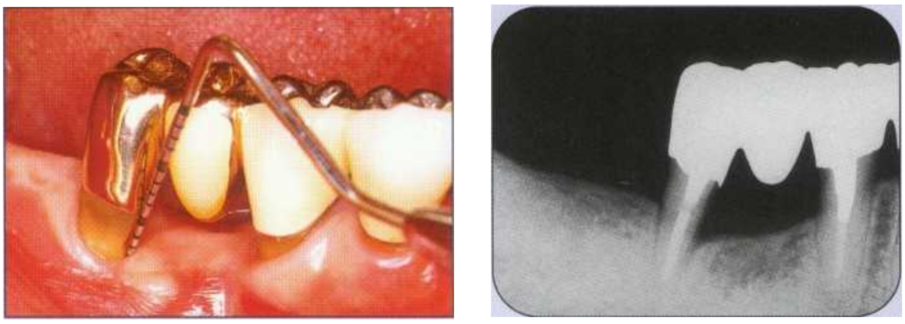
j. One month after surgery. Note the new tissue on membrane removal.

Fig 1-25 (continued) Osseous resection after hemisection.



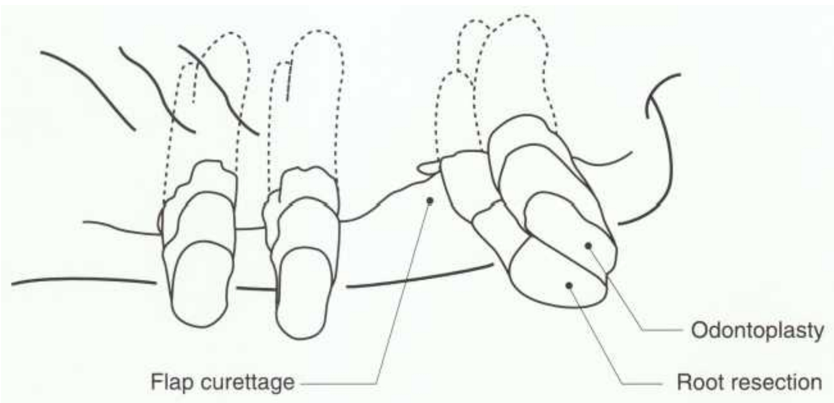
k. Six and one half months after GTR. At re-entry, there is remarkable bone regeneration in the osseous defect area.

l. A one-wall osseous defect of a combined osseous defect remains, so the defect is removed with osseous resection.



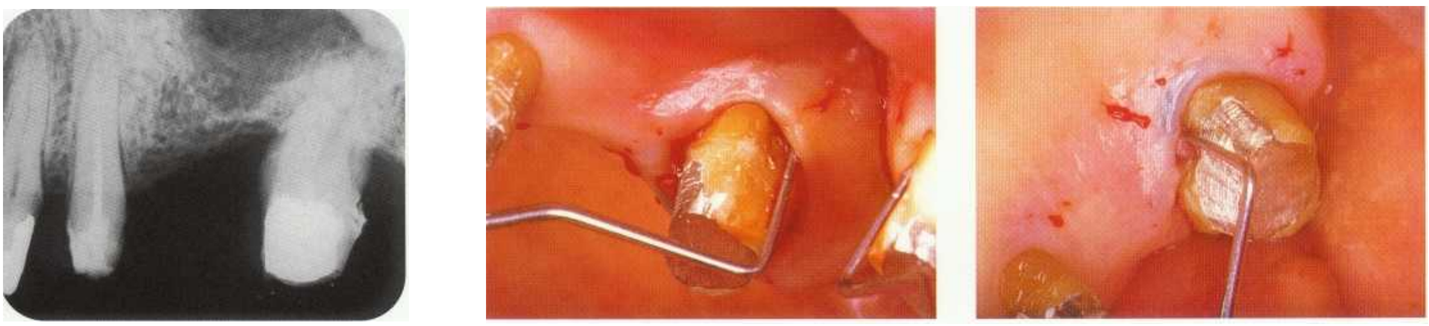
m. Eleven years and 5 months after initial examination; and 10 years and 3 months after the placement of final restorations. The probing depth is 2 mm on the mesial aspect of the distal root of 30.

Case 1-6 Root resection in the maxillary molars



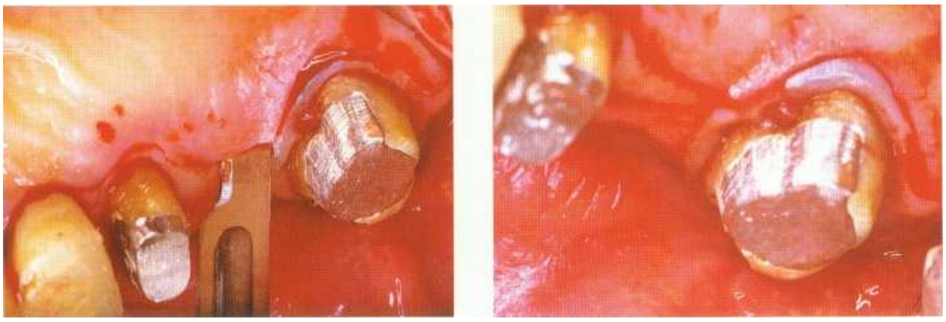
Described is the root resection technique, which is one of the basic resective techniques. Shown is flap curettage as the first surgery and buccal root resection on 15, which has a deep osseous defect.

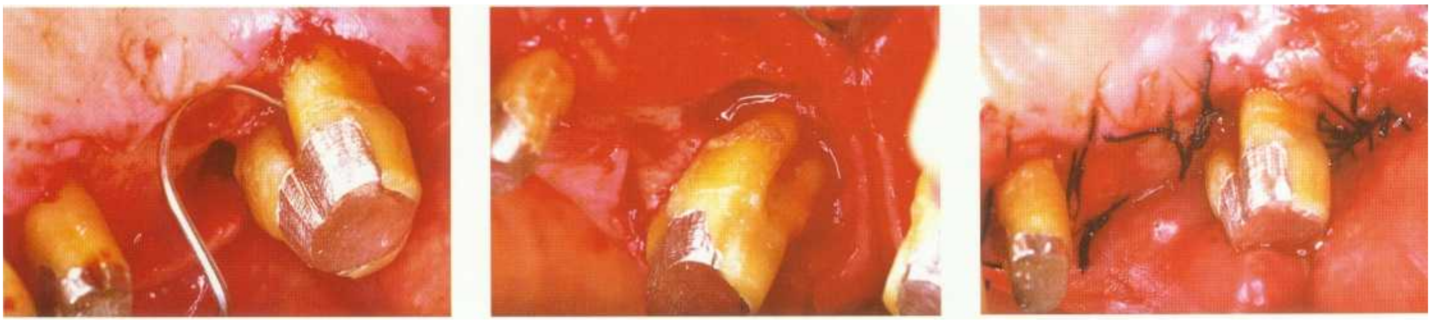
Flap curettage as the first stage of root resection



c6-1 Four months after initial examination and initial therapy, 49-year-old man. Note the 8-12 mm pathologic pocket around 15, bleeding on probing, and drainage. Pathologic mobility is Class III, and severe bone loss is evident radiographically. The roots tend to fuse, and the supporting bone is diminished.

c6-2 Flap curettage using the square incision. Flap curettage is performed using a square incision because the wedge tissue is thick, the periodontal pocket and osseous defect are deep, and there is sufficient attached gingiva.





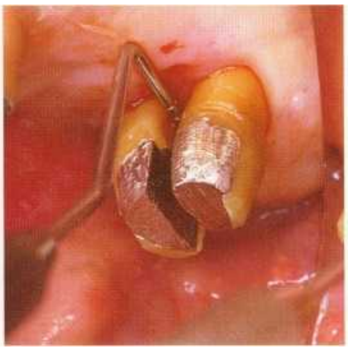
c63 Flap curettage. The deep intrabony defect is thick, with a shelflike alveolar wall and root concavity, making subgingival instrumentation difficult. Note the bone resorption close to the apex on the buccal aspect. The furcation involvement on **the mesial** and distal aspects is Class II, and the entrance of the furcation is narrow. Only **flap curettage is performed because of inadequate supporting bone and short residual roots.**

Root resection as secondary surgical procedure

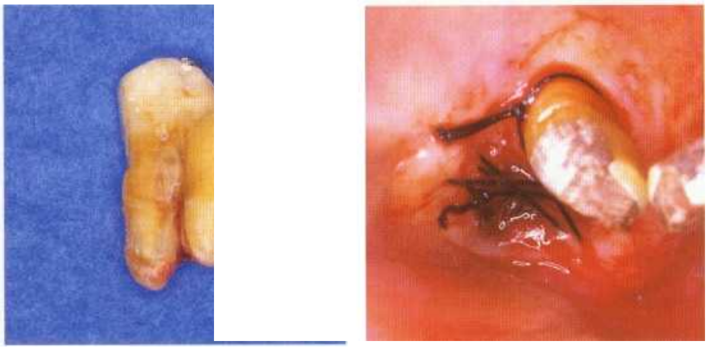
c6-4 Root resection.

a. Preoperative status, three months after flap curettage. Inflammation in the furcation is alleviated, and there is periodontal support with decreased mobility. A periodontal environment for proper buccal root resection is achieved.

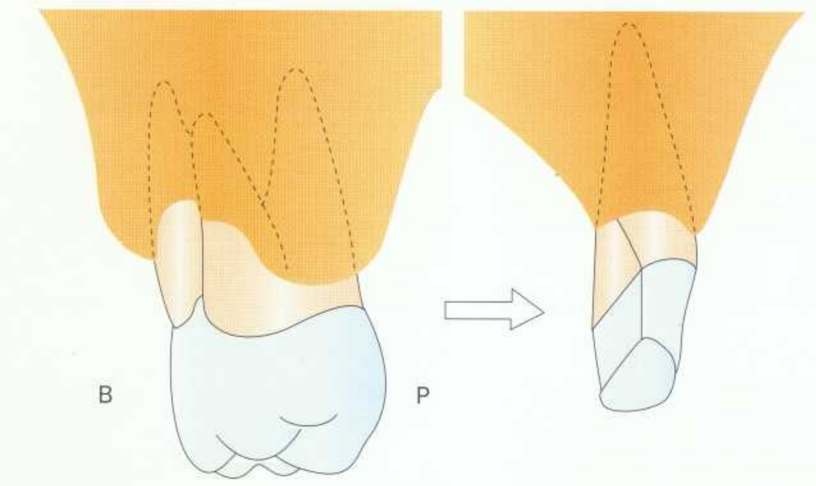
b. The root is amputated without preparing a flap because of the exposed furcation. First, the furcation of the removed root is cut with a thin fissure bur.



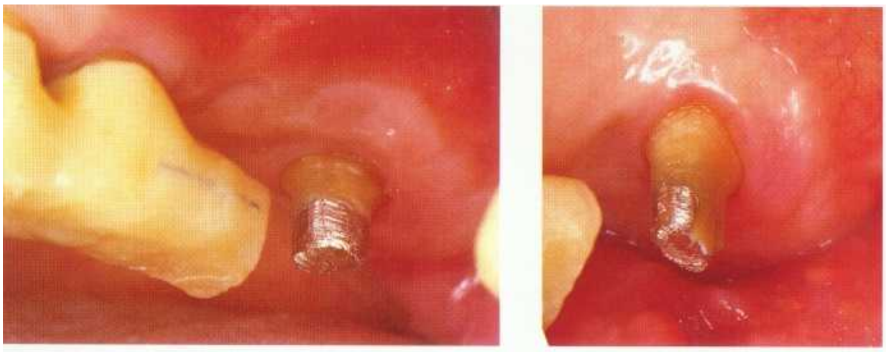
c. The bur is held parallel to the tooth axis and the root amputated with a deep cut. The root is probed after amputation to confirm completeness.



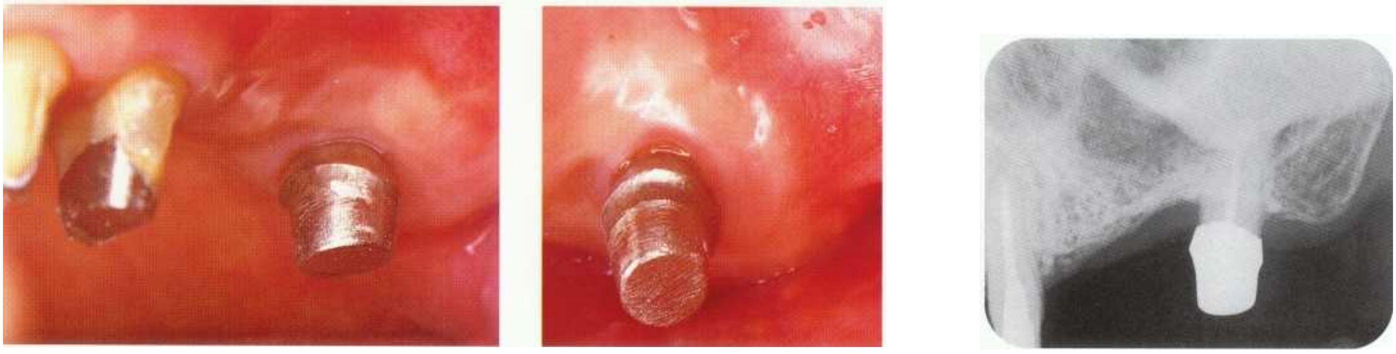
d. The buccal root is removed and the palatal root saved. The flap is prepared and the shape of the amputated surface corrected by performing odontoplasty from the alveolar crest toward the occlusal surface. **The craterlike osseous defect** around **the palatal root is eliminated.**



Prognosis



c6-5 Three months after root amputation. The furcation and periodontal pocket are eliminated.



c6-6 Placement of coping. A coping is placed on 15 to preserve parallelism and to prevent root fracture.

c6-7 Eleven years and 5 months after initial examination, 10 years and 10 months after root resection, and 10 years and 3 months after placement of final restorations. The depth of the gingival sulcus on the preserved palatal root of 15 is within 2 mm, the height of the alveolar crest is maintained radiographically, and there is no enlargement of the periodontal membrane space.

Case 1-7 Hemisection and an implant in a mandibular molar

c7-1 Three years and 8 months after initial examination, 44-year-old woman. Note the advanced furcation involvement on 30. The furcation is exposed because the roots of 29, 30, and 31 are short, as is the root trunk of 30.

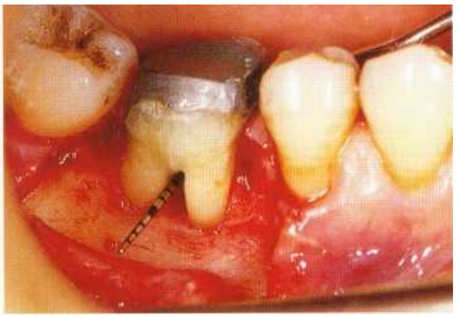
c7-2 Free autogenous gingival graft.

a. Because of the lack of attached gingiva on the mesial root of 30, a free autogenous gingival graft is performed to gain **keratinized** gingiva necessary for flap surgery. Preparation of periosteum-connective tissue recipient site.
b. After graft suturing.

Flap curettage as the first-stage treatment

c7-3 Flap curettage.

a. Three months after the free autogenous gingival graft. Sufficient keratinized gingiva for adequate flap preparation has been acquired.



b. Debridement of the furcation. A through-and-through condition, Class III, is revealed.

c. Flap suturing.

Hemisection

c7-4 Hemisection without flap preparation.

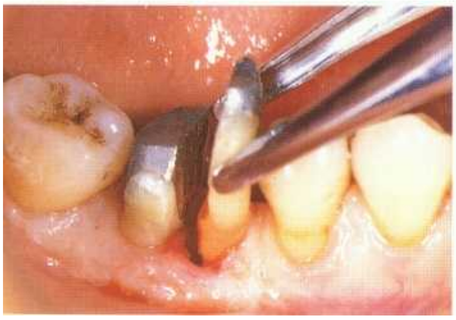
a. Exposed furcation.

b. The tooth is cut, 2-3 mm, with a long, thin fissure bur from the buccal aspect toward the lingual aspect with the bur held parallel to the long axis of the tooth.

c. Caution is required when cutting deep to avoid damaging the residual root. Roots are separated to probe.

c7-4 (continued)

d. The gingivodental fibers of the mesial root are cut with a no. 15 blade.



e. The mesial root is removed.

f. With a curette, the granulation tissue in the extraction socket is removed and the tissue sutured.

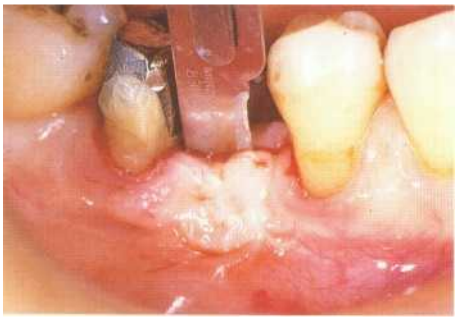
Key point

Use a small elevator and extraction forceps to luxate the tooth gently and with minimal resistance. Never insert the elevator into the buccal and lingual walls.

Osseous resection after hemisection

c7-5 Osseous resection.

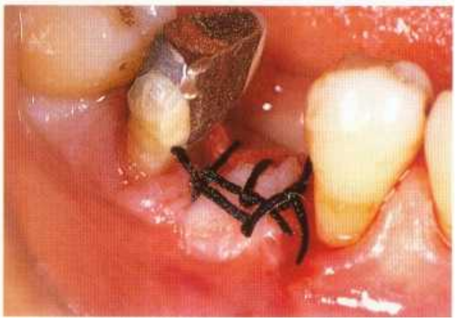
a. Two months after hemisection.



b. Incision of the wedge procedure (linear incision).

c. Note the shallow crater on the mesial aspect of the distal root of 30 and an overhang on the resected crown after flap reflection.

d. The osseous defect around the residual root is removed and a smooth bone morphology created. At the same time, the overhang of the crown is removed with a finishing bur. Odontoplasty is performed to create a smooth crown form.



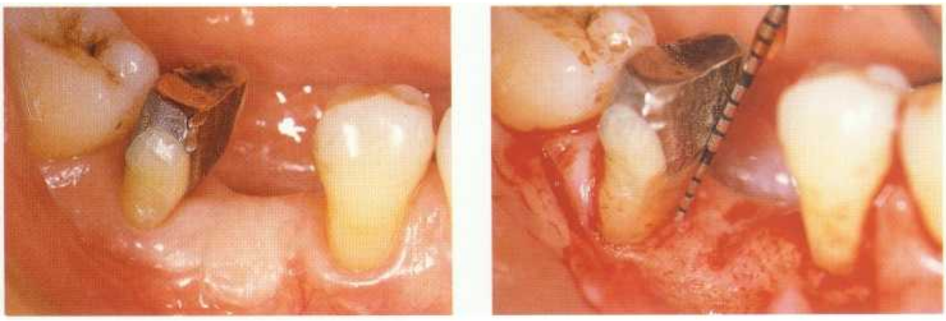
e. Suturing.

Key point

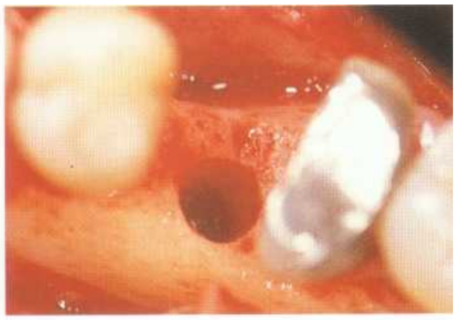
Perform osseous resection after root resection or hemisection to remove craterlike osseous defects around the preserved root. This eliminates periodontal pockets, provides a harmonious, physiologic gingiva-alveolar form, and achieves a form that makes plaque control easier.

Osseointegrated implant placement

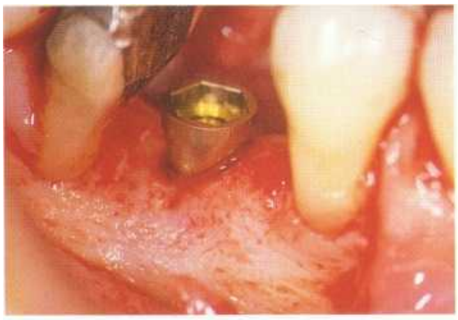
c7-6 Implant placement.



a. Four months after osseous resection and 6 months after hemisection of the mesial root. An implant is placed in the removed mesial root area to avoid using 29 (which has a short root) as the abutment of the fixed partial denture.



b. Drilling is completed at the implant site.



c. A POI two-piece implant (Finafix; Kyocera), 10 x 3.7 mm, is placed (left).

d. Suturing.

c7-7 Two and one *half* months after implant placement.

c7-8 Nine months after surgery. A coping is placed on the distal root and a straight post is placed on the implant. The radiograph shows status 7 months after surgery.

c7-9 One year and 4 months after implant placement. The crown connecting the implant superstructure and the distal root is placed.

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2

Increasing the Attached Gingiva

Methods and Indications of Mucogingival Surgery

Friedman[1] described mucogingival surgery (MGS) as plastic surgery that concerns relations between mucogingival tissues and attached gingiva, alveolar mucosa, frenum, muscle attachment, and vestibule. There were a number of surgical methods for various conditions and objectives, but no method satisfied all objectives. The main objective of mucogingival surgery is shifted to improve the periodontal environment by increasing the attached gingiva and providing root coverage (Table 2-1). This is further discussed in Chapter 6.

Mucogingival surgery is appropriate where there is little attached gingiva and persistent inflammation (after initial therapy) or in areas with advanced gingival recession. However, it is unnecessary where narrow gingiva is healthy or there is no attached gingiva.

Most cases of advanced periodontal disease that require periodontal prostheses or implant prostheses lack attached gingiva, have deep periodontal pockets, or have intrabony defects. In these cases, mucogingival surgery is not indicated because of the presence of gingival inflammation.

The important consideration is whether there is or is not a sufficient band of attached gingiva. This will determine the surgical approach to periodontal pockets or intrabony defects.

When considering mucogingival surgery and surgical methods, problems related to the band of attached gingiva, osseous defect, and periodontal pocket must be taken into account. As Figure 2-1 shows, there are three primary factors:

1. Band of attached gingiva
2. Presence of osseous defect
3. Whether the bottom of periodontal pocket is beyond the mucogingival junction[2]

If there is a narrow band or no band of attached gingiva, there are two possible uses of mucogingival surgery. If there is an osseous defect and if the periodontal pocket extends beyond the mucogingival junction, it is desirable, as a pretreatment for managing the intrabony defect, to increase the attached gingiva by mucogingival surgery to facilitate flap surgery.[3]

In the absence of these problems, surgical methods should be determined by the 1) thickness of the alveolar process, 2) existence of osseous dehiscence, 3) tooth position in dental arch and root protrusion, and 4) gingival thickness (Fig 2-2).

Table 2-1 Objectives and Methods of Mucogingival Surgery
1. Increasing the width of the attached gingiva
a. Partial-thickness, apically positioned flap surgery
b. Pedicle gingival grafts (full or partial thickness)
• Laterally positioned flaps
• Double papilla flaps
• Multiple interdental papilla grafts
• Edentulous-area pedicle grafts
c. Free autogenous gingival grafts
d. Connective tissue grafts
• Free connective tissue grafts
• Subepithelial connective tissue grafts
2. Root coverage (explained in detail in Chapter 6)
3. Frenum surgery

Fig 2-1 Indications for mucogingival surgery (MGS).

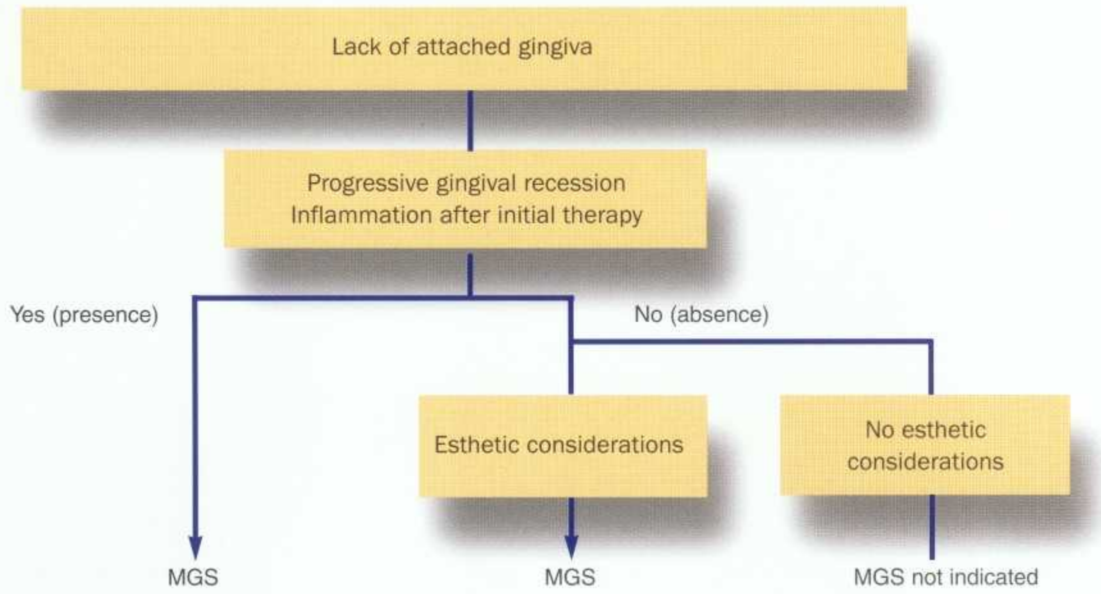
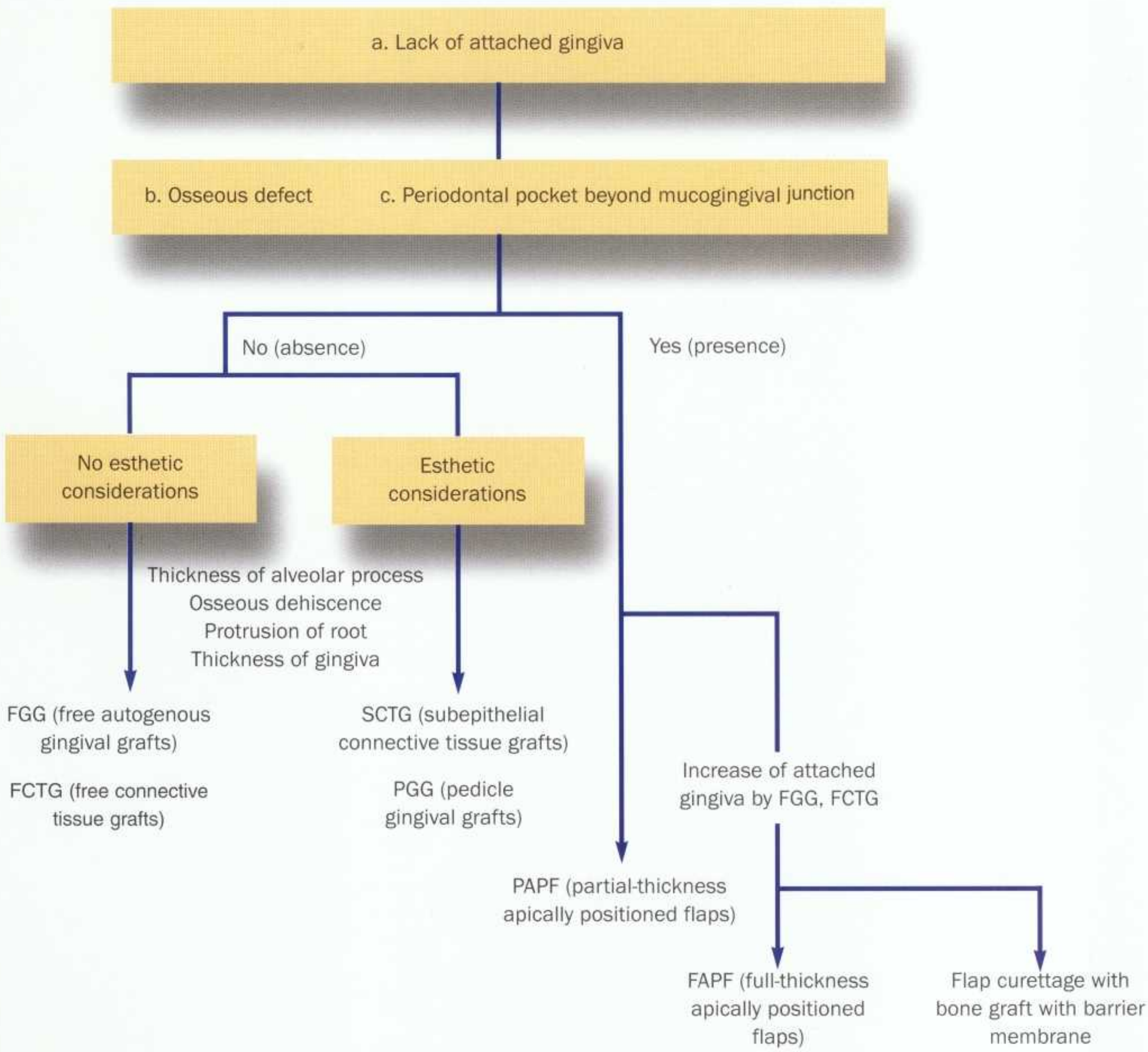


Fig 12-2 Lack of attached gingiva and selection of mucogingival surgery.



Partial-Thickness, Apically Positioned Flap Surgery

Partial-Thickness and Full-Thickness

Apically positioned flap surgery, in which flaps are reflected with an internal bevel incision and sutured apical to the preoperative position, is one of the most reliable techniques for the elimination of periodontal pockets.

Norberg[14] first advocated this technique for mucogingival problems in periodontal disease. Nabers introduced the concept of repositioning the attached gingiva; the full-thickness flap was displaced apically to increase the attached gingiva. Friedman called the procedure the apically repositioned flap.

In summary, attached gingiva can be increased by displacing the flap apically. This eliminates the periodontal pocket and ensures the sound root surface needed for increasing the biologic width on the alveolar crest.

The apically positioned flap may be a full-thickness flap or a partial-thickness flap. In the full-thickness, apically positioned flap, the full-thickness flap is displaced apically and the flap's edge placed apical to the alveolar bone crest. Postoperatively, the exposed bone is covered by gingiva with an increase in attached gingiva.

With the partial-thickness, apically positioned flap, the partial-thickness flap is displaced apically and a periosteal suture made. This technique increases the width of the attached gingiva on the exposed periosteum-connective tissue between the flap's edge and the edge of the periosteum-connective tissue.

In this section, partial-thickness, apically positioned flap surgery is described for increasing the width of the attached gingiva. For apically positioned flap surgery as a resective procedure, see Chapter 1.

If apically positioned flap surgery is performed where the periodontal pocket reaches or extends beyond the mucogingival junction and the attached gingiva is extremely thin, the flap may be prepared with full thickness (including periosteum) or partial thickness (excluding periosteum). The choice of method is determined by:

1. Whether osseous defects therapy is necessary or not.
2. The thickness of the gingiva and alveolar bone margin in the operative area.

In the case of an osseous defect, it is necessary to make a full-thickness flap to ensure the accessibility of instruments to the osseous defect area; periosteum and connective tissue should be removed from the bone by curette, bur, or bone chisel, even if the periosteum-connective tissue site is prepared on the bone surface using a partial-thickness incision.

Position of the Displaced Flap

The position of the flap after apically positioned flap surgery varies and depends on the desired results and objectives (Table 2-2).

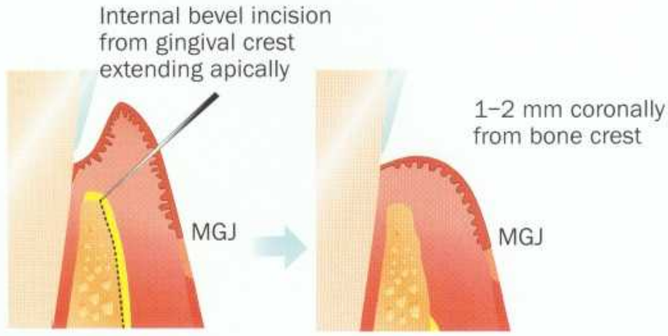
Table 2-2 Factors in Determining the Position of the Apically Positioned Flap

1. Width and thickness of gingiva
2. Thickness of marginal alveolar bone
3. Amount of periodontal pocket to be eliminated
4. Clinical crown length required for restorative/prosthetic treatment and esthetics
5. Length of root trunk

Table 2-3 Friedman and Levin Classification[17]

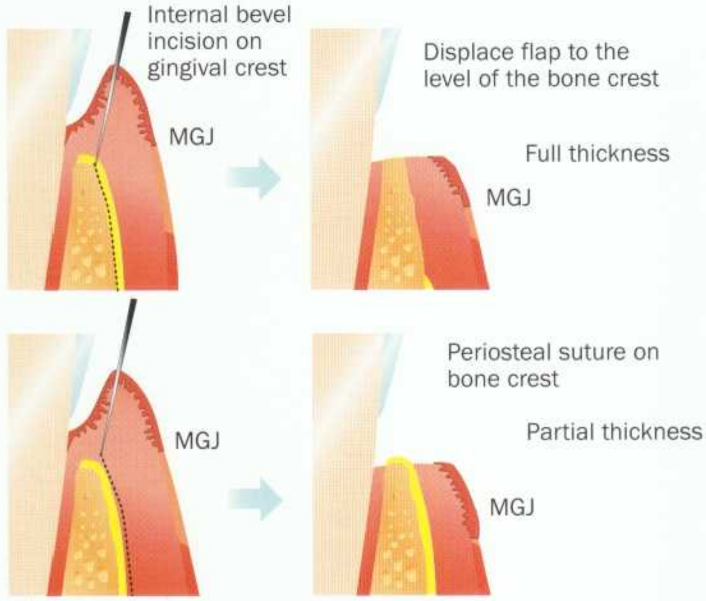
Class I: Wide and sufficient keratinized gingiva width (4–6 mm)

- The primary incision is an internal bevel incision beginning at the gingival crest and extending apically.
- Displace the full-thickness flap apically where the flap covers the marginal bone and 1–2 mm coronally from the bone crest. Suture.



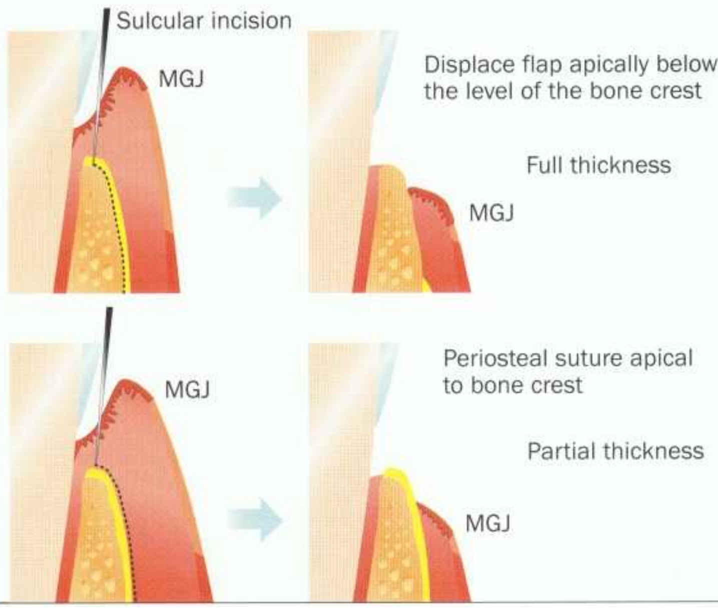
Class II: Sufficient keratinized gingiva width

- The primary incision is an internal bevel incision on the gingival crest.
- Displace the flap (either full-thickness or partial-thickness) to the alveolar crest and suture.



Class III: Insufficient keratinized gingiva width

- The primary incision is a sulcular incision to preserve the keratinized gingiva.
- Displace the flap edge apically from the bone crest to increase the width of the keratinized gingiva and suture. If the marginal alveolar bone is thick, expose the periosteum–connective tissue or a small part of bone surface on the alveolar crest. This augments the width of the attached gingiva.



Friedman and Levin classified the primary incision position and displaced flap position of the apically positioned flap on the basis of the amount of existing keratinized gingiva in the surgical area (Table 2-3). The amount of increased gingiva postoperatively is influenced by the position of the displaced flap.

In areas where the gingiva is insufficient, the width of the attached gingiva is increased by displacing the flap far apically from the bone crest. Therefore, when performing apically positioned flap surgery to increase the width of the attached gingiva, the flap should be displaced on the bone crest or apical to the bone crest. One advantage of this method is that it creates a favorable gingival morphology postoperatively. It also increases the attached gingiva and helps to avoid unstable epithelial attachment (Table 2-3, Class III).

However, displacing the flap apically to the alveolar bone crest where the marginal bone is exposed may cause irreversible loss of marginal alveolar bone, especially where the marginal alveolar bone is very thin or where there is root proximity. Bone loss and prolonged postoperative pain are possible risks.

In full-thickness, apically positioned flap surgery, the author displaces the flap close to the bone crest to avoid such risks, except in conditions that are extremely favorable. 13

Where increased width of attached gingiva is desirable, marginal bone cannot be exposed because it is thin. Therefore, a partial-thickness flap should be used to increase the attached gingiva.

Indications for Partial-Thickness Flaps

There are two advantages to the partial-thickness flap.

1. The flap can be attached firmly to the desired position with a periosteal suture (Case 2-l, cl-10) if the reflected flap is displaced apically.
2. The thin marginal bone can be protected by the periosteum-connective tissue bed.

However, the biggest problem of a partial-thickness flap is with the thickness of the remaining periosteum-connective tissue bed on the bone. If it is less than 0.5 mm, the remaining periosteum-connective tissue may become necrotic, with decreased protective effect for the alveolar bone.'

Generally, narrow attached gingiva is thin tissue with thin underlying bone. Therefore, it is difficult to prepare a periosteum-connective tissue site of adequate thickness on the bone surface to prevent bone loss. And it is difficult to prepare a partial-thickness flap of adequate thickness to maintain blood supply to the flap. Conversely, in an area with thick periodontium and sufficient attached gingiva width, deep intrabony defects are frequent because of the thick underlying bone tissue. In these cases, an apically positioned flap is not indicated. In such cases, the periosteum-connective tissue that covers the root and bone should be thinned to make it nonmobile during surgery.

As indicated above, partial-thickness, apically positioned flap surgery is considerably limited clinically, so sufficient gingiva thickness is essential for good results. If the gingiva and mucosa covering the alveolar process are thin, a partial-thickness, apically positioned flap is contraindicated.

In conclusion, partial-thickness apically positioned flap surgery is used to increase the width of the attached gingiva and to eliminate periodontal pockets. It is used in areas where the gingiva is thick, where the width of the kera tinized gingiva is 2-3 mm, and the periodontal pocket is close to or apical to the mucogingival junction.

The choice of therapies to increase the width of attached gingiva are:

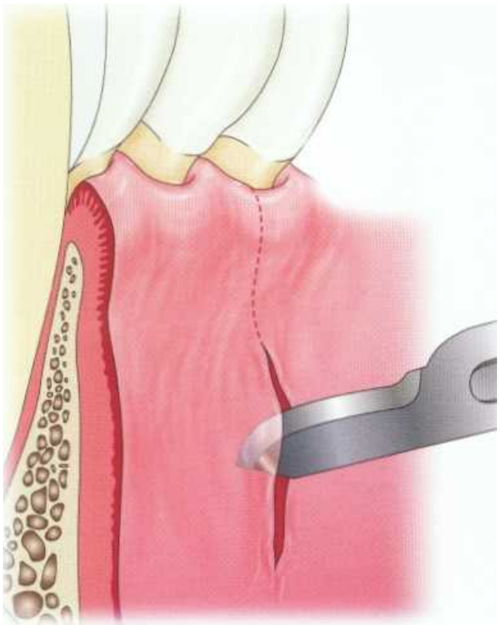
1. Partial-thickness apically positioned flap surgery in cases where thick keratinized gingiva exists on the gingival margin preoperatively, and where the oral vestibule has sufficient depth.
2. Free autogenous gingival grafts or connective tissue grafts in cases where keratinized gingiva is completely absent, and marginal tissue becomes alveolar mucosa.
3. Free autogenous gingival grafts in cases where 1-2 mm of keratinized gingiva exists but underlying marginal alveolar bone is extremely thin.

Both partial-thickness, apically positioned flap surgery and free autogenous gingival grafts produce sufficient width; however, free autogenous gingival grafts better prevent recession of the gingival margin than do partial-thickness, apically positioned flaps. Free autogenous gingival grafts protect the deep connective tissue and bone.'

Table 2-4 Conditions Necessary for Partial-Thickness, Apically Positioned Flap Surgery
1. Thick gingiva. The partial-thickness flap must be of adequate thickness (1–1.5 mm) where there is adequate blood supply. Thick gingiva is necessary for the remaining periosteum–connective tissue on the marginal alveolar bone to protect the bone and root surface completely. It is also necessary for a successful periosteal suture.
2. Absence of thick alveolar bone margin, marginal alveolar bone defect, bony protuberance, or exostosis, which require extensive osseous resection.
3. Sufficient oral vestibule depth.
4. Adequate alveolar bone covering the root.
5. Little attached gingiva on gingival margin preoperatively. If the marginal tissue is alveolar mucosa, a free autogenous gingival graft is indicated.
6. No deep intrabony defect. If there are intrabony defects, they should be as shallow as possible because they may have to be removed by osseous resection.

Table 2-5 Indications and Contraindications of Partial-Thickness, Apically Positioned Flap Surgery
Advantages
1. Ability to fix flap to optimal position with periosteal suture.
2. Periodontal pocket eliminated and width of the attached gingiva increased with one treatment.
3. Thin marginal alveolar bone can be protected by periosteum–connective tissue site.
4. Easily combined with other forms of mucogingival surgery.
5. Clinical crown length extended while biologic width gained.
Disadvantages
1. Technically demanding.
2. Danger of penetrating flap during incision. Necrosis may result because of severe damage to the blood vessels.
3. Difficulty in manipulating the suture.
4. Postoperative swelling.
5. Delayed healing because healing is by secondary intention.
6. Treatment may be complicated if combined with osseous resection.
Indications
1. Increase of the attached gingiva in an area with narrow attached gingiva and sufficient oral vestibule depth, with no extensive treatment for bone necessary.
2. Avoid exposing areas where the alveolar bone is thin because of a protruding tooth and where there is likelihood of osseous dehiscence or osseous fenestration.
3. Elimination of a periodontal pocket that extends beyond the mucogingival junction with narrow attached gingiva.
4. Extension of clinical crown length for restorative/prosthetic treatment (crown lengthening surgery).
Contraindications
1. Thin gingiva.
2. Lack of keratinized gingiva at gingival margin.
3. Narrow oral vestibule.
4. Extremely thin alveolar process.
5. Extensive osseous surgery required.
6. Deep intrabony defect requiring bone regeneration or restoration.

Case 2-1 Apically positioned flap surgery to increase the width of the attached gingiva



c1-1 Preoperative status. 62-year-old woman after removal of a fixed partial denture. The crown margin is deeply subgingival. Note the subgingival caries. Because of the narrow attached gingiva on 29 and 28, extension of crown length and increase of the width of attached gingiva is required before restorative treatment.

Preparation of buccal partial-thickness flap

c1-2 Vertical incision. With a no. 15 blade, a vertical incision is made from the alveolar mucosa toward the crown without extending into the bone.

Key point

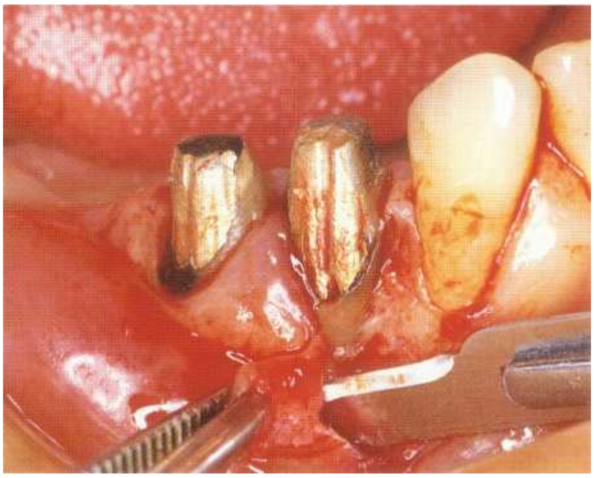
For apical migration of the flap, make a vertical incision beyond the mucogingival junction but not to the bone.

c1-3 Scalloped incision. A scalloped horizontal incision and a scalloped internal bevel incision are prepared from the gingival sulcus. They are connected with a vertical incision.

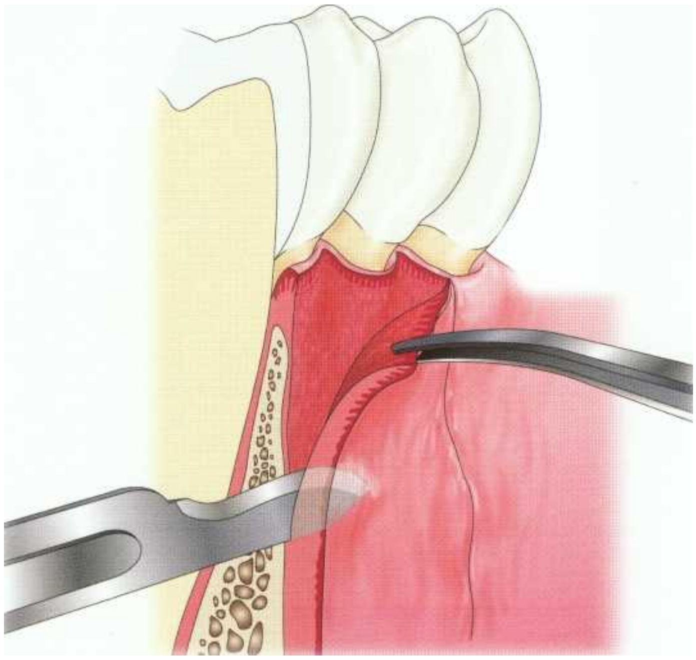
Key point

Prepare a scalloped, partial-thickness internal bevel incision between the epithelium and periosteum, including the gingival sulcus surface, using the 2-3-mm tip of a no. 15 blade. Prepare the incision while holding the blade parallel to the gingival surface. Preserve the keratinized gingiva as much as possible in the internal bevel incision.

c1-4 Partial-thickness incision.



a. The partial thickness incision is prepared with the flap edge held with tissue pliers, with tension provided to the flap by pulling. The blade is turned toward the gingival margin and slowly moved apically. Then reflect the flap.



b. Preparation for the partial-thickness flap is completed. A vertical incision is made on the distal aspect of 29.

Key point

To prevent flap perforation in partial-thickness incisions.

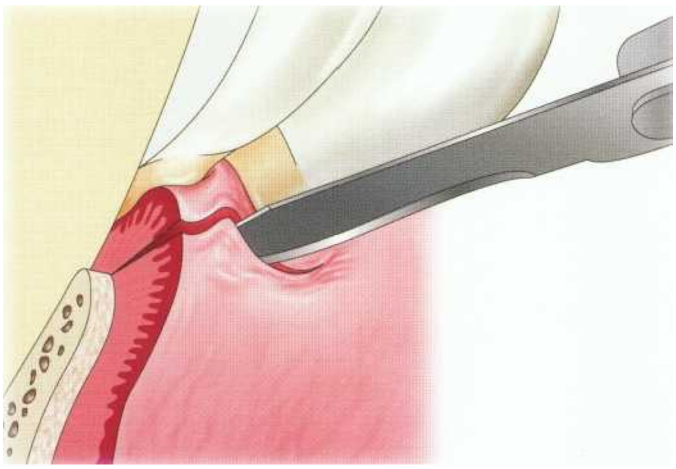
1. Use 2-3-mm tip of blade.
2. Always adapt the side of the blade to the periosteurn-connective tissue and keep it parallel to the gingiva during the incision.
3. The thickness of the flap should not be less than 1.5 mm to prevent necrosis and to facilitate suturing.

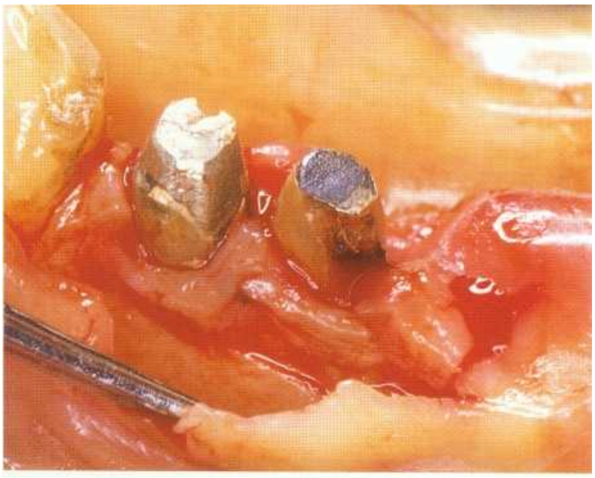
Prepare a partial-thickness flap while holding and pulling the flap edge with tissue pliers, turning the blade toward the gingival margin. The flap is dissected slowly from an apico-occlusal direction. To prevent flap penetration, use the side of the blade and hold it parallel to the periosteum to make the incision.

Preparation of a lingual full-thickness flap

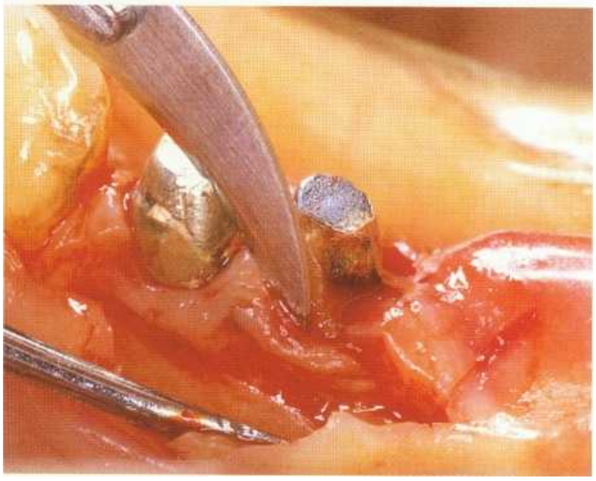
c1-5 Primary incision.

a. A primary incision (internal bevel incision toward the alveolar bone crest) is prepared apical to the gingival margin to obtain sufficient supragingival tooth structure after surgery.

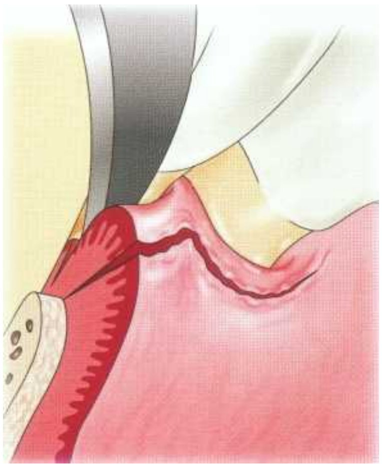




b. A full-thickness flap is reflected.

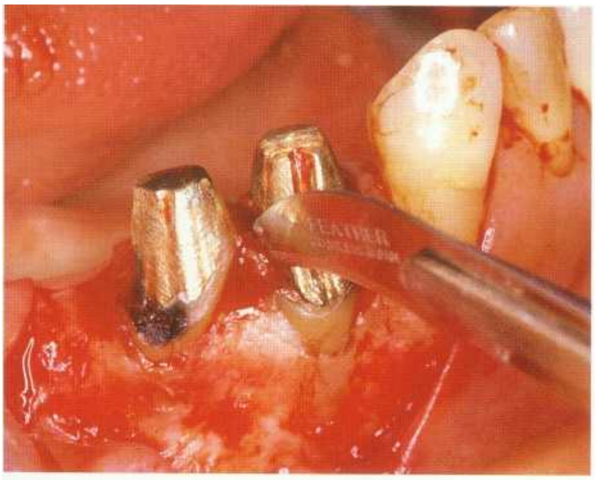


c1-6 Secondary incision. A secondary incision is made from the gingival sulcus toward the bone crest with a no. 12 blade. The secondary flap is separated from the tooth.

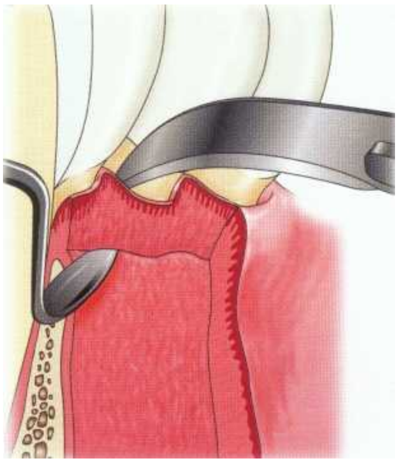


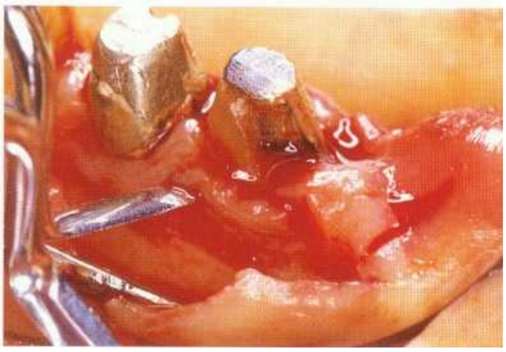
Preparation of the partial-thickness recipient site

cl-7 Removal of marginal gingiva.



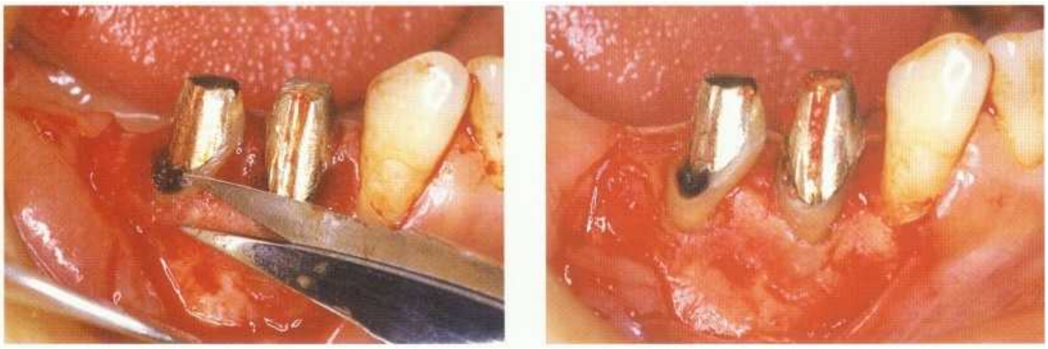
a. Secondary incision is made with a no. 12 blade to remove, as a mass, the marginal tissue on the alveolar bone crest.





b. A third incision is made with an Orban interdental knife along the alveolar bone crest from the buccolingual aspect, and the secondary flap is removed with a curette.

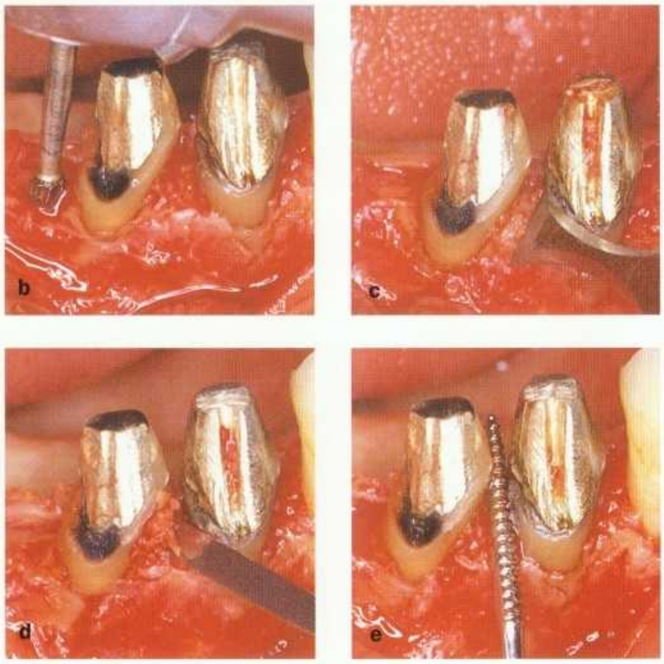
c1-8 Preparation of the periosteum-connective tissue site. The residual elastic and muscle fibers are removed with an Orban interdental knife or scissors, and a smooth, solid, and immobile (or keratinized) periosteum-connective tissue bed is prepared.



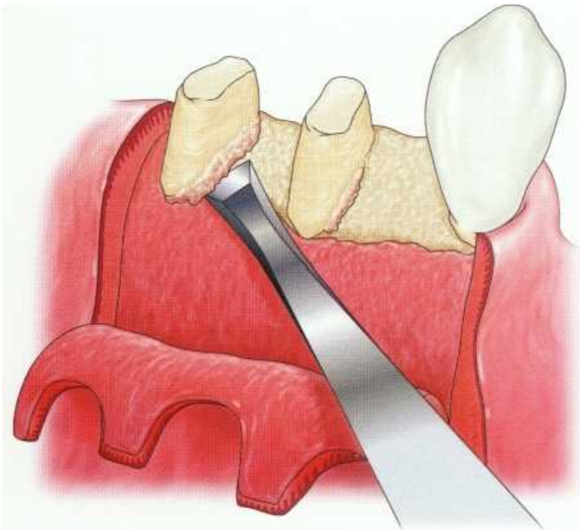
Crown lengthening by osseous resection

c1-9 Osseous resection.

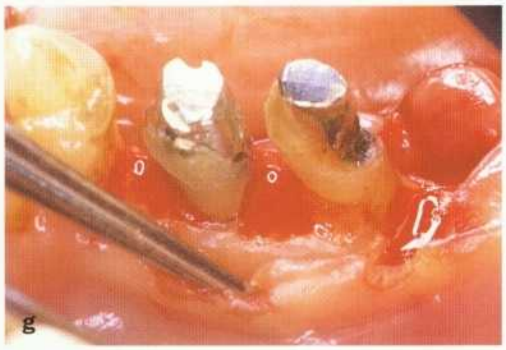
a. The distance from the prepared tooth margin to the alveolar crest of 28 is 2 mm **on the mesial aspect and 1 mm on the distal aspect.** On 29, it is 2 mm on the mesial aspect.



b-e. Osteoplasty and osseous resection are performed with a carbide bur (b), Ochsenbein chisel (c), Wedelstadt chisel (d), and Sugarman file (e) to extend the crown length while preserving the biologic width.



f. After osseous resection, 3-4 mm of sound tooth structure is gained on the alveolar bone. The distance from prepared tooth margin to the alveolar bone is 3 mm on the mesial and distal aspects of 28, and 4 mm on the mesial aspect of 29.

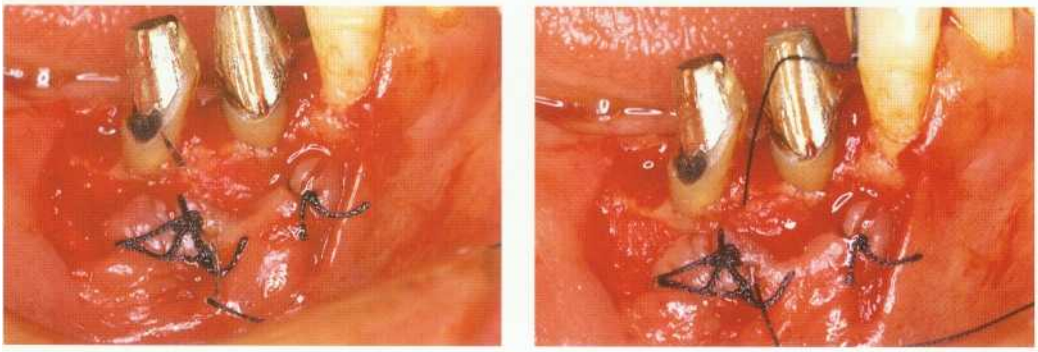


g. After osseous resection on the lingual aspect, 5 mm of sound tooth structure from the prepared tooth margin to the bone crest (approximately 4 mm on the alveolar bone) is preserved.

Suturing of flap

cl-10 Periosteal suture.

a. The flap is displaced apically from the bone crest to extend the crown length and to increase the width of the attached gingiva. A periosteal suture is made by first suturing the bilateral papilla on the mesiodistal aspect of 29 to make a double papilla flap. It is then placed on the root surface of 29.



b. On 28, a partial-thickness flap is displaced apically and a periosteal suture using 4.0 silk thread is made.

c. The flap is displaced so that it covers the bone on the thin root. A periosteal suture is made. A continuous suspensory suture is prepared on the lingual flap. A periodontal pack (dressing) is placed after suturing.

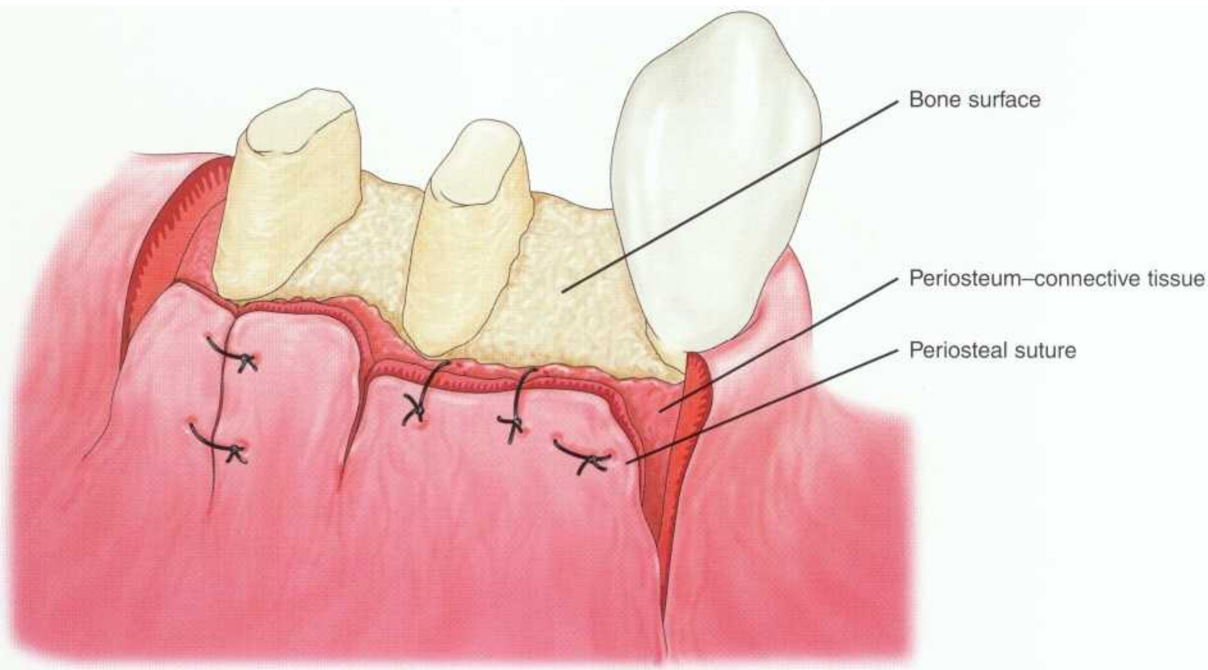
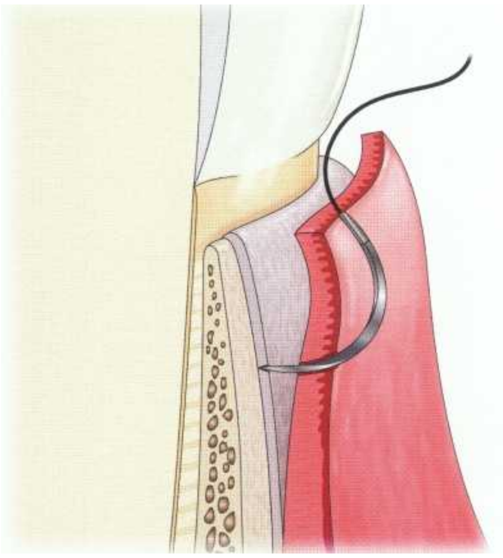
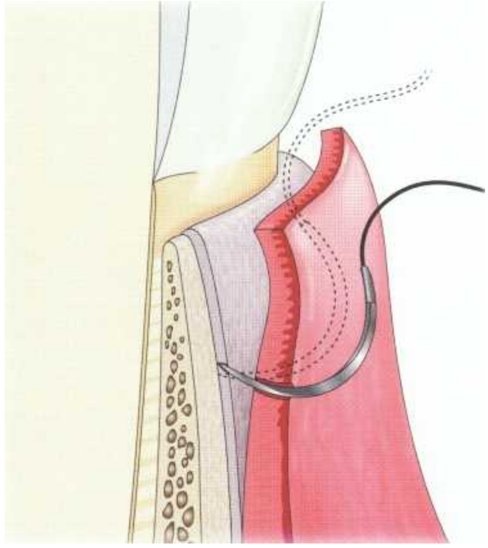


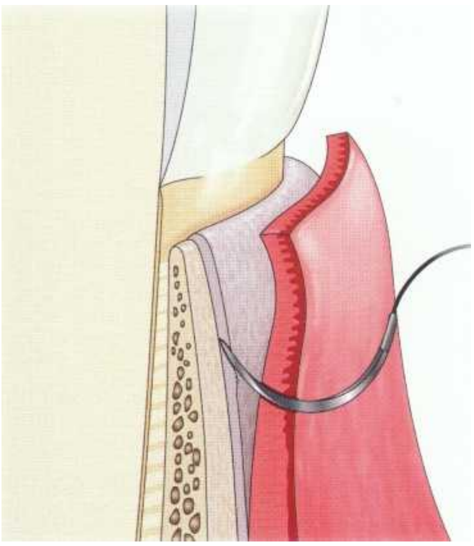
Fig 2-3 Procedure for periosteal suture.



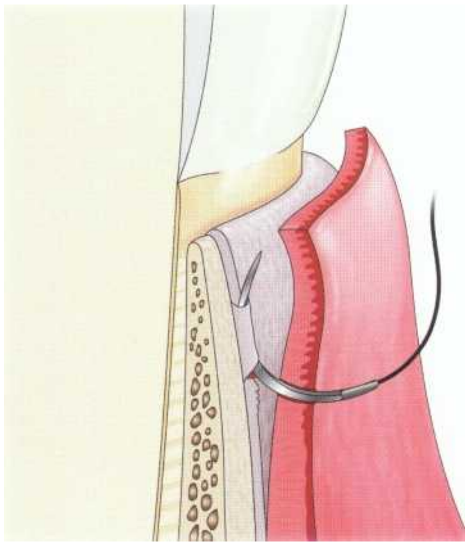
a. Pierce the flap perpendicular to the tissue surface.



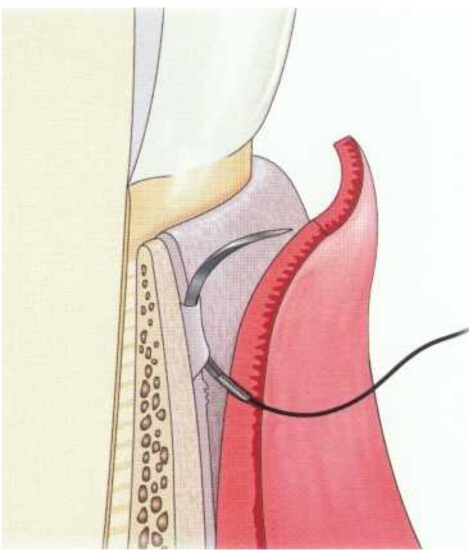
b. Insert the needle perpendicular to the periosteum-connective tissue and rotate it along the needle's curve with the needle tip as the center of rotation.



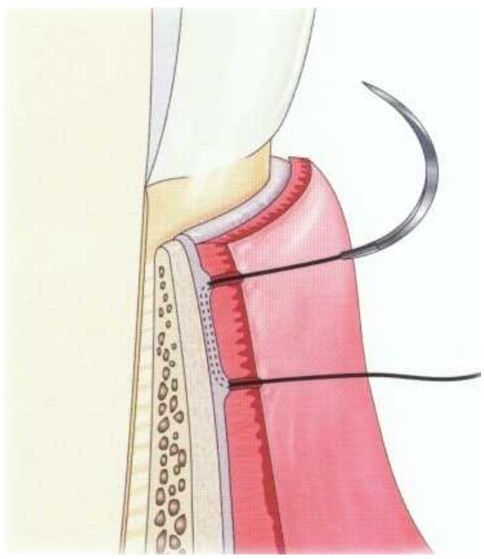
c. Engage the periosteal fibers while rotating the needle.



d. Slide the needle coronally along the bone surface.



e. Remove the needle from the periosteum-connective tissue from the internal surface of the flap.



f. Make a surgical knot with the end of the suture thread and complete the periosteal suture.

Prognosis

cl-11 Prognosis of the apically positioned flap.

a. Eleven days after surgery.

b. Eighteen days after surgery.

c. Twenty-eight days after surgery. The gingival surface is almost healed, the crown length is extended, and the width of the attached gingiva is increased.

d. About 15 months after surgery.

e. About 2 years and 3 months after surgery.

f. About 2 years and 4 months after surgery.

g. About 4 years after surgery.

Multiple Interdental Papilla Grafts

Hattler" described the modified laterally positioned flap using the interdental papilla as the donor tissue to gain attached gingiva. This method was later related in detail as multiple interdental papilla grafts by Corn."' With this method, a partial-thickness pedicle flap is prepared with sufficient interdental papilla. The flaps are displaced apically or a half of tooth laterally, the papilla flap is placed at the center of the root surface or marginal alveolar bone crest, and a periosteal suture is made.

Table 2-6 Multiple Interdental Papilla Grafts

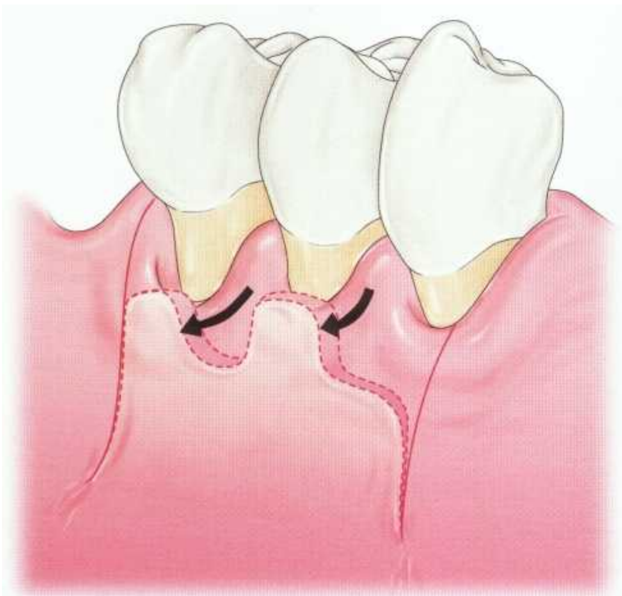
Advantages
1. The partial-thickness grafts, composed of thick interdental papilla, protects the alveolar bone covering the root surface.
2. This method is available for areas where attached gingiva is lacking but where there is interdental papilla of sufficient width and length.
3. Can be used for cases with a shallow oral vestibule.
4. Interdental craterlike osseous defects can be removed using osseous resection.
5. Can increase the width of the attached gingiva of multiple teeth and eliminate a periodontal pocket with one surgery.
6. Clinical crown length can be extended.
Indications
Multiple interdental papilla grafts are used to increase narrow attached gingiva and acquire new attached gingiva where attached gingiva is lacking. The indications are:
1. Interdental papilla with sufficient thickness (at least 3–4 mm length and width).
2. Interdental periodontal pockets are to be eliminated and the width of the attached gingiva increased.
3. For partial-thickness apically positioned flap surgery where the alveolar bone covering the root is extremely thin. Minimizes defects such as loss of thin marginal alveolar bone and osseous dehiscences or osseous fenestrations postoperatively.

Case 2-2 Multiple interdental papilla grafts to increase the width of the attached gingiva

Key point

This is a **modified method for the laterally positioned flap** and is usually used with partial-thickness apically positioned flaps.

Use a papilla flap as the donor tissue and displace the flap apically or half a tooth mesially or distally Suture the papilla flap at the center of the root surface or at the marginal alveolar bone crest. This method is indicated when the length and width of the interdental papilla is 3-4 mm or more.



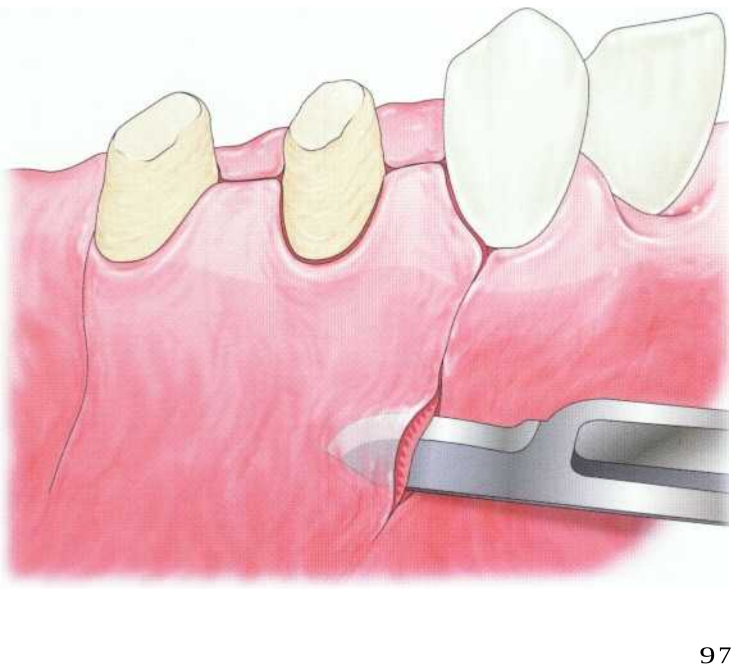
c2-1 Preoperative status. The depth of the periodontal pocket is 4-6 mm, and the bottom of the pocket on the buccal aspect of 29 is beyond the mucogingival junction. The width of the attached gingiva is also narrow. The length and width of the interdental papilla are 3-4 mm.

Multiple interdental papilla grafts

c2-2 Incision on the lingual aspect. An internal bevel incision is made to the alveolar bone crest on the lingual aspect.

c2-3 Incision on the buccal aspect.

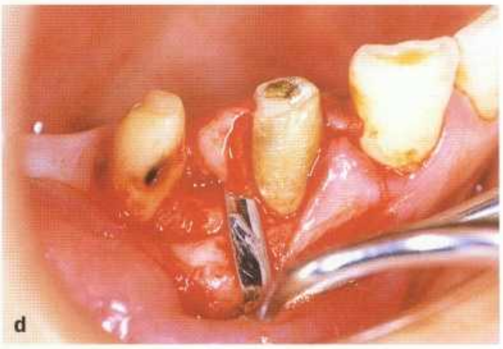
a. A vertical incision is made on the mesial aspect at the surgical site and the alveolar mucosa incised without making contact with the bone.
b. A scalloped partial-thickness internal bevel incision is made in the interdental papilla with a no. 15 blade. A partial-thickness pedicle flap with sufficient interdental papilla is prepared.
c. The no. 15 blade is guided to the gingival margin. A vertical incision is made and the blade advanced coronally from apical of the alveolar mucosa. A partial-thickness flap is prepared.



Key point

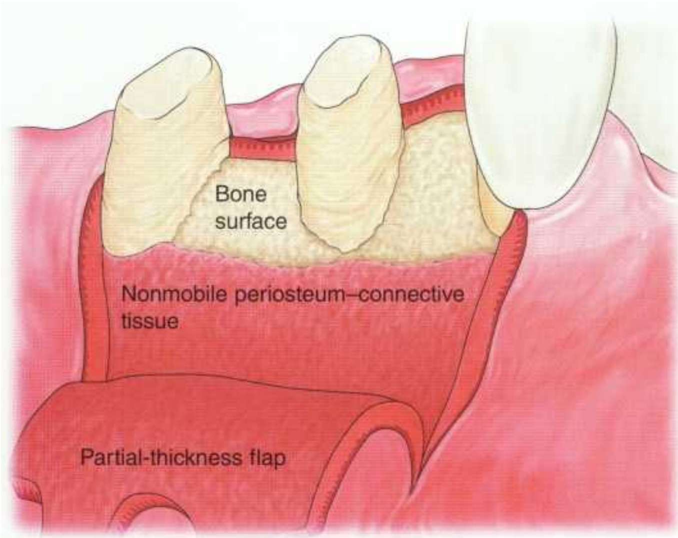
Make a partial-thickness incision as deep as 2-3 mm from the gingival margin, moving apically using the anterior 2-3 mm of the blade.

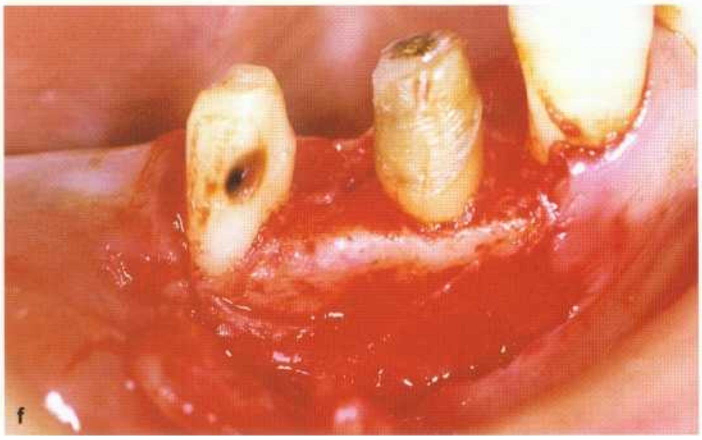
When making the incision, always hold the blade **tip parallel** to the gingival surface. Undermine the interdental papilla little by little while lifting the papilla gently with the side of the blade. Separate it from the underlying connective tissue. It is important to preserve the mesiodistal width of the interdental papilla.




d, e. The secondary flaps are removed in the lingual interdental area with an Orban interdental knife.

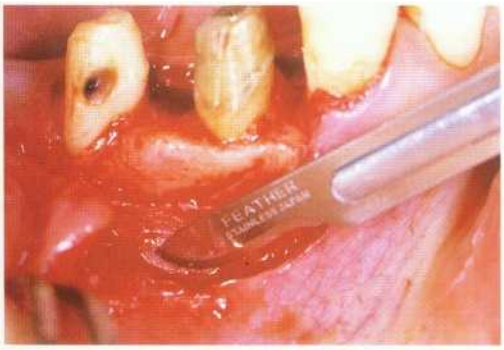
f. The bone surface of the thick, buccal marginal alveolar bone of 29 is exposed. Apically, nonmobile (or keratinized) periosteum, which is the connective tissue site, has formed. Osseous resection is unnecessary because there is 3 mm from the prepared tooth margin to the bone crest of 28 and 29. The biologic width is also preserved.



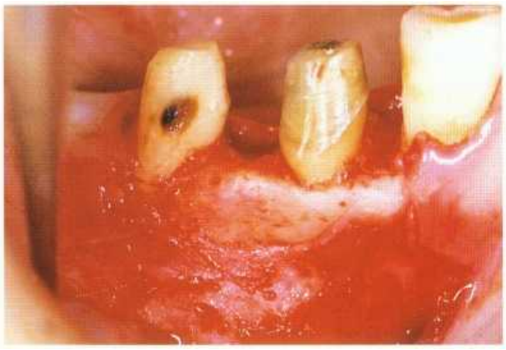


Suturing

c2-4 Releasing incision of the periosteum.

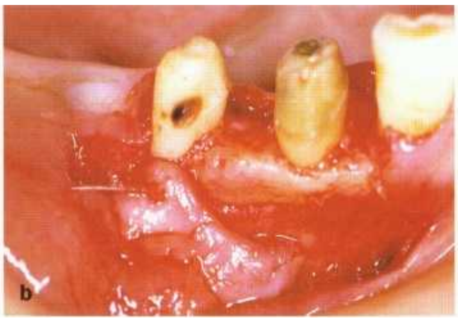
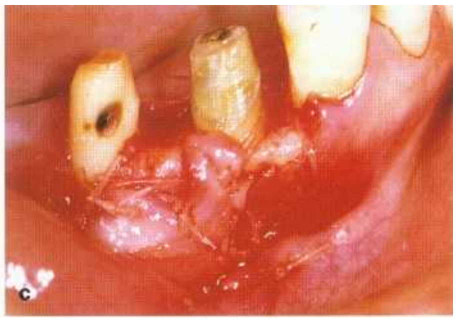


a. A periosteal relieving incision to the alveolar mucosa apical to the flaps is made to permit flap migration without tension.



b. Incised flap.

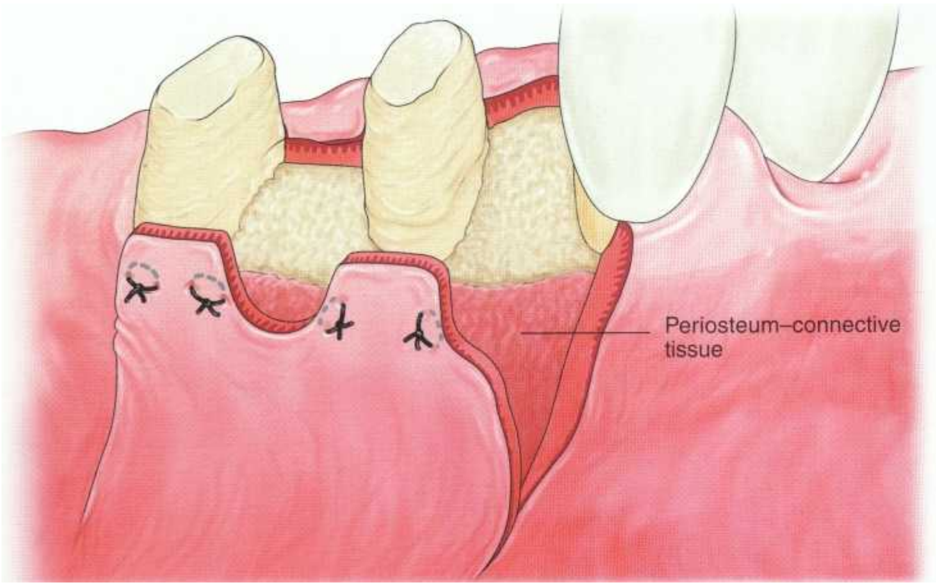
c2-5 Suturing.

a. The flap is displaced apically and half of the tooth distally to increase the attached gingiva. The papilla flap is placed on the marginal alveolar bone of 28 and 29 and a periosteal suture made with 4-0 absorbable material.

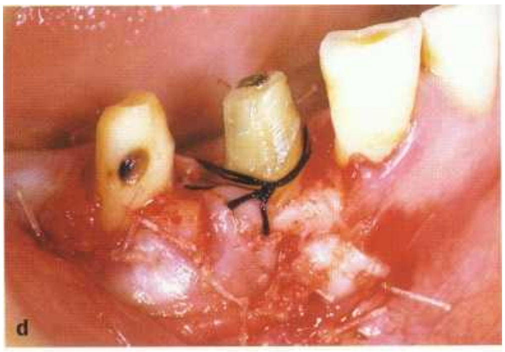
b, c. A periosteal suture of the distal part of the papilla flap is made and secured. Periosteal suture on 28.

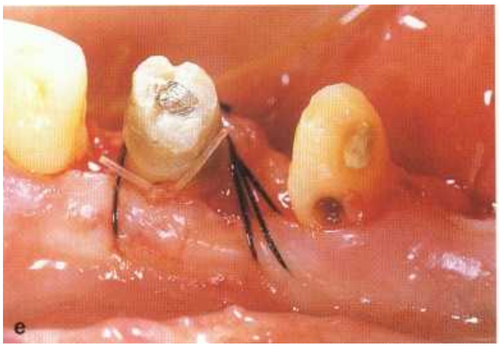
Displace the flap apically and half of tooth distally and make a periosteal suture on the marginal alveolar bone crest.

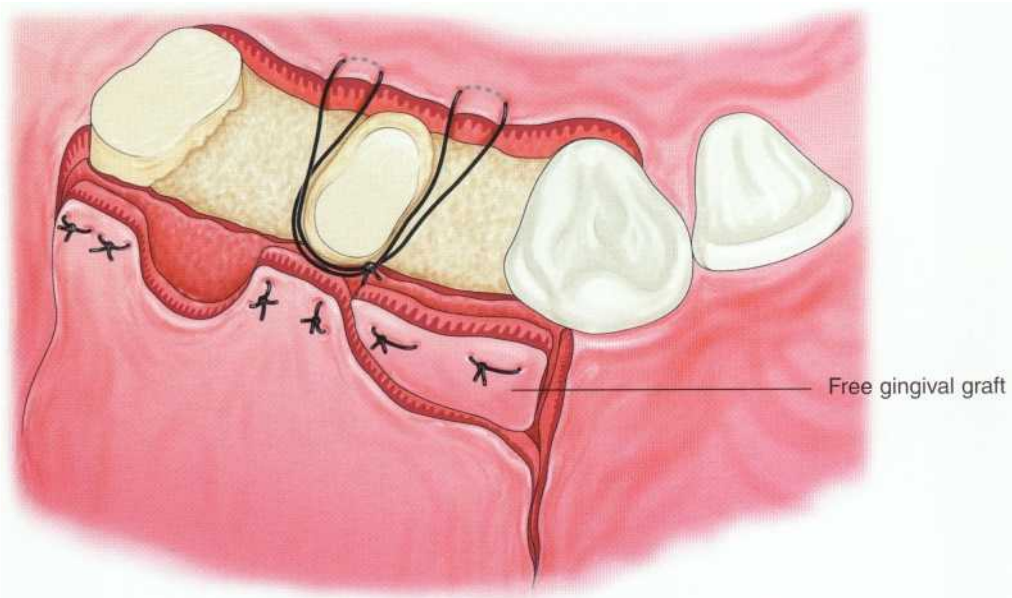


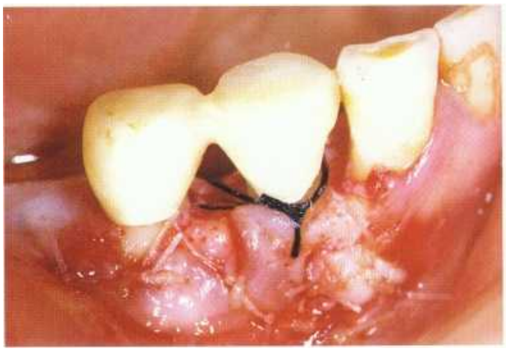
d. The gingiva removed from the lingual interdental area is placed as a free gingival graft mesobuccal to 28.

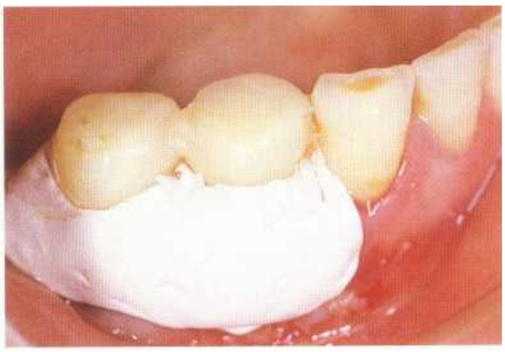
e. A suspensory sling suture of the lingual flap is made.







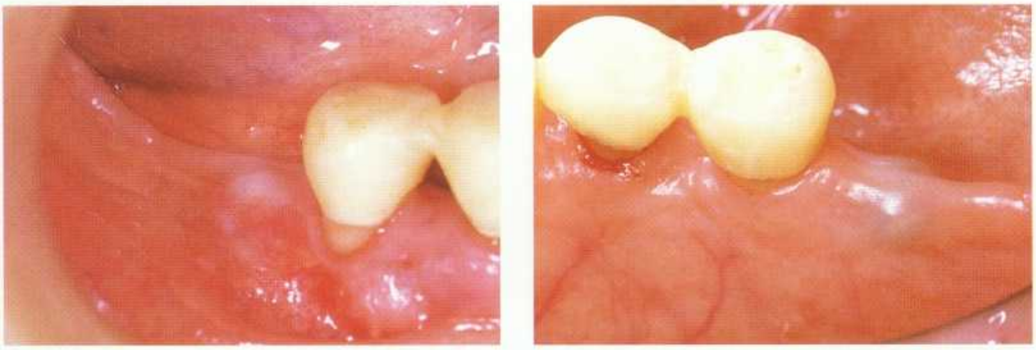




f. Provisional restorations are placed followed by a periodontal pack.

c2-6 **Prognosis.**

a. About 2 weeks after surgery. The periodontal pack is removed.



b. About 55 days after surgery.

c. About 8 months after surgery. Note the sufficient attached gingiva and the elimination of the periodontal pocket. Tooth 30 is an implant.

d. About 2 years and 5 months after surgery. Final restorations are placed.

Free Autogenous Gingival Grafts

The free autogenous gingival graft is widely used. Introduced by Bjorn and King and Pennel,=z it is a highly predictable technique used to increase the width of attached gingiva. Nabers described the procedure for vestibuloplasty and for covering exposed roots. Haggerty used free autogenous gingival grafts to increase attached gingiva for full crown (or complete veneer crown) preparation. Sullivan and Atkins described indications, techniques, wound healing, and successful systematized principles of free autogenous gingival grafts.

Table 2-7 Free Autogenous Gingival Grafts

Advantages

1. A high success rate for increasing the width of the attached gingiva and forming new attached gingiva.
2. Applicable for multiple teeth.
3. Simple procedure.
4. Removes abnormal frenum attachment.
5. Technique used for root coverage.

Disadvantages

1. Requires two surgical areas.
2. An open wound is left on the palate from which the graft is taken. Discomfort and achieving hemostasis may also be problems.
3. Poor blood supply to grafts.
4. Color harmony with surrounding tissue after grafts is suboptimal. (The grafted area is lighter than the surrounding gingiva because palatal tissue is thicker and keratinized.)

Indications

1. To increase the width of attached gingiva.
2. To form new functional attached gingiva where attached gingiva is completely lacking.
3. For pedicle gingival graft where gingiva of the adjacent teeth is insufficient as donor site.
4. To remove abnormal frenum and attachment.
5. To deepen the oral vestibule.
6. To cover exposed roots (see Chapter 6).
7. For ridge augmentation procedures.

Case 2-3 Free autogenous gingival grafts to increase the width of the attached gingiva

c3-1 One year and 7 months after initial examination, 62-year-old man. The mesial root of 30 was removed by hemisection because of Class III furcation involvement.

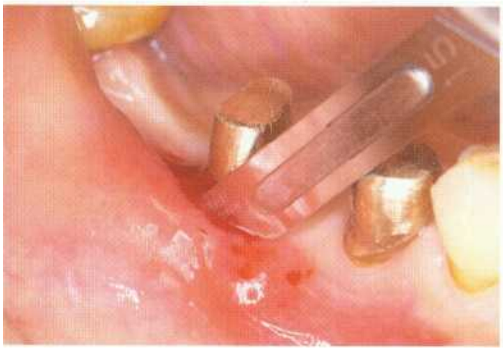
Preparation of recipient site

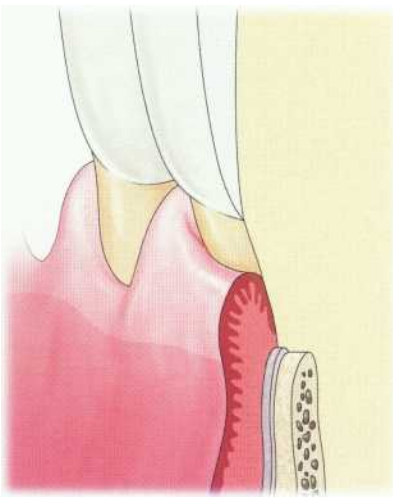
c3-2 Preoperative status.

a. The width of the attached gingiva on 30 is insufficient, and the attachment is very close to the gingival margin.

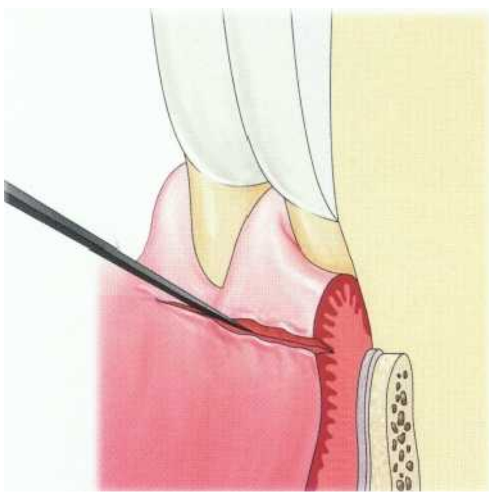
b. Infiltration anesthesia. Care must be taken to avoid blanching the mucosal tissue with excessive anesthesia.

c3-3 Horizontal incision. Strain is placed on the oral vestibule by pulling the lip down and forward. A horizontal incision about 1 mm deep is made along the mucogingival junction with the anterior 2-3 mm of a no. 15 blade. The horizontal incision is extended one tooth wider mesiodistally than the usual length.



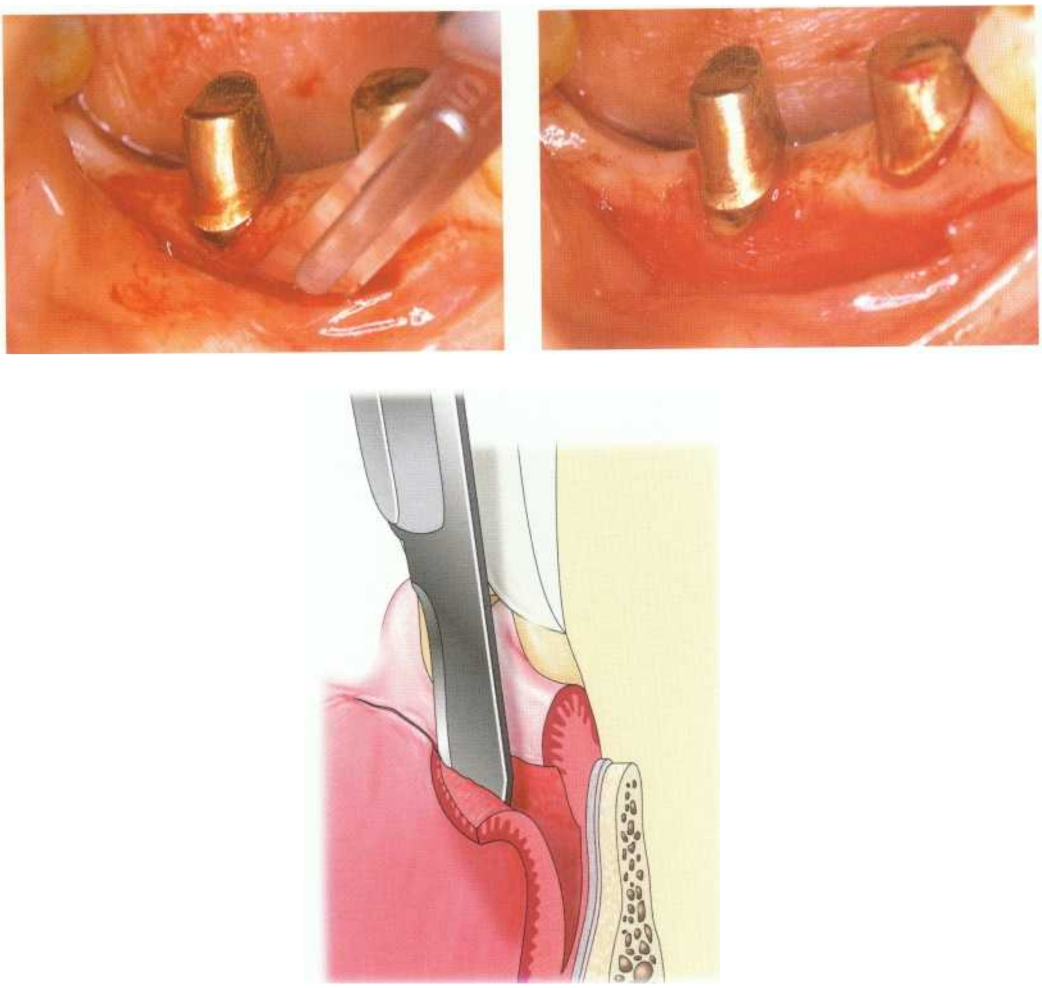


Preoperatively. The width of the attached gingiva is narrow.

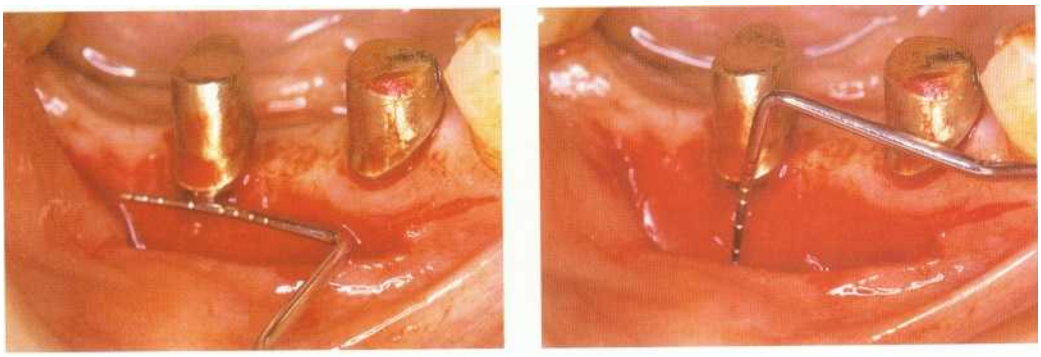


Make a partial-thickness horizontal incision along the mucogingival junction with a no. 15 blade.

c3-4 Preparation of the periosteum-connective tissue bed. The anterior 2-3 mm of the blade is used with care notto damage the flaps and periosteum. The side of the blade contacts the periosteum while a horizontal incision is extended apically and mesiodistally along the inside of the flaps. A recipient site, which consists of the periosteum-connective tissue, is prepared.

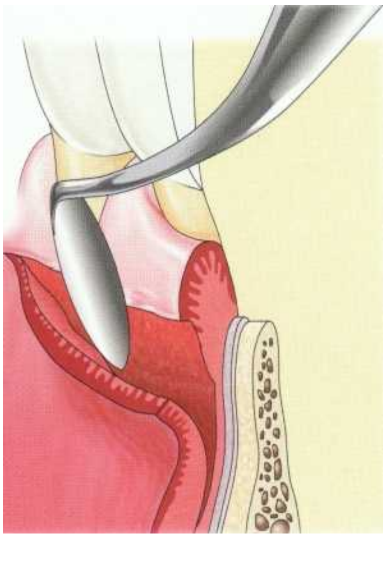


c3-5 Width of recipient site. A recipient site must be large enough to accommodate contraction of the graft during healing. In alveolar mucosa, the recipient bed is enlarged apically 3 mm more than the necessary width. Approximately 6-8 mm of recipient site is prepared in the absence of anatomic restrictions.

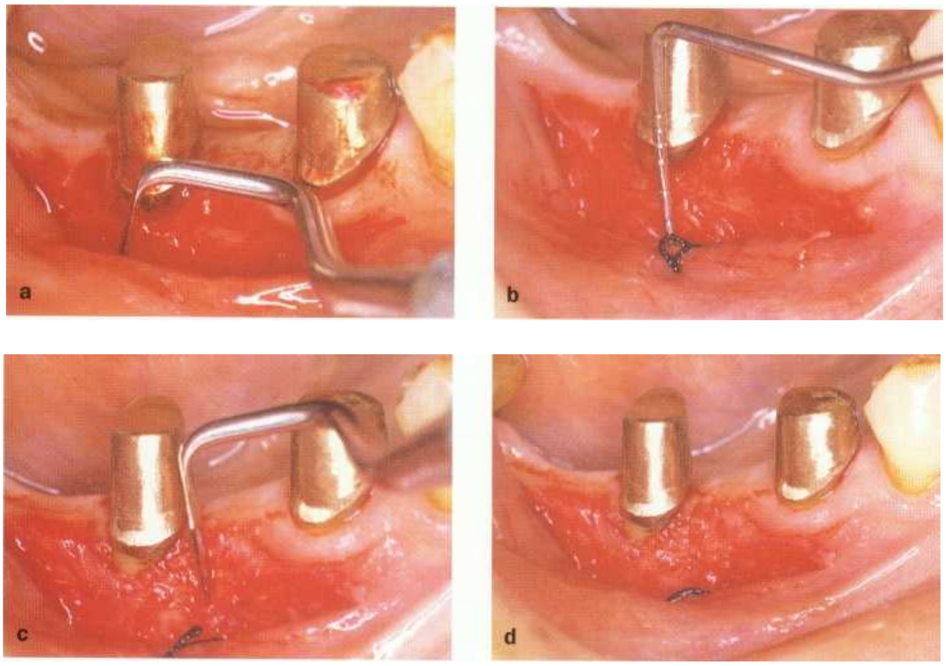


Key point

Remove the elastic and fibers with an Orban interdental knife to ensure graft stability after healing. Prepare a uniform nonmobile periosteum-connective tissue bed.



Resect the gingival epithelium on the coronal portion of the recipient site and make a bevel incision. Make periosteal suture of the partial-thickness flap apical to the recipient site.



c3-6 Adjustment of the recipient site. The elastic and fibers are removed with an Orban interdental knife or scissors, and an immobile, uniform, thin, and stable periosteum-connective tissue bed is prepared (a). A vertical mattress suture is made with a partial-thickness flap and apical periosteum (b). The gingival epithelium of the coronal portion of the recipient site is then refected with an interdental knife with a bevel incision. This technique makes a smooth graft and smooth recipient site (c, d), leading to a better esthetic result.

Key point

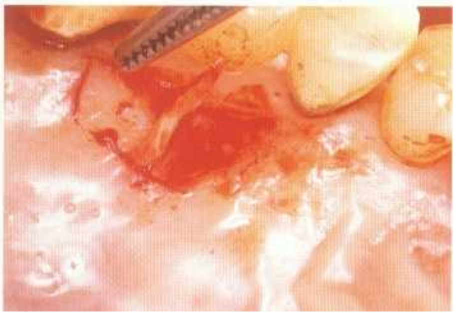
Stabilize the mobile flap edge on the periosteum and prevent coronal movement of the flap after grafting with a periosteal suture of the flap apical to the recipient site. This also lessens postoperative pain on cheek movement.

Harvest of donor tissue

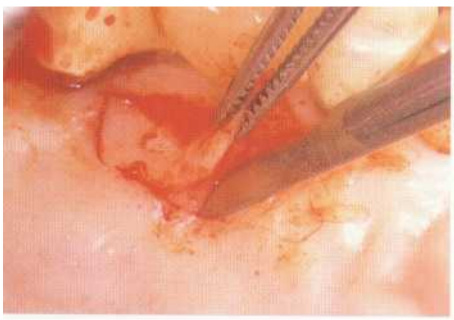
c3-7 Incision on the palatal aspect.

a. A piece of tinfoil the size of the recipient tissue is placed on the palatal aspect.

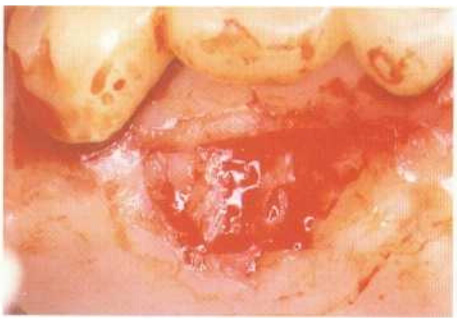
b. The outline of the graft is marked with a shallow incision line approximately 1 mm from the edge of the tinfoil. Graft shrinkage must be considered.



c. A no. 15 blade is inserted at the mesial edge of the incision. The mesial margin of the graft is raised from the underlying connective tissue while the graft is lifted with the side of the blade.



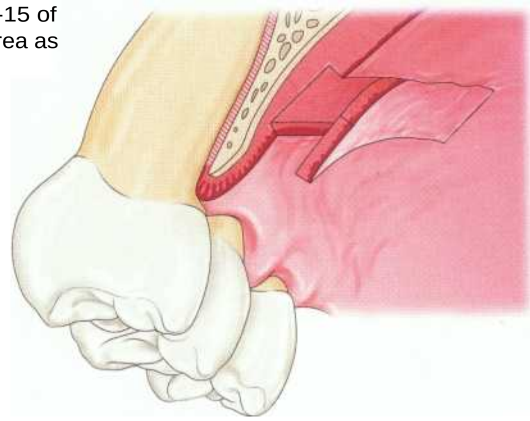
d. The graft is slowly separated with a partial-thickness incision while the reflected margin is lifted with tissue pliers.

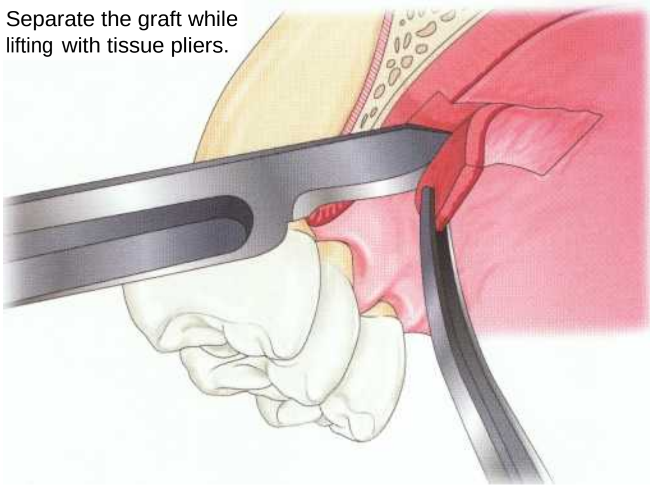


e. A uniform graft with 1 mm of epithelium and connective tissue is harvested using the edge of a no. 15 blade tip as a guide (the edge of blade is 1-mm thick).

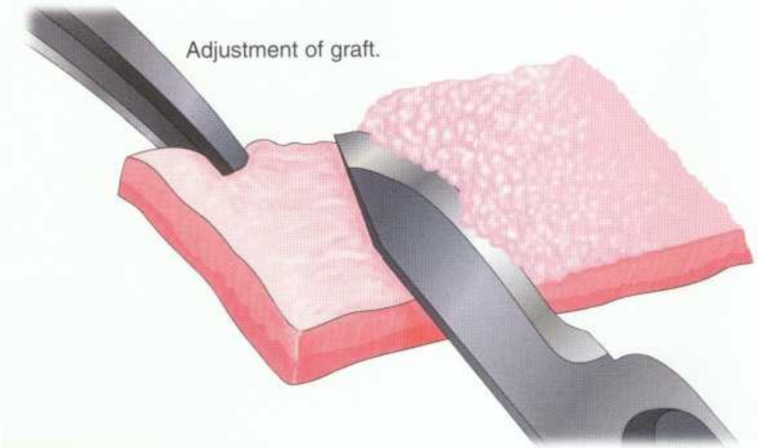
f. After graft harvest the donor site is sutured. A resorbable gauze is used for hemostasis.

Use areas 2-5 or 12-15 of the palatal gingival area as donor tissue.





c3-8 Graft. Place the graft on gauze soaked in sterile physiologic saline solution. Remove uneven tissue and adipose tissue with scissors or a blade and adjust the thickness.



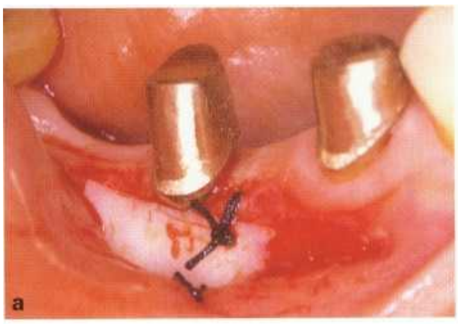
Suturing and stabilizing graft

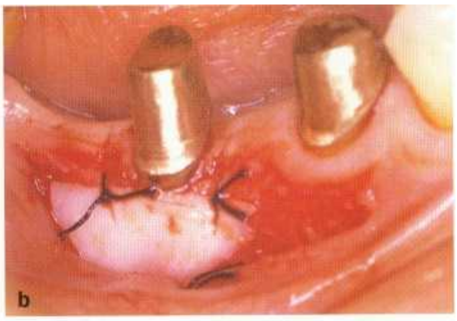
c3-9 Suture.

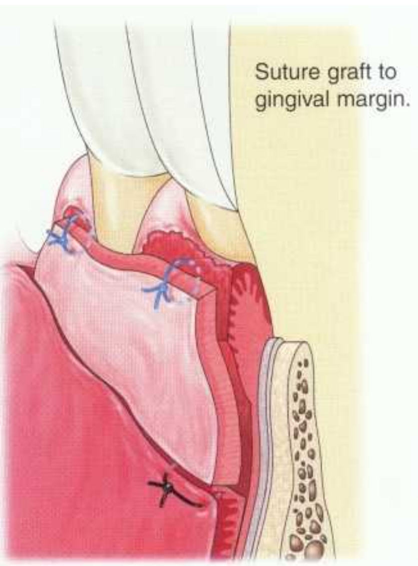
a. The graft edge is placed to overlap the area where the bevel incision is made in the recipient site. The graft is sutured and stabilized directly on the root surface of the gingival margin (marginal graft).

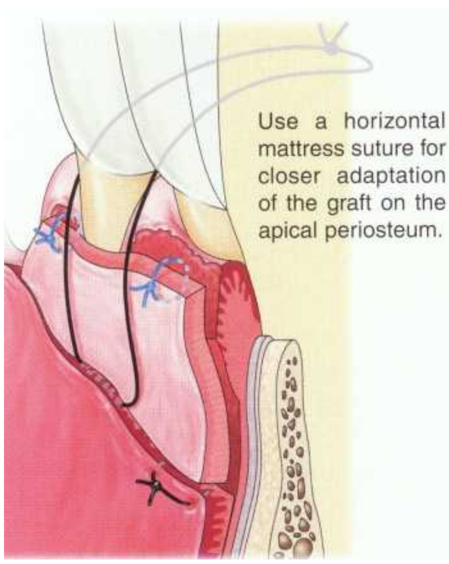
The graft is pierced with a needle, and sutured through the periosteum of the recipient site.

b. The graft is sutured on the coronal aspects. Suturing the bottom of the graft is avoided.









c. For closer adaptation of the graft to the recipient site, a horizontal mattress suture is made on the apical periosteum of the graft. The thread is turned around the cervical area and suspended, and a ligature is made on the lingual aspect. The graft is pressed for 5 minutes with gauze soaked in physiologic saline solution to avoid hematoma after ligature. Bleeding or hematoma hinders vascularization of the graft. A periodontal pack is then placed.

Prognosis

c3-10 Removal of suturing material.

a. The periodontal pack and thread are removed 10 days after grafting. Anastomosis and vascularization of the graft and recipient site are established. (Mandibular right buccal aspect, left; donor site, right.)

b. Two weeks after surgery.

c. About 3 weeks after surgery.

d. About 6 weeks after surgery. A functional attached gingiva is achieved.

e. About 1 year and 3 months after free autogenous gingival grafting.

f. About 3 years after surgery. A 1 mm depth of the gingival sulcus is maintained.

Edentulous-Area Pedicle Grafts

In the edentulous-area pedicle graft, the edentulous area is used as a donor site. This procedure was introduced by Corn[27] and Robinson."

Table 2-S Edentulous Area Pedicle Grafts

Advantages

1. There is no danger of exposing thin marginal bone, which prevents the problems of bone loss and gingival recession at the donor site.
2. There is a greater likelihood that the exposed root surface will be covered because the thick full-thickness flap can be sued as the pedicle graft.

Indications

1. To increase the width of the attached gingiva.
2. To form new attached gingiva.
3. To cover exposed root adjacent to the edentulous area.

Fig 2-4 Acquiring attached gingiva using edentulous-area pedicle grafts.

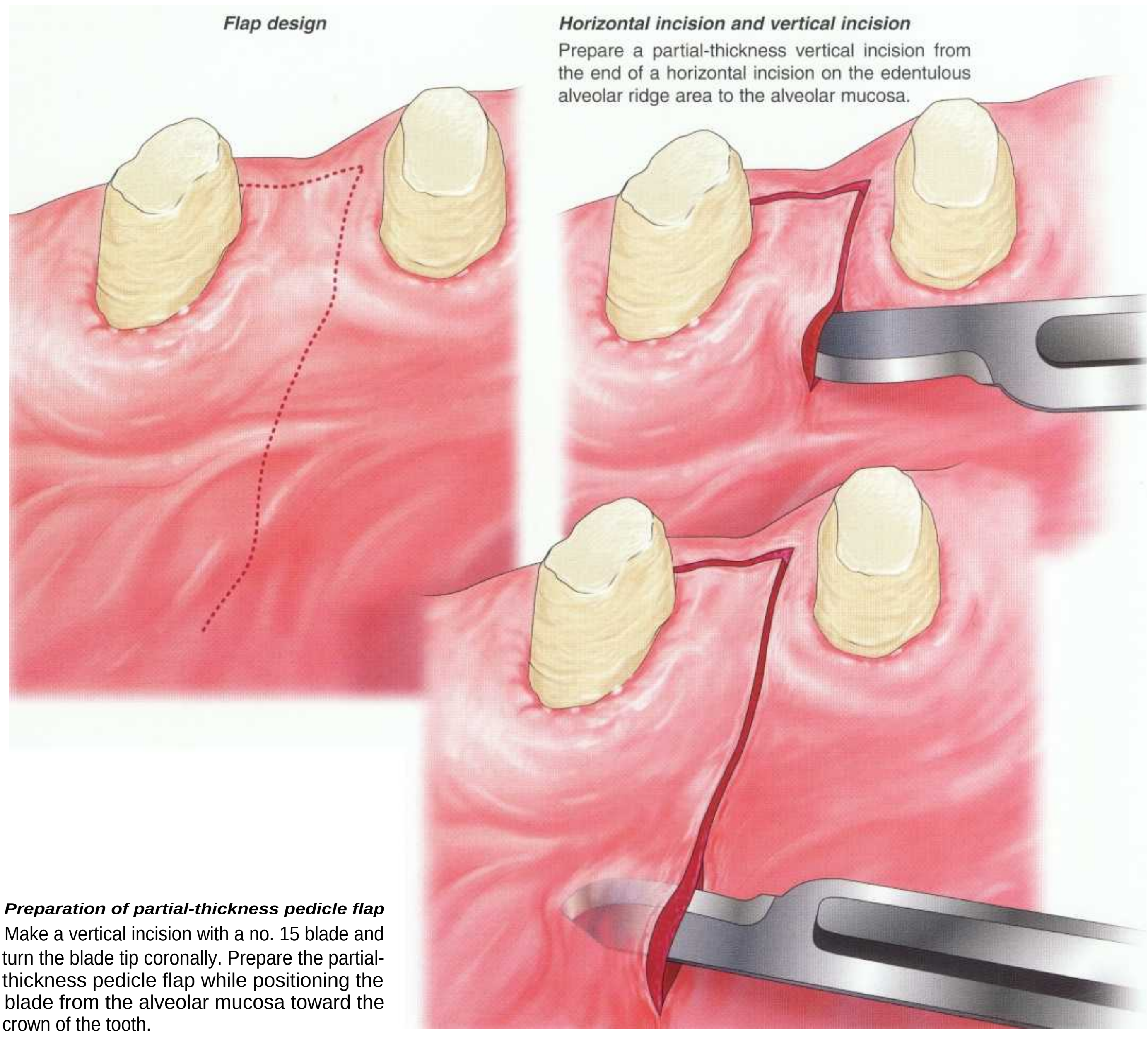
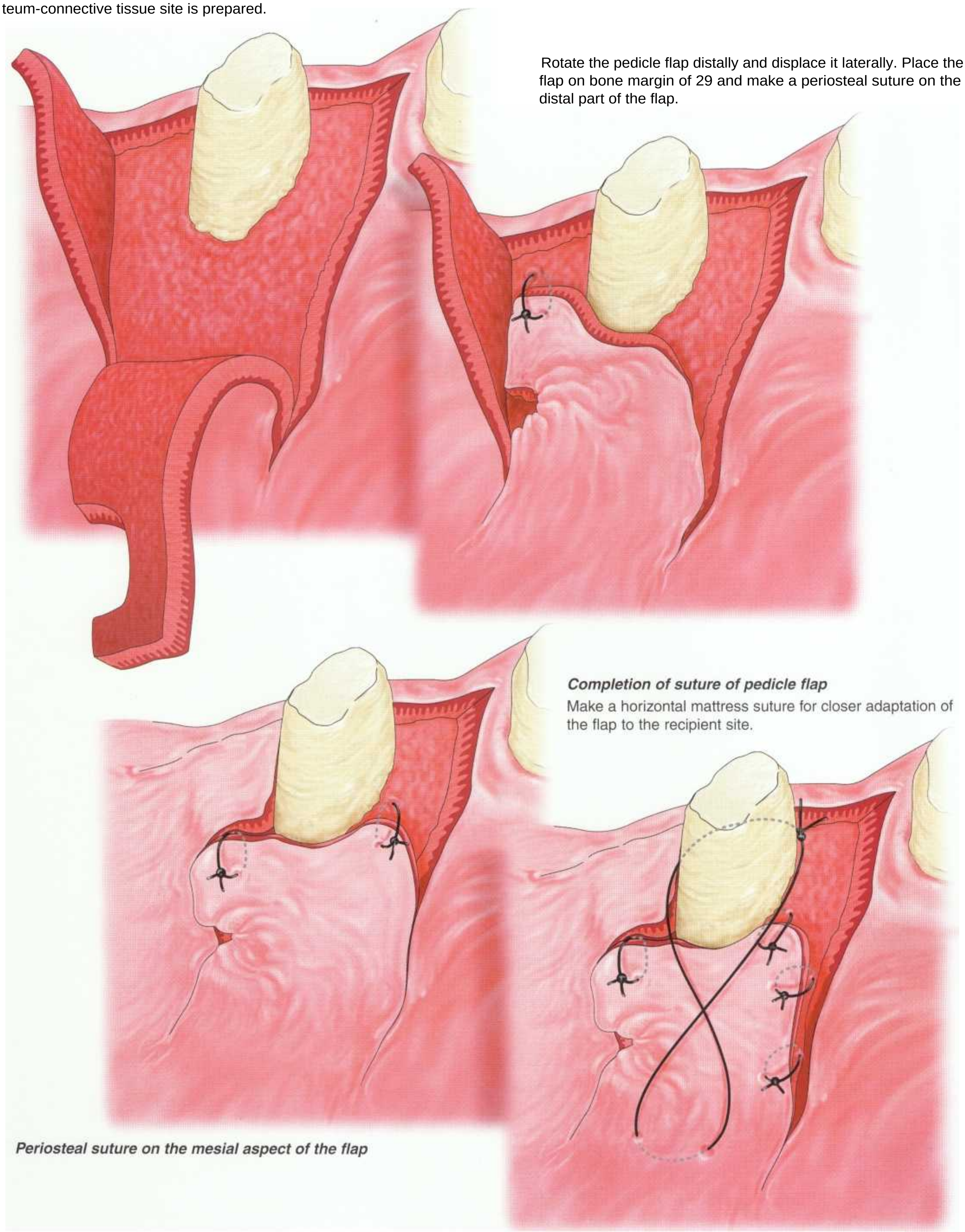


Fig 2-5 Acquiring attached gingiva using edentulous-area pedicle grafts.



Reflection of partial-thickness pedicle flap

Prepare a releasing incision of the periosteum at the base of the flap so the flap can be moved freely. The immobile (or keratinized) periosteum-connective tissue site is prepared.

Rotate the pedicle flap distally and displace it laterally. Place the flap on bone margin of 29 and make a periosteal suture on the distal part of the flap.

Periosteal suture on the mesial aspect of the flap

Completion of suture of pedicle flap

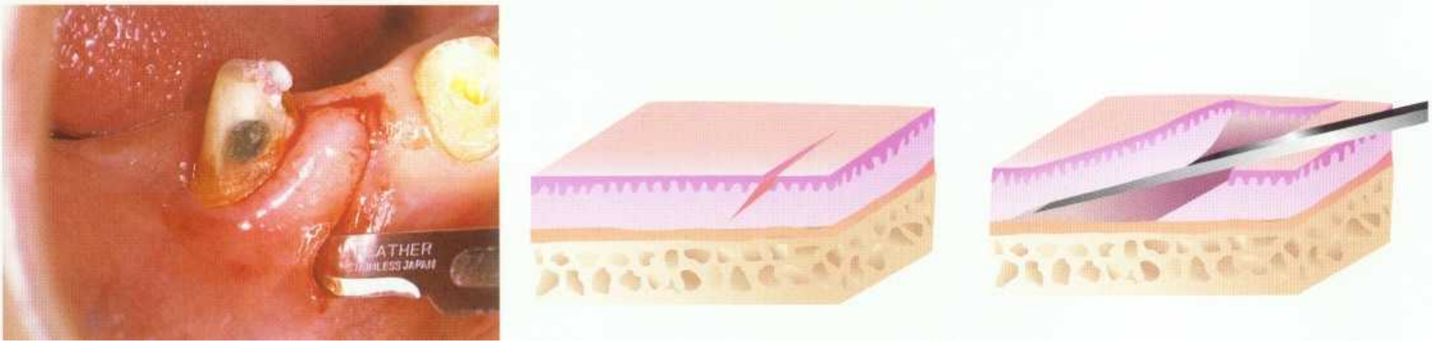
Make a horizontal mattress suture for closer adaptation of the flap to the recipient site.

Case 2-4 Edentulous-area pedicle grafts to increase the width of the attached gingiva

c41 About 7 months after initial examination, 41-year-old woman. There is no attached gingiva on the buccal aspect of 29. The depth of the periodontal pocket is 4 mm, and the base of the pocket is apical to the mucogingival junction.

Flap design

c42 Horizontal incision. The keratinized tissue of the adjacent edentulous ridge (28) is used as donor tissue. A horizontal partial-thickness incision is made with a no. 15 blade from the mesial proximal surface of 29 to the edentulous ridge crest. A horizontal incision is prepared lingually to 29 to make a large pedicle flap.



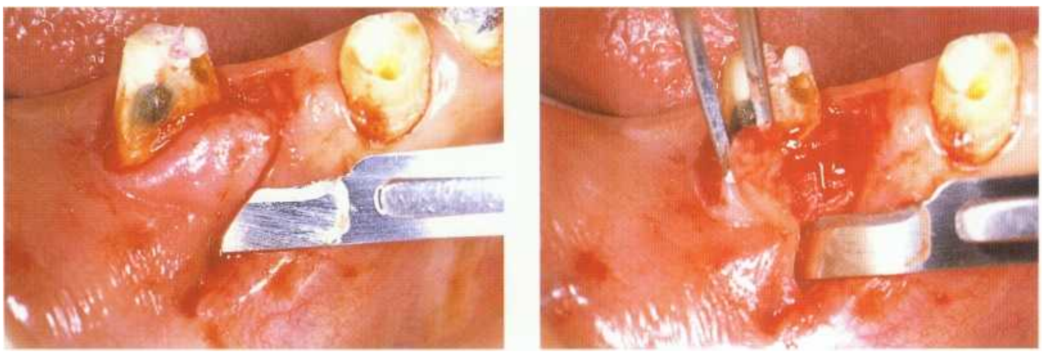
c43 Vertical incision. A vertical incision 1-mm deep is made from the end of the horizontal incision apical to the mucogingival junction.

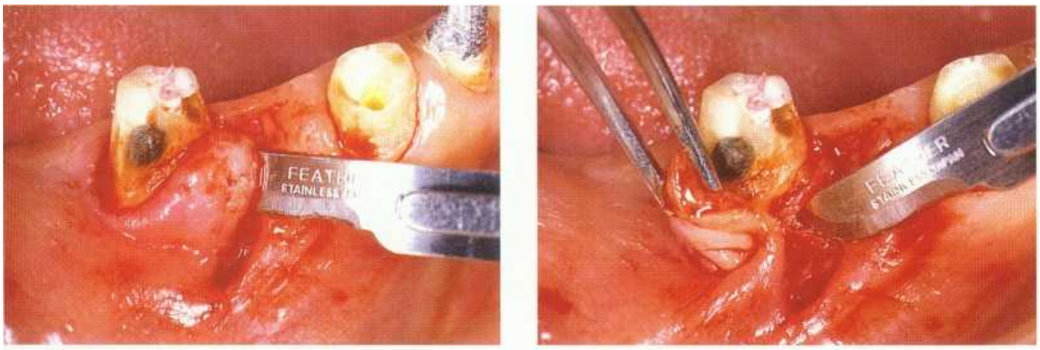
Key point

A vertical incision is an oblique incision; it is not a straight line but inclines to the recipient site. This makes it possible for the prepared pedicle flap on the donor site to rotate easily to the recipient site and lessens the necessity of a relieving incision.

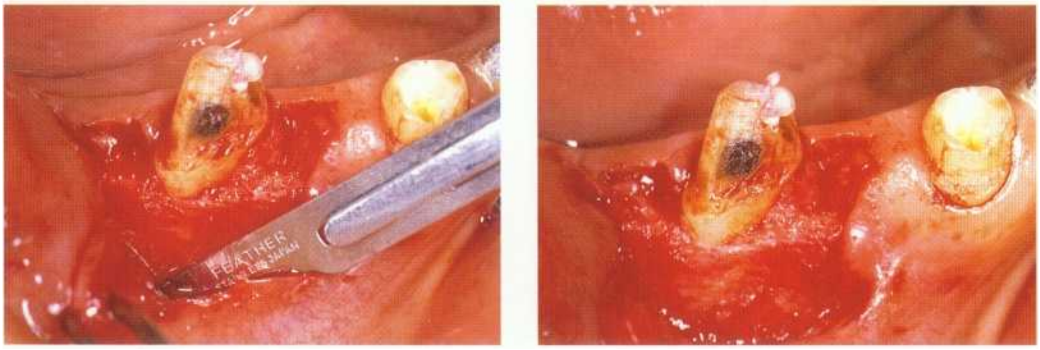
c4-4 Reflection of ***partial-thickness***.

a. The blade is inserted under the alveolar mucosa of a vertically incised area while the tip of the blade is turned coronally. The flap edge is held with tissue pliers with tension applied to the flap by pulling. A partial-thickness incision is prepared coronally, parallel to the bone, with care taken not to damage the periosteum-connective tissue.



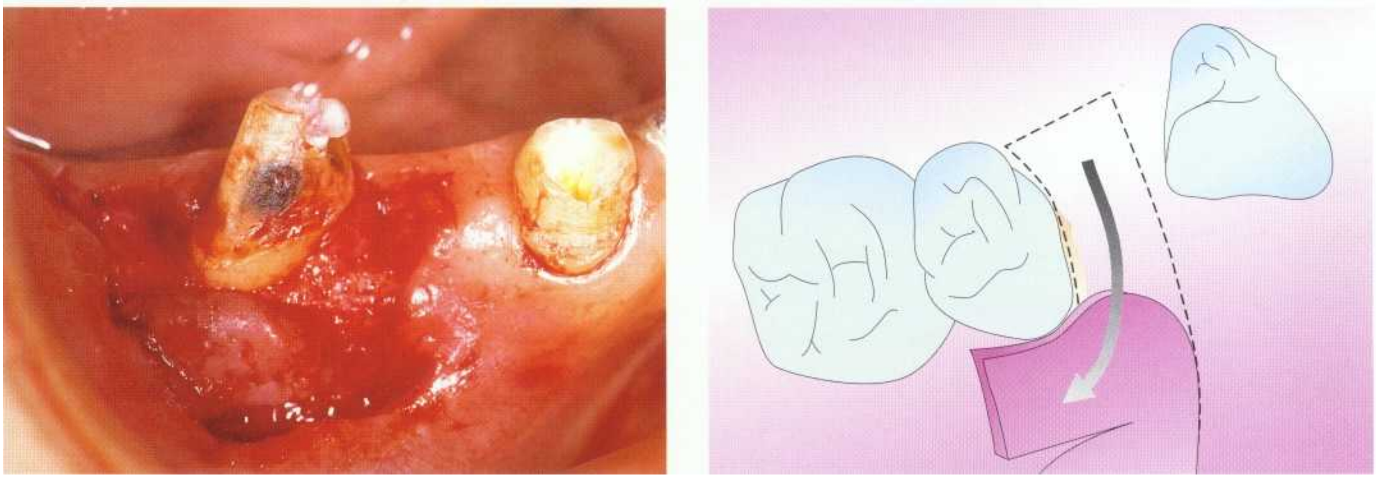


b. The blade is inserted into incised area on the alveolar ridge area. The flap is reflected slowly mesiodistally, leaving the periosteum on the bone surface, toward the alveolar mucosa along the crest while the blade tip is turning apically. It is connected with an incision from the apical aspect and a partial-thickness pedicle flap is reflected.

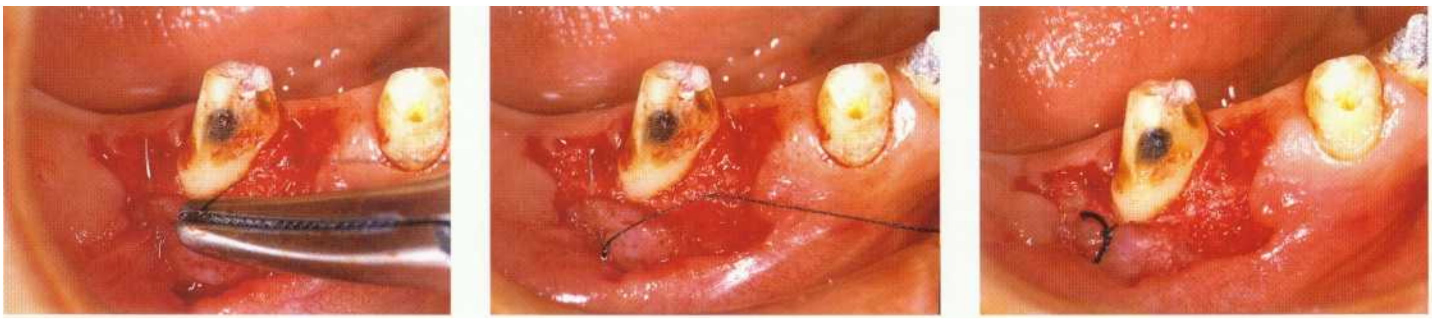


c. A releasing incision of periosteum is made at the base of the flap to avoid tension that could impede blood circulation and to enable the flap to move without tension. The incision is then enlarged to the alveolar mucosa. The nonmobile periosteum-connective tissue site on the bone surface is prepared.

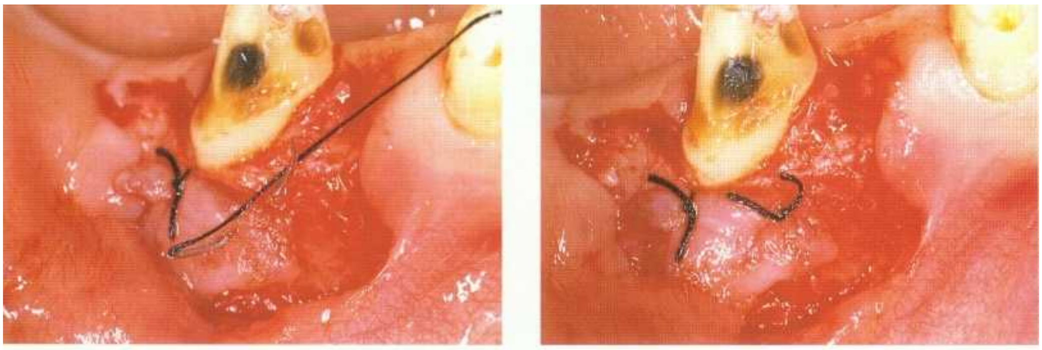
c45 Suture of pedicle flap.



a. The pedicle flap is displaced laterally while being rotated distally. The end of the flap is then placed at the bone margin of 29.

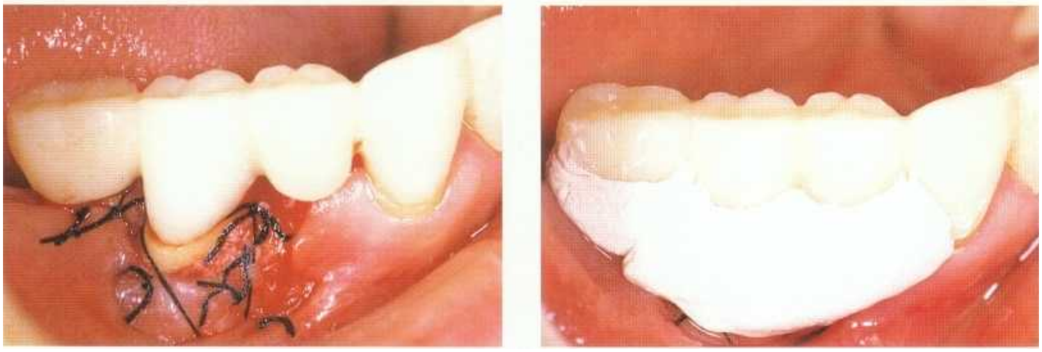


b. The distal part of the flap and periosteum is sutured with 4-0 silk thread. The needle pierces the **flap perpendicular to it and the periosteum, and the periosteal fibers are** engaged while the needle is moved along the needle curve. The flap is placed in the planned position and sutured.



c. A periosteal suture is made on the mesial aspect.

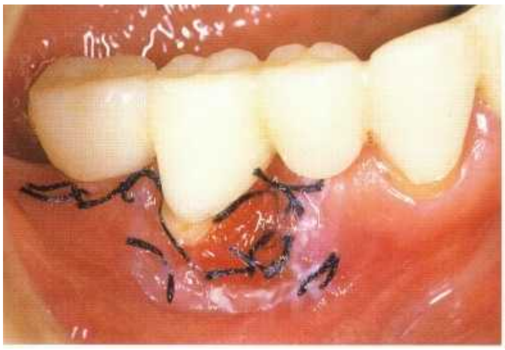
d. A horizontal mattress suture is prepared on the apical periosteum of the mesial flap for better flap adaptation to the recipient site. The suture material surrounds the cervical area and is suspended. A ligature is tied on the lingual aspect (circumferential horizontal mattress suture).



e. Provisional restorations are placed, followed by a periodontal pack.

Prognosis

c46 Prognosis after increasing the width of the attached gingiva.



a. The periodontal pack and suture material are removed approximately 9 days after surgery.

b. Two weeks after surgery.

c. Three weeks after surgery.

d. About 5 weeks after surgery.

e. Ten weeks after surgery. Note the thick and sufficient width of attached gingiva around the abutment on 29.

f. Five and one half months after surgery.

g. One year and 2 months after surgery.

h. Two years after surgery.

Connective Tissue Grafts

Subepithelial Connective Tissue Grafts

The connective tissue graft was first introduced as a technique to increase the width of the gingiva. Later, the technique was used to cover exposed roots and augment the alveolar ridge. The two methods used in connective tissue grafts to increase the width of attached gingiva are free connective tissue grafts and subepithelial connective tissue grafts. The subepithelial connective tissue graft combines the pedicle graft and the free connective tissue graft.

Table 2-9 Subepithelial Connective Tissue Grafts

Advantages

1. The width of the attached gingiva is increased and the root covered simultaneously. This method is the most predictable soft tissue graft.
2. Blood supply is available from both the flap and the recipient site to the graft.
3. It is possible to acquire and increase the width of the attached gingiva in multiple teeth.
4. Because there is little exposure of the donor site after harvesting the graft and a closed wound, there is rapid healing and less discomfort postoperatively.
5. Harmonious results are achieved in color and esthetics in the surrounding tissue and attached gingiva.

Disadvantages

1. The technique is technically demanding.
2. Compared to the free autogenous gingival graft, epithelization takes longer.

Table 2-10 Methods and Indications of Connective Tissue Grafts

	Indications
Free connective tissue grafts 	• Acquire width of attached gingiva • Deepen oral vestibule • Remove frenum and muscle attachment
Subepithelial connective tissue grafts 	• Acquire width of attached gingiva • Deepen oral vestibule • Remove frenum and muscle attachment • Acquire esthetically attached gingiva • Cover exposed root surface • Increase the attached gingiva on the mandibular lingual aspect

Bouchard et al" performed subepithelial connective tissue grafts in areas of gingival recession on 30 patients (30 sites of Miller's classification Class 1, Class 11). They used two procedures:

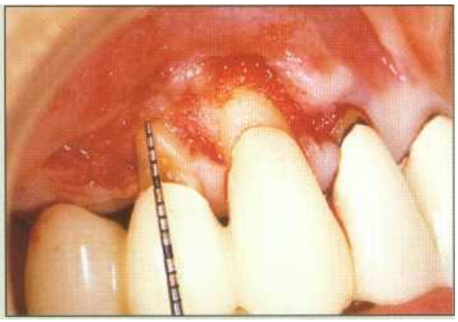
1. Connective tissue graft (CTG) group (15 sites)-Conventional method used (preserve a few millimeters of epithelium on the edge of the connective tissue graft and expose a part of the graft without flap coverage.
2. Coronally repositioned (CR) group (15 sites) Remove the epithelium of the graft edge and cover the graft completely with coronally repositioned flaps.

Figures 2-6 and 2-7 show the difference between the two approaches. The 6-month results are as follows.

1. The average root coverage is 69.2% for the two groups.
   CTG group: 1.60-4.53 mm; complete root coverage achieved in 5 of 15 sites.
   CR group: 1.27-4.20 mm; complete root coverage achieved in 3 of 15 sites.

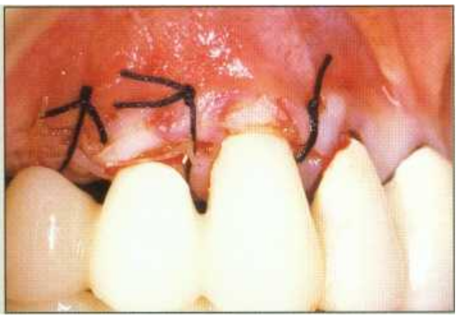
Fig 2-6 Connective tissue grafts with epithelium on the graft edge and one part of the coronal flap exposed.

a. Lack of attached gingiva.



b. Osseous dehiscence on the buccal aspect.

c. Epithelium remains on graft.



d. Flap coverage, with one part of graft exposed.

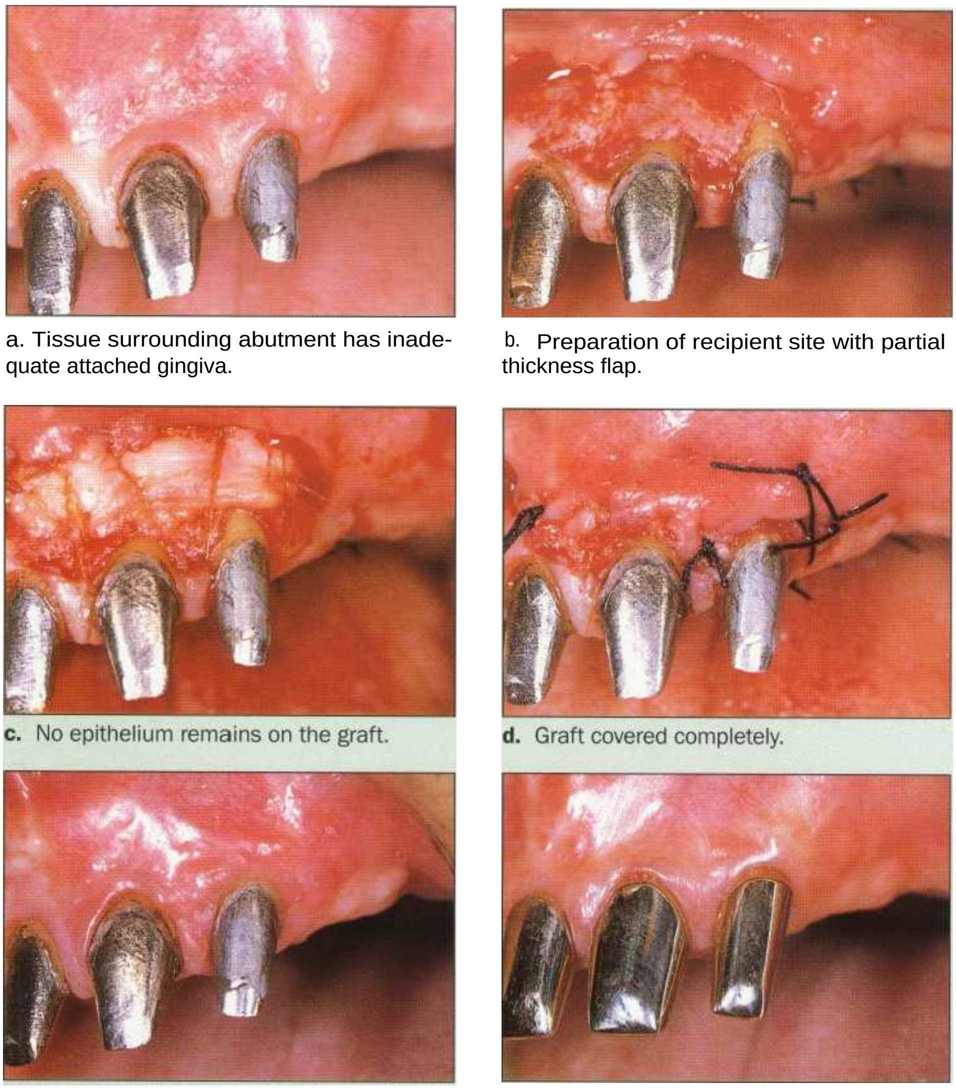
e. Eight months after surgery.

t. One year after surgery.

2. Gingival width increased.
   CTG group: 1.73-3.8 mm (gingiva width increased by 94.4%).
   CR group: 2.13-3.07 mm (gingiva width increased by 65.5%).
3. The CR group had more harmonious results for color and esthetics in relation to surrounding tissue.

Therefore, if subepithelial connective tissue grafts are being used primarily to increase the width of the attached gingiva, it is better to not completely cover the connective tissue graft with flaps (Case 2-5). However, in cases where es thetics is a concern, the connective tissue graft should not have epithelium on the edge, and the graft should be covered with flaps as much as possible. See Chapter 6 for surgical techniques for connective tissue grafts.

Fig 2-7 Connective tissue grafts with removal of graft edge epithelium and complete flap coverage.



a. Tissue surrounding abutment has inadequate attached gingiva.

b. Preparation of recipient site with partial thickness flap.

c. No epithelium remains on the graft.

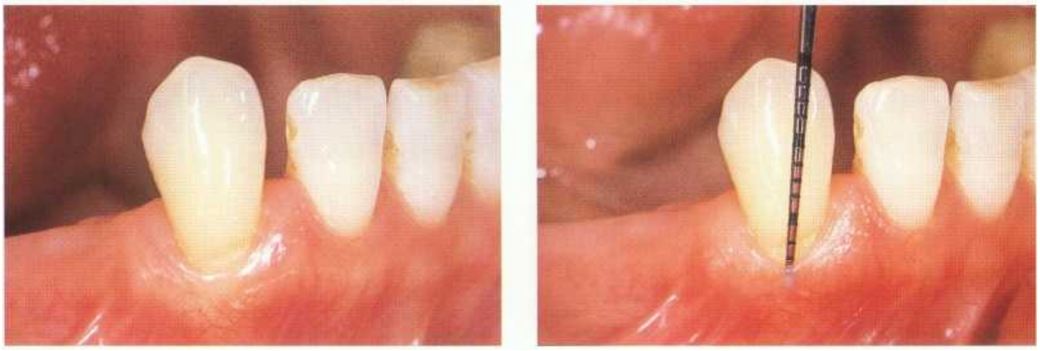
d. Graft covered completely.

e. Three weeks after surgery.

f. Eight months after surgery.

Case 2-5 Subepithelial connective tissue grafts to increase the width of the attached gingiva

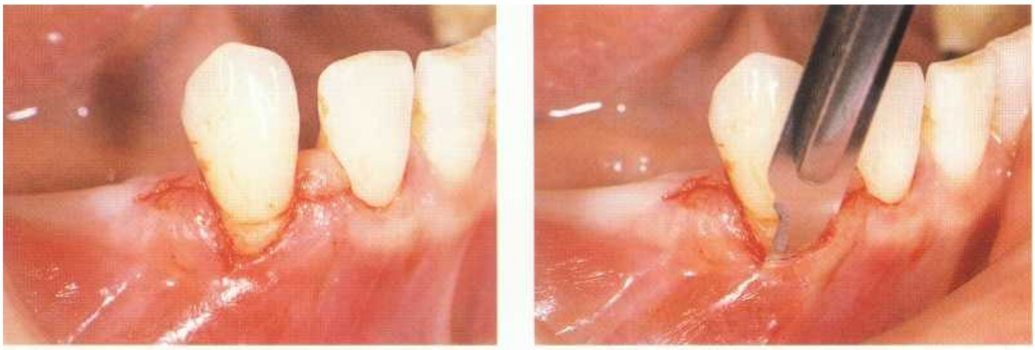
Details on subepithelial connective tissue grafts for root coverage are described in Chapter 6. However, in this case, where the objective is to increase the width of the attached gingiva, the graft is not completely covered by flaps. This approach facilitated increase of the attached gingiva.



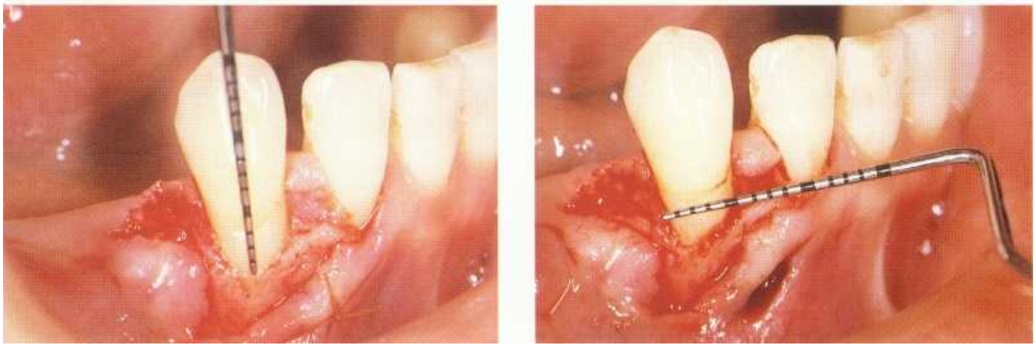
c5-1 Preoperative status, 35-year-old woman. Tooth 27 is the terminal abutment tooth for a removable partial denture to be retained by an RPI clasp. **Note the** gingival recession and lack of attached gingiva. A subepithelial connective tissue graft is performed to increase the width of the attached gingiva and to cover the exposed root surface.

Preparation of the recipient site

c5-2 Horizontal, partial-thickness incision.

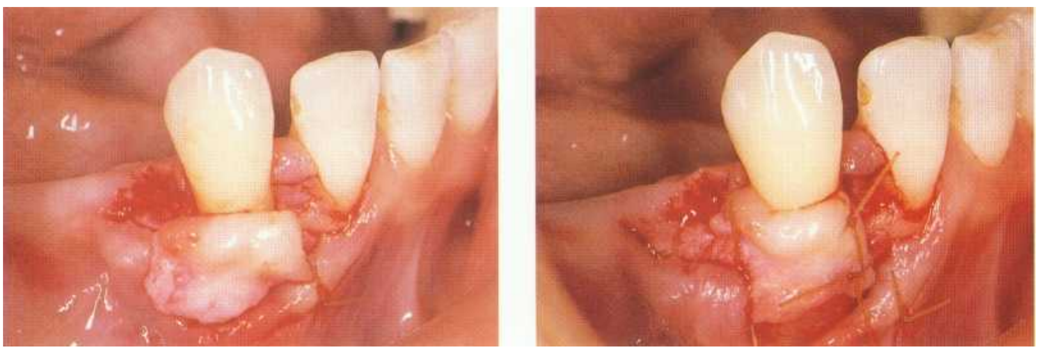


a. A horizontal, sulcular, partial-thickness incision is prepared, as well as a horizontal incision at the base of the mesial papilla. Interproximal papilla is left intact. A partial-thickness flap is reflected.



b. The osseous dehiscence is approximately 5 mm from the CEJ.

Transplant of connective tissue graft



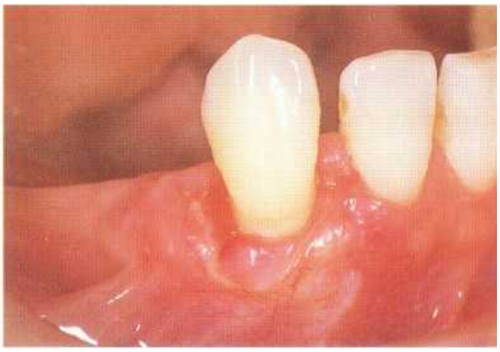
c5-3 Suture of connective tissue graft. The connective tissue graft is placed on the exposed root surface and sutured coronal to the CEJ with a 4-0 resorbable suture material.

c5-4 Suture of flap. A part of the connective tissue graft is left exposed to increase the width of the attached gingiva.

Prognosis

c5-5 Prognosis and progress of the attached gingiva.

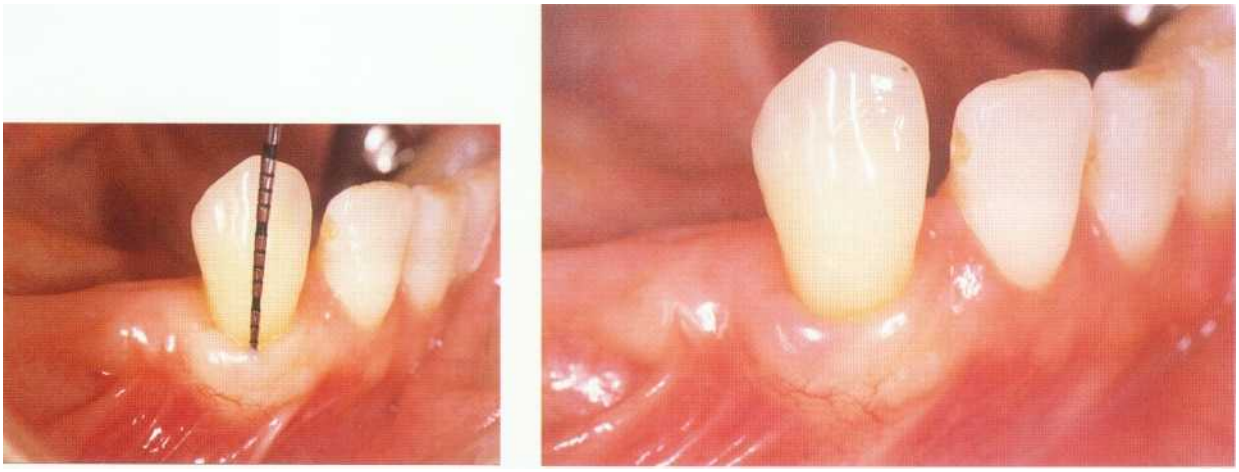
a. One weekafter surger;.



b. Two weeks after surgery.

c. Approximately 4 months after surgery. Note the root coverage and the remarkable increase in the width of the attached gingiva.

d. Seven months after surgery. The RPI partial denture is delivered.



e. Approximately 1 year and 7 months after surgery. Creeping attachment is formed and the root surface is covered. There is an increase of approximately 3.5 mm in the width of the attached gingiva and complete root coverage.

The Importance of Attached Gingiva for Prosthetic Treatment

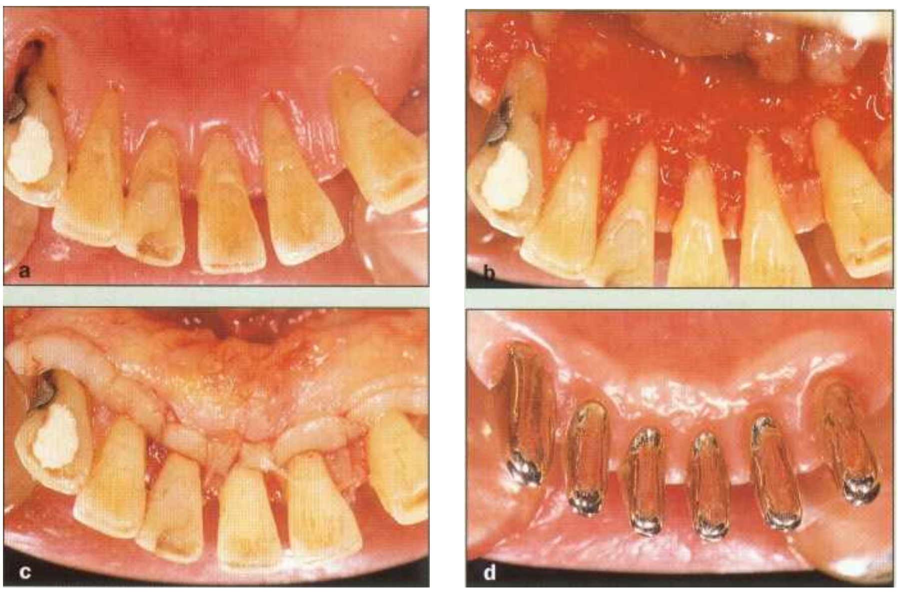
Abutments for prosthetic treatment require healthy periodontal tissue.[18] Therefore, before preparing the abutment tooth, it is essential to eliminate any periodontal pockets and to have sufficient attached gingiva. It is especially important that there be sufficient attached gingiva if the restoration's margin is to be placed subgingivally to avoid aggravating existing periodontal disease and margin exposure due to gingival recession. If there is sufficient width and thickness of the attached gingiva, temporary damage to the gingival tissue following restorative/prosthetic treatment (trauma to gingival sulcus epithelium from procedures such as subgingival preparation of the abutment, gingival retraction, impression making, or cementation) will resolve quickly, with little chance of progression.

In the case of 1) a tooth protruding buccolingually, 2) gingival recession, and/or 3) an abutment tooth for a partial denture to be retained by a clasp, or an abutment tooth for an overdenture, it is especially important that there be sufficient attached gingiva width.

The width of the attached gingiva must be at least 2-3 mm if the restoration margin is placed subgingivally or if the tooth is used for a denture abutment. For gingiva-alveolar mucosa of the abutment or the anchor tooth of a partial den ture, sufficient nonmobile, keratinized gingiva is of utmost importance. Such teeth are apt to undergo trauma with a retaining appliance or lose the self-cleansing form that natural teeth possess (Fig 2-8 and Case 2-6).

If the abutment has gingival recession, an osseous dehiscence, or lacks attached gingiva, the partial denture will damage the abutment and abutment loss will occur in a short period. The lingual or palatal aspect is usually covered by thick, nonmobile keratinized gingiva; therefore, these areas do not usually require increase in the width of the attached gingiva. Case 2-7 shows an exceptional case of gingival recession on the mandibular lingual gingiva due to an inadequate lingual bar. Vestibuloplasty and root coverage were the preprosthetic treatments. With subepithelial connective tissue grafts, immobile keratinized gingiva width and root coverage were achieved.

Fig 2-8 Subepithelial connective tissue grafts to increase mandibular lingual attached gingiva.



a. The width of the lingual attached gingiva on 22, 23, 26, and 27 is narrow, and the oral vestibule is shallow. The bases of the lingual periodontal pockets of 24 and 25 are apical to the mucogingival junction.

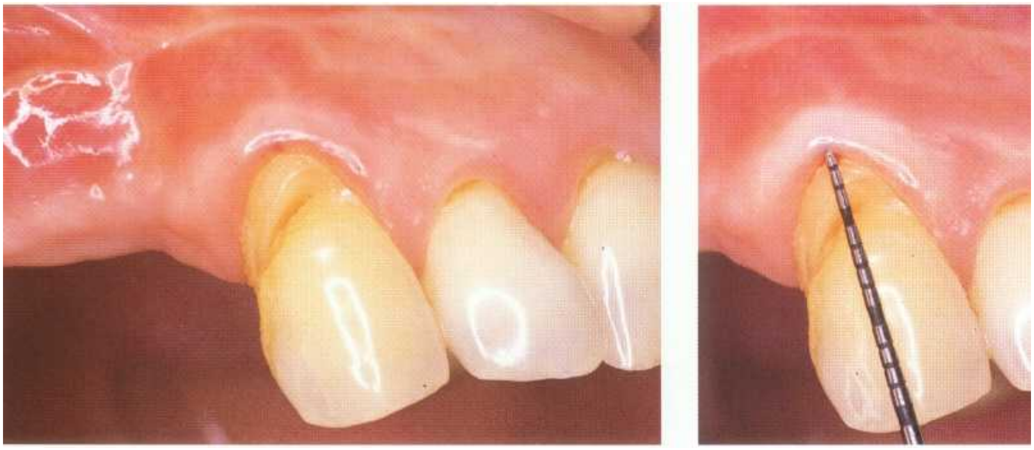
b. The recipient site is prepared with a modified Langer and Langer technique.

c. The subepithelial connective tissue graft is sutured.

d. The width of the attached gingiva is increased and the oral vestibule expanded. Crown-sleeve coping partial denture are placed.

Case 2-6 Root coverage and increase of the attached gingiva before prosthetic treatment

c6-1 Eight months after initial examination. 56-year-old man. Note the deep and wide gingival recession and wedge-shaped defect with caries on 6, which is the abutment of the partial denture. Complete root coverage is difficult because the distal interdental papilla crest is apical to the CEJ.



Root coverage by GTR

c6-2 Surface management for root coverage.

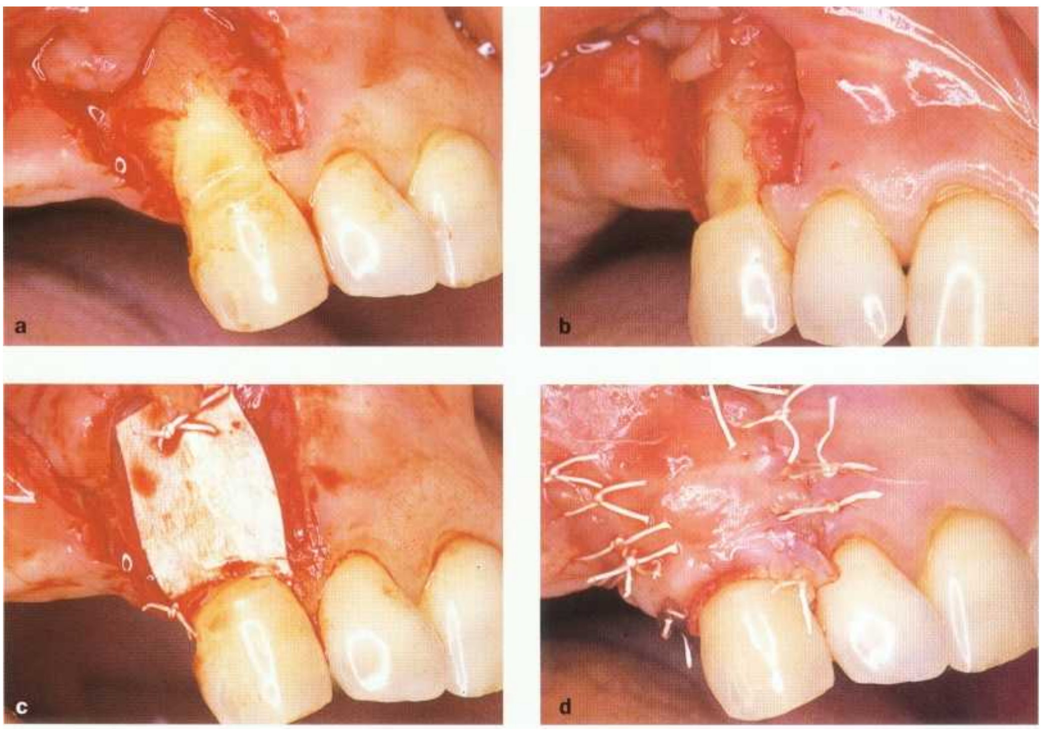
a. A tin.... ing bur and a sharp curette are used to remove the decayed tissue and for root planing. Odontoplasty is performed.

b. Tetracycline solution is applied to the root sur face for 3 minutes.

c6-3 Membrane placement.

a. A trapezoid flap consisting of one horizontal and two vertical incisions is prepared and reflected.

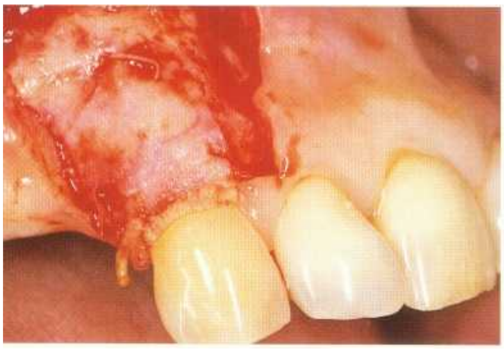
b. For coronal migration of the flap, a full-thickness flap is made on the coronal aspect and a partial-thickness flap on the apical. Note the 7-mm osseous dehiscence from the CEJ to the bone crest. The exposed root surface undergoes odontoplasty and is leveled to the bone surface.



c. The bent membrane is sutured and stabilized to the CEJ.

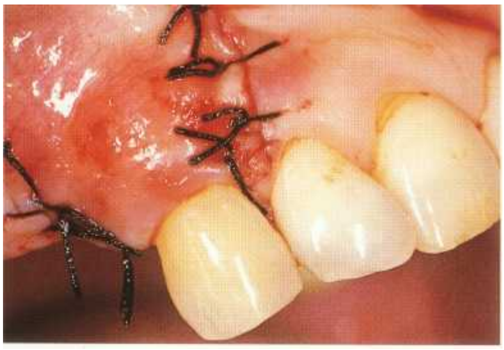
d. The flap is displaced coronally and the membrane covered firmly.

c6-4 Membrane removal.

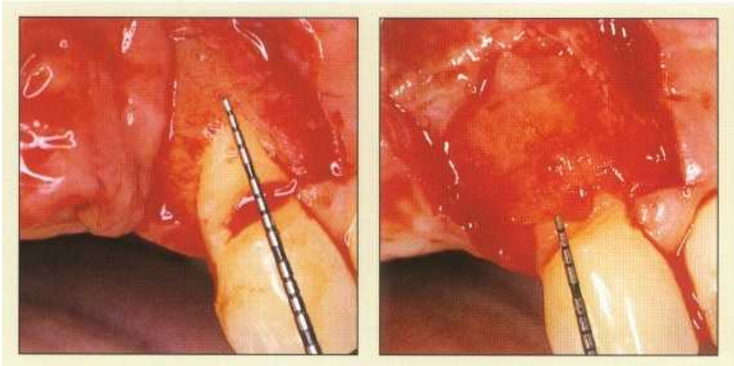


a. Five weeks after surgery. The membrane is exposed with a partial-thickness incision.

b. Removal of the membrane reveals new tissue formation on the exposed root surface.



c. The flap is sutured to cover the new tissues.

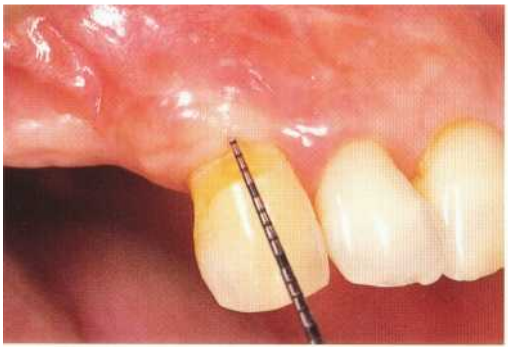


d. Before membrane placement (left) and after membrane removal (right).

Prognosis

c6-5 Postoperative keratinized gingiva.

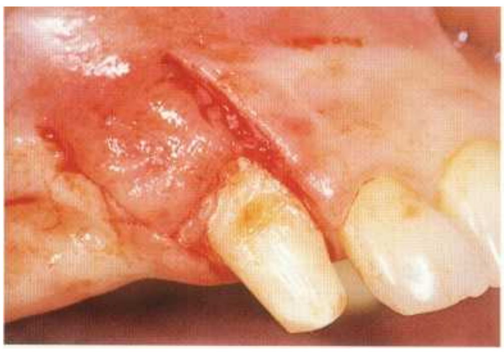
a. Two weeks after membrane removal.



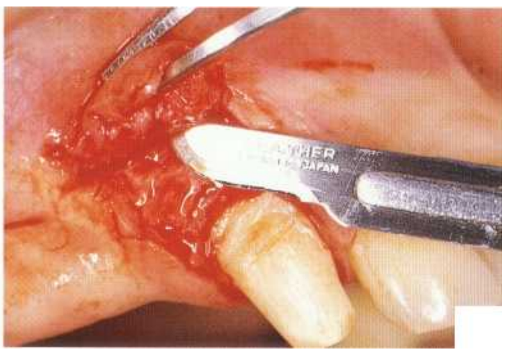
b. About 1 year after surgery. Approximately 2.5 mm of root coverage and 4 mm of keratinized gingiva are achieved. The keratinized gingiva around 6 is very thick.

Periodontal pocket elimination with thick keratinized gingiva

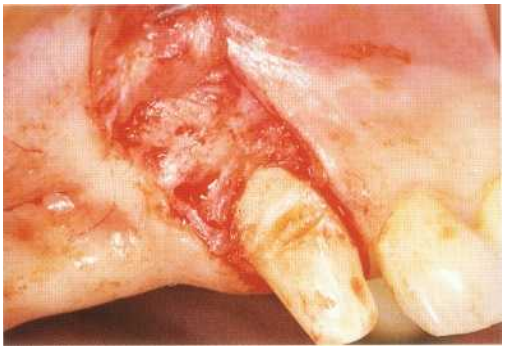
c6-6 Periodontal pocket elimination using partial-thickness, apically positioned flap.



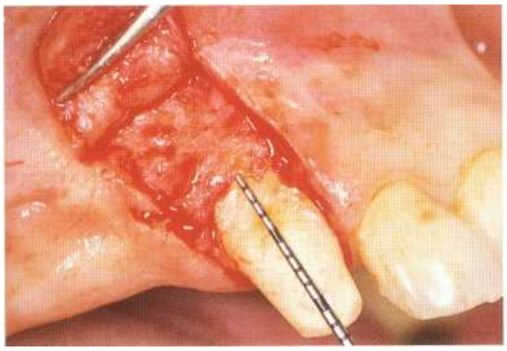
a. Partial-thickness, apically positioned flap surgery is performed with thick keratinized gingiva obtained by a previous tissue graft. This helps establish an ideal biologic width for an abutment. Two parallel vertical incisions are made to the alveolar mucosa on the mesial and distal aspects of 6.



b. A no. 15 blade is used to make a vertical incision by turning the blade tip coronally. A partial-thickness incision is then made toward the gingival margin, parallel to the gingival surface, with the flap edge held with tissue pliers. The flap is reflected.



c. One layer of the nonmobile periosteum-connective tissue site on the bone surface is prepared.



d. A distance of 3 mm on the buccal aspect from the abutment margin to the bone crest is ensured.

e. The flap is displaced apically and sutured with a 4-0 silk thread.

f. Approximately 5 months after surgery, the coping is placed.

	Extent of gingival recession	Depth of gingival sulcus	Attachment level	Width of keratinized gingiva
Preoperative	4.5 mm	1.0 mm	5.5 mm	2.0 mm
Postoperative	2.0 mm	1.0 mm	3.0 mm	4.0 mm

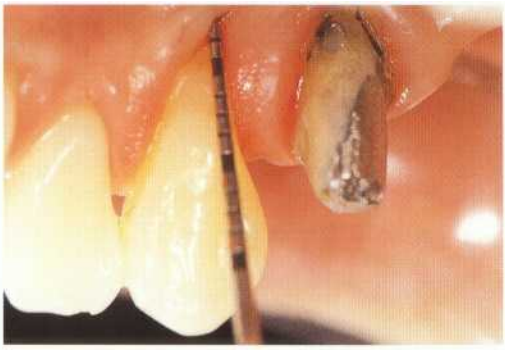
Case 2-7 Increase of the lingual attached gingiva before prosthetic treatment

c7-1 Mandibular lingual gingival recession.

a. Note the exceptional depression on the mandibular lingual gingiva alveolar mucosa due to the poor lingual bar design in the existing prosthesis.

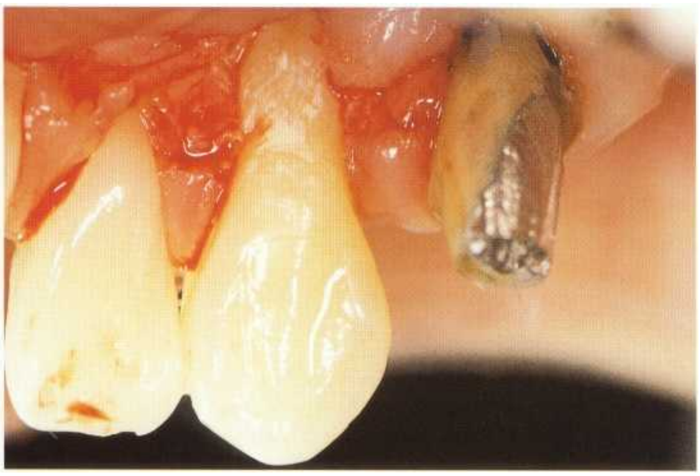
b. Seven years later. The gingival depression was alleviated, but recession of the gingiva-alveolar mucosa must be resolved before prosthodontic treatment.

Lingual subepithelial connective tissue grafts



c7-2 Preparation of the recipient site (lingual of 22).

a. The width of the lingual keratinized gingiva on 22 is narrow, and the base of the periodontal pocket is apical to the mucogingival junction.



b. Partial-thickness flap reflection reveals an osseous dehiscence greater than 7 mm from the CEJ to the bone crest. The root surface is treated with tetracycline solution.

c7-3 Connective tissue graft.

a. Suture of free connective tissue graft.

b. Graft covered by flaps.

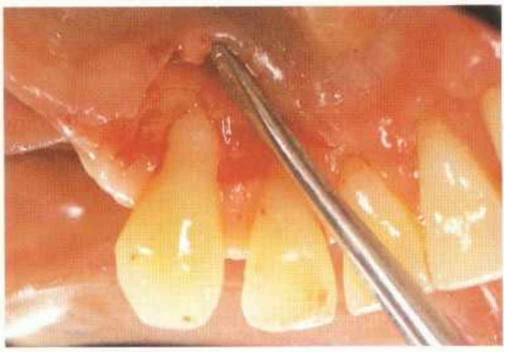
c7-4 Prognosis.

a. About 2 weeks after surgery.

b. Thirty-five weeks after surgery. The periodontal pocket is eliminated, there is sufficient attached gingiva, and the oral vestibule is expanded.

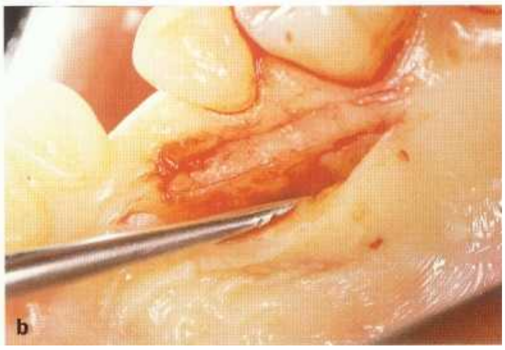
c7-5 Preparation of the recipient site (lingual of 26 and 27).

a. Note problems on the lingual gingiva-alveolar mucosa of 27 and the narrow oral vestibule.



b. A horizontal incision to the interdental papilla is made coronal to the CEJ and a partial-thickness flap reflected beyond the mucogingival junction. In this case, no vertical incision was made for flap preparation on the recipient site (modified Langer and Langer technique).

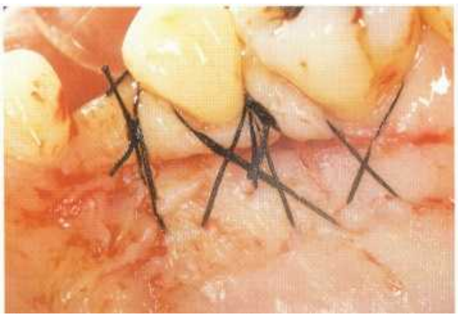
c7-6 Harvesting of connective tissue graft.



a. Two horizontal incisions are made on the palate. A primary partial-thickness incision is prepared approximately 5 mm apical to the gingival margin. A secondary incision is made 2 mm coronal and parallel to the primary incision.

b. The internal partial-thickness bevel incision is expanded apically for the width of graft.

c. A small periosteal elevator is used to separate the secondary full-thickness flaps (graft).



d. The harvesting area of the graft is closed with a cross horizontal mattress suture of 4-0 silk thread. Hemostasis and rapid healing are expected because no vertical incision on the palate was made.

e. The subepithelial connective tissue graft is 1.5-mm thick.

c7-7 Suture and stabilization.

a. The graft is adjusted and placed on the recipient site.

b. The graft is sutured and stabilized with resorbable suture material. The horizontal incision on the recipient site and the graft edge must be adapted to a buttjoint.

c. The flaps are displaced coronally. A 4-0 silk thread is used to make an interrupted suture to cover the graft as much as possible, and a periodontal pack is placed.

Prognosis

7-8 Prognosis

a. Removal of suture material 10 days after surgery. The gingival recession is completely eliminated.

b. Thirty-eight days after surgery. Patient may brush with an ultrasoft brush.

c. About 11 weeks after surgery.

d. About 24 weeks after surgery. Note the complete root coverage, sufficient attached gingiva, and expanded oral vestibule.

e. About 10 months after surgery. There is complete root coverage and gained attached gingiva with 4 mm of keratinized gingiva.

f. Placement of partial denture.

		Extent of gingival recession	Depth of gingival sulcus	Attachment level	Width of keratinized gingiva
22 lingual center	Preoperative	4.0 mm	3.0 mm	7.0 mm	1.0 mm
	Postoperative	2.0 mm	1.0 mm	3.0 mm	4.0 mm
27 lingual center	Preoperative	4.0 mm	1.0 mm	5.0 mm	1.0 mm
	Postoperative	0.0 mm	0.5 mm	0.5 mm	5.0 mm

Increase of the Attached Keratinized Tissue Around Implants

The Necessity of Nonmobile Keratinized Tissue Around Implants

It is important to ensure that there is sufficient keratinized tissue around the implants before proceeding with the usual prosthetic treatirment. This is especially so in the extremely resorbed alveolar ridge where the oral vestibule tends to be narrow and small and keratinized tissue width lacking. If there is insufficient immobile keratinized tissue, the movement of lips, cheeks, and tongue will pull the alveolar mucosa or frenum, exerting tension on the peri-implant tissue. Additionally, Lange and Loe and Lange" stated that excess movement of the gingival margin due to a lack of keratinized gingiva could promote bacterial invasion of the gingival sulcus.

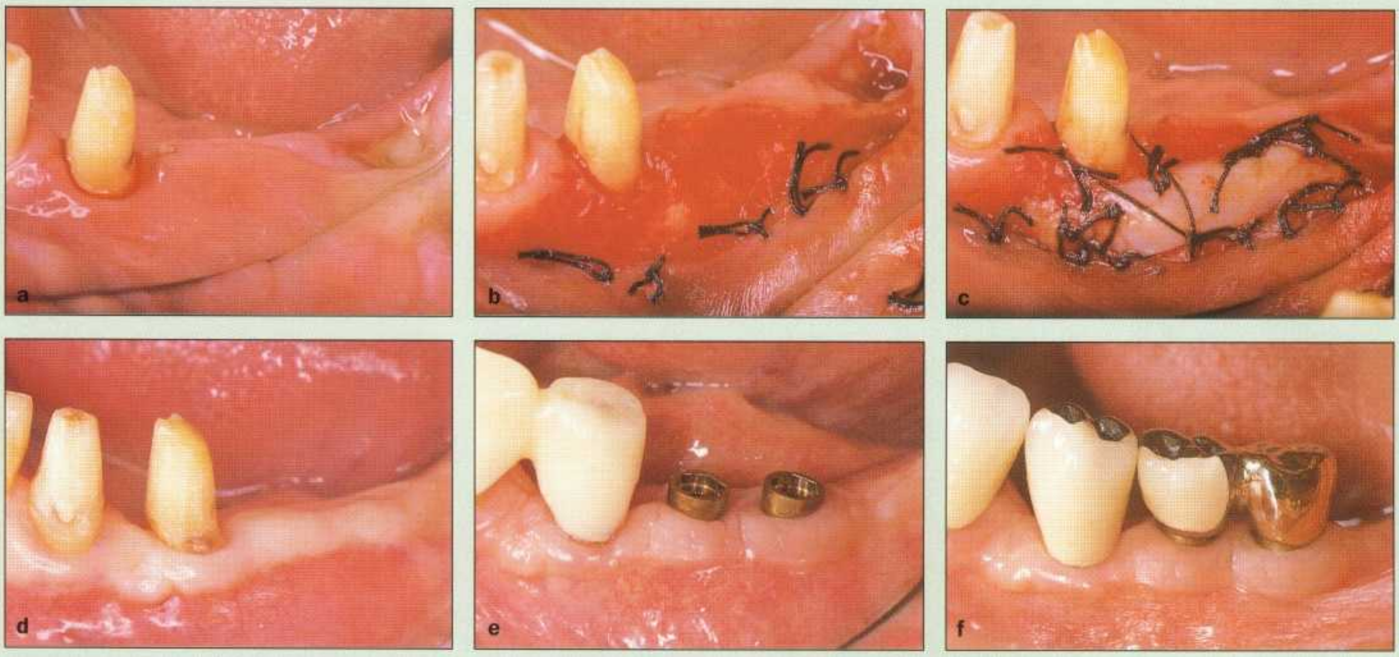
The attachment of the implant abutment and the mucosa is extremely fragile compared with the bond between tooth and periodontal tissue, because connective tissue fibers adjacent to the implant abutment are parallel to the implant surface; therefore, connective tissue attachment cannot be formed on an implant surface. (Periodontal tissue, however, has thick supracrestal fibers that enter the cementum under the epithelial attachment). Therefore, if the mucosa around the abutment is mobile, space between the abutment and the mucosa epithelium may allow plaque build-up. Such a condition also makes proper plaque removal difficult, and increasing inflammation may result.

Warrer et al, in an endosseous implant study conducted on a monkey, reported that the presence or absence of peri-implant keratinized tissue affects plaque-induced tissue destruction. The study reports that recession or the amount of attachment loss in tissue lacking keratinized tissue around implants is greater than it is with keratinized tissue. Lack of keratinized tissue around endosseous implants is thought to lead to loss of resistance to plaque-induced tissue destruction.

For these reasons, adequate immobile keratinized tissue around implants is desirable. Keratinized tissue at the implant site also facilitates wound closure after fixture-placement surgery. Therefore, if there is no nonmobile, keratinized tissue or if its width is extremely narrow at the implant site, keratinized tissue should be acquired by free autogenous gingival grafts or free connective tissue grafts prior to implant placement (Fig 2-9).

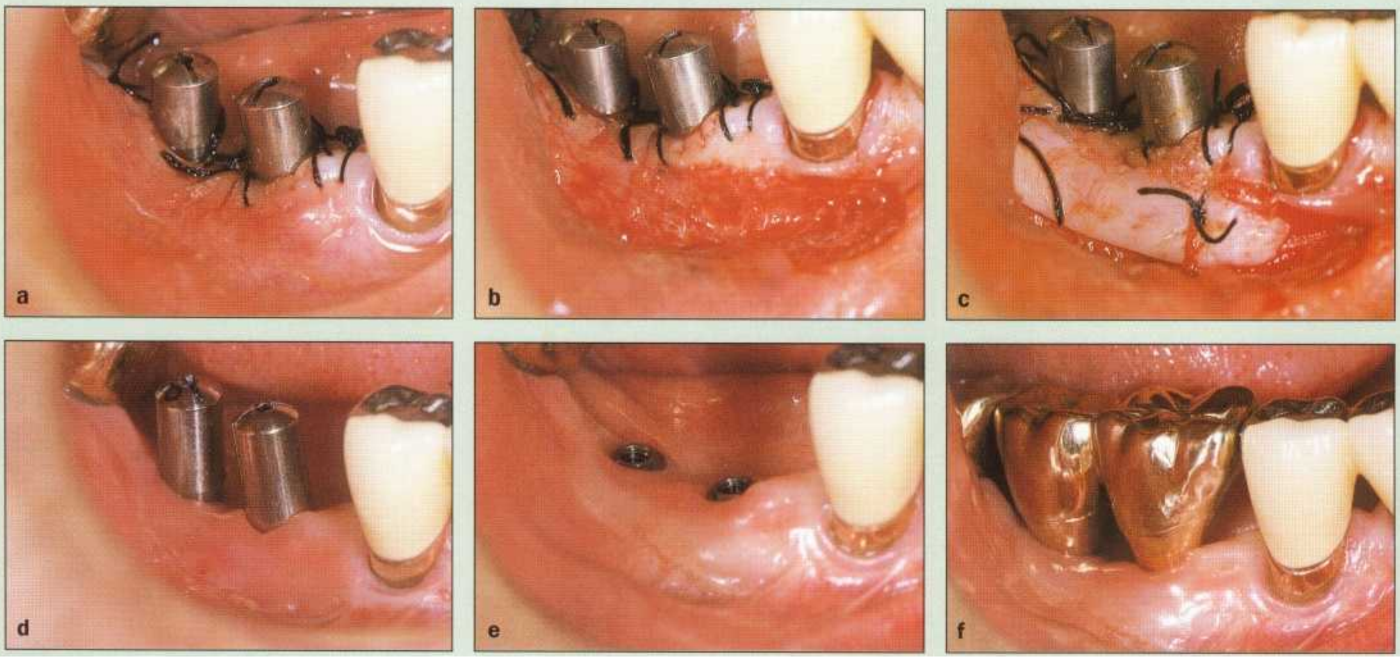
For secondary surgery, keratinized tissue may be acquired using the same methods (Fig 2-10). If there is a lack of keratinized tissue after the secondary surgery, the same methods may again be used. Caution is required to avoid damaging the area between the established abutment and soft tissue (Fig 2-11 and Case 2-9).

Fig 2-9 Free autogenous gingival grafts prior to fixture placement.



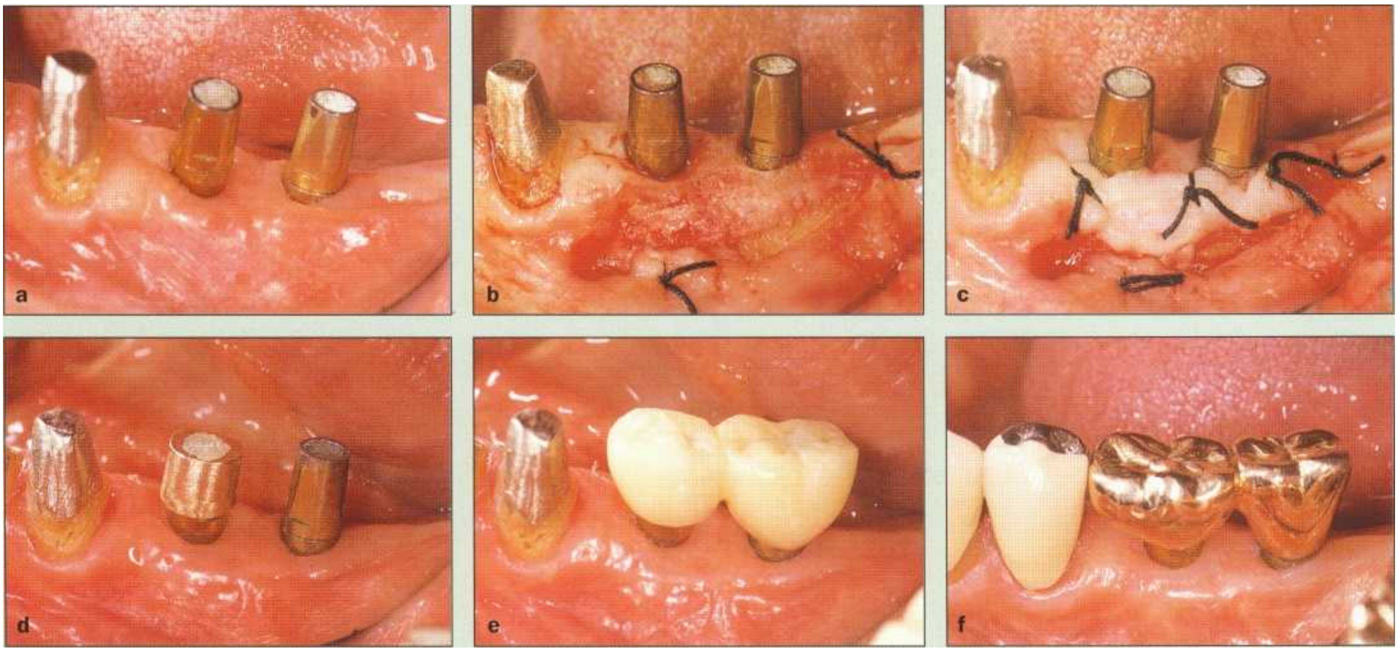
a. The buccal mucosa of the edentulous alveolar ridge of 19 and 20 extends onto the alveolar crest. Keratinized tissue is absent.
b. The periosteum-connective tissue recipient site is prepared.
c. The free gingival graft harvested from palate is sutured and stabilized.
d. Periodontal treatment of the abutment adjacent to the implant site is completed and an adequate environment for implant placement achieved.
e. Sufficient keratinized tissue around the implant abutments is available after secondary surgery.
f. Final restorations are placed,

Fig 2-10 Second-stage implant surgery.



a. The implants for 30 and 31 are exposed for placement of temporary healing abutments, and flaps are sutured; however, the flap's edge moves because of cheek movement, caused by the strong traction of the alveolar mucosa.
b. Free autogenous gingival grafts are performed to ease the tension on the peri-implant mucosa and to correct the shortage of keratinized tissue and expand the narrow and small oral vestibule. The recipient site is prepared with partial thickness.
c. The free autogenous gingival graft harvested from the palate is sutured.
d. Thirty-seven days after surgery. Keratinized tissue of sufficient width and thickness has formed on the temporary healing abutments.
e. Prior to impression making.
f. Placement of final restorations.

Fig 2-11 Increase of keratinized tissue around implants using free autogenous gingival grafts.



a. Two osseointegrated implants (Kyocera) are placed in the mandibular molar area; however, the width of the buccal keratinized tissue is insufficient.

b. Preparation of the partial-thickness recipient site. Because the traction of the alveolar mucosa of 19 is strong, the periosteum is fenestrated apically in a linear fashion and the bone surface exposed. This helps reduce the possibility of relapse after grafting.

c. The free autogenous gingival graft (marginal graft) is sutured.

d, e. Three months after surgery. Sufficient keratinized tissue width has formed around implants.

f. Nine months after gingival grafting. Peri-implant mucosa is stabilized by the increase of keratinized tissue.

Incision (Reconstructive) Technique

In second-stage-implant surgery, the secondary surgery is performed 3 to 6 months after fixture placement. While secondary surgery is primarily to expose the fixture head for the abutment connection, other objectives are:

1. To adjust the thickness of soft tissue around the implants.
2. To preserve and increase the nommobile keratinized mucosa around the implants.
3. To create an environment for the abutment connection that makes an esthetic and hygienic emergence profile possible.
4. To improve the esthetics of soft tissue around the implants.

Because there is the possibility of losing the nomnobile keratinized mucosa around the implants in secondary surgery, it is important to monitor this width.

Table 2-11 Indications of Various Techniques of Second-Stage Implant Surgery

Condition of keratinized tissue around implants		Indicated technique
Width ≦ 8 mm	Excisional technique	Resect gingiva on fixture by blade, tissue punch, or electrosurgery and expose implants
Width 1–8 mm	Incisional technique	See Case 2-10
Width ≤ 1 mm	Partial-thickness, apically positioned flap surgery	See Case 2-8
Completely absent	Free autogenous gingival grafts or connective tissue grafts	See Case 2-9
Esthetic improvement of surrounding soft tissue	Papilla regeneration technique	See Case 6-17
	Connective tissue grafts or roll procedure	See Fig 6-3 in Chapter 6

Hartel et al conducted a comparison study of second-stage implant surgery (excisional technique vs incisional technique). In the study, the width of the fixed mucosa was measured before surgery,, at the time of connection abutment, and 3 months after the surgery at each implant site. With the excisional technique, 18% of the preoperative fixed mucosa was preserved 3 months after surgery. With the incisional technique, 45% was preserved.

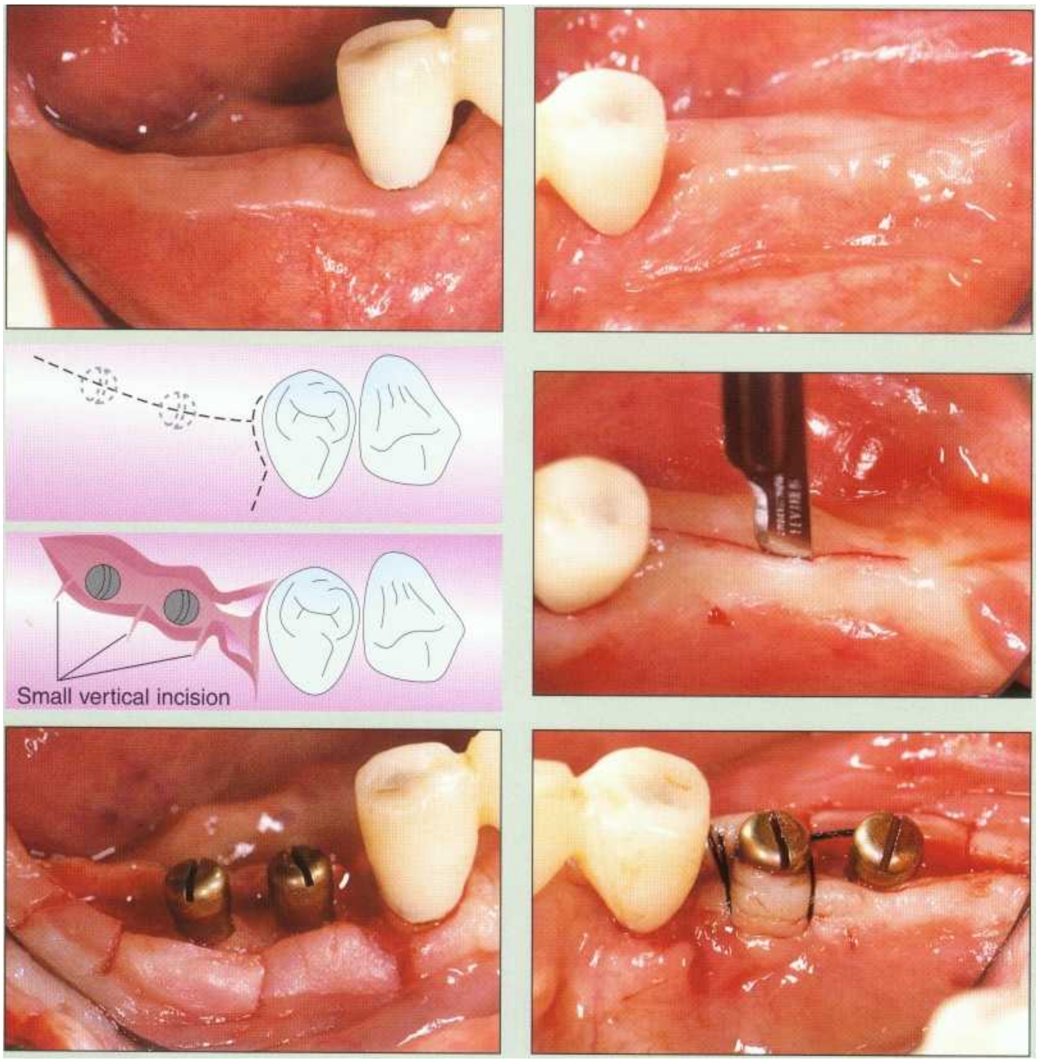
As the results show, the incisional technique is the better method for preserving nonmobile fixed mucosa around implants. In the incisional technique, a small vertical incision and an alveolar crest incision are made mesially, distally, and between implants within the fixed mucosa. This technique makes close adaptation of the abutment and full-thickness flap possible (Fig 2-10).

While this is a useful technique to preserve keratinized tissue, this technique is not indicated if the width of the fixed mucosa is less than 1 mm.

Table 2-12 Comparison of the Width of Fixed Mucosa in Second-Stage Implant Surgery (average)[45]

	Preoperatively	Immediately postoperative	3 months after surgery
Excisional technique (214 teeth)	4.4 mm	0.9 mm	0.8 mm
Incisional technique (253 teeth)	4.6 mm	2.2 mm	2.1 mm

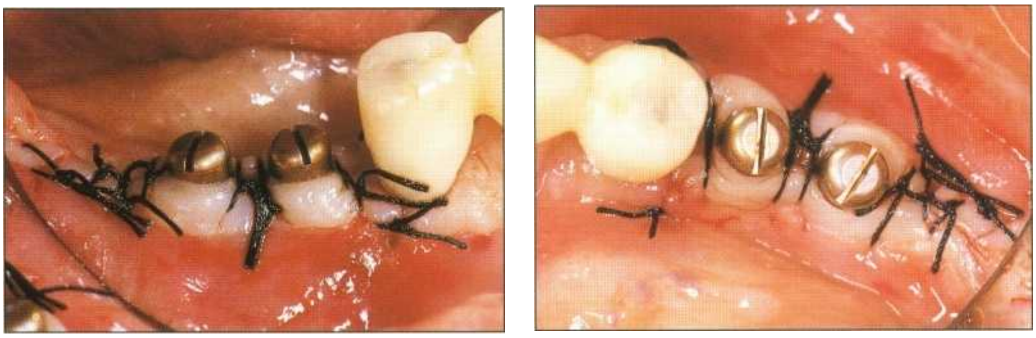
Fig 2-12 Incisional technique.



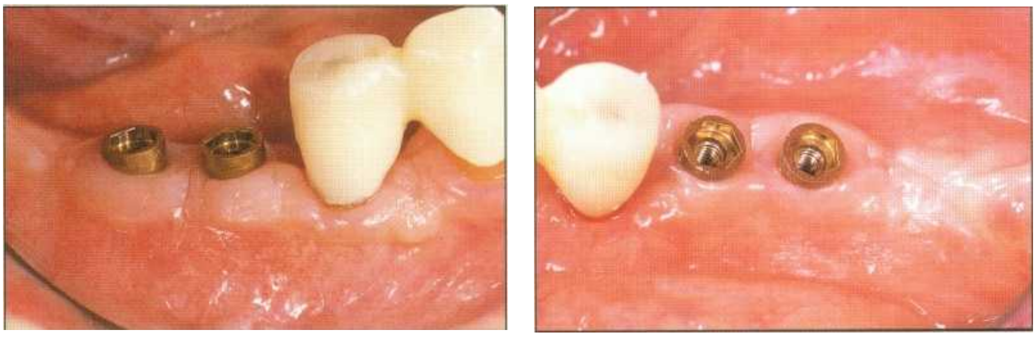
a. Before secondary surgery (right, lingual aspect).

b. A crestal incision is made to the center of the nonmobile keratinized mucosa.

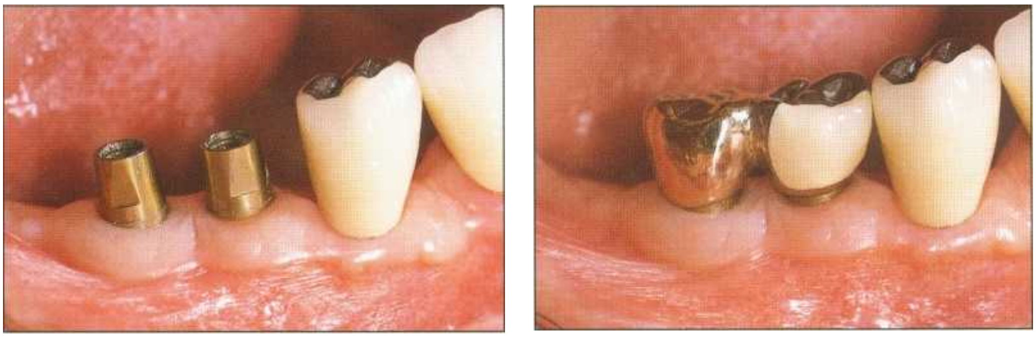
c. Small incisions are made on the mesial and distal aspects of the buccal flap and between the two implants (buccal aspect) (right, lingual aspect).



d. The flaps are sutured.



e. One month after surgery. The width of nonmobile keratinized tissue around the abutments is sufficient.

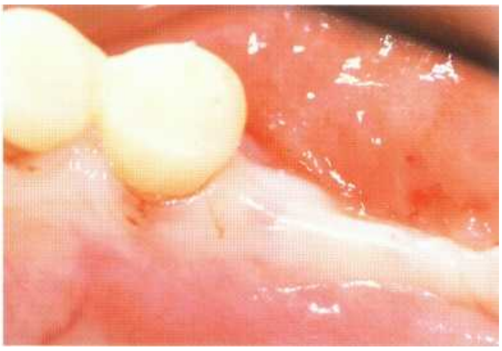


f. Abutments and final restorations are placed.

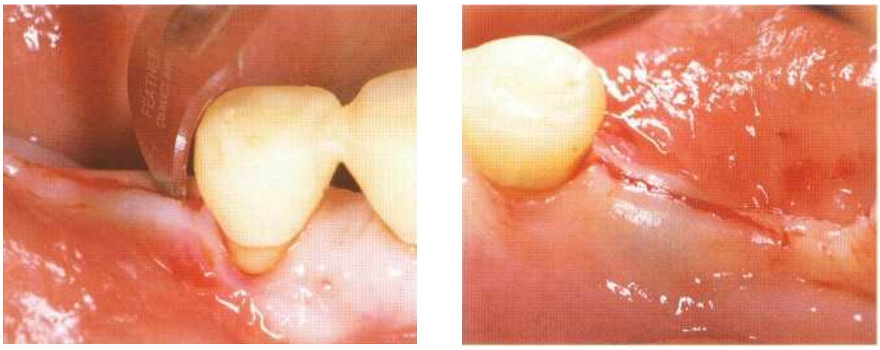
Case 2-8 Partial-thickness, apically positioned flap in second-stage implant surgery

Incision

c8-1 Crestal incision.



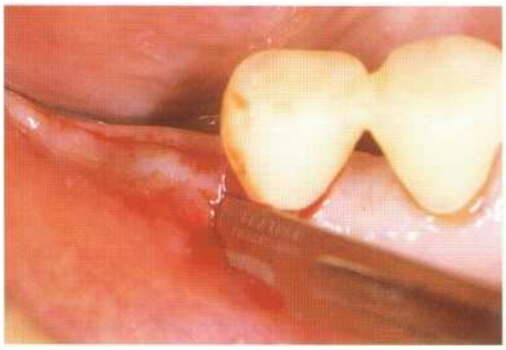
a. Sixteen weeks after the placement of a P01 two-piece implant (Finafix, Kyocera), 40-year-old woman. The width of the keratinized tissue on the buccal and lingual aspects is narrow.



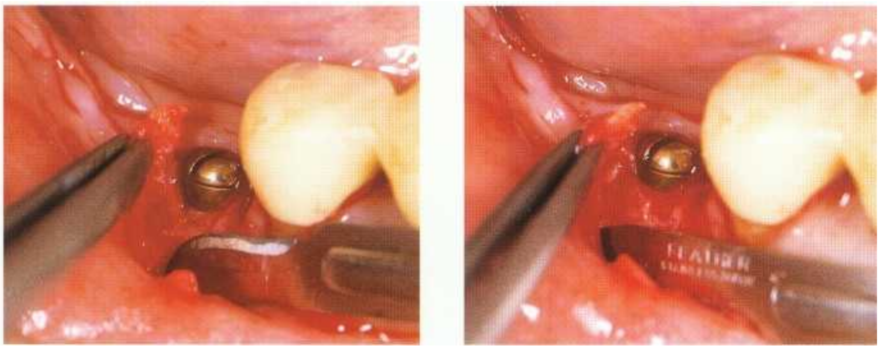
b. A crestal incision to expose the fixture is made with a no. 12 blade.

Partial-thickness flap preparation

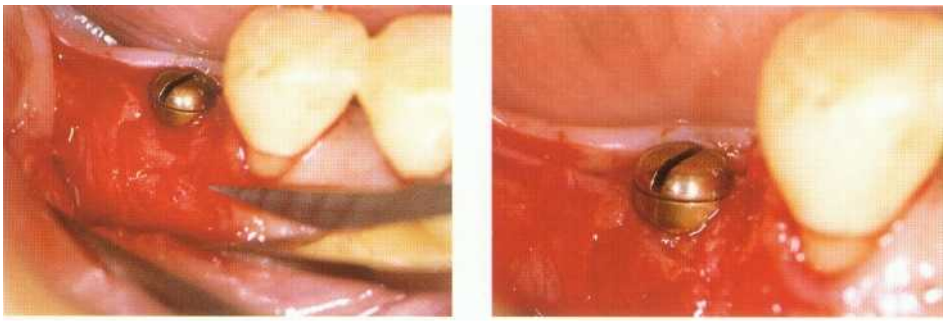
c8-2 Flap preparation.



a. A no. 15 blade is used to make a vertical incision on the mesial aspect of the implant, with care taken not to contact the bone.



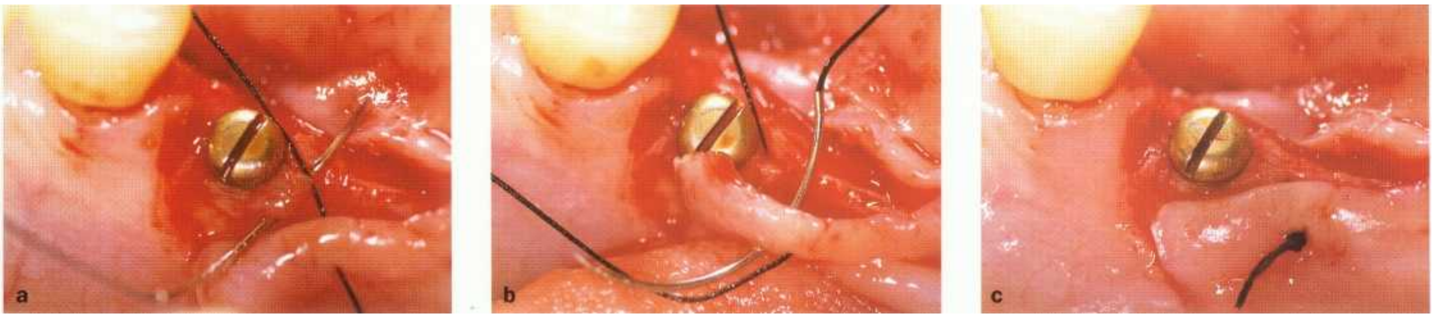
b. Tension is applied with the flap edge held and pulled with tissue pliers. A vertical incision is made with a no. 15 **blade, and the tip maneuvered** apically and coronally slowly toward the periosteum. The blade tip is held parallel to **the gingival surface** to avoid flap penetration.



c. The residual elastic and muscle fibers are removed with scissors. The nonmobile periosteum-connective tissue site around the fixture is prepared.

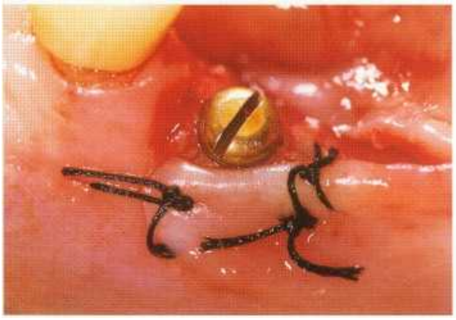
d. A vertical incision is made on the mesial aspect and a partial-thickness flap prepared on the lingual aspect.

Periosteal suture of flap

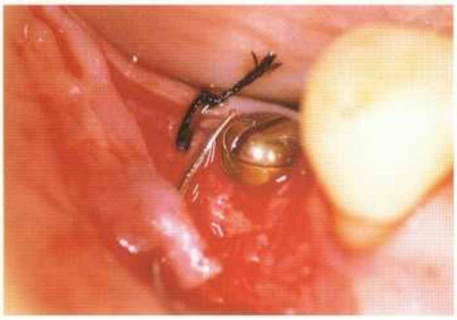


c8-3 Vertical mattress suture. A periosteal suture and a vertical mattress suture are made. The needle is inserted from the outside of the lingual flap distal to the fixture (a). The needle is then inserted to the periosteum-connective tissue site from the inside of the lingual flap (b). The ligature is made with suture material (c).

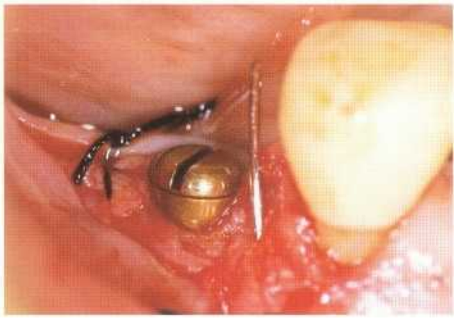
c8-4 Interrupted suture on vertical suture area.



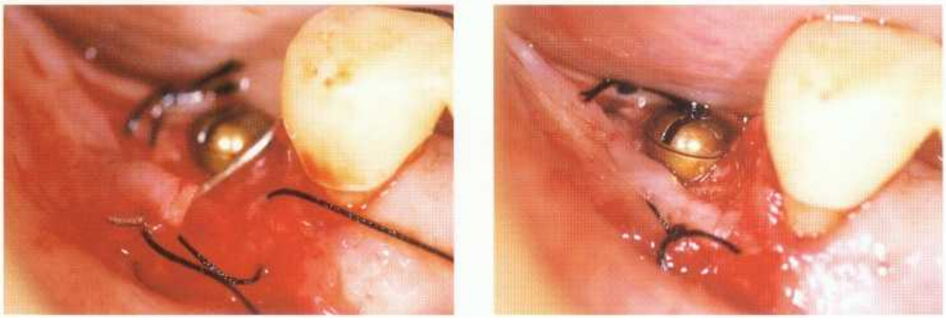
a. The mesial vertical incision area is displaced apically and an interrupted suture made.



b. The needle is inserted mesial to the buccal flap from the outside of the flap.



c. The needle is inserted in the periosteum-connective tissue site around the fixture.

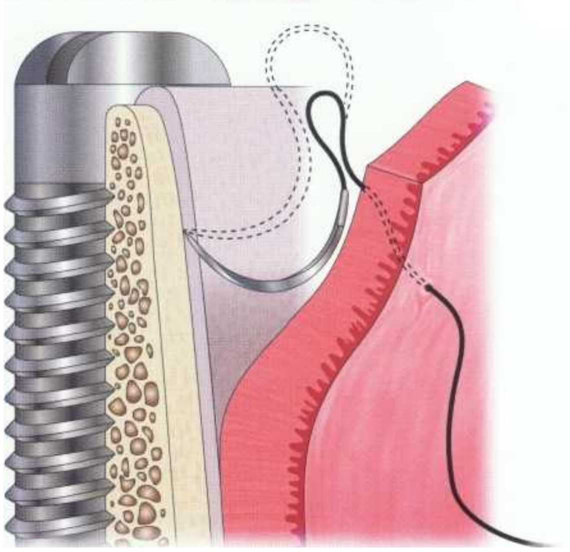


d. The needle is inserted trom the inside of the buccal flap, an acute angle made, and the needle drawn out to the gingival surface. The flap is brought to the intended site and the periosteal suture completed with a vertical mattress suture, with care taken not to move the flap. The distal flap is sutured with the same technique.

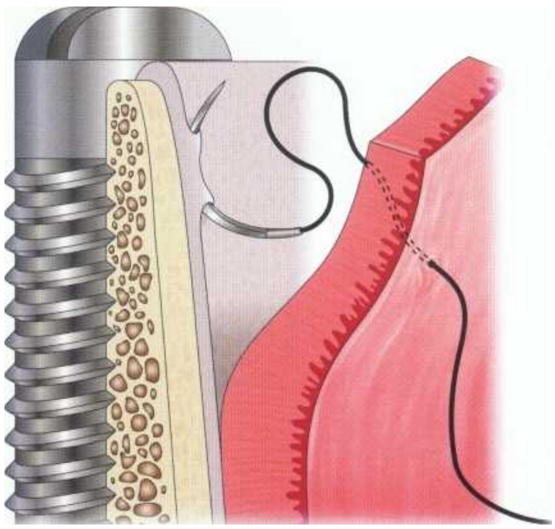
e. The flap is stabilized apically with a periosteal suture.

Fig 2-13 Periosteal suture in second-stage implant surgery.

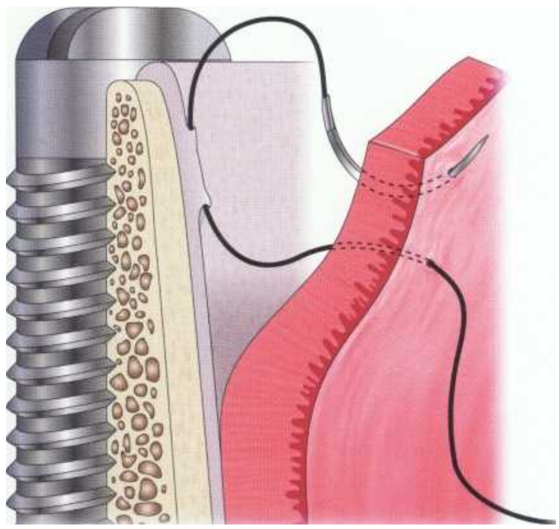
a. Insert the needle directly perpendicular to the surface of the flap.



b. Insert the suture material (or needle) perpendicular to the periosteum-connective tissue site, and engage the periosteal fibers while rotating the needle along the needle curve, using the needle tip as the center of rotation.



c. Slide the needle coronally along the bone surface and engage the periosteum-connective tissue site.

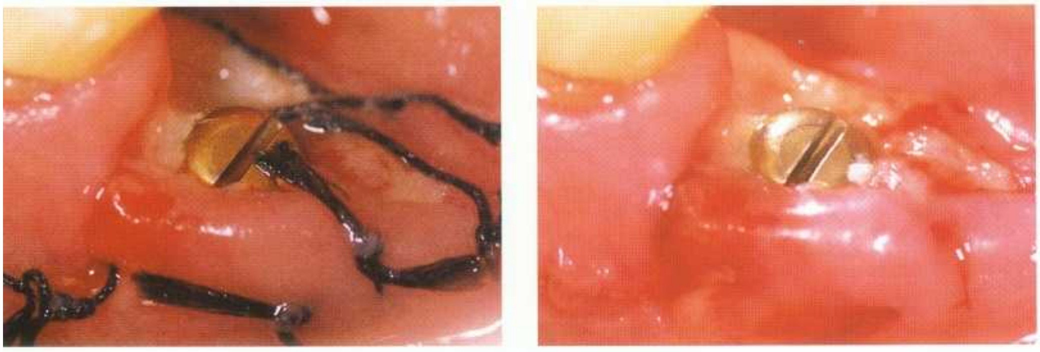


d. Insert the needle from the inside of the flap and pull it out to the gingival surface.

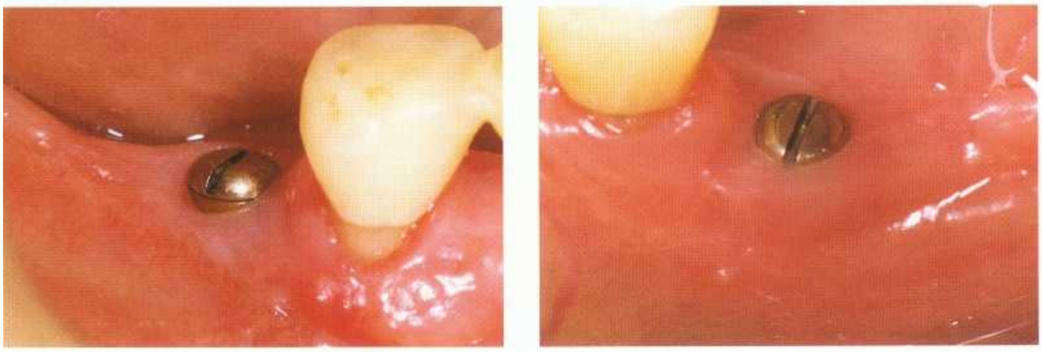
e. Make a surgical knot at the end of the thread and complete the suture.

Prognosis

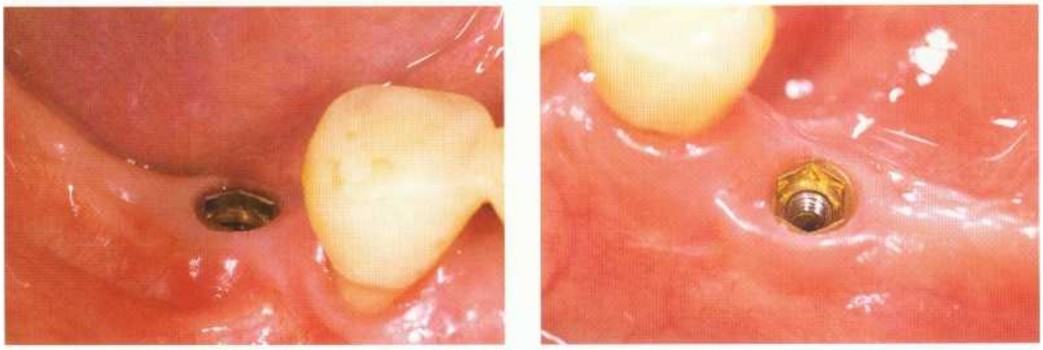
c8-5 Removal of suture thread.



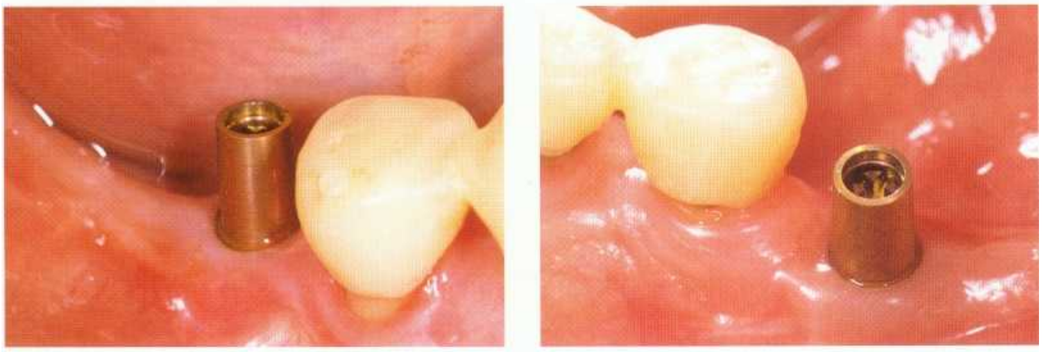
a. Five days after surgery. (Right, after removal of suture material.) The patient now can begin to gently brush with an ultrasoft brush.



b. Two weeks after surgery.



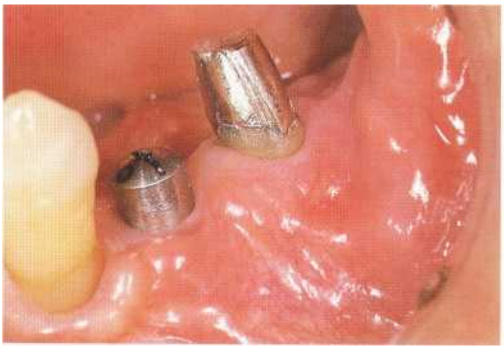
c. Ten weeks after surgery. The cover cap is removed.

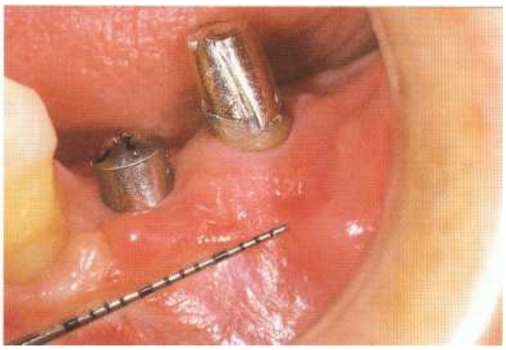


d. Placement of post.

e. Placement of final restoration 2 years and 3 months after surgery.

Case 2-9 Connective tissue grafts to increase keratinized tissue around implants

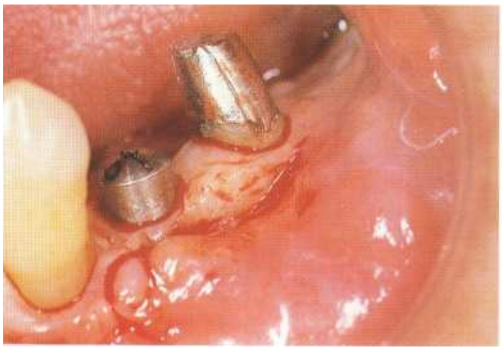




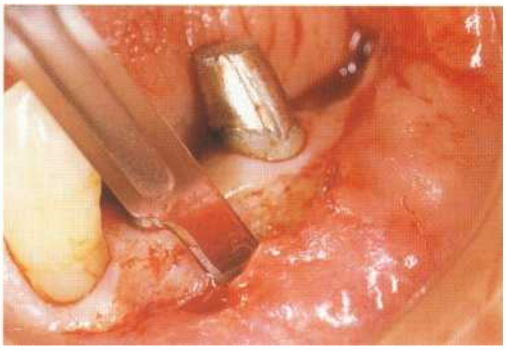
c9-1 Peri-implant keratinized tissue. The buccal keratinized mucosa of the osseointegrated implant on 21 is lacking, and the muscle attachment extends to the marginal area. Also, the attached gingiva width on 20 is narrow (64-year-old man).

Preparation of the recipient site

c9-2 Preparation of horizontal incision and periosteum-connective tissue recipient site.



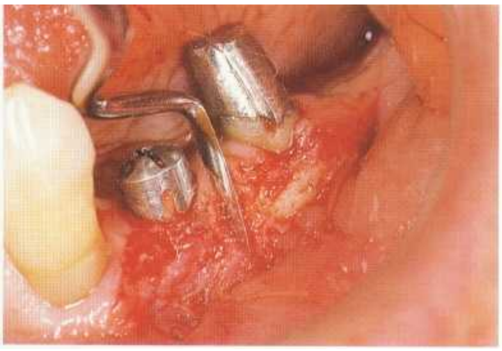
a. With a no. 15 blade, a horizontal partial-thickness incision is made parallel to the mucogingival junction (distal to mesial) while the lip is pulled.



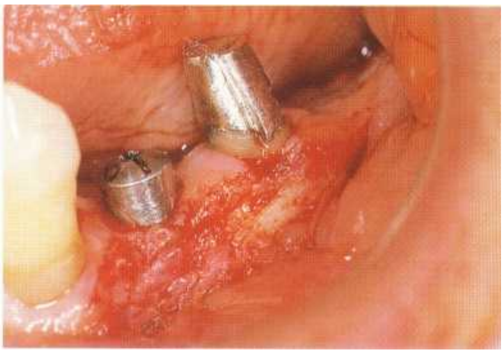
b. The incision is extended apically. The surface layer of the thick connective tissue on the bone is carefully incised, and an immobile periosteum-connective tissue recipient site with uniform thickness is prepared.

Key point

Extend the incision at least one tooth rnesiodistally more than the planned range of the graft.



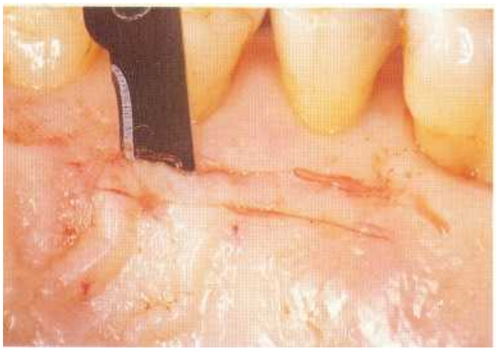
c. An Orban interdental knife is used to remove the gingival epithelium coronal to the initial horizontal incision line and to provide a bevel.



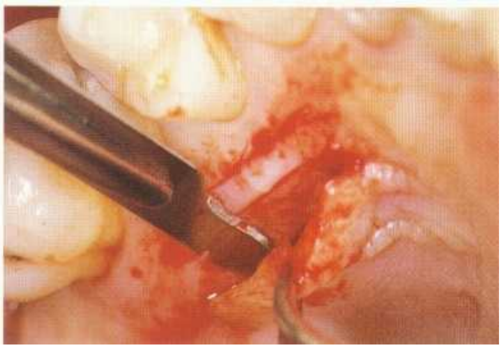
d. Prepared recipient site.

Harvesting of graft

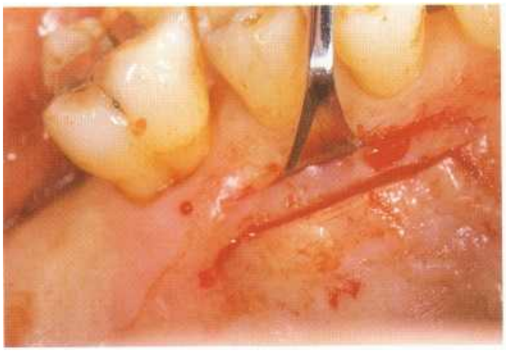
c9-3 Harvesting of connective tissue graft.



a. A horizontal partial-thickness primary incision and a parallel horizontal secondary incision that extends to the bone are made,



b. The flaps are reflected toward the center of the palate while the primary flap edge is held with tissue pliers. A partial-thickness 2-mm primary flap is made.



c. A Kirkland 15/16 knife is used to separate the secondary flap from the bone. The graft is harvested.

d. The primary flap is sutured and an oxycel gauze placed for hemostasis.

Grafts

c9-4 Suture of graft.

a. The graft is adjusted and placed on the gingival margin area of 20 and 21. An interrupted suture with a 4-0 silk thread (marginal graft) is made.

b. The surgical area is protected with a periodontal pack.

Prognosis

c9-5 Grafted area 22 days after surgery. The wound is almost healed with sufficient keratinized tissue width on 20 and 21.

c9-6 Twenty weeks after surgery.

c9-7 Placement of prosthesis.

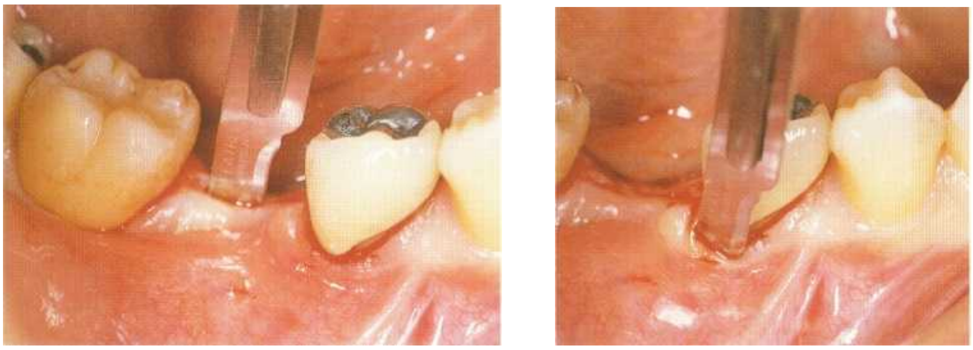
a. An abutment is attached to the fixture. A coping covers 20.

b. Final restorations.

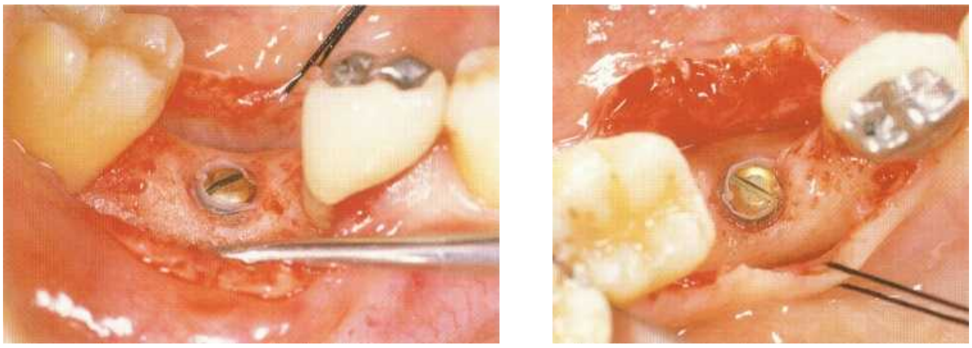
Case 2-10 Second-stage surgery for implants using the incisional technique

c10-1 Before second-stage surgery. The buccal aspect of the P01 three-piece implant (Kyocera) on 30, 8 months after placement.

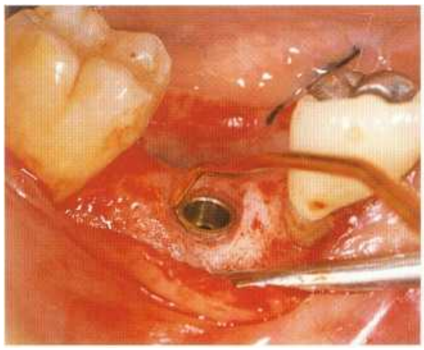
Second-stage surgery



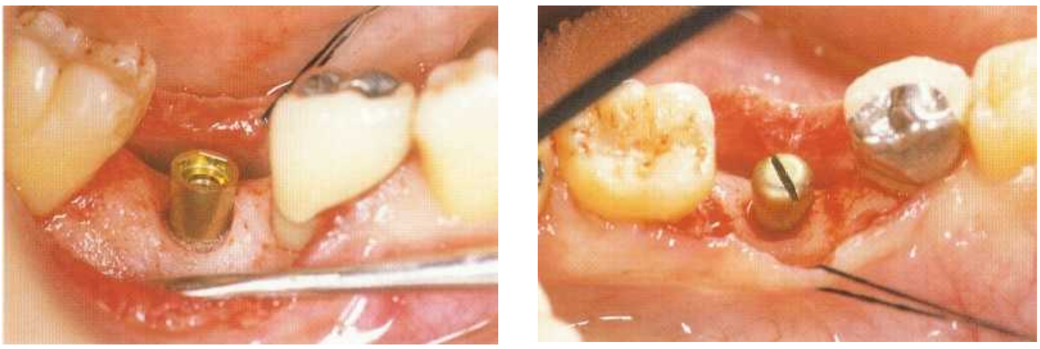
c10-2 Crestal incision. With a no. 15 blade, a crestal incision on the center of the keratinized tissue is made. The incision is extended to the buccal aspect of 29, making a sulcular incision. In general, the length of a crestal incision is three to four times the implant diameter.

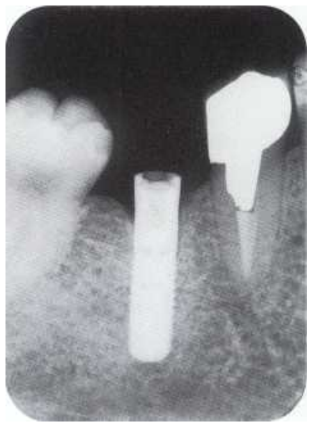


c10-3 Exposure of fixture. The prepared full-thickness flap is reflected and the fixture exposed.



c10-4 Removal of soft tissue. The fixture cap is removed and all the soft tissues that may interfere with the abutment are removed with a titanium curette.





c10-5 Abutment connection. The abutment is connected to the fixture and a cover cap placed. Radiograph shows status before placement of the cover cap.

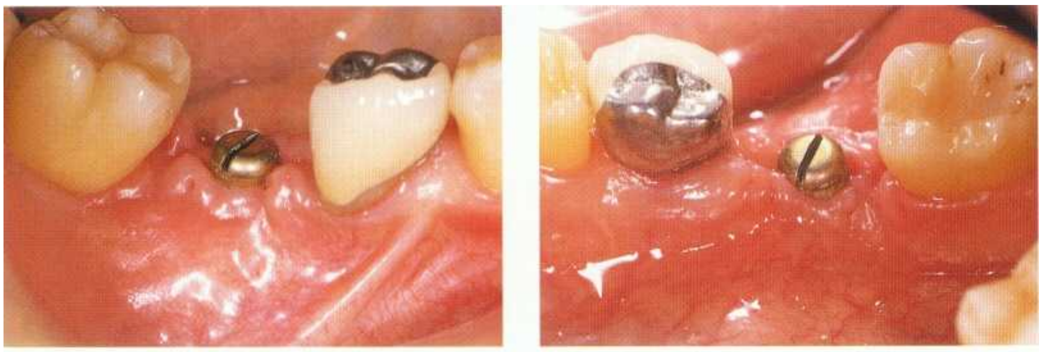
c10-6 Interrupted suture. The buccal flap of the mesial part of the implant and the lingual flap are closely adapted to the abutment. An interrupted suture is made.

c10-7 Preparation of short vertical incision. A short vertical incision is made in the keratinized tissue on the distal area of the buccal and lingual flap.

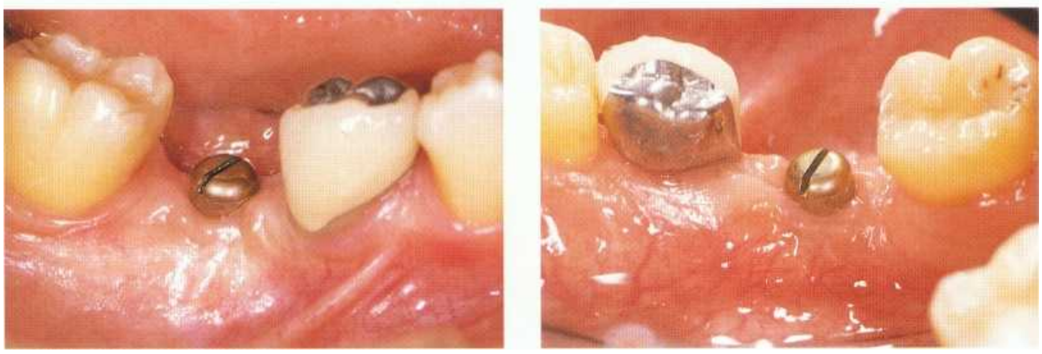
c10-8 Complete wound closure. The keratinized tissue of the flap is closely adapted to the distal area of the abutment. There should be complete wound closure and no interdental bone exposure.

Prognosis

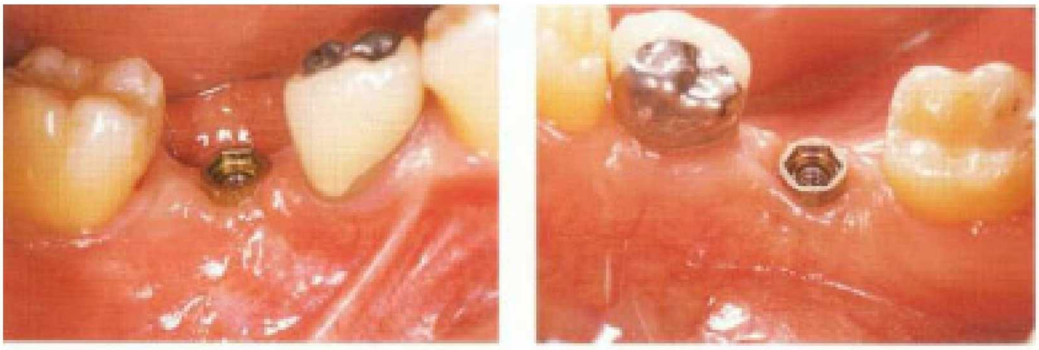
c10-9 After second-stage surgery.



a. Twelve days after surgery.

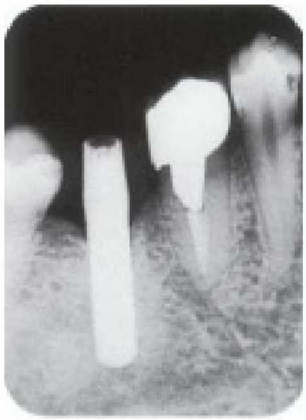


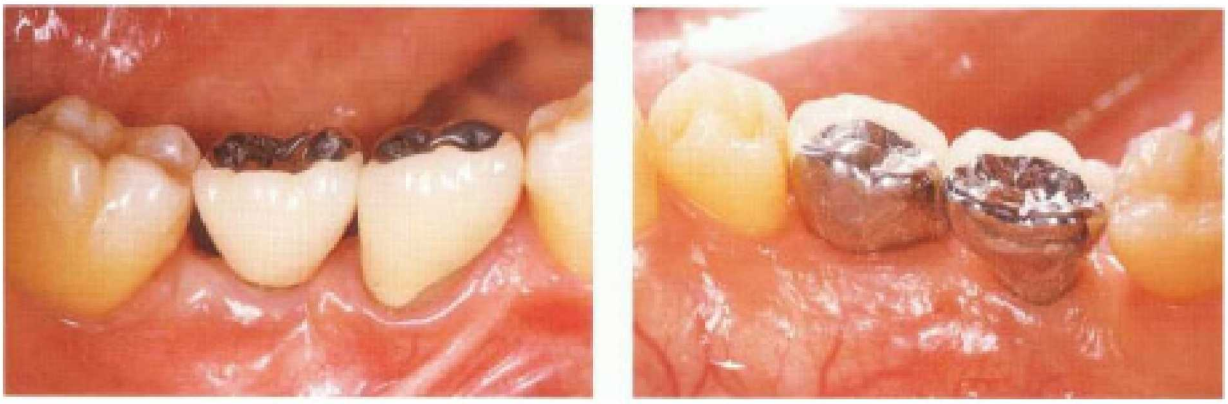
b. Fifty-three days after surgery.



c. Approximately 2 months after surgery.

d. Placement of post.





c10-10 Final restorations. Adequate width of nonmobile keratinized mucosa around the implant is preserved.

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3

Periodontal Regeneration Using Flap Curettage

Flap Curettage as a Regenerative Procedure

Classification of Periodontal Surgery for Periodontal Pocket Treatment

Damage to periodontal tissues is caused by bacteria in the gingival sulcus. The inflammatory reaction of the body against this bacterial plaque causes the formation of periodontal pockets and resorption of alveolar bone due to the apical migration of junctional epithelium. Periodontal disease can be controlled by reducing or completely eliminating the bacteria by chemical or physical methods, or by changing the bacterial flora. However, in the presence of a periodontal pocket, bacteria will return, even if the bacterial flora is controlled. Therefore, surgical procedures have been devised to eliminate periodontal pockets and to establish a periodontal environment where bacterial plaque can be easily removed.

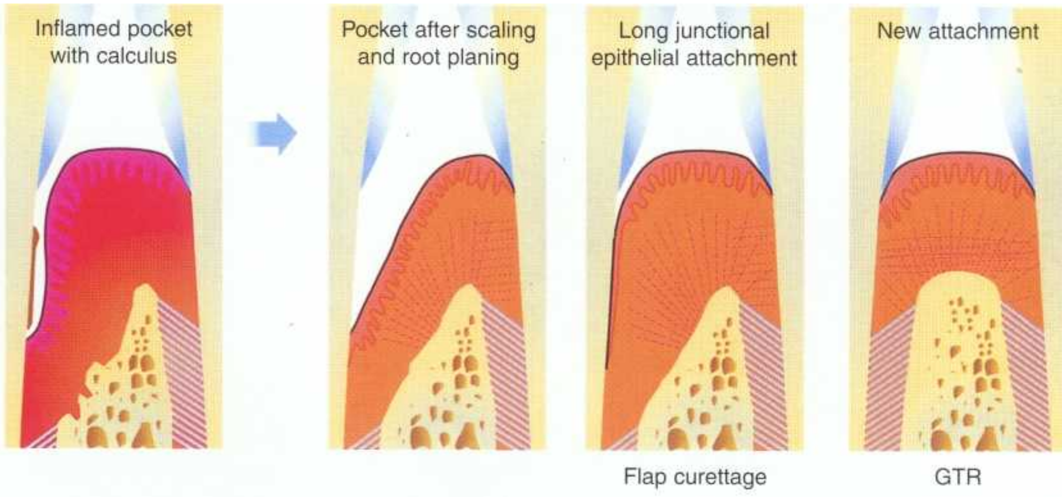
Treatment for periodontal pockets includes pocket reduction procedures and pocket elimination procedures. Reduction may involve resective surgery or regenerative surgery (Table 3-1).

Elimination of the periodontal pocket is best achieved by new attachment, such as that obtained with GTR (Fig 3-1). However, all factors must be considered in selecting the most appropriate technique.

Table 3-1 Classification of Periodontal Surgery for Periodontal Pocket Treatment

1. Pocket reduction procedures
   - a. Scaling and/or root planing
   - b. Flap curettage for reattachment of soft tissue to root surface
2. Pocket elimination procedures
   - a. Resective surgery
     - Resection of soft tissue that forms pocket walls
       - — Gingivectomy
       - — Flap curettage (internal bevel gingivectomy)
     - Displacement of soft tissue that forms pocket walls apically to cover alveolar crest
       - — Apically positioned flap surgery
     - Elimination of osseous defect walls that form intrabony pocket
       - — Osseous resection (osteoplasty, ostectomy)
     - Elimination of tooth surface that forms periodontal pocket
       - — Root resection, hemisection
       - — Strategic extraction
   - b. Regenerative surgery
     - Elimination of periodontal pocket with new attachment
       - — Flap curettage with bone graft
       - — Flap curettage with guided tissue regeneration (GTR)
         - ǂ GTR without bone graft
         - ǂ GTR with bone graft
     - Reduction of furcation involvement by new attachment
       - — Flap curettage with GTR
         - ǂ GTR without bone graft
         - ǂ GTR with bone graft

Fig 3-1 Periodontal pocket elimination by new attachment.



Flap Curettage as a Regenerative Procedure

If, during initial therapy, the patient's oral hygiene is adequate but therapy is ineffective because of insufficient gingival response or poor accessibility of instruments to the root surface due to a deep periodontal pocket, flap curettage may be necessary. Because of its wide indications, it is the most frequently used flap surgery (Table 3-2).

Guided tissue regeneration (GTR) has been a key interest in periodontics.[5] Regeneration of periodontal tissue with bone grafts has preoccupied periodontal researchers for years.

Controlling subgingival inflammation adequately is required for all regenerative procedures. Therefore, flap curettage is the foundation of all periodontal regenerative procedures.

Much attention has been given to bone grafts and GTR. Simply transplanting autogenous bone to an osseous defect area or placing a barrier membrane without performing thorough debridement will not, however, lead to regener ation, and may even be harmful. Accordingly, for the purpose of this discussion, flap curettage is a central part of bone graft therapy and GTR (Fig 3-2).

Table 3-2 Indications for Flap Curettage

1. Need access flap for final root debridement.
2. Need to reduce inflammation of deep periodontal pocket with thick fibrous gingiva.
3. Recurrent periodontal abscess.
4. Treatment followed by partially hemisectioned tooth during initial therapy.
5. Existing deep osseous defect prior to orthodontic treatment.
6. Pretreatment for more complex periodontal surgery.
7. Bone regeneration planned for intrabony defect area.
8. Initial therapy for severe periodontitis.
9. Cases that may require a more conservative initial surgical approach by limiting gingival recession as a consequence of pocket depth reduction.
10. Need to visually examine to make definite diagnosis.

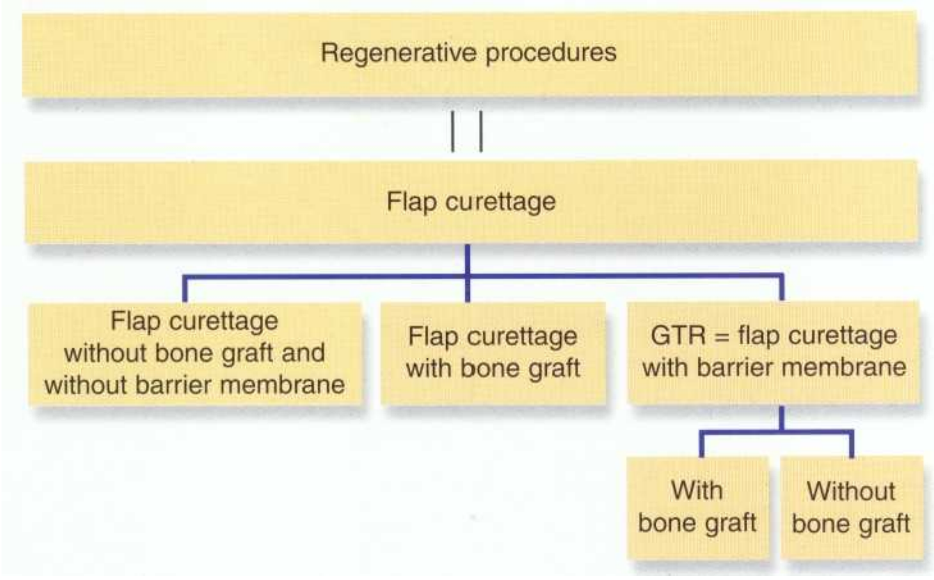
Severe periodontal disease with deep intrabony pockets over the dentition and localized deep intrabony defects is not an indication for resective procedures, which requires removal of the supporting bone. In such a case, flap curettage is first performed, with or without a bone graft or GTR, to eliminate the subgingival inflammation and to improve periodontal support. Based on postoperative re-evaluation, maximum pocket reduction or treatment to eliminate the remaining osseous defect is then performed."

Bone apposition to the osseous defect area has been described Nvith flap curettage used in deep intrabony defects.

Table 3-3 Advantages and Disadvantages of Flap Curettage as a Regenerative Procedure

Advantages
1. Rapid healing.
2. Short surgical time.
3. Less postoperative discomfort and fewer complications.
4. Less postoperative gingival recession, therefore esthetic.
5. Less dentin exposure.
6. Maximum preservation of supporting bone.
7. Less technically demanding than other regenerative procedures.
Disadvantages
1. Possibility of deep periodontal pockets remaining after surgery.
2. Possibility of formation of postoperative gingival craters in proximal surface areas (especially in molars).
3. New attachment is unpredictable.
4. Less regeneration achieved compared to other regenerative procedures.

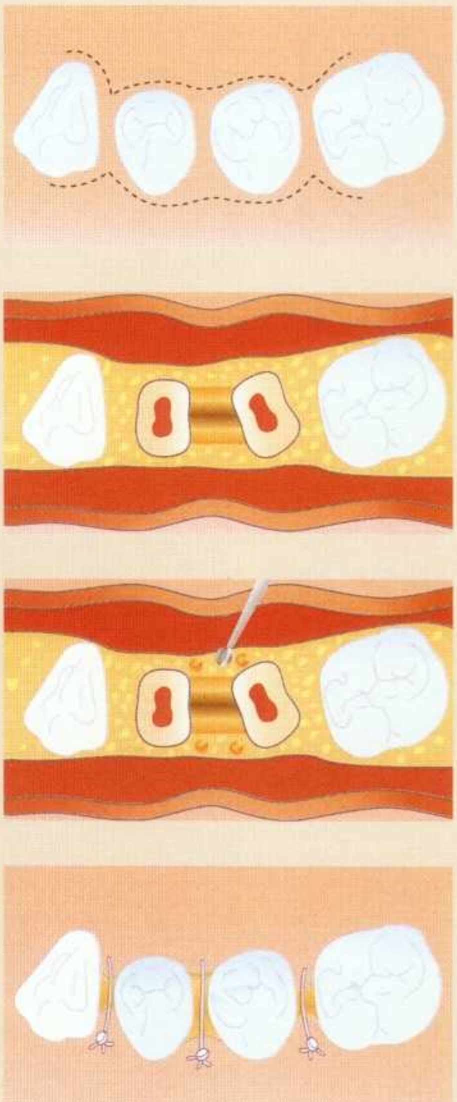
Fig 3-2 Periodontal tissue regenerative procedures.



Prichard introduced the diagnostic standard and therapy for good results for three-wall intrabony defects. (A three-wall intrabony defect is a defect on the root surface with three walls of surrounding bone; if the defect is in a molar, the lesion does not extend to the furcation.) He believed that to achieve a better result, the flap epithelium must be eliminated in flap procedures. Therefore, in suturing, the interdental alveolar crest was exposed without covering the entrance of the endosseous defect with flaps; this prevented epithelial migration along the root surface (intrabony technique; Fig 3-3).

This technique was first used for only three-wall osseous defects, but later it was used with 2- and 3-wall osseous defects in interdental areas. Kramer said that if the objective was bone regeneration on an interdental osseous defect, the interdental denudation technique is required, except in the maxillary anterior teeth for esthetic reasons. The advantages and disadvantages of the interdental denudation technique are the same as for flap curettage. Kramer claimed that less regeneration is achieved than in GTR; but the difference is insignificant clinically.

Fig 3-3 Intrabony technique.[13,14,23]



a. Make an internal bevel incision at the osseous defect area apical to the gingival margin, and expose sufficient bone margin. Prepare a linear or semilunar incision from the adjacent tooth line toward the alveolar bone crest.

b. Coronal to the incision, remove gingiva in the papilla with part of the marginal gingiva to expose the bone margin wall.

c. Perform debridement of the root surface and osseous defect area. Curette the osseous defect and expose the bone marrow cavity. If there is no bleeding from the defect area after curetting, penetrate the bone walls with a small round bur and expose the bone marrow cavity.

d. To prevent rapid epithelial migration along the root surfaces, the entrance of the intrabony defect is not covered by flaps.

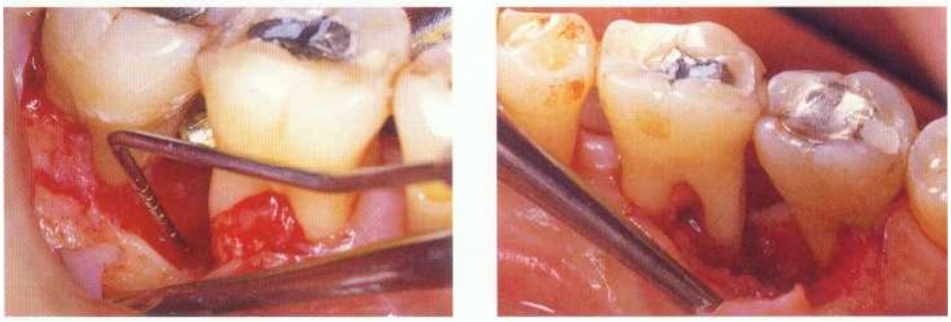
Case 3-1 Intrabony technique to achieve bone regeneration

c1-1 Initial examination. 41-year-old man with severe periodontitis and secondary occlusal trauma. The depth of the periodontal pocket is 8-12 mm. Note the profuse bleeding and suppuration on probing, advanced furcation involvement (Class II) in the molars, and Class II-III pathologic mobility on most teeth.

Intrabony technique for bone regeneration

c1-2 Deep osseous defect in interdental area. After initial therapy (8 months after initial examination), there is an 11 mm intrabony pocket on the distal aspect of 30 and vertical bone resorption on the distal interdental area.

c1-3 Interdental denudation.



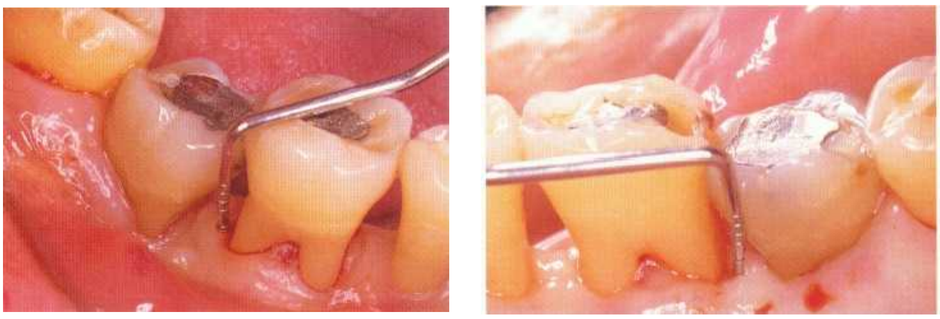
a. Note the deep and wide three-wall intrabony defect on the distal aspect of 30 after the removal of the papillary gingiva and curetting of the osseous defect area. The depth of the osseous defect is 7 mm and reaches close to the apex. (Left, buccal aspect; right, lingual aspect.)

b. The flaps are sutured without covering the entrance of the intrabony defect.

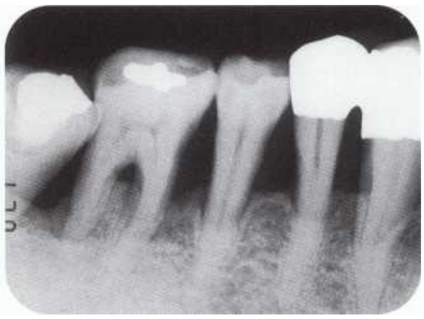
c1-4 Prognosis. Three months after surgery.

c1-5 Three years after placement of final restorations, 5 years after initial examination. There are no pathologic pockets except on the distal aspect of 19. The depth of the gingival sulcus is within 3 mm, and there is no bleeding on probing by flap curettage in the mandibular molars. Bone grafts were performed on the maxillary right molars, 14 underwent strategic extraction, 12 and 13 underwent osseous resection, and a wedge procedure was performed on 10 and 11. Periodontal curettage was repeatedly performed on the distal aspect of 30, where a 5 mm periodontal pocket was present on maintenance visits.

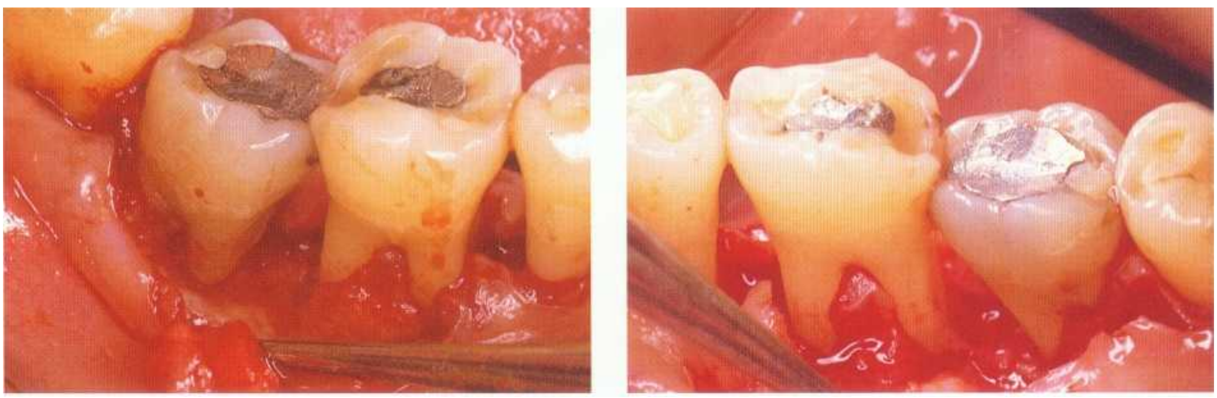
c1-6 Second flap curettage.



a. Four years and 11 months after flap curettage. Note the 5 mm pocket on the distobuccal aspect of 30 and a 4 mm pocket on the distolingual aspect of 30. (Left, buccal aspect; right, lingual aspect.)



b. Bone fill on the distal aspect of 30 interdentally is remarkable radiographically.



c. Flap reflection reveals newly formed bone in the deep and wide 3-wall osseous defect area.

cl-7 Prognosis.

a. Twelve months after surgery and 6 years and 11 months after the first flap curettage.

b. Two years and 5 months after surgery.

c. Three years and 9 months after surgery (9 years and 8 months after the first flap curettage, and 10 years and 4 months after the initial examination). Professional hygiene and maintenance was performed every 4-5 months. Note the bone fill in the deep intrabony defect area, the elimination of periodontal pockets, and the lack of bleeding on probing. The depth of the gingival sulcus on 30 is 2-3 mm. (Center, buccal aspect; right, lingual aspect.)

Evaluation of Bone Regeneration on Flap Curettage

Becker et al reported the results of flap curettage for the treatment of intrabony defects (three walls or surrounding root) (Table 3-4). They reported that bone repair took place without relation to the width of entrance of bone defect. A certain amount of bone apposition was observed by flap curettage on three-wall intrabony defects with deep vertical bone walls.

Cells participating in regeneration are supplied from residual bone walls around the osseous defect and residual periodontal ligaments. Therefore, bone regeneration can be expected in deep and narrow three-wall osseous defects because there are sufficient bone walls around the defect.

Flap curettage is very effective for bone regeneration in narrow three-wall osseous defects. It is also indicated for two-wall intrabony defects and combined two- and three-wall intrabony defects (Table 3-5)."

Table 3-4 Repair of Intrabony Defects by Flap Curettage[22]

Depth of osseous defect before surgery	Depth of residual osseous defect	Amount of bone fill	Bone resorption in bone crest
4.70 mm (average)	1.67 mm (average)	2.55 mm (average)	0.48 mm (average)

Table 3-5 Regeneration of Intrabony Defects (91 patients, 191 sites)[16]

Three-wall defect	72%
Combined two- and three-wall defect	40%
Two-wall defect	45%

Rosling et all' evaluated intrabony defects 24 months after flap curettage by probing depth. They found that postoperative plaque control influenced the final results (Table 3-6).

Another study" showed that bone regeneration after flap curettage occurred in teeth with advanced mobility (Table 3-7). They concluded that the success of bone regeneration in osseous defects after flap curettage depended on optimal plaque control.

The amount of bone apposition after flap curettage in the intrabony defect area is influenced by 1) the anatomic condition of the osseous defect, 2) the degree of resorption of the bone crest, and 3) the degree of chronic inflammation.

However, long junctional epithelium remains between the bone tissue regenerated by flap curettage and the root surface. The apical cells of the newly formed junctional epithelium are thought to be at the same level as the attachment level before surgery.[2627]

In short, after flap curettage, bone regeneration takes place in the osseous defect area but new attachment does not because of the long junctional epithelium. New attachment is not always necessary for bone regeneration.

Ellegaard et al-" attempted flap curettage in which the intrabony defect area was covered by free autogenous gingival grafts to prevent epithelium from entering the osseous defect area. The graft degenerates shortly after grafting, and new epithelial cells cannot develop 4 to 5 days after surgery. Therefore, epithelial cells migrate apically along with root surface. This approach delays invasion into the intrabony defect area. As a result, newly formed granulation tissue may integrate with the root surface without disturbance of epithelium. The author used this technique with better results than those achieved with conventional flap curettage (Case 3-2).

Many investigators found that bone regeneration took place with flap curettage and thorough postoperative plaque control after surgery in deep intrabony defects surrounded by bone walls. However, in most cases, some portion of the osseous defect remained. Therefore, removal of the defect became necessary by osseous resection (Case 3-3).

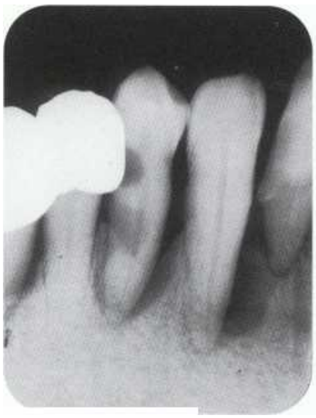
Table 3-6 Effect of Professional Hygiene on Periodontal Pocket Reduction (24 patients)[17]

	Test group Recall every 2 weeks		Control group Recall once a year	
	Before surgery	**24 months after surgery**	**Before surgery**	**24 months after surgery**
Probing depth	4.8 mm (average)	2.7 mm (average)	4.9 mm (average)	3.9 mm (average)

Table 3-7 Bone Regeneration by Flap Curettage in Teeth with Mobility (9 patients, 15 sites)[18]

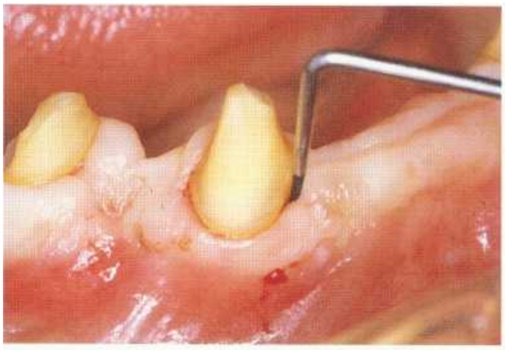
Depth of osseous defect before surgery	**Depth after surgery (6–8 months)**	**Bone regeneration**	**Crestal bone resorption**
Average 3.5 mm (2–8 mm)	**Average 0.3 mm**	**Average 2.5 mm (range, 1–5 mm)**	**Average 0.7 mm**
Mobility I = 6 teeth II = 4 teeth III = 2 teeth Mobile teeth = 12 teeth	I = 5 teeth II = 1 tooth Mobile teeth = 6 teeth		

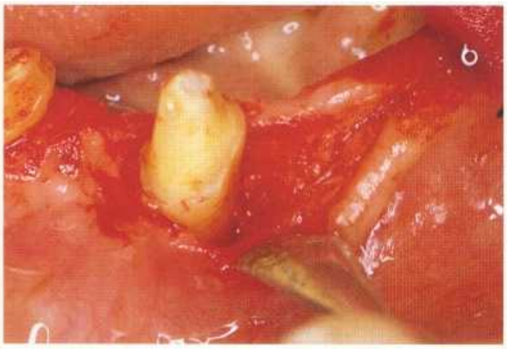
Case 3-2 Use of free autogenous gingival grafts to retard epithelial migration

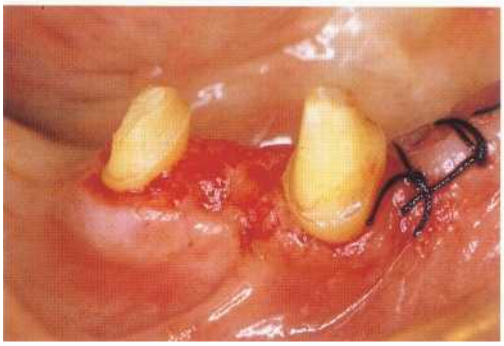


c2-1 Initial examination, 50-year-old man.

c2-2 After initial therapy. Three months after initial examination.





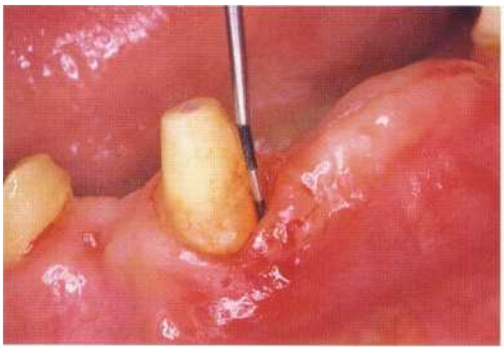


c23 Deep osseous defect. Note the 10-mm deep intrabony pocket beyond the gingiva-alveolar mucosa on the mesial aspect of 27. Flap reflection reveals an osseous defect that nearly reaches the a pex.

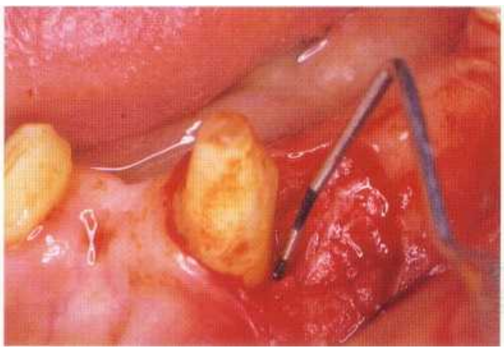
Flap curettage and free autogenous gingival grafts

c2-4 Two months after flap curettage.

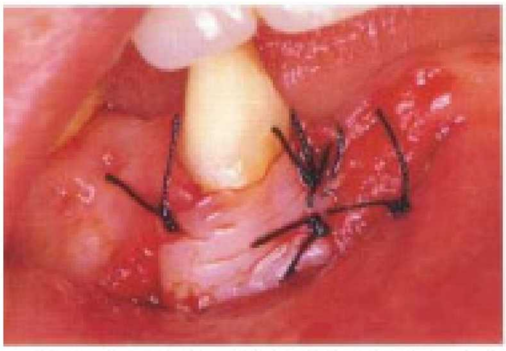
c2-5 **Flap curettage combined with free autogenous gingival grafts.**



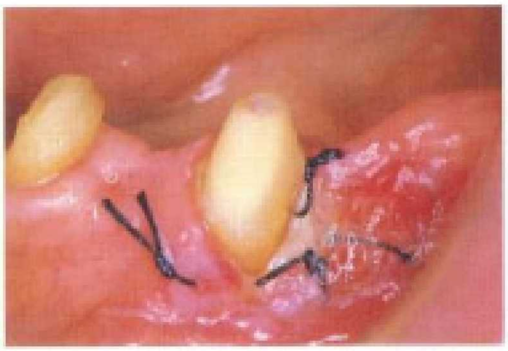
a. Nine months after flap curettage.



b. The intrabony defect remains on the mesial aspect of 27.

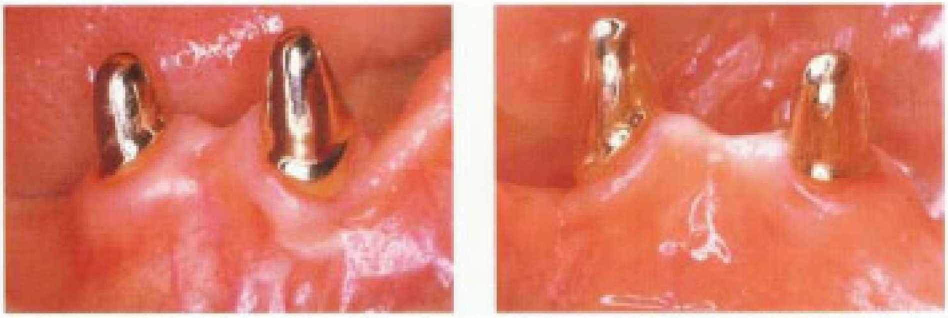


c. To **achieve bone regeneration, the defect** area is covered by a free autogenous gingival graft harvested from the palate. It is sutured after debridement to prevent rapid migration of oral epithelium apically along the root surface during the initial stage of wound healing. (Method of Ellegaard et al.28)

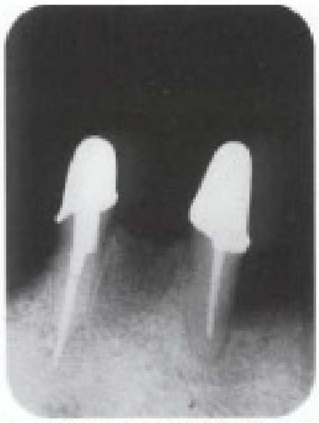


d. One week after surgery the graft epithelium degenerated.

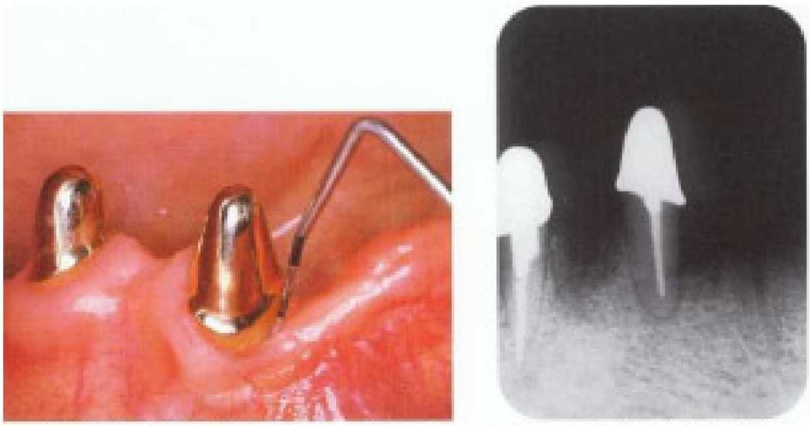
c2-6 Prognosis.



a. Four months after surgery. The telescope inner coping of the crown and sleeve coping (CSC) is placed after healing of the periodontal tissue.



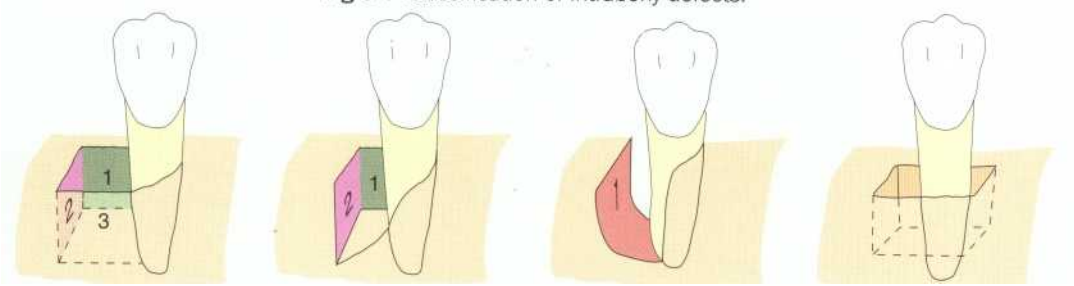
b. About 3 years after surgery.



c. About 4 years and 6 months after surgery, and 6 years and 1 month after the initial examination. The depth of the gingival sulcus is within 2 mm, and there is no bleeding on probing.

Selection of Method in Regenerative Procedures

Fig 3-4 Classification of intrabony defects.[31]



Three-wall osseous defect Two-wall osseous defect One-wall osseous defect Four-wall osseous defect

Morphology of the Intrabony Defect

In regenerative procedures where regeneration of the attachment apparatus with new bone formation is expected, the morphology of the osseous defect is key to the outcome. Goldman and Cohen classified intrabony defects by the number of walls around the lesion (Fig 3-4).

1. A three-wall intrabony defect is surrounded by three bone walls, with the root surface as the fourth wall. A defect that extends to the tooth and surrounds the tooth continuously to two or more roots is called circumferential defect.
2. A two-wall intrabony defect is the most common osseous defect in the interdental area. This defect usually includes the buccal and lingual walls.
3. A one-wall intrabony defect usually exists in the interdental area. If the remaining bone wall is on the proximal surface, it is called a hemiseptal defect. However, most intrabony defects are of mixed types; eg, the entrance is one wall or two walls but the bottom is three walls.

Attachment gain can be achieved by flap curettage in a three-wall defect area. And new attachment can be achieved even in 1- to 2-wall defects by using a barrier membrane. However, this approach is limited to deep osseous defects due to requirements of spacemaking. Important factors in determining therapy for intrabony defects include: 1) depth of defect, 2) width, 3) position, 4) number of remaining bone walls, and 5) adjacent root morphology.

Selection of Method

The method of achieving regeneration is selected after preoperative probing examination and clinical and radiographic examination. The final decision should be made after evaluating the condition of the osseous defect (depth and width), degree of furcation, and the anatomic condition of the root as observed clinically after incision and reflection of flaps (Fig 3-5). In shallow osseous defects, for example, a resective procedure should be selected because bone regeneration cannot be expected (Fig 3-6). However, morphology is not the only factor to consider when selecting a method for treating the osseous defect.

Of the regenerative procedures, GTR (discussed in the next chapter) is the method that requires preservation of the interdental papilla and thick gingiva. Therefore, GTR cannot be used where there is thin gingiva or gingival recession. And in flap curettage without a barrier membrane, sufficient width of keratinized gingiva is necessary. If there is insufficient keratinized gingiva in the surgical area, increasing the keratinized gingiva with a free autogenous gingival graft is needed as pretreatment (Fig 3-7).

Fig 3-5 Morphology of intrabony defects and approaches to treatment.

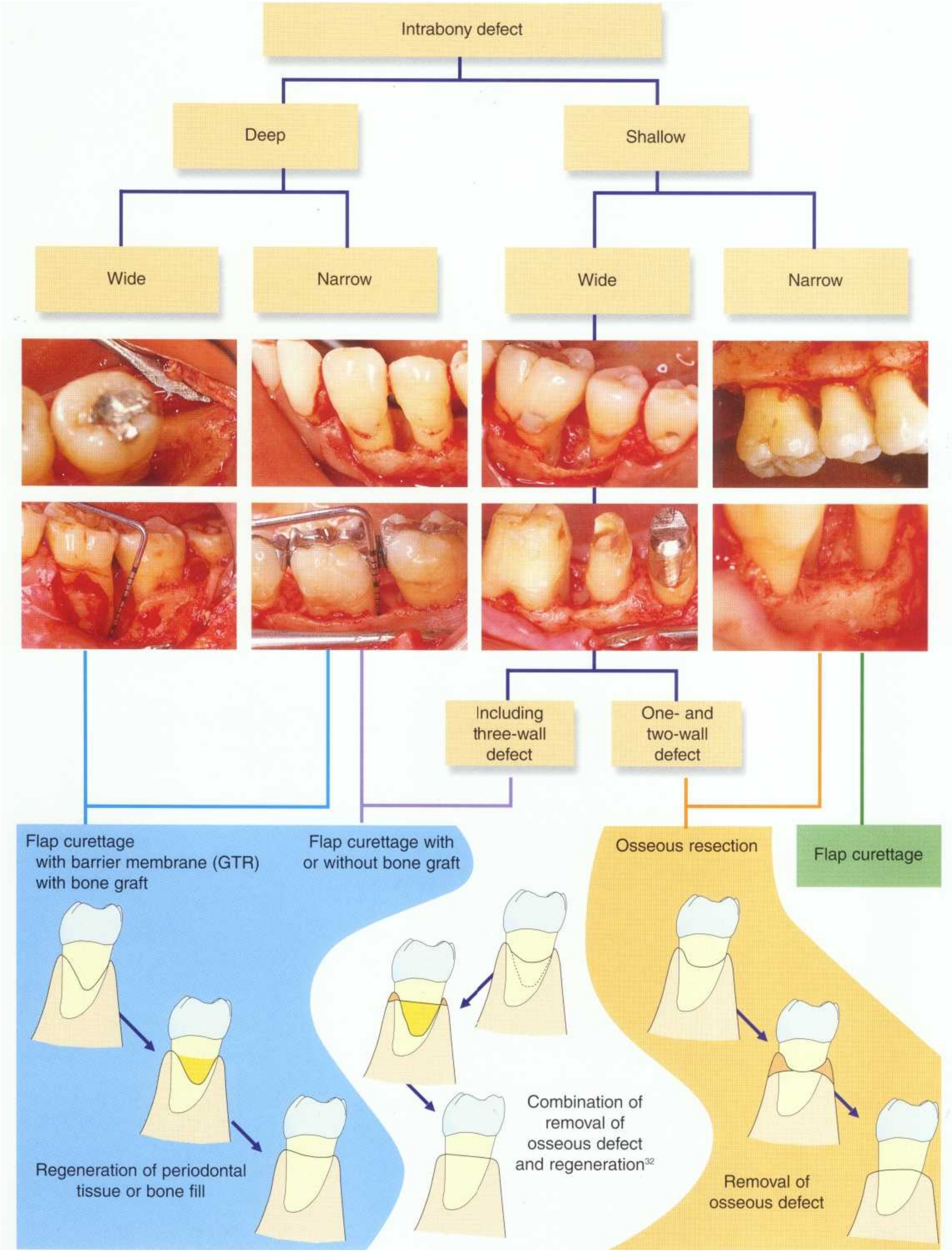
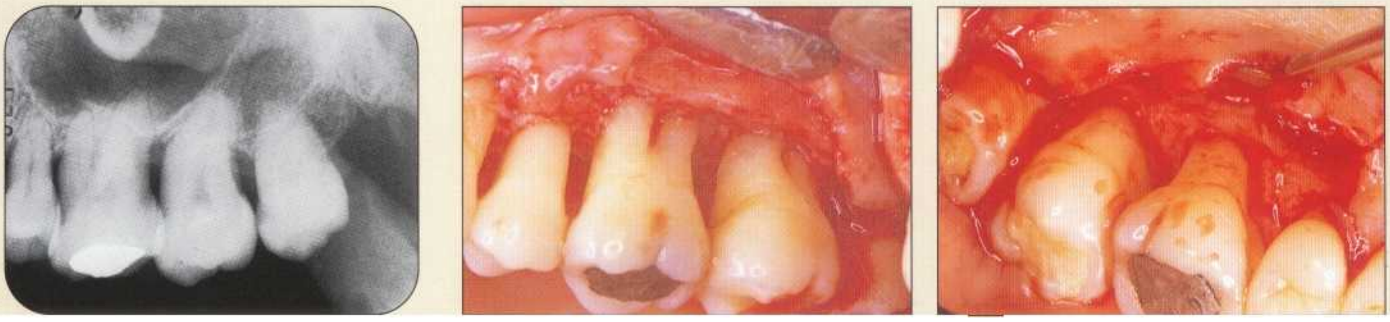


Fig 3-6 Problems of flap curettage in a shallow osseous defect.

a. Note the osseous defect in the interdental area of 14 and 15. The defect is shallow because of the short roots and little remaining supporting bone. Flap curettage only is performed (no osseous resection).



b. About 1 year and 1 month after flap curettage. A 5-mm pathologic pocket persists on the distal aspect of 14. Bone apposition is not observed radiographically or clinically.

Fig 3-7 Gingival condition and selection of regenerative procedures.

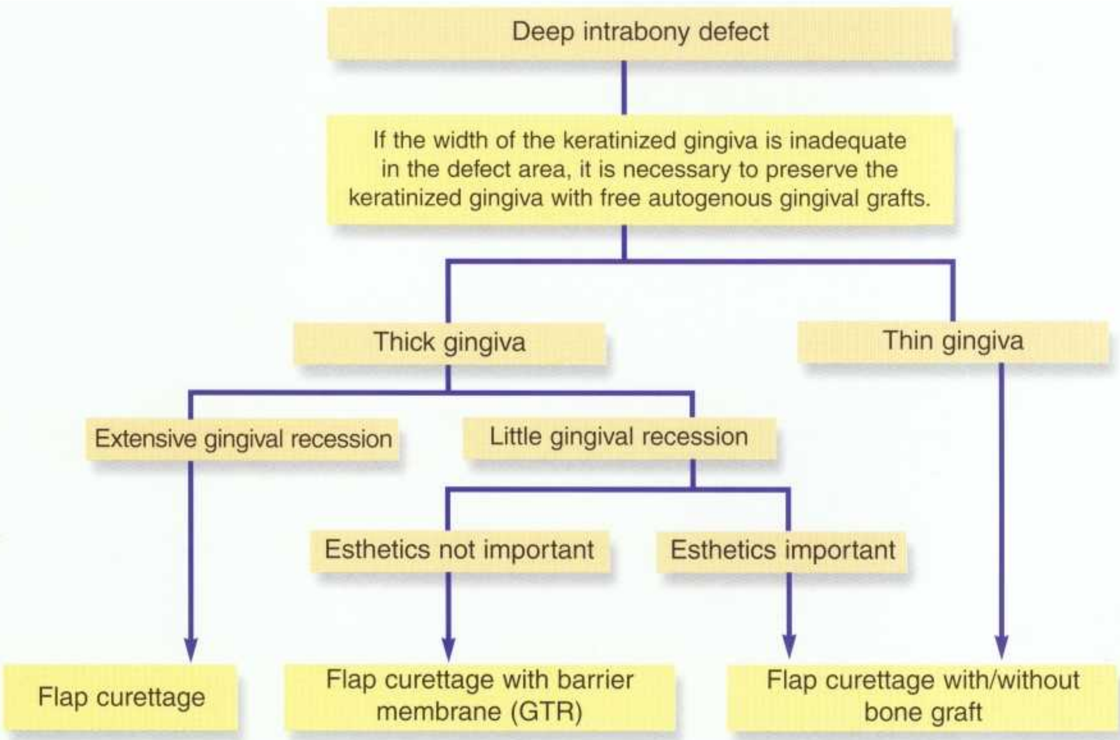


Table 3-8 Factors in the Selection of Regenerative Procedures[24]
1. Technical difficulty
2. Time required
3. Postoperative discomfort (pain, swelling)
4. Financial restrictions
5. Frequency of required surgical procedures
6. Esthetics

Regenerative procedures using a barrier membrane is another choice. However, this technique is technically demanding, requires frequent surgical procedures for a desirable outcome, and causes postoperative discomfort and swelling. In addition, it is not applicable in the esthetic zone because remarkable postoperative gingival recession occurs if complete membrane coverage is not achieved. Kramer' described the factors in the selection of regenerative procedures (Table 3-8).

Regenerative Procedures and the Elimination of Osseous Defects

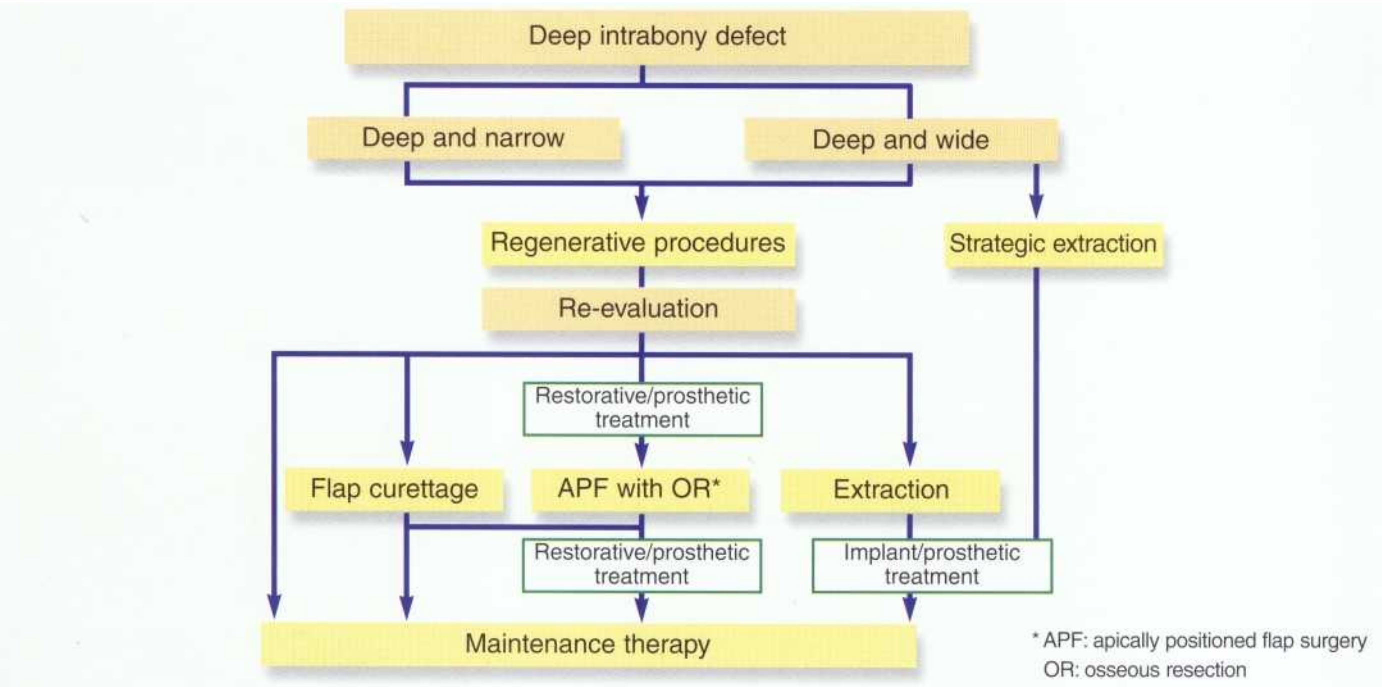
There are now more options for the surgical management of deep intrabony defects. The increased predictability of regenerative procedures makes these procedures the first choice for treatment. However, regenerative procedures cannot eliminate all intrabony defects completely.

It is exceptional that a three-wall intrabony defect responds well to regenerative procedures. Most intrabony defects are of combined types; therefore, osseous defects may persist even if the regenerative procedure succeeds. Hence, postoperative re-evaluation is essential in regenerative procedures, and additional therapy is often needed to eliminate residual osseous defects (Fig 3-8).

A conventional resective procedure may be needed, especially if prosthetic treatment will follow. Regenerative procedures require a long treatment duration, and more than one surgical procedure is required.

Ochsenbein proposed surgical therapy that combined regenerative and resective procedures, because he foresaw that osseous defects may remain after regenerative procedures (see Fig 3-5). To manage the problem in which intra bony pockets remain after regenerative procedures, the bone wall of the osseous defect is resected in advance. This wall, coronal to a three-wall combined-type intrabony defect, has no hope for regeneration. The osseous defect then is reshaped to three walls, and a barrier membrane is placed over the osseous defect to facilitate regeneration. As described in the next chapter, the use of absorbable membranes is widespread because secondary surgical therapy is not required.[33–36]

Fig 3-8 Therapy for osseous defects after regenerative procedures.

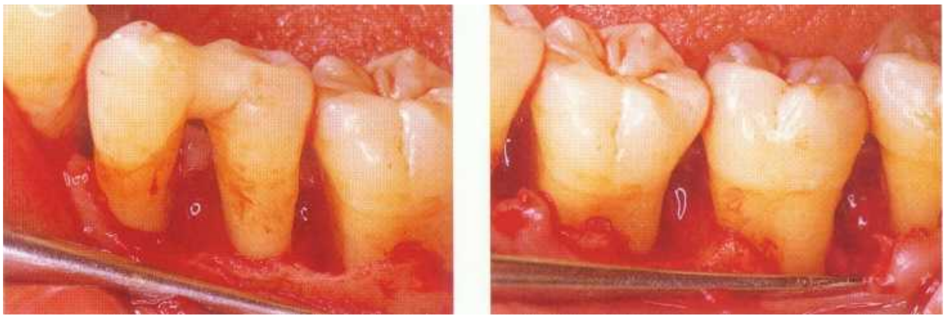


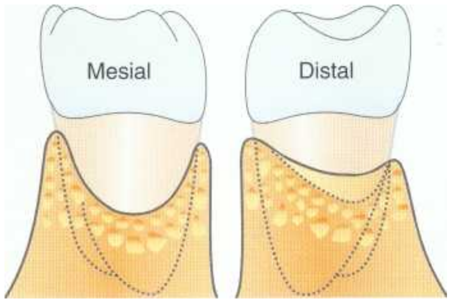
Case 3-3 Treatment of residual osseous defects following flap curettage

Regeneration of bone by flap curettage

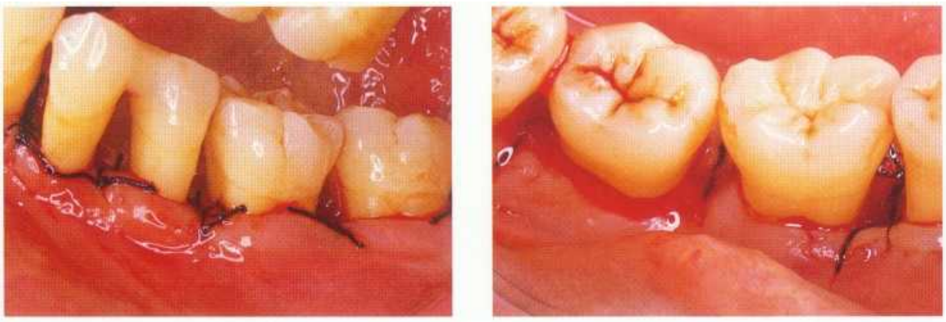
c3-1 Preoperative status. Three months after initial examination, 48-year-old man. Note the 10-mm intrabony pockets on the mesial and distal aspects of 19. The flat periodontium with thick gingiva conceals a periodontal lesion.

c3-2 Flap curettage.





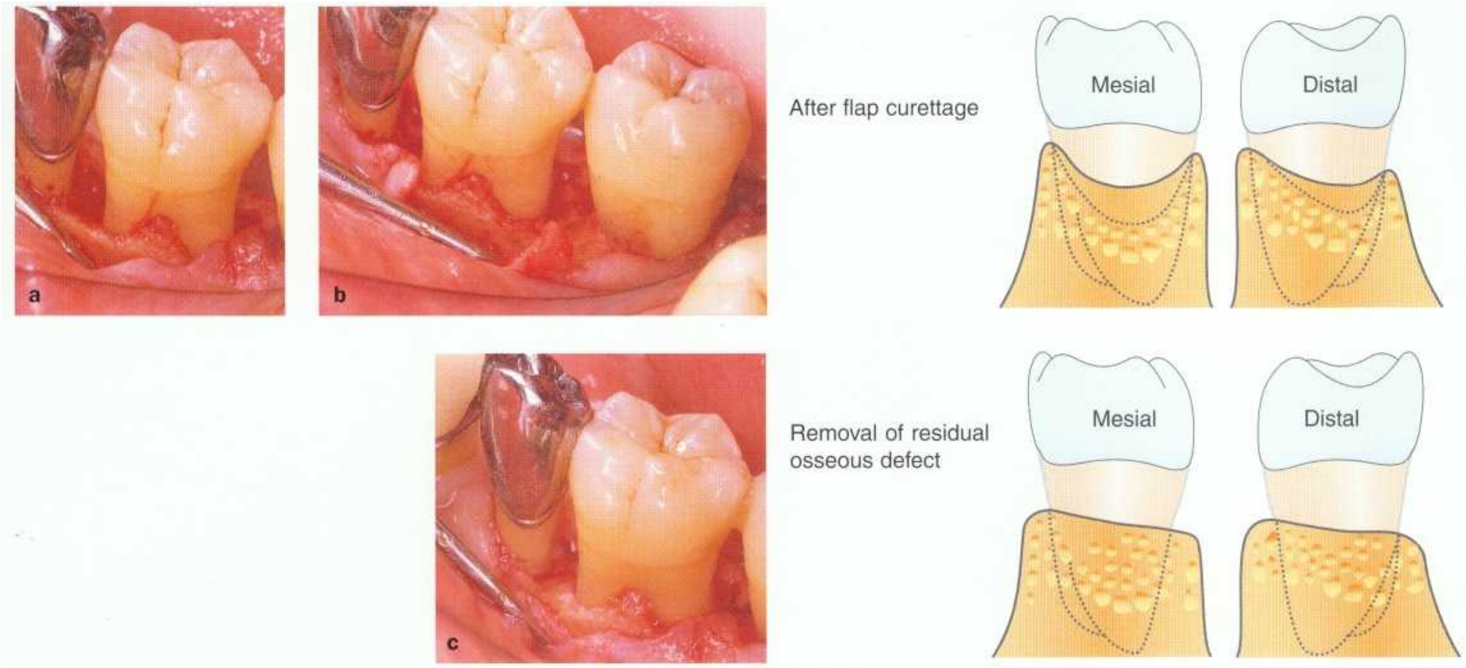
a. Note the deep and wide craterlike two-wall intrabony defect on the mesial interdental area of 19, and the deep and wide combined-type one-wall and three-wall intrabony defect on the distal interdental area of 19.



b. In suturing, the flaps are not approximated on the mesial aspect of 19, and the buccolingual flaps adapted to each other distally. A suture is made.

Removal of the residual osseous defect

c3-3 Before pocket elimination procedures. Four years and 1 month after the initial examination. While there is bone fill on the distal aspect of 19, there is a residual osseous defect on the mesial aspect of 19 radiographically. Note the 6 mm (mesial) and 4 mm (distal) pathologic pockets on 19.



c3-4 **Removal of residual osseous** defect after flap curettage. **Flap reflection reveals exceptional osseous regeneration on the distal interdental area** of 19, but subgingival calculus remains on the distal surface of the distal root (b). Osseous regeneration is observed in the mesial interdental area, but a shallow, craterlike osseous defect remains (a). The craterlike osseous defect is removed by osteoplasty and osseous resection with an attempt to eliminate periodontal pockets (apically positioned flap surgery with osseous resection) (c).

c3-5 Prognosis.

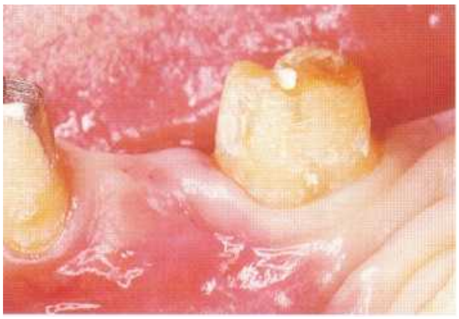
a. **Seven years and 3 months after the initial examination, and 3 years and 2 months after osseous resection.**

b. Eleven years and 4 months after the initial examination. A shallow gingival sulcus is achieved and maintained.

Case 3-4 Bone regeneration of a three-wall intrabony defect by flap curettage

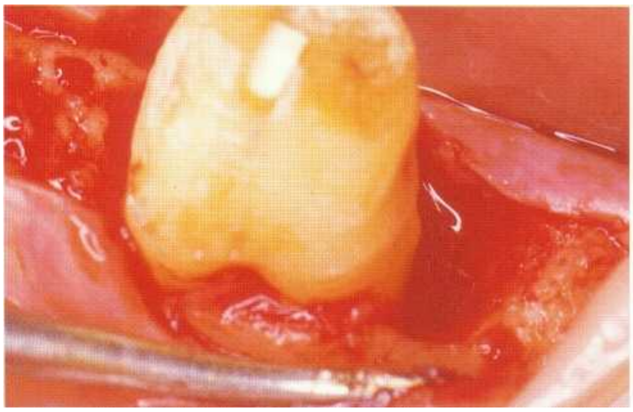
c41 Initial examination, 49-year-old man. The probing depth is 8-12 mm. There is exceptional bleeding and suppuration on probing, advanced furcation involvement (Class II, III), and severe bone resorption in all molars. Note the severe vertical bone resorption (related to occlusal trauma), enlargement of the periodontal membrane space, shadows in the furcation area, and Class II pathologic mobility on 2, 4, 10, 11, 15, 19, 22, 27, and 30.

Flap curettage

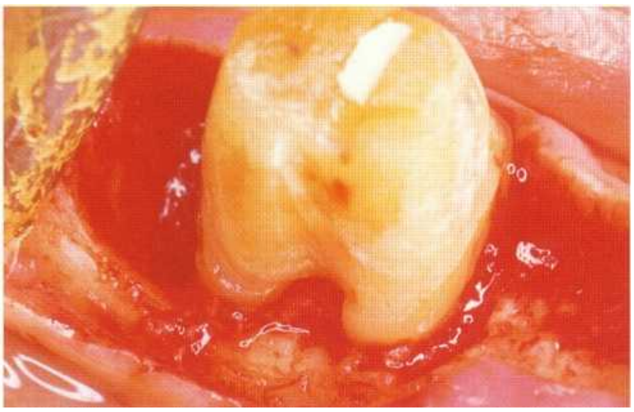


c42 Treatment by flap curettage.

a. Six months after initial examination. Note the 9-mm pathologic pocket on the distal aspect of 19 and the Class II furcation involvement on the lingual aspect.

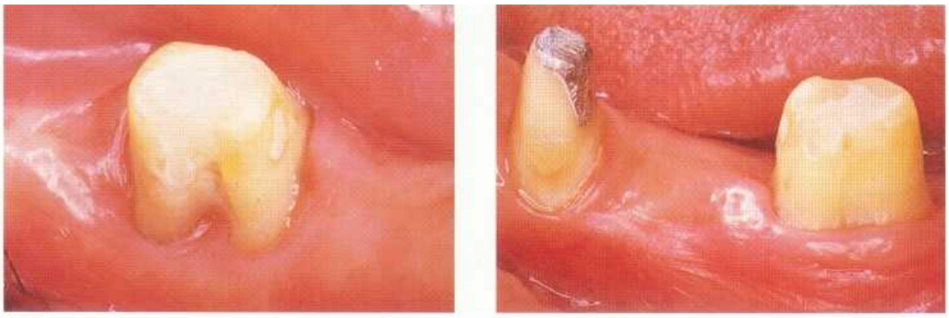


b. Flap reflection reveals a wide and deep three-wall osseous defect on the distal aspect of 19. Soft tissue debridement of the defect area and root planing of the root surface are performed.



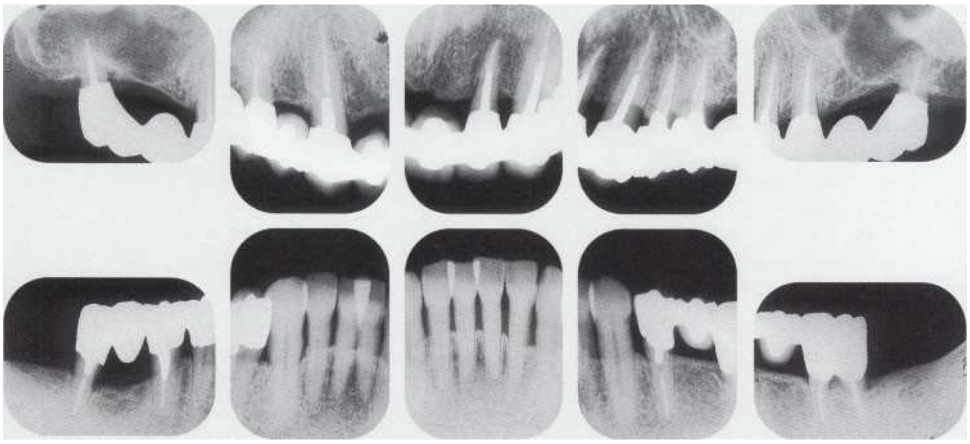
c. A vertical groove on the alveolar septum of the lingual furca tion area is made by osteoplasty.

c43 Five months after surgery. Barreling of the inner coping is performed.



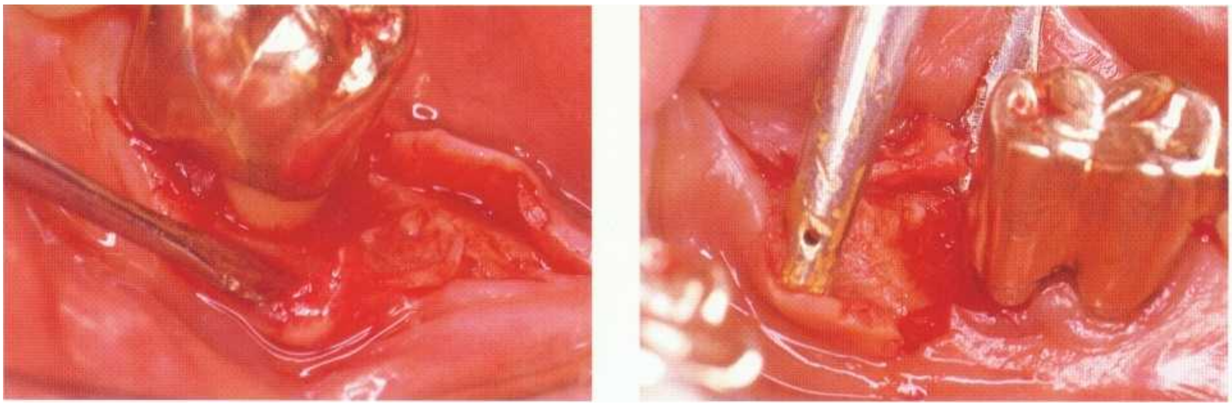
c44 Eight months after surgery. A provisional restoration is fabricated, then final restorations placed.

Initial examination

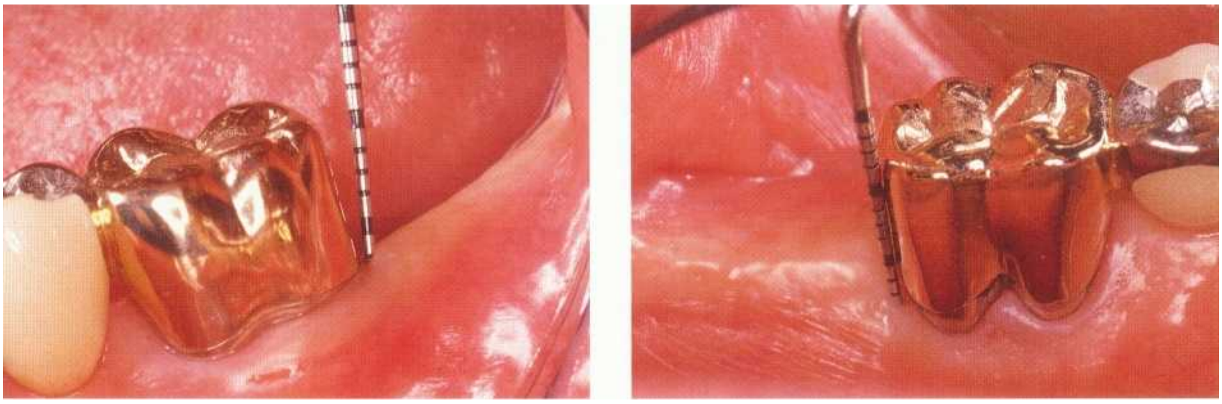


c45 About 5 years and 4 months after final restorations. The periodontal pockets and osseous defect are eliminated, and the furcation problem is resolved by hemisection and root resection of 2, 15, and 30.

Re-entry and removal of the residual osseous defect



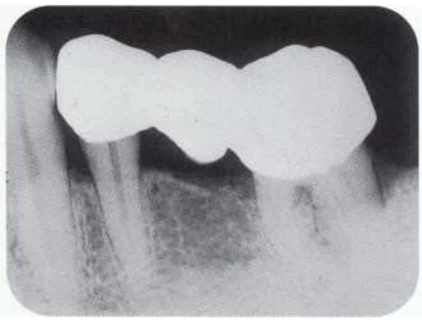
c46 On re-entry after flap curettage. Seven years and 3 months after the initial examination. Note the extraordinary bone regeneration in the deep and wide three-wall intrabony defect area on flap reflection. The residual shallow osseous defect is eliminated by osteoplasty.



c47 Eleven months after the second surgery. A shallow gingival sulcus is maintained.

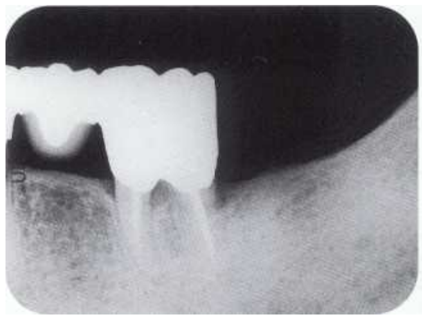
c48 Ten years after final restorations. The depth of the gingival sulcus over the entire mouth is within 2-3 mm, and periodontal tissue health is maintained by the patient's plaque control and professional hygiene, performed every two to three months. The height of the alveolar crest is maintained, and there is no enlargement of the periodontal membrane space.

c49 Changes on radiography.



a. Initial examination.

b. Second flap surgery, 7 years and 3 months after the initial examination. Note bone fill.

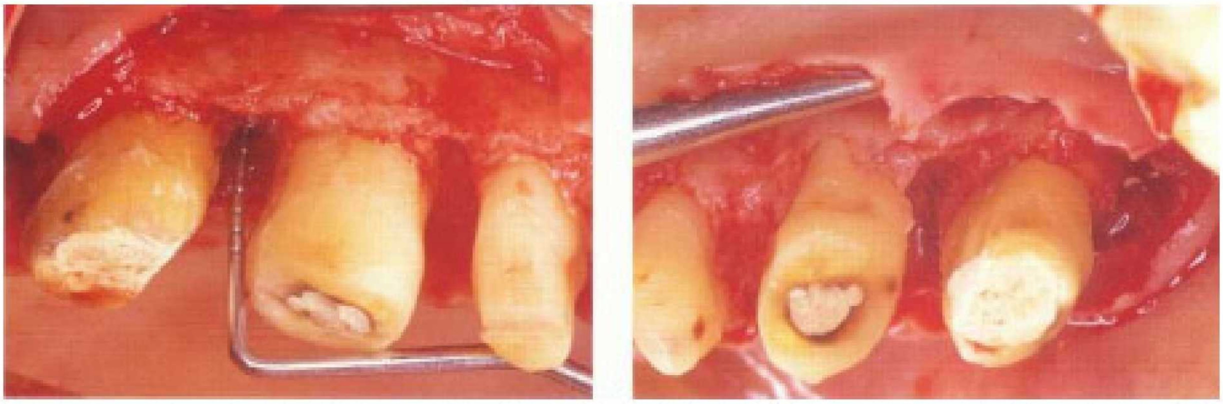


c. Eleven years and 1 month after the initial examination.

Case 3-5 Bone regeneration of a two-wall intrabony defect by flap curettage

Intrabony technique

c5-1 Three months after initial therapy, 38-year-old woman. Note the 5 mm periodontal pocket on the mesial and a 7 mm pocket on the distal aspect of 3. The osseous defect on the mesial and distal interdental area of 3 is not clear radiographically.



c5-2 Flap curettage. Note the deep and wide craterlike two-wall intrabony defect on the distal interdental area of 3 (not apparent radiographically) on flap reflection. A curette is used to perform root planing and to remove the residual granulation tissue in the osseous defect area. The bone marrow cavity is exposed.

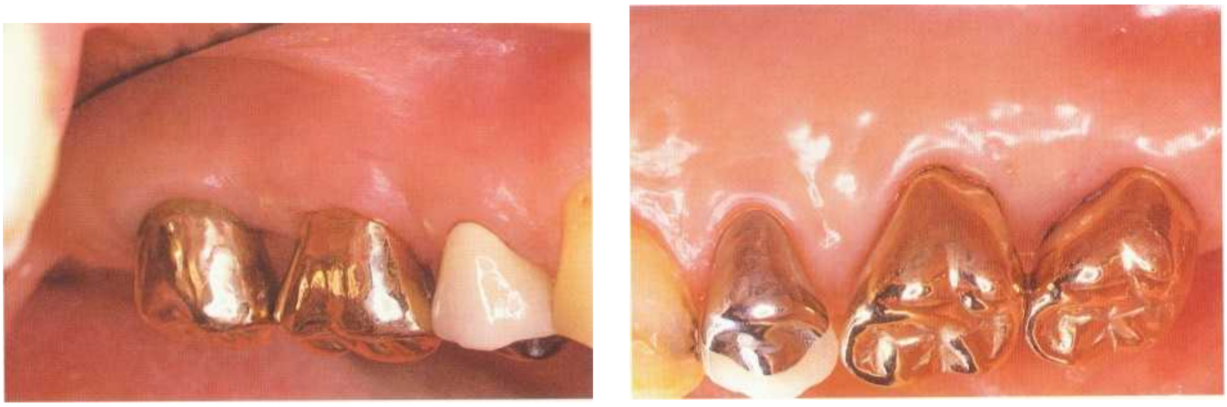
Key point

Deep and wide two-vvall osseous craters are often not apparent radiographically because they are concealed by thick osseous walls buccally and lingually.

c5-3 Suture. The entrance of the osseous defect is not covered by flaps (method of Prichard[13,14]).

c5-4 Status 1 year after surgery.

c5-5 **On re-entry.** One year and 1 month after surgery, the deep and wide two-wall osseous defect has been eliminated by osseous regeneration.



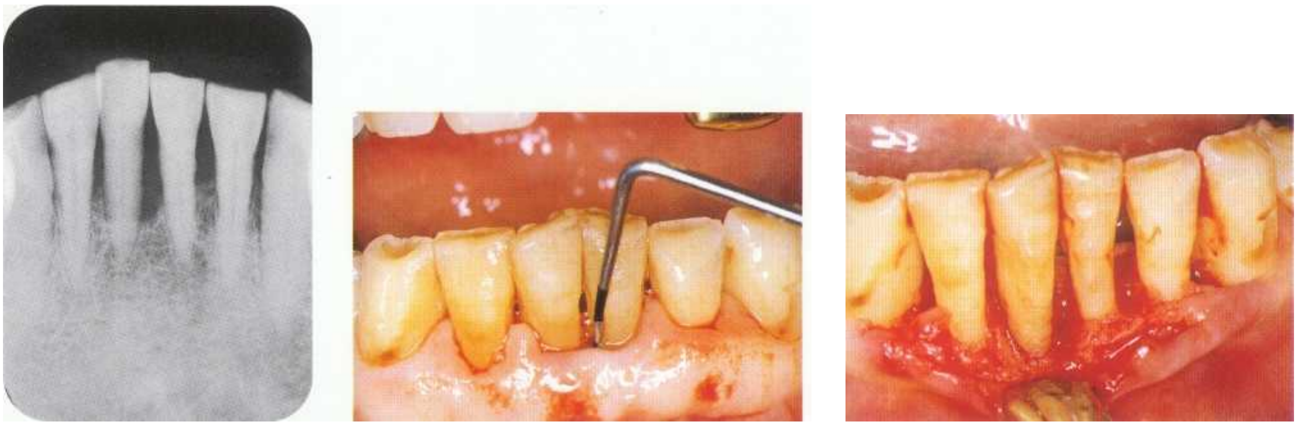
c5-6 **Two years and 2 months after initial examination.** Placement of final restorations.

c5-7 **Two years and 4 months after initial examination.**

c5-8 **Five years after initial examination.** Two years and 10 months after the placement of final restorations. There is no bleeding on probing, and the depth of the gingival sulcus is within 2 mm, providing easy maintenance.

Case 3-6 Bone regeneration of combined osseous defects by flap curettage

Flap curettage as initial therapy



c6-1 Three months after initial examination, 53-year-old man. Note the 8 mm periodontal pocket and the vertical osseous defect on the mesial aspect of 25. Flap curettage was the initial therapy.

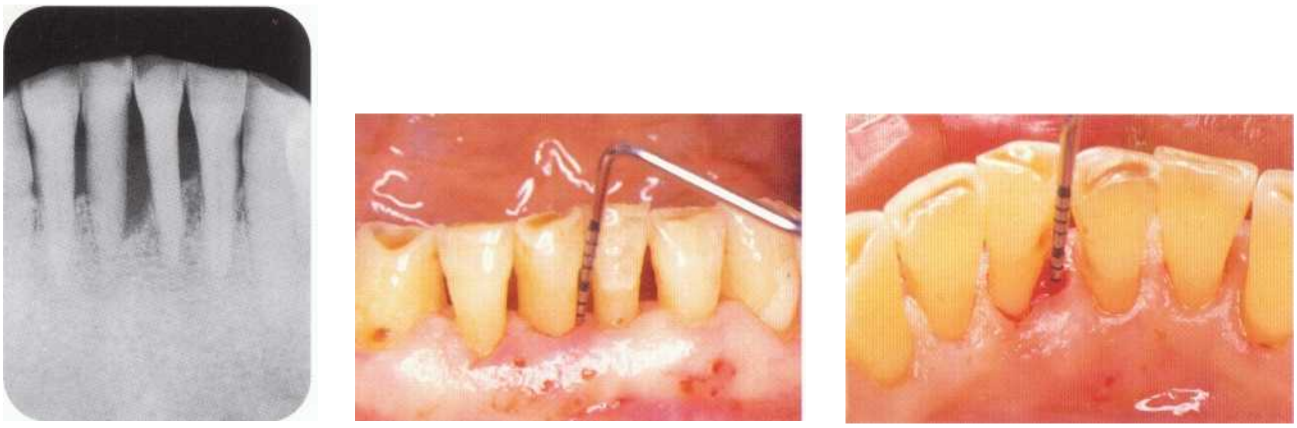
c6-2 Prognosis.

Seven months after surgery.

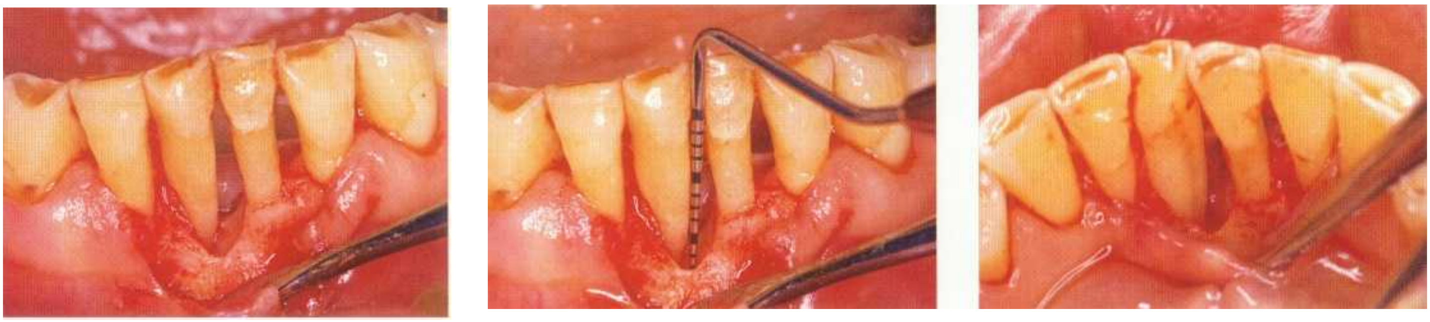
Three years and 11 months after surgery.

Six years and 11 months after surgery.

Flap curettage for bone regeneration

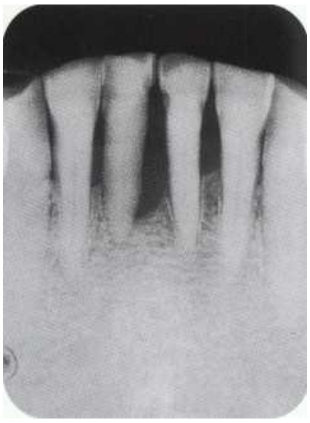


c6-3 Second flap curettage 9 years after initial examination. The patient continues maintenance therapy once every 3 months, but the osseous defect extends nearly to the apex as observed radiographically. The periodontal pocket on the labial and mesiolingual aspects of 25 is 6 mm, and the attachment level is 10 mm.

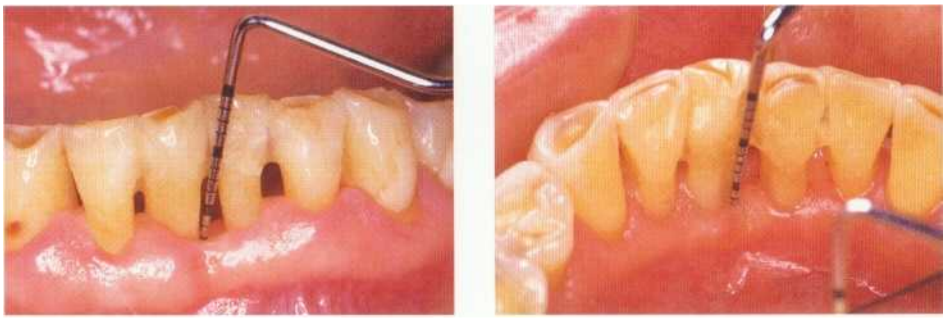


c6-4 One-to-three wall osseous defects. Note the intrabony defect in which the entrance is a one-wall defect and the bottom is a three-wall defect.

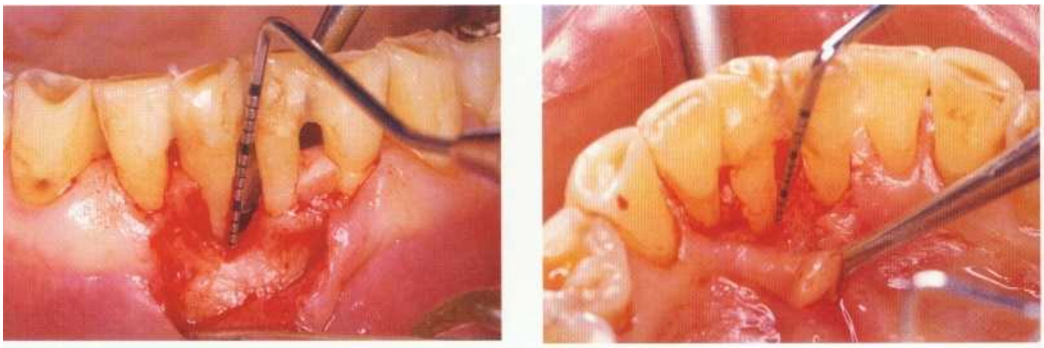
c6-5 Re-entry (8 months after surgery).



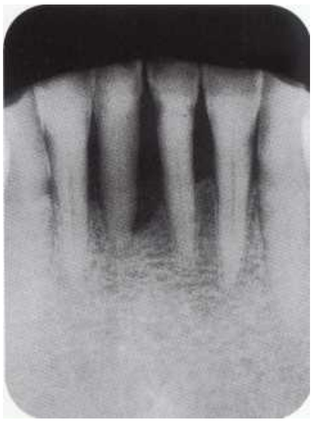
a. Bone fill is extraordinary on radiography.



b. Note the periodontal pocket reduction. Probing depths are reduced to 4 mm on the labial aspect and 3 mm on the lingual aspect.



c. Note the considerable bone regeneration in the osseous defect on flap reflection.



c6-6 Three years and 7 months after the second flap curettage. Professional hygiene is performed every 2 months. The probing depth remains 2 mm on the labial aspect and 3 mm on the lingual aspect. There is no osseous defect.

	Probing depth*		Attachment level		CEJ-osseous defect area		CEJ-alveolar crest		Depth of osseous defect	
	BM	LM	BM	LM	BM	LM	BM	LM	BM	LM
After initial therapy	8.0	8.0								
Flap curettage (second time)	6.0	6.0	10.0	10.0	13.0	12.0	10.0	10.0	3.0	2.0
Re-entry	2.0	3.0	7.0	8.0	10.0	10.0	9.5	10.0	0.5	0
3 y, 7 mo after surgery, 12 y, 7 mo after initial visit	2.0	3.0	7.0	8.0						

*All values in mm. Two to 3 mm of attachment was gained by the second flap curettage; however, same degree of bone regeneration was gained on three-wall intrabony defect area.

Bone Regeneration of Intrabony Defects Using Bone Grafts

Various bone graft materials have been used in an attempt to regenerate bone and to gain new attachment in the intrabony defect area. Graft materials for bone grafts include autografts, allografts, and synthetic materials (Table 3-9).

The use of flap curettage with bone grafts to facilitate regeneration of periodontal tissue is decreasing because good results are achieved by using GTR for intrabony defects with wide entrances in which regeneration may be difficult by flap curettage only.

Currently, bone grafts are used mainly for spacemaking with the placement of a barrier membrane. The bone graft placed under the membrane acts as a scaffold, preventing the membrane from collapsing into the defect. Thus bone grafts are mostly used with membranes.

Bone grafts for regenerative procedures are indicated in advanced (or severe) periodontitis with deep periodontal pockets in maxillary anterior teeth where esthetics is a concern. If, however, GTR is performed in the maxillary anterior region where gingiva is thin, postoperative membrane exposure and gingival recession may result, causing esthetic problems. In such cases, flap curettage with a bone graft can achieve the objectives of regenerative procedures without exposing the membrane or causing gingival recession as can GTR (Table 3-10).

Table 3-9 Bone Graft Materials
1. Autograft
• Cortical bone (osseous coagulum)
• Blend of cortical bone and cancellous bone
• Cancellous bone and bone marrow
— Intraoral donor site
— Extraoral donor site
2. Allograft
• Freeze-dried bone (FDBA)
• Demineralized freeze-dried bone (DFDBA)
3. Bone substitute or synthetic graft material
• Hydroxyapatite, bioactive composite, etc

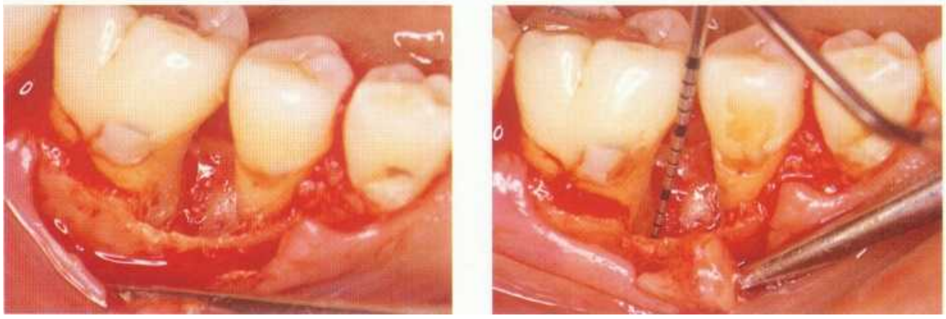
Table 3-10 Flap Curettage with Bone Graft for Regeneration
Indications
1. Deep intrabony defects (except furcation involvement)
2. Advanced periodontitis with thin gingiva where gingival recession might occur if GTR is performed
3. Combined with GTR for spacemaking or facilitating membrane manipulation
Contraindications
1. Considerable gingival recession in the surgical area
2. Extraordinary soft tissue crater in surgical area
3. Insufficient width of keratinized gingiva
4. Advanced furcation involvement

Case 3-7 Bone regeneration using osseous coagulum

c7-1 Three weeks after initial examination, 38-year-old woman. Note the periodontal abscess with a 10-mm pocket on the mesial aspect of 30. Radiograph reveals calculus and vertical bone resorption.

Flap curettage with bone graft

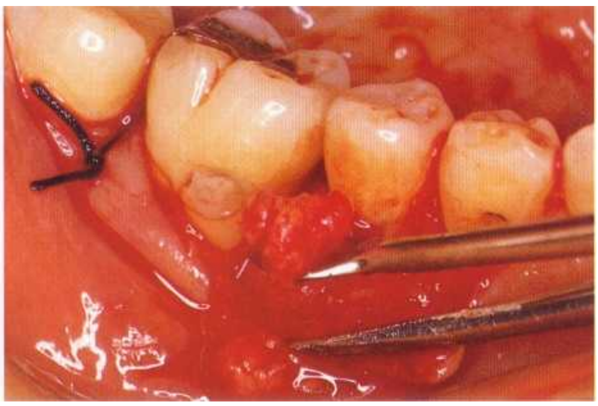
c7-2 Eight months after initial examination, after initial therapy. Note the periodontal pocket on 30 6 mm buccomesially and 5 mm linguomesially.



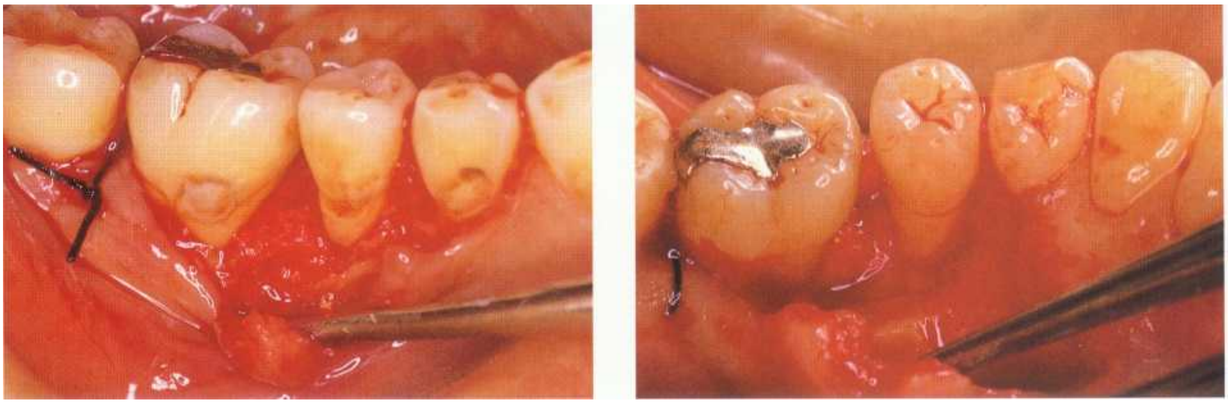
c7-3 Flap curettage. Note the wide and shallow two-wall craterlike intrabony defect in the mesial interdental area of 30. The depth of the osseous defect is 2-3 mm.

c7-4 Osseous coagulum graft.

a. A slow-speed round bur is used to resect the bone projection on the lingual aspect of 28 and 29, and a small piece of cortical bone is harvested and put in physiologic saline solution in a Dappen dish (osseous coagulum).

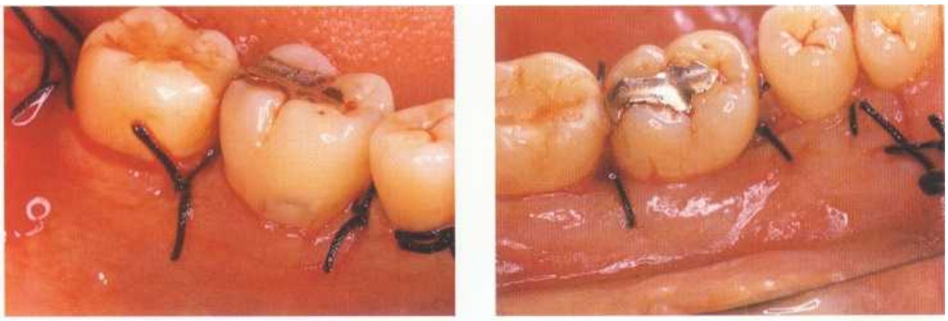


b. The osseous coagulum is transferred to the osseous defect area with an elevator.



c. After placement of the osseous coagulum.

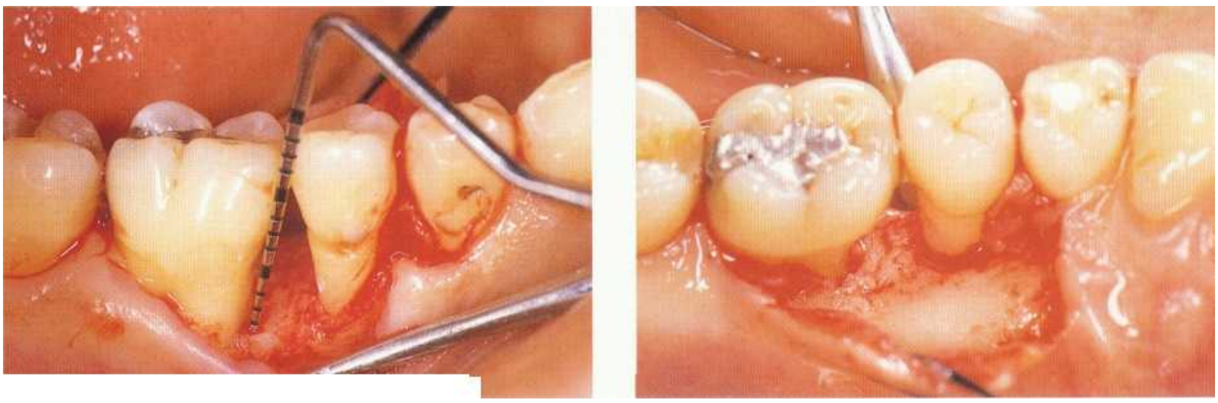
c7-5 Suture. The grafted area is covered with flaps and sutured.



c7-6 **Re-entry.**

a. Two years and 2 months after bone grafting. The probing depth of 30 is 2 mm buccomesially and 3 mm linguomesially.

b. Bone regeneration is apparent radiog raphy.

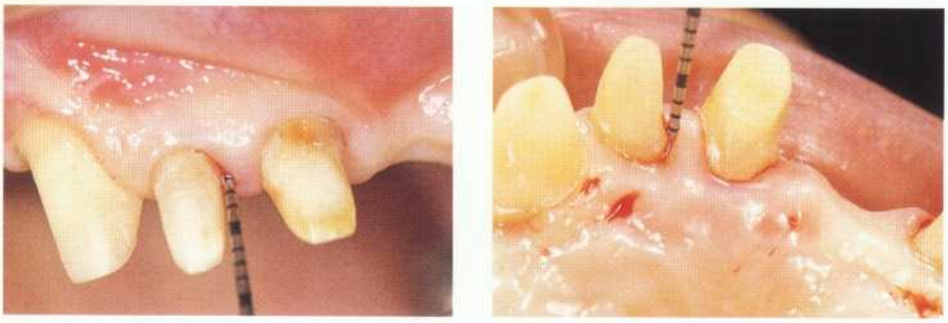


c. The wide and shallow two-wall osseous defect is eliminated.

Case 3-8 Bone regeneration using bone grafting to avoid esthetic problems

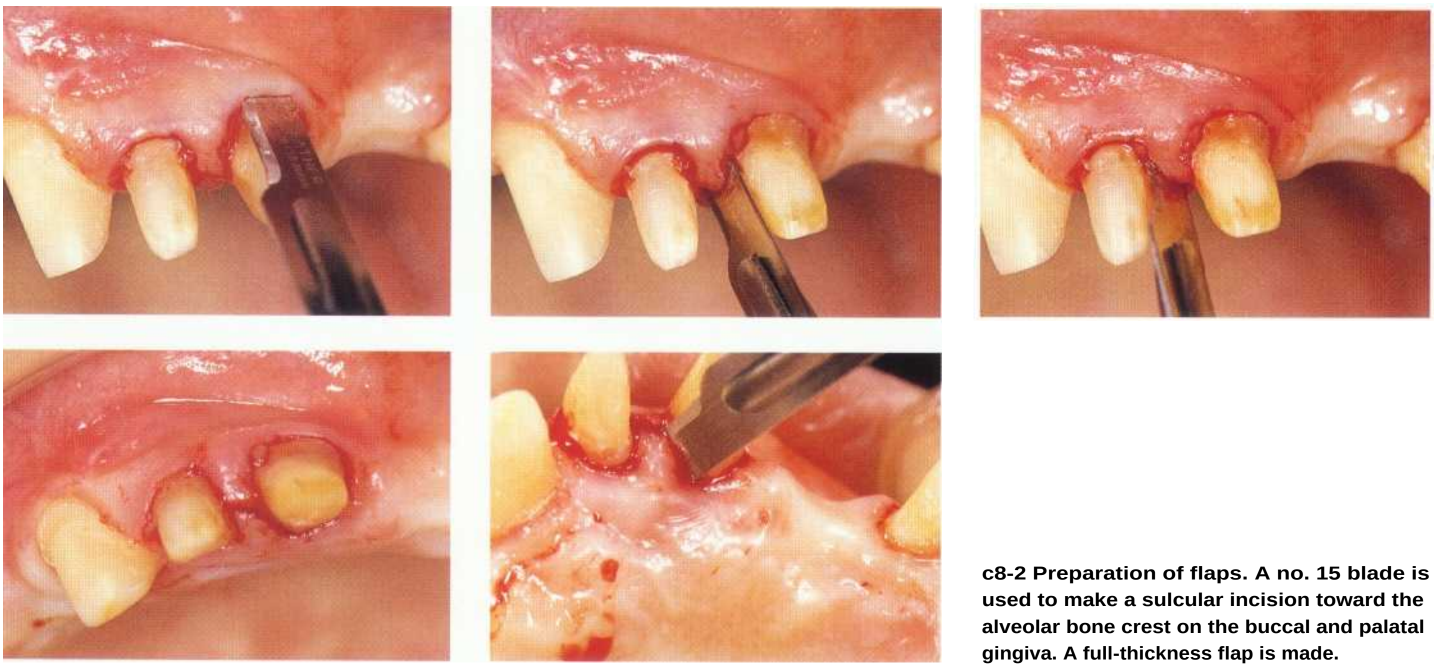
c8-1 After initial therapy.

a. Fixed provisional restorations (58-year-old woman).



b. Note the periodontal pockets on 7: 6 mm buccomesially and 5 mm linguomesially.

Flap curettage with bone graft



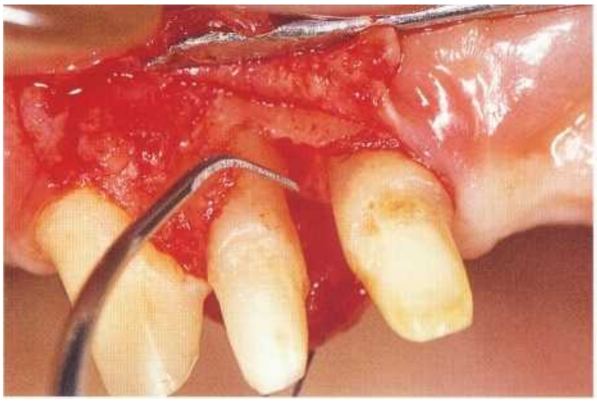
c8-2 Preparation of flaps. A no. 15 blade is used to make a sulcular incision toward the alveolar bone crest on the buccal and palatal gingiva. A full-thickness flap is made.

Key point

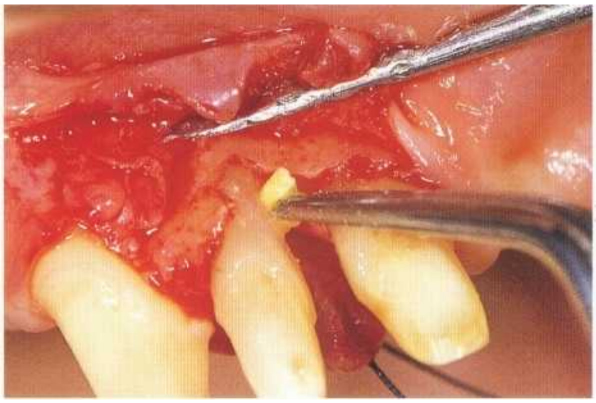
To ensure instrument accessibility to the surgical area and ability to sec the lesion area well, extend the incision more than one tooth longer mesiodistally from the bone graft area. After surgery, preserve the interdental papilla to cover the entire bone graft area with flaps. Make an incision and divide it into two parts at the center of the interdental papilla buccopalatallv. Thick flaps must be prepared to cover the grafted bone.

c8-3 Flap reflection. A small periosteal elevator is used to reflect a full-thickness flap from the interdental papilla area. A vertical incision on the mesial aspect of 6 is made for better access to the osseous defect area. Note the one-wall intrabony defect on the mesiobuccal aspect of 7 upon removal of the granulation tissue inside the osseous defect with curette. The distance of the prepared tooth margin to the bottom of the osseous defect is 7 mm (5 mm to alveolar crest). The depth of the osseous defect is 2 mm labially and 4 mm palatally.

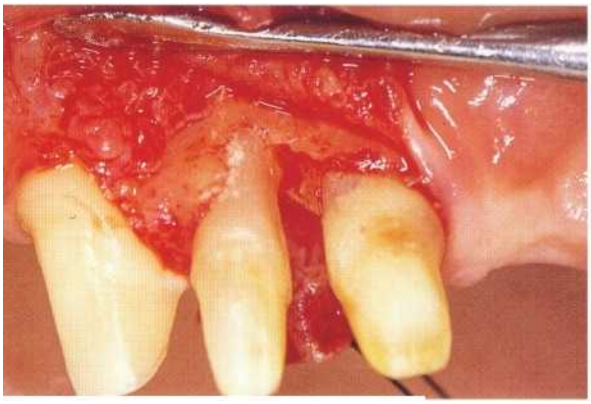
c8-4 Debridement of the root surface and bone grafting.



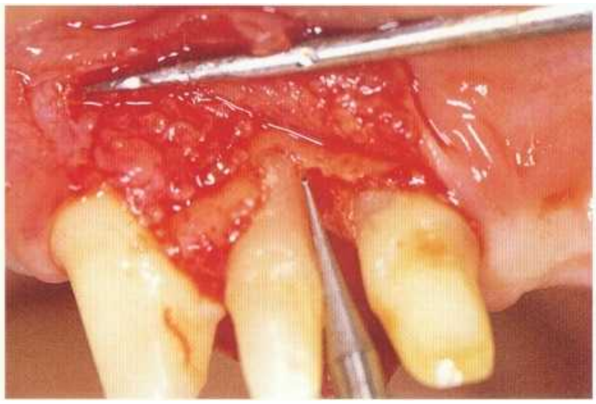
a. Root planing is performed with an ultrasonic scaler and curette.



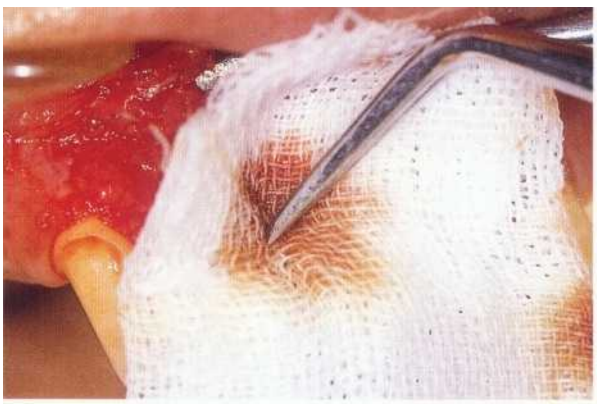
b. Tetracycline solution is applied to the root surface.



c. After root planing and root surface management.

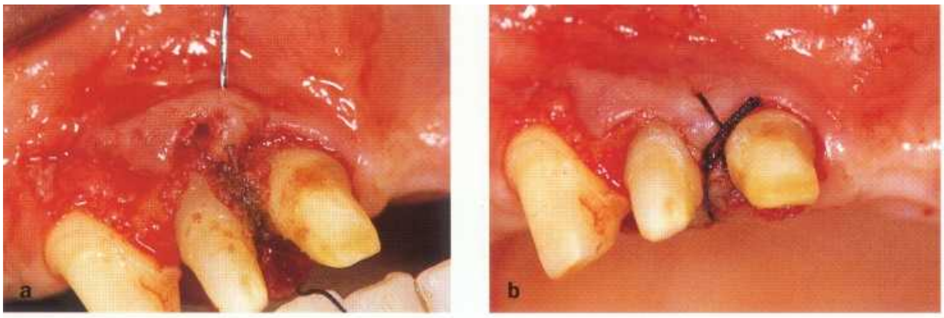


d. A small round bur is used to penetrate the cortical bone of the bottom of the osseous defect (decortication).



e. After the osseous defect area has been slowly filled with bone graft material, gauze soaked in physiologic saline solution is pressed to the site and extra moisture removed.

f. After grafting.

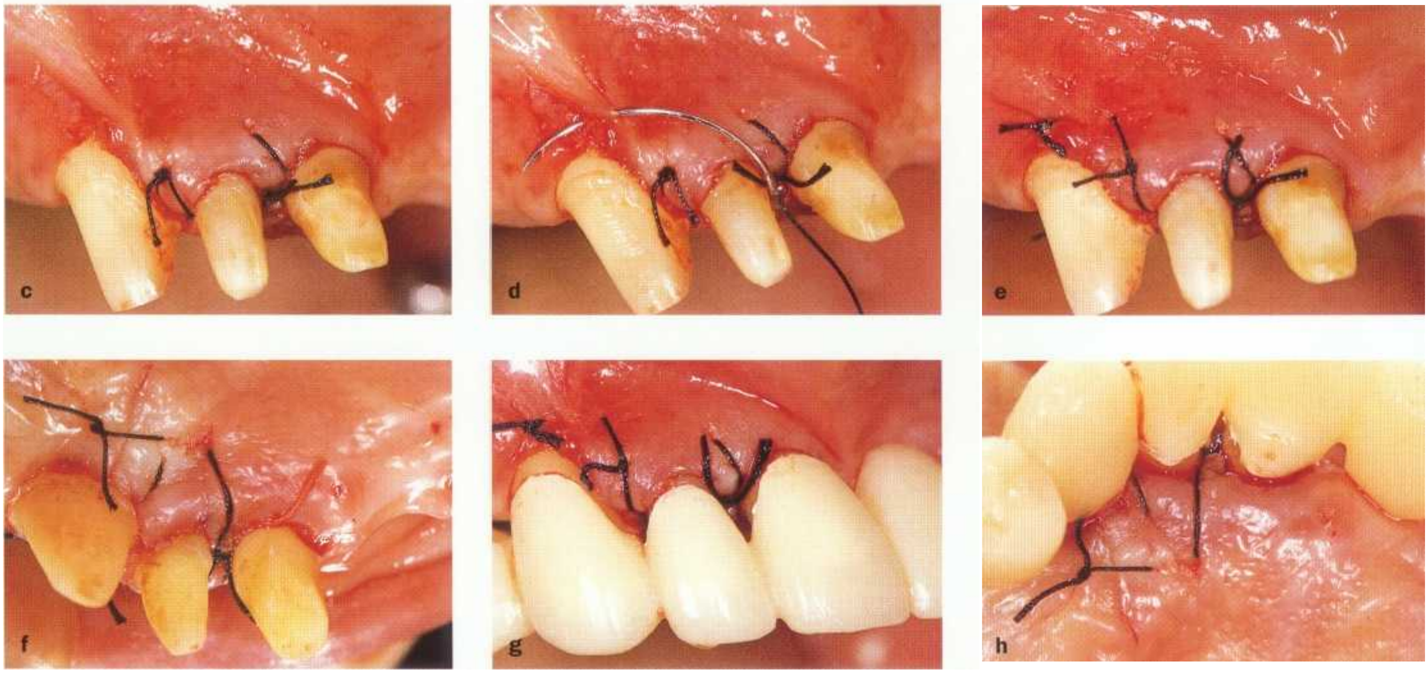


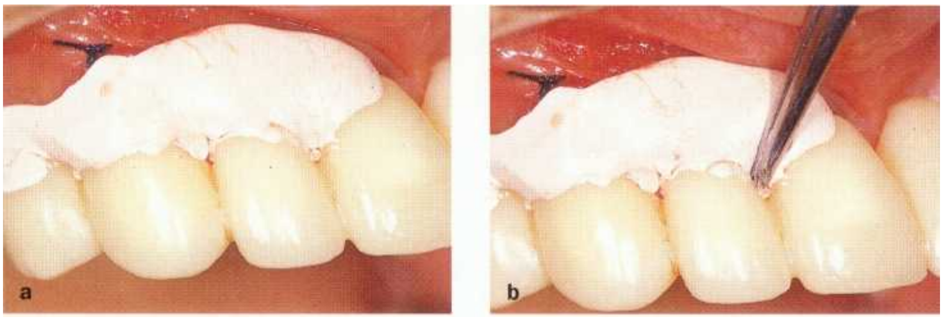
c8-5 Flap suture.

a, b. The suture should be begun from the grafted interdental papilla area to cover the grafted area completely with flaps. A vertical mattress suture of 3.0 silk thread is placed for primary closure of the papilla of the buccal and palatal flap.

c-f. An interrupted suture is made over the remaining interdental papilla area, then the suture of the vertically incised area is completed.

g, h. Provisional restorations are placed.





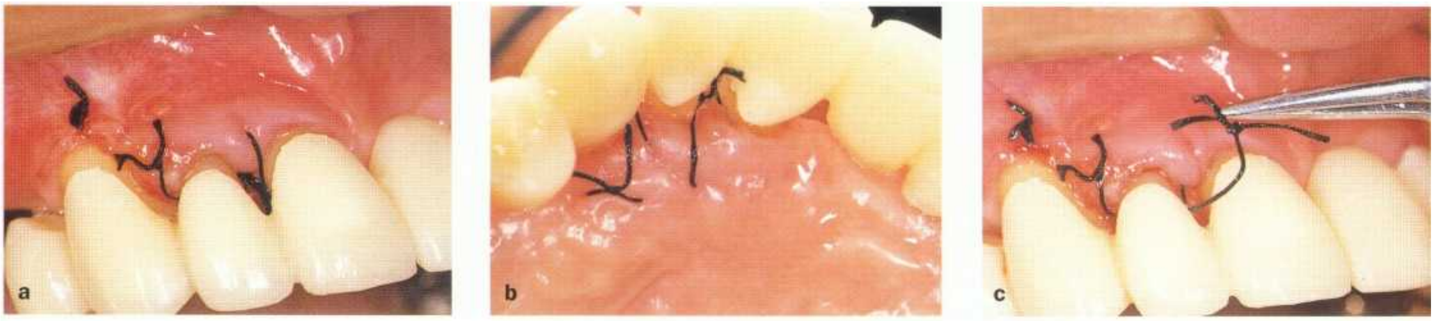
c8-6 Placement of periodontal dressing.

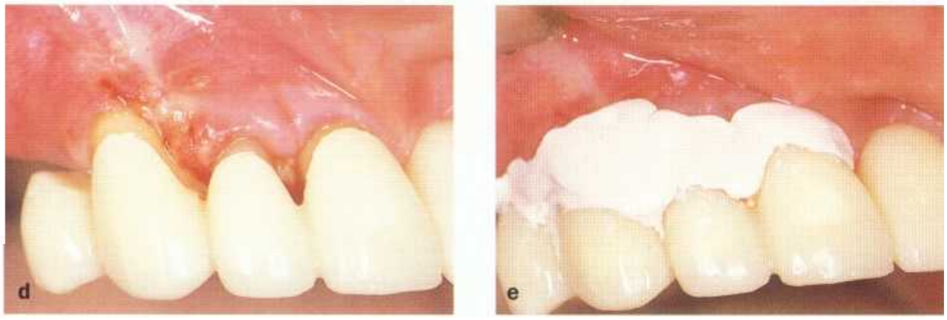
a. The periodontal dressing is placed on the buccal area first to prevent the ligatured area from entering the periodontal dressing.

b, c. The periodontal dressing is then pressed lightly into the wound area. Then the tip of the forceps is used to press the dressing into the interdental area, little by little, with horizontal manipulation. The dressing is pushed palatally beyond the center or the interdental area.

d. Palatal periodontal dressing is placed over the dressing in the interdental area from the buccal to the palatal aspect.

e. With forceps, pressure is applied apically and the periodontal dressing closely adapted.





c8-7 Removal of suture thread.

a-c. The periodontal dressing is removed 1 week after surgery.

d, e. After the removal of the suture thread, tooth surfaces are cleaned and periodontal dressing placed again.

Key point

Remove the periodontal dressing from the palatal aspect. This facilitates removal.
Use scissors to cut the palatal loop, then remove each thread by pulling the buccal knot.

Prognosis

c8-8 Prognosis.

a. Two weeks after surgery. Note the crater-like soft tissue. The patient may brush with an ultrasoft brush.

b. Three weeks after surgery. The patient may use a soft brush.

c. Four weeks after surgery.

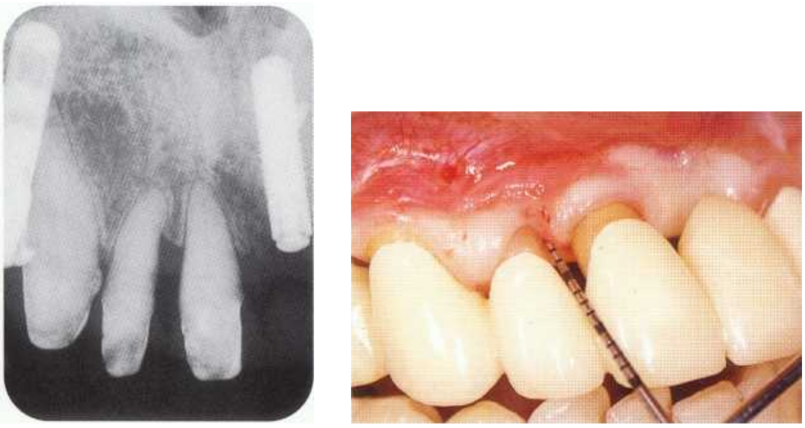
d. Thirteen weeks after surgery. Note the improvement in the craterlike tissues.

Re-entry

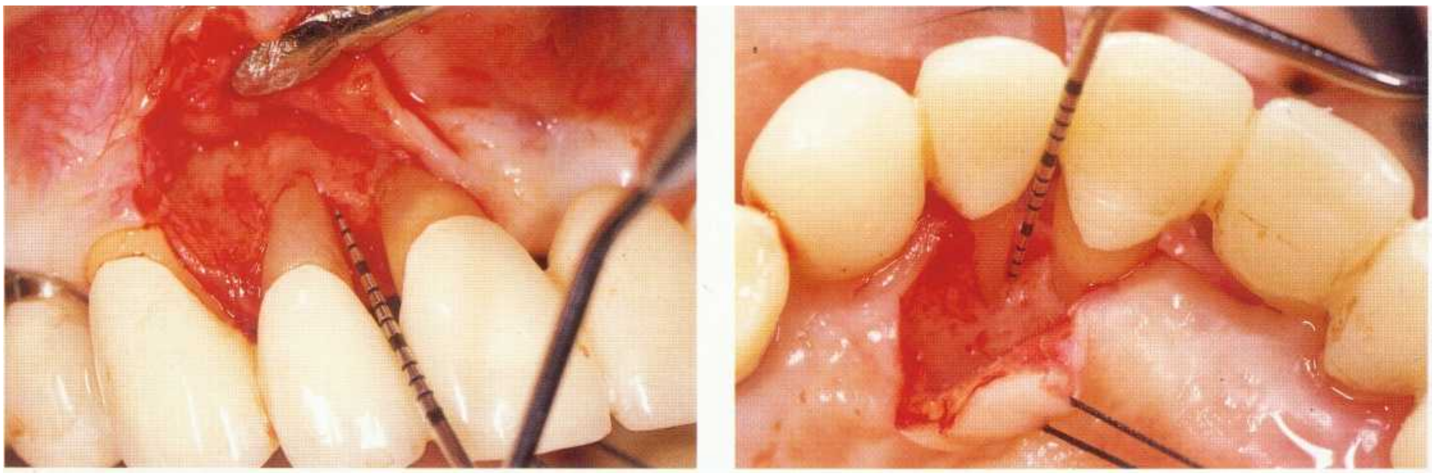
c8-9 **One year after surgery.**

a. The periodontal pocket on 7 is BM 3 mm and PM 2 mm.

b. Preoperative radiograph.



c. One year after surgery. Note the bone stability on the radiograph.



d. Note the bone apposition on the one-wall osseous defect area.

Regenerative Procedures for Furcation Defects

The basic treatments for furcation involvement are resective procedures such as root resection or hemisection (see Chapter 1). In recent years, much attention has been given to the application of GTR for furcation involvement, and good results have been achieved with appropriate indications.

Regenerative procedures for furcation involvement are an extension of flap curettage. Indications of regenerative procedures for furcation involvement should be considered based on the indications of flap curettage.

Compared with the use of GTR for deep intrabony defects, the predictability of GTR for furcation involvement is not always reliable currently (see Chapter 4). GTR should not be used for easy spacemaking with a barrier membrane.

Furcations possess unfavorable conditions for regenerative procedures, and the prognosis of conservative treatment for furcation involvement depends on debridement of the furcation. Success of debridement influences the progno sis of treatment for furcation involvement without the use of resective procedures.

1. Accessibility of instruments

Accessibility of instruments to furcations is extremely difficult due to complicated furcation morphology (Fig 3-9). Complete debridement of furcations is challenging and may even be impossible (Fig 3-10) even with instrument accessibility. Instrument inaccessibility is the main cause of unpredictability of GTR in furcation involvement.

2. Enamel projections

Enamel projections may extend from the crown to the furcation. Because connective tissue attachment cannot occur against the surface of an enamel projection, enamel projections should be removed if new attachment or bone regeneration is expected in the furcation. However, if the enamel projection extends deep into the furcation, complete removal is difficult (Fig 3-11).

3. Cleanability

In furcations, plaque is difficult to control; therefore, periodontal diseases are apt to occur after treatment. GTR results depend on postoperative oral hygiene, as does flap curettage without membrane.[55]

4. Cause of furcation defects

Attachment loss and subsequent osseous defects in the furcation are caused by periodontal diseases, occlusal trauma, pulpal lesions, caries, and root fractures. Therefore, integrated, interdisciplinary treatment (periodontal surgery, endodontic, restorative, and prosthetic treatment, and improvement of occlusion) is required.

Complete debridement of the furcation, however, does not alone resolve the problems.

Anatomic morphology complicating debridement in furcations

Fig 3-9 Instrument limitations. Note the 7-mm periodontal pocket on the mesial furcation entrance of 14. The furcation involvement is Class II with a horizontal-vertical osseous defect in the mesial furcation of 14. Debridement is difficult due to instrument limitations.

Fig 3-10 Concavity of furcation. Note the Class I furcation involvement on the buccal aspect and the Class II involvement on the mesial and distal aspects of 15. Complete debridement is difficult because of depressed root morphology and complicated furcation morphology.

Key point

Note the concavity on the mesial and distal root on the horizontal section of root. In the furcation area adjacent to the concavity, instrumentation is unfavorable (accessibility of instruments such as curettes is poor), and maintenance is difficult, making plaque control difficult.

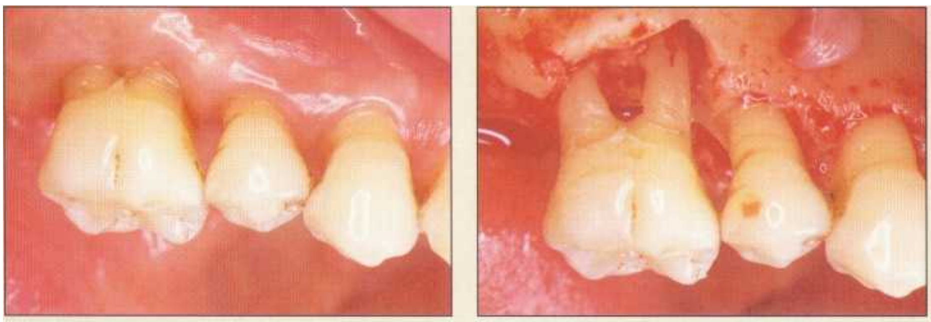


Fig 3-11 Enamel projection. Note the enamel projection on the buccal cervical area of the first molar. The enamel projection extends deep into the furcation, facilitating the formation of deep periodontal pockets and worsening the furcation involvement remarkably.

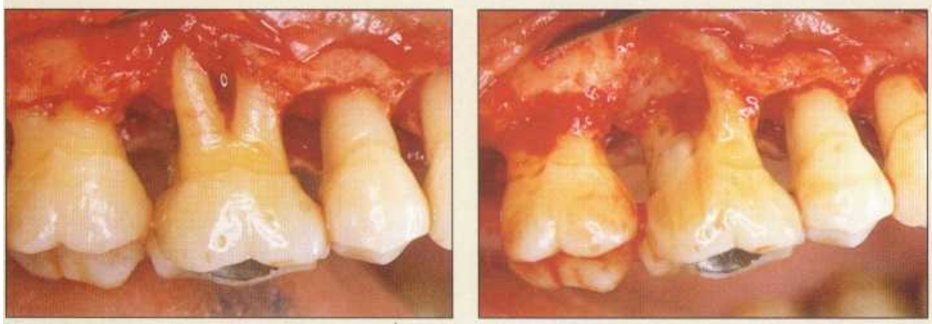


Fig 3-12 Residual calculus in furcation. Observe the Class II furcation involvement in the buccal and distal areas of 3 and the osseous dehiscence on the distobuccal root.

There is residual subgingival calculus on the palatal root in the furcation after root resection of the distobuccal root. Root resection makes the furcation accessible and adequate debridement of the residual root possible.

Because the predictability of regenerative procedures using flap curettage for furcation involvement is poor, root resection or hemisection is still the most reliable treatment. And while the predictability of regenerative procedures for furcation involvement is improved with GTR, indications are limited.

Currently, there is no treatment that can solve all furcation involvement problems; the prognosis of advanced furcation involvement (Class 11 deep, Class 111) with periodontal diseases is poor. Therefore, advanced furcation in volvement is the lesion that most threatens the maintenance and stability of the occlusion and dentition.

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4

Periodontal Regeneration Using Guided Tissue Regeneration

Biologic Basis and Clinical Evaluation of Guided Tissue Regeneration

Biologic Basis of GTR

The objectives of periodontal treatment are not only the control of periodontal diseases but the regeneration of periodontal tissue destroyed by such diseases. A number of surgical procedures to achieve these goals have been devised over the years.

Melcher' suggested that attachment of periodontal tissue to the root after periodontal surgery was determined by the type of cells that attached to the root surface first (epithelial cells, cells derived from connective tissue, cells de rived from periodontal membrane, or osseous cells). Based on this assumption, Nyman et a conduced experiments to recover attachment of contaminated root surfaces and established a rationale of new attachment formation. Nyman et al' covered the root surface and bone in osseous defects with a Millipore filter, prohibiting contact of gingival connective tissue and gingival epithelium with the root surface. They found histologic evidence of cementum formation with new collagenous fibers on the root surface where attachment had been lost due to periodontal disease.

The mechanism of new attachment formation was described by a series of studies by Nyman, Karring, Lindhe and others,' and based on this rationale, guided tissue regeneration (GTR) was designed as a periodontal tissue regen erative procedure. GTR has become the most effective regenerative procedure of periodontal tissue.

The rationale of GTR is to impede apical migration of the epithelium by placing a membrane between the flap and root surface (preventing contact of the connective tissue with the root surface); cells derived from the periodontal membrane are induced on the root surface selectively and periodontal tissue regenerated (Fig 4-1). GTR can be used for periodontal tissue regeneration in intrabony defects and furcation-involvement areas caused by periodontal dis- eases.

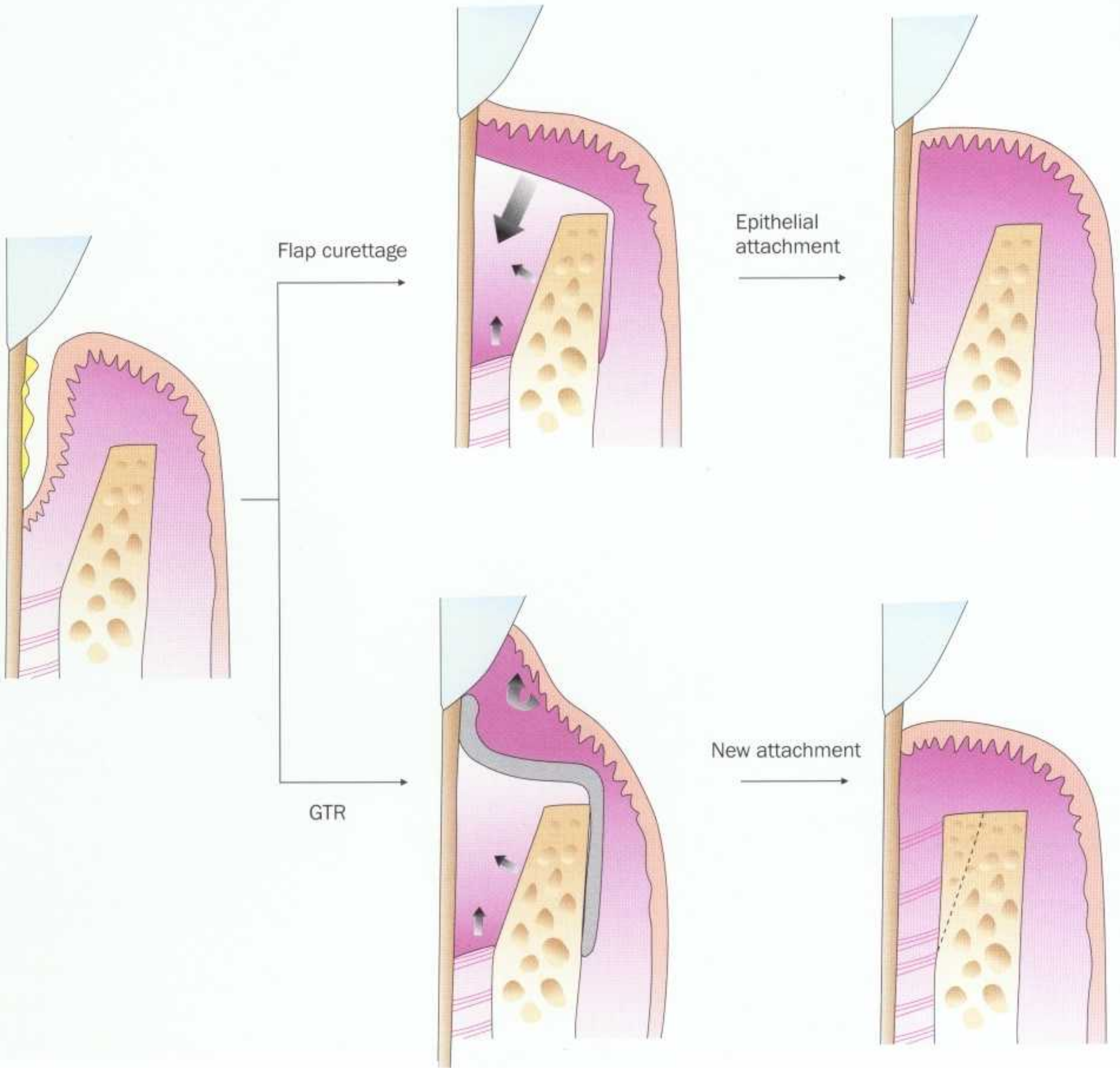
Clinical Evaluation of GTR

Gottlow et al performed GTR over five sites with intrabony defects and reported 3-7-mm attachment gain. Becker et al" performed GTR in nine cases of three-wall intrabony defects and gained an average of 4.5-mm attachment after 6 months. There was an average of 3.1-mm bone regeneration on re-entry, with more than 2 mm in 90% of cases and more than 4 min in 55% of cases.

Table 4-1 Maintenance of Gained Attachment[13]

Time in years after treatment	1	2	3	4	5
No. of sites monitored	80	65	40	17	9
No. of sites with > 2-mm new attachment	74	60	36	17	9
Attachment gain (2–7mm) 80 sites					

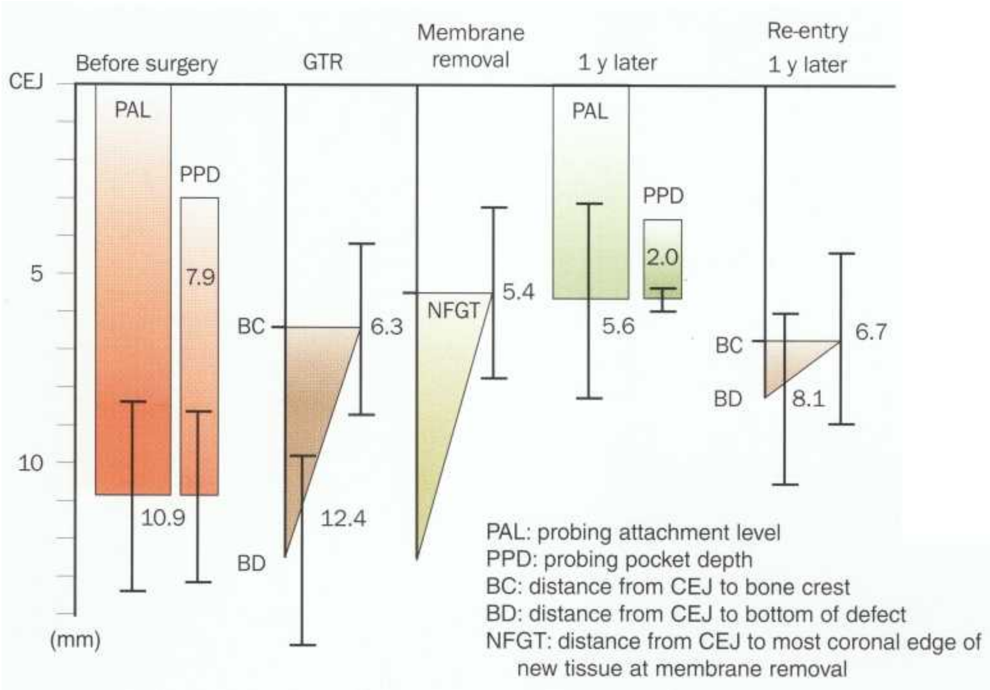
Fig 4-1 Rationale of GTR.



Gottlow and Karring observed and reported new attachment gain by GTR over long periods (Table 4-1). Their study suggested that new attachment gained by GTR was maintained over several years.

A series of studies have indicated that attachment gain, slight gingival recession, and remarkable bone regeneration were obtained with GTR. Cortellini et al" measured osseous defects before surgery and on re-entry and reported the relation between the amount of new tissue, attachment gain, and defect morphology (Fig 4-2). Their measurements were obtained by radiographic evaluation and probing. They also made impressions of the exposed bone surface to fabricate models, then measured the depth of the one-, two-, and three-wall component. The results revealed that the amount of new tissue and attachment gain depended on the numbers of walls composing the osseous defects. Three-wall defects were filled to 95% of their initial depth, two-wall defects were filled to 82%, and one-wall defects 39%, suggesting that the predictability of bone regeneration is extremely high in areas surrounded by bone walls (Fig 4-3).

Radiographic observation reveals that the amount of bone fill is more than the measurement taken because defects surrounded by bone walls cannot be adequately assessed.



4-2 Clinical results of GTR in intrabony de- (Cortellini et al[11,14]).
e clinical results of GTR for osseous defects in atients and 40 sites showed a mean probing :hment gain of 4.1 mm, along with a probing et reduction of 5.9 mm. The sites presented a vertical bone loss of 12.4 mm (CEJ to the om of the defect), and a decrease in intrasur- probing bone level was observed 1 year after from 12.4 to 8.1 mm. Thus a significant re- ration of bone of 4.3 mm was determined, g with a 0.4 mm resorption of alveolar crest. yzing the characteristics of the selected de- at baseline, it was observed that the most nal interproximal extension of the bone crest was located 6.3 mm from the CEJ (CEJ–BC), the mean depth of the intrabony component 6.1 mm. This corresponds to a mean vertical loss of 12.4 mm.

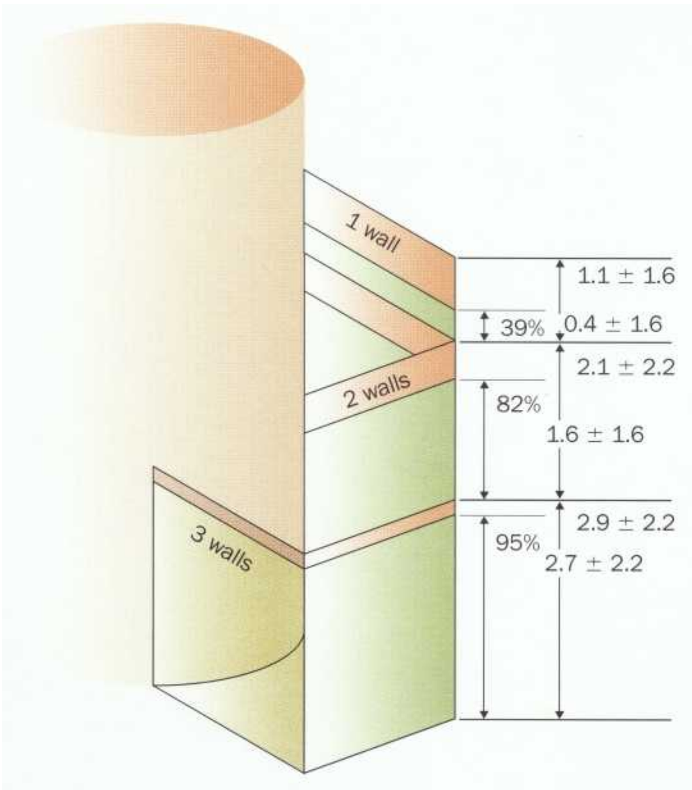


Fig 43 Number of bone walls composing intrabony defect and amount of bone regeneration (Cortellini et al").

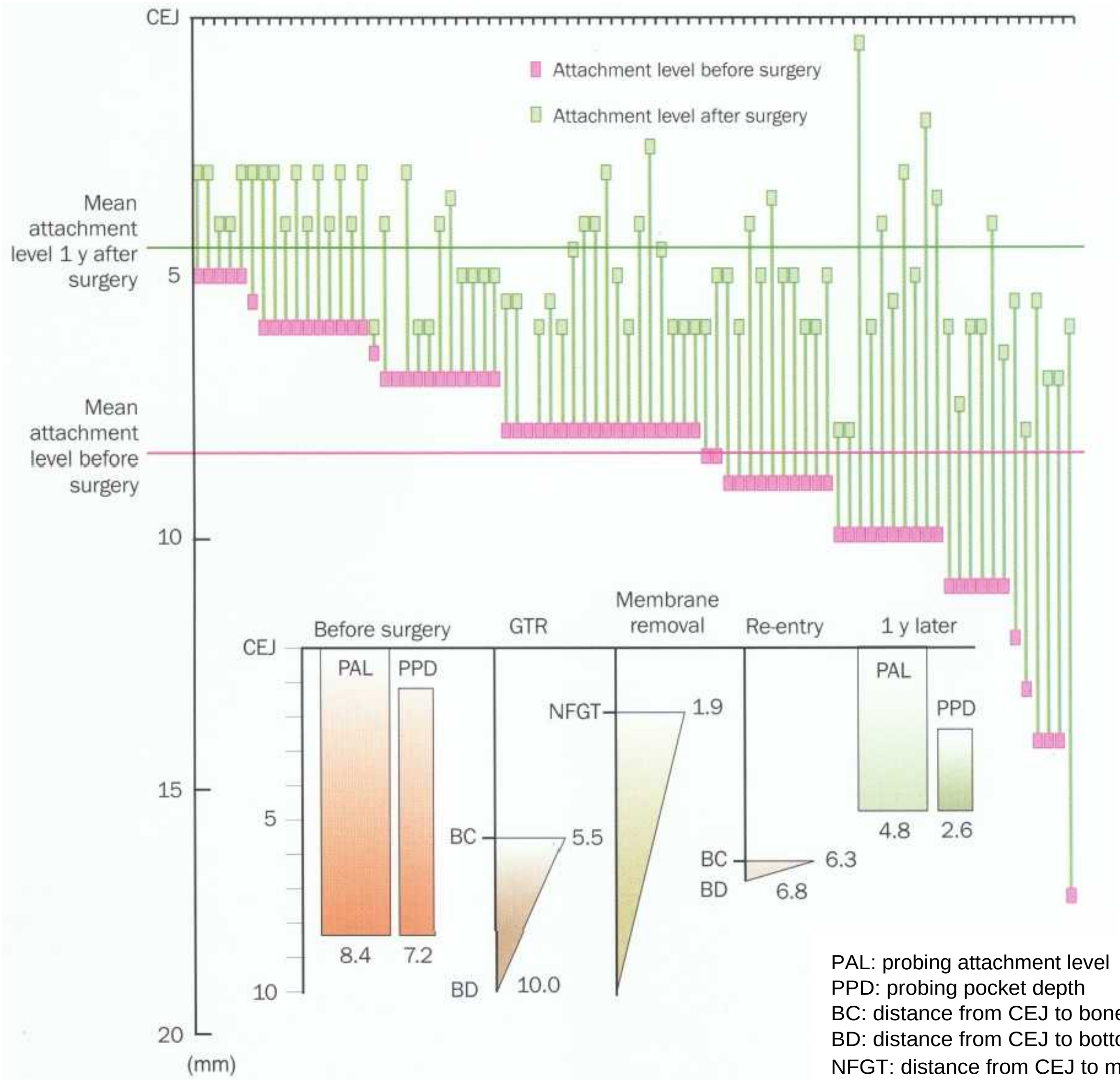
Analyzing the amount of bone regeneration by the number of walls affected revealed that areas with fewer walls had less regeneration and a slower regenerative rate.

Bone regeneration can be achieved by flap curettage if intrabony defects are surrounded by bone walls (see Chapter 3). However, in a one-wall osseous defect, bone regeneration cannot be expected at all.

In this study, the amount of mass was not measured on re-entry. Therefore, intrabony defects were simply classified as three-wall, two-wall, or one-wall according to the entrance of the defect, and bone fill was most likely to occur in three-wall intrabony defects.

Cortellini et al showed that the number of walls in the entrance of defects is important from the point of view of predictability of bone fill. However, the author's clinical results showed no difference in attachment gain or bone fill in relation to the type of defect (Table 4-2).

Fig 44 Clinical results of GTR in intrabony defects. Average (bottom graph) of 22 patients, 39 teeth, and 79 sites (surfaces), and change of attachment level (upper graph) (re-entry = 35 sites).



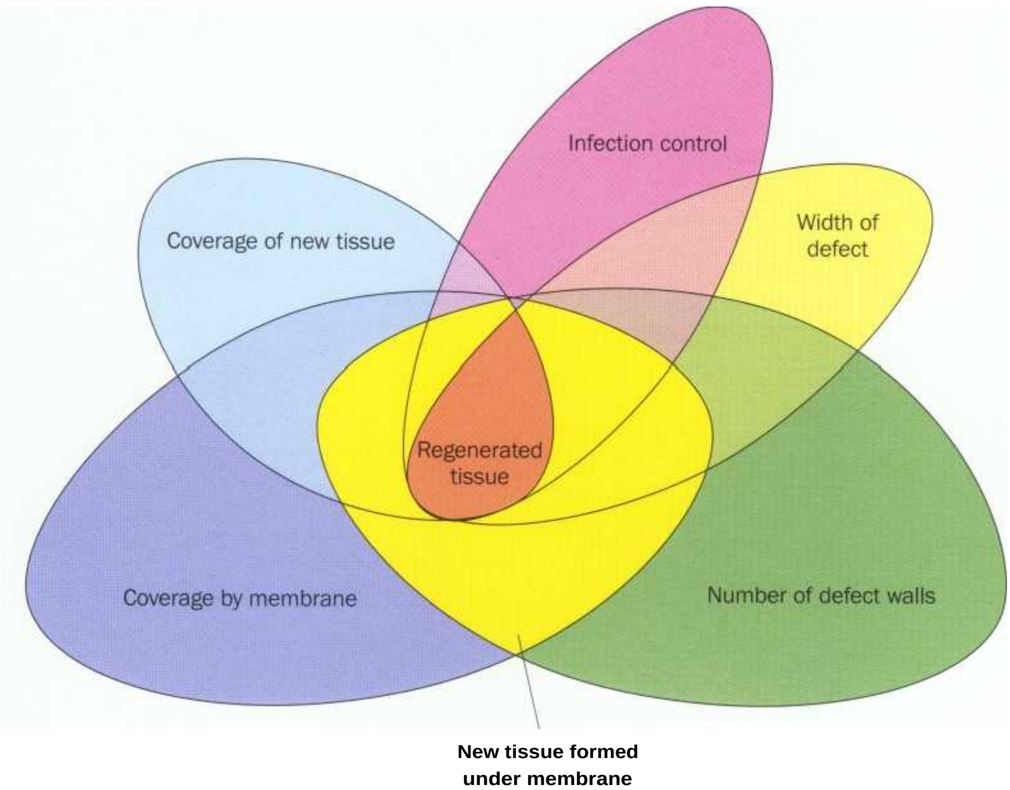
PAL: probing attachment level
PPD: probing pocket depth
BC: distance from CEJ to bone crest
BD: distance from CEJ to bottom of defect
NFGT: distance from CEJ to most coronal edge of new tissue at membrane removal

Table 4-2 Improvement of Various Types of Osseous Defects (mm) (22 patients, 39 teeth, 79 sites [re-entry in 35 sites])

	One-wall (20 teeth)		Two-wall (10 teeth)		Three-wall (9 teeth)	
	Baseline	**Re-entry**	**Baseline**	**Re-entry**	**Baseline**	**Re-entry**
Probing depth	7.20	2.75	7.15	2.55	7.36	2.25
Attachment level	8.63	4.99	7.70	4.25	8.81	5.17
CEJ–bottom of defect	10.92	6.89	9.40	5.89	12.12	7.25
CEJ–bone crest	6.77	6.68	4.50	5.11	5.35	6.79
INTRA*	4.15	0.21	5.05	0.78	6.96	0.46
NFGT**	2.00		1.47		2.53	
Improvement of probing depth		4.45		4.60		5.11
Attachment level gain		3.64		3.45		3.64
Amount of bone resorption (depth)		−0.21		1.50		1.50
Amount of loss of NFGT		3.21		2.84		2.91
Amount of bone regeneration (depth)		4.21		3.30		4.41

*INTRA: (CEJ-BD)-(CEJ-BC).
"NFGT: newly formed granulation tissue.

Fig 45 Determinants influencing the regeneration of periodontal tissue.



In GTR, results should be evaluated by the amount of clinical attachment gain. It must be remembered that the greater the attachment loss before surgery, the more attachment gained (see Fig 4-4). However, this is limited to cases that meet the conditions for GTR.

Tonetti et al described the factors that influence the predictability of regeneration of deep intrabony defects treated by GTR as follows (Fig 4-5):

1. The amount of regenerated tissue under the membrane is dependent on the baseline depth of the intrabony component.
2. The width of the intrabony defect-the greater the distance between the root and bone wall, the less regeneration achieved.
3. Infection control, measured as full-mouth bleeding scores, significantly affects the maturation process.
4. The regenerated tissue obtained at membrane removal should be protected during the maturation phase. Lack of good coverage of the regenerated tissue results in a decrease of attachment gain and bone fill.

Indications for GTR and Factors Achieving Optimal Results

Conditions Required for GTR

GTR is a form of flap surgery, the objective of which is tissue regeneration as described in Chapter 3. Where tissue regeneration can be expected by debridement of the root surface after flap reflection, the membrane is used to prevent the gingival epithelium and gingival connective tissue from contacting the root surface. This facilitates new attachment gain. In other words, attachment gain can be achieved by conventional flap surgery in deep vertical osseous defects and Class 11 furcation involvement, but using a membrane enhances predictability greatly.

However, because the membrane requires precise positioning and complete flap coverage, GTR requires minimal gingival recession and thick gingiva. Also, in GTR healing is delayed due to the foreign body (membrane), and new tissue should be covered by flaps again for healing.

The maintenance of gained attachment is influenced by postoperative inflammation, hence the result of GTR is more affected by oral hygiene than is flap surgery (Fig 4-6).

Because the amount of new attachment is influenced by the size of the space between the membrane and the root surface, the better the spacemaking, the higher the predictability (Figs 4-7 to 4-10).

Amount of Gingival Recession and New Tissue Gained

Where there is minimal gingival recession, much keratinized gingiva may cover the membrane, easing surgical manipulation. Also, the more coronally the membrane is placed, the more new tissue will be gained.'' The less the gingival recession, the greater the regeneration (Fig 4-11).

For best results with GTR, the case will involve minimal gingival recession, a vertical osseous defect with minimal loss of interdental papilla, arid furcation involvement with minimal exposure of the furcation.

Fig 46 Indications of GTR.

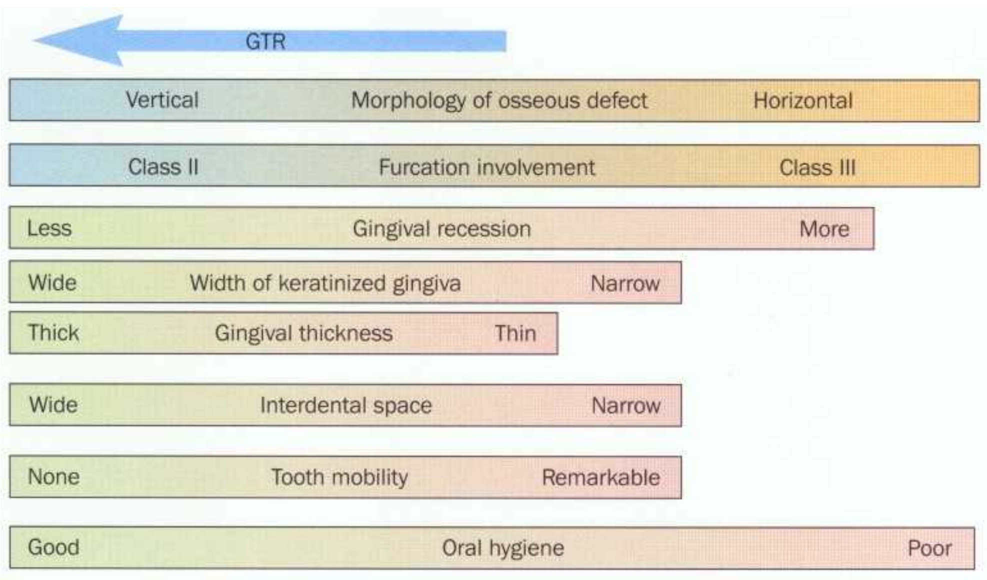
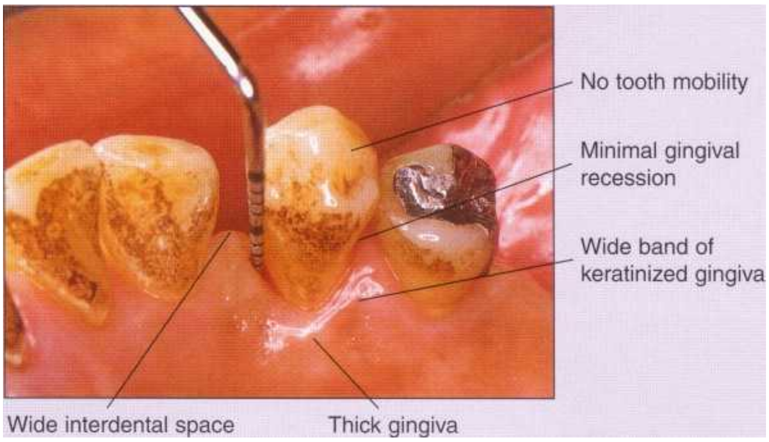
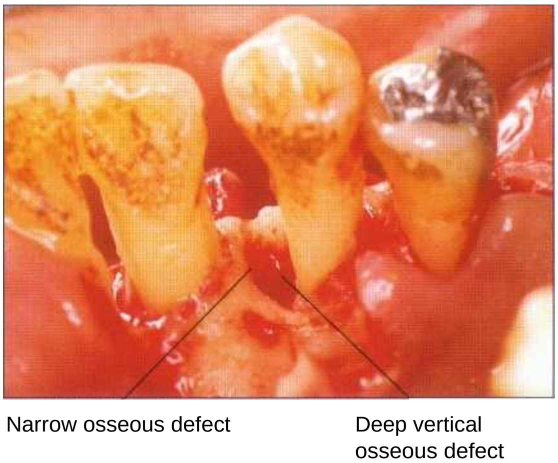
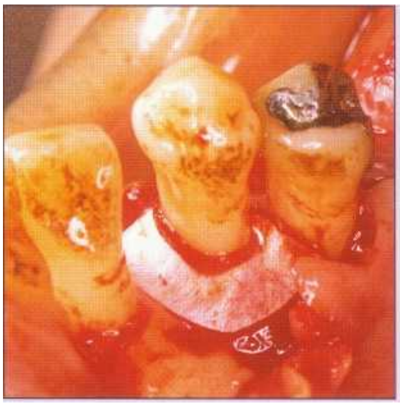
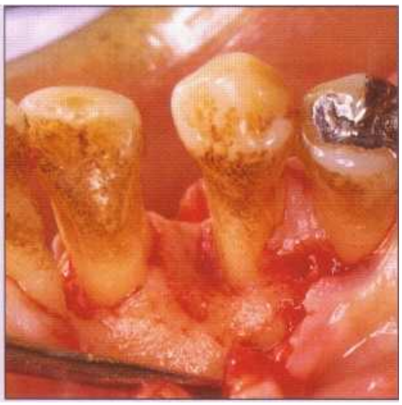


Fig 4-7 Suitable conditions for GTR.



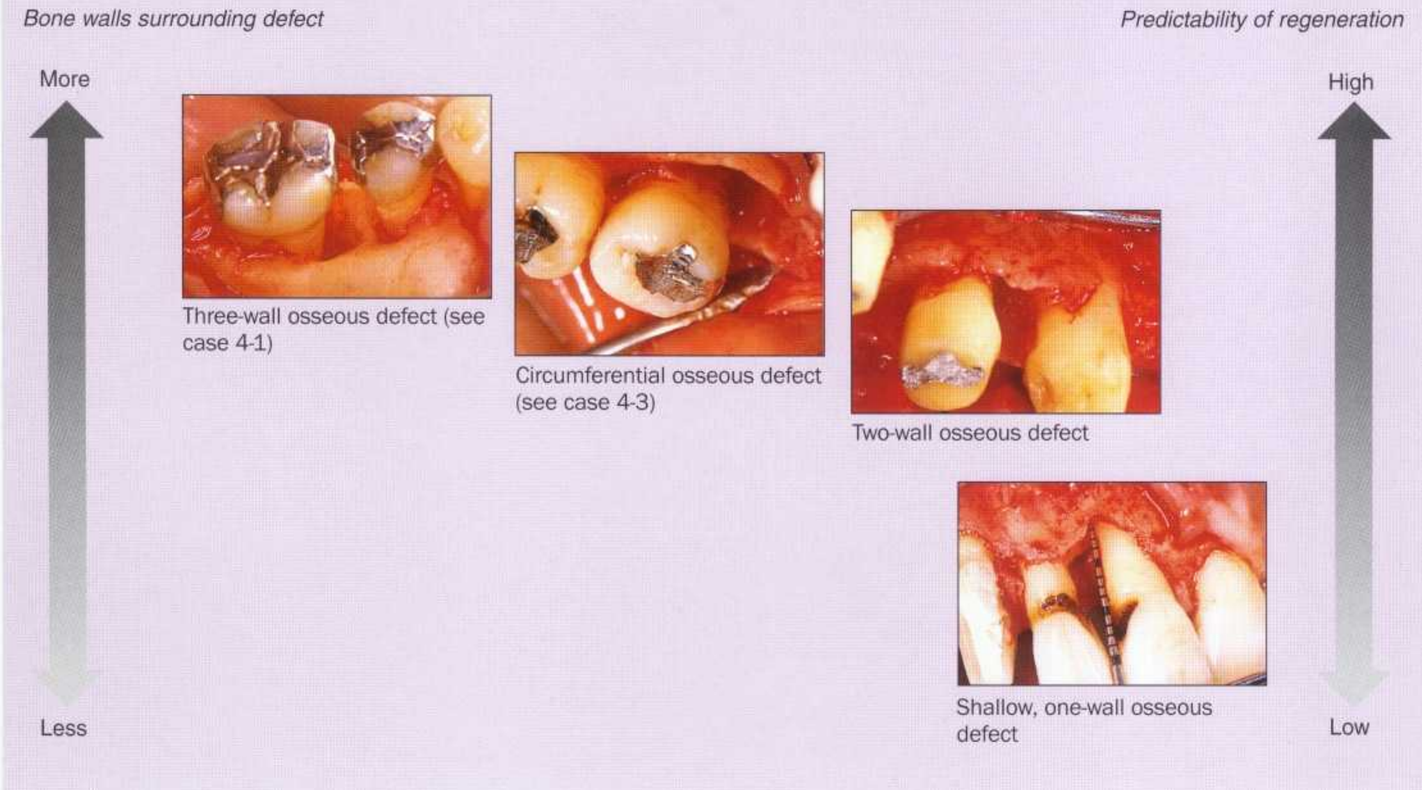






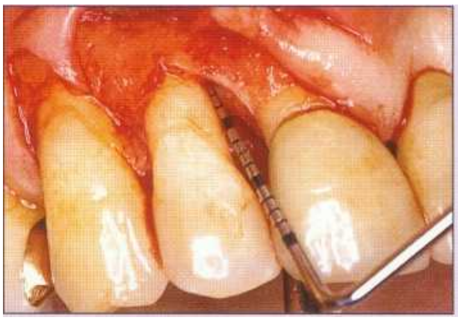
The defect is covered by a wraparound-type membrane. The placement and manipulation of the membrane are easy, and depression of the membrane does not occur because the interdental space is wide. The membrane is covered completely because the gingiva is thick and because of the absence of gingival recession. Note the remarkable bone regeneration in the osseous defect area on re-entry.

Fig 4-8 Morphology of intrabony defects and the predictability of regeneration.

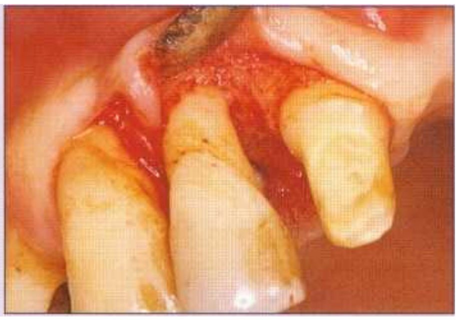


Characteristics of osseous defects and bone regeneration

Fig 49 GTR in a one-wall osseous defect.

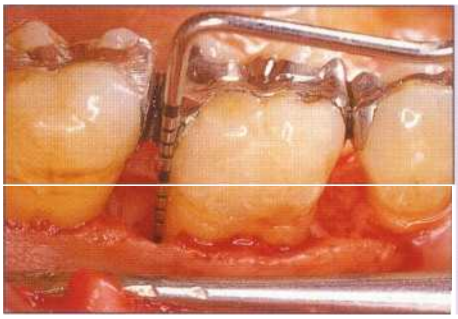


a. Osseous defect on the mesial aspect of 7 (46-year-old man).



b. On re-entry 7 and a half months after GTR. There is minimal bone regeneration.

Fig 410 GTR for an osseous defect consisting of three-walls up to the bone crest.



a. Note the three-wall osseous defect on the distal interdental area of 19 (57-year-old woman).

b. On re-entry 1 year and 6 months after GTR. Note the almost-complete bone regeneration in the three-wall area of the defect.

Gingival Thickness and Membrane Exposure

The most frequent postoperative complication of GTR is membrane exposure. Murphy" reported membrane exposure in 87% of GTR-treated sites in 62 patients (102 sites). The average time of membrane exposure was 16.2 days after surgery, with most membranes exposed within 2 weeks. The membrane exposure rate was high because Murphy used GTR for interdental osseous defects.

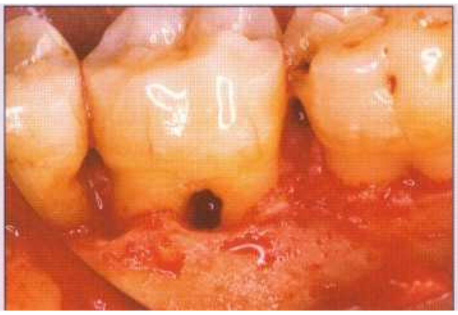
With membrane exposure, thorough plaque control of the exposed area is essential to avoid infection. One cause of early membrane exposure is necrosis of a thin flap covering the membrane. In GTR, blood supply to the flaps de pends on flap thickness because blood supply from the bone to the flap is impeded by the membrane.

The less the gingival recession during healing after GTR, the more new attachinent gained. Sufficient gingival thickness is critical (Fig 4-12).

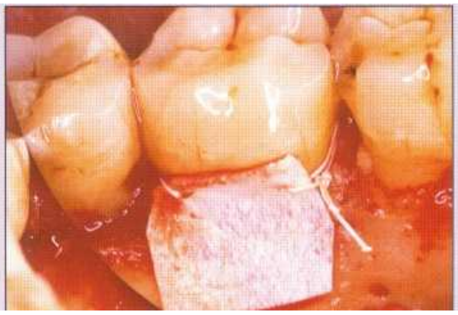
Anderegg et al" reported on the relation between the thickness of the flap covering the membrane and gingival recession occurring after surgery. They measured the thickness of flaps 5 mm apical to the gingival margin during surgery and classified patients into two groups based on flap thickness. Six months after surgery, they found an average 2.1-mm gingival recession in the group with less than 1-mm flap thickness, and an average of 0.6-mm gingival recession in the group of flaps of greater thickness (Table 4-3). The thickness of the flap covering the membrane is an essential consideration.

Fig 411 Gingival recession and new tissue gained.

a. 48-year-old man, The probing depth on the center of the buccal aspect of 31 is 5 mm. There is no gingival recession nor furcation apparent on visual inspection. The gingiva is thick, and there is a sufficient width of keratinized gingiva.

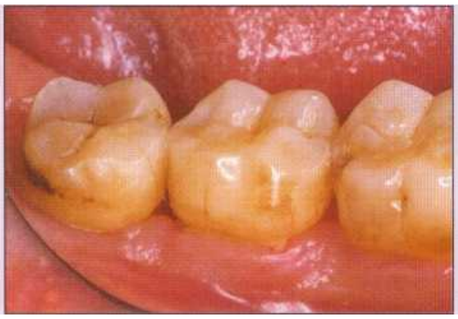


b. Class II furcation involvement. There is a 6-mm furcation defect in horizontal direction.

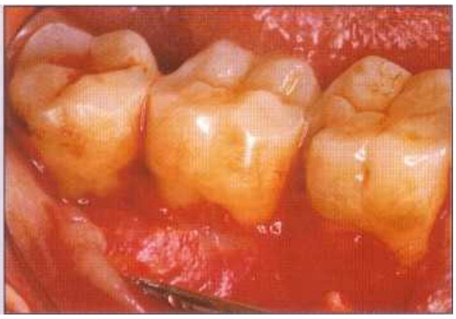


c. Placement of an e-PTFE membrane.

d. The suture of the flap is simple because of the abundant keratinized gingiva to cover the membrane.



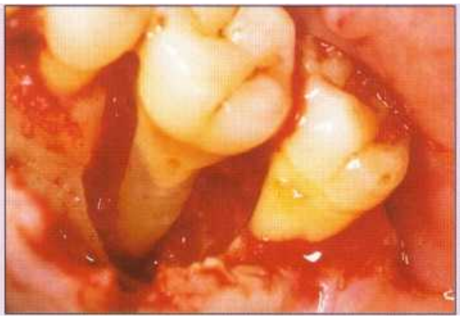
e. Five weeks after surgery preceding membrane removal. Note the slight membrane exposure.



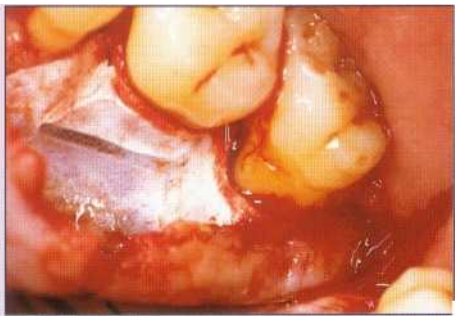
f. Note the new solid tissue on the furcation entrance. The coverage of the new tissue by the flap is uncomplicated.

Fig 412 Gingival thickness and membrane exposure.

a. 56-year-old man. Note the deep intrabony pocket (11 mm buccally and 12 mm palatally) on the distal aspect of 14. The buccal and palatal gingiva is thick, but there is recession in the interdental papilla. Primary closure of the flap may be difficult.

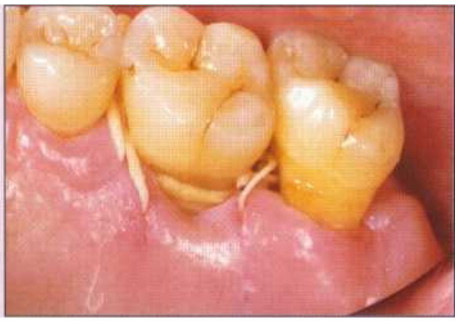


b. Osseous defect after flap reflection.



c. Placement of the titanium-reinforced membrane.

d. Primary closure cannot be achieved during flap suture on the distal interdental area of 14. The membrane collar is exposed on the palatal aspect of 14.



e. Twenty-three days after surgery. Membrane exposure is not progressing.

Table 4-3 Flap Thickness and Amount of Gingival Recession[19]			
		37 sites (37 patients) with Class I or II furcation involvement	
		Flap thickness 5 mm apical to gingival margin	Amount of gingival recession 6 mo later
Group 1	Gingival thickness < 1 mm (Average 0.76 mm)	16 sites	2.1 mm
Group 2	Gingival thickness > 1 mm (Average 1.44 mm)	21 sites	0.6 mm

The blood supply to the flap covering the membrane resembles the blood supply to a free autogenous gingival graft covering the root surface. Miller z° and Holbrook and Ochsenbein recommended 1.5-2.0-mm thickness of free auto genous gingival graft for root coverage. Mormann et al concluded that the thinner the graft, the greater the postoperative shrinkage. These studies con-

firm that approximately 1.5-mm flap thickness is needed to cover the mem-ane. Furthermore, if there is tension where the flap covers the membrane, blood supply may be especially hindered with thinner flaps.

To maintain blood supply to the flaps, to prevent flap necrosis, and to achieve favorable results, more than 1.5-mm gingival thickness is a prerequisite in GTR. If GTR is performed in deep osseous defects with thin gingiva in the maxillary anterior region, recession of the interdental papilla or gingiva will occur. Therefore, for esthetic reasons, other procedures, such as flap curettage or bone grafts, should be considered.

Position of Membrane

The coronal position of the membrane is an important factor in predicting the amount of tissue regeneration. Caton et al " created one-wall osseous defects in the proximal tooth surfaces of monkeys which they studied histologically 1 month and 3 months later. Regeneration of periodontal tissue occurred in one-wall osseous defects of proximal surfaces, but the amount of tissue regeneration was determined by the position of the membrane; the more coronal the membrane, the more regeneration achieved. They found that the least regeneration was achieved where the membrane was collapsed into the intrabony defect area.

If the membrane is placed more coronally, more space for regeneration is acquired. However, it is useful to support the membrane's shape with grafted bone'°'z or to use a titanium-reinforced membrane.

Tonetti et al reported that the amount of attachment bone gains after GTR depended on the amount of new tissue gained at membrane removal.

Cortellini et a l compared the clinical results of a titanium-reinforced membrane placed right under the CEJ using the papilla preservation technique and a conventional polytetrafluoroethylene (e-PTFE) membrane. Then they showed that placing the membrane as coronally as possible produced better results (Table 4-4).

If a membrane that does not have formability is placed coronally, space-making becomes difficult; however, the use of titanium-reinforced membranes is very effective. Additionally, if a membrane is placed more coronally, mem brane coverage by flap becomes difficult, hence, more advanced surgical technique (flap design, incision, management of flaps, suture) is required.

Table 4-4 Effect by Titanium Reinforced Membrane (45 patients, 45 sites)[26]

	1 year after treatment	
	Attachment gain	**Residual probing depth**
Titanium-reinforced membrane placed right under CEJ (papilla preservation technique)	5.3 ± 2.2 mm (more than 4 mm in 86% of sites)	2.1 ± 0.5 mm
e-PTFE membrane placed coronal to the alveolar crest	4.1 ± 1.9 mm (more than 4 mm in 60% of sites)	2.7 ± 1.0 mm
Modified Widman flap	2.5 ± 0.8 mm	3.7 ± 1.3 mm

Timing of Membrane Removal and the Amount of Tissue Gained

Murphy'-' described how the timing of membrane removal affected tissue regeneration. He studied early membrane removal and delayed removal (Table 4-5). He later examined the effect of the timing of membrane removal on the amount of new tissue gained.[28] In this study, he divided the membranes into two groups: membranes removed within 6 weeks of placement and after 6 weeks of placement. He also took into consideration whether GTR with bone grafts or GTR with membrane only was performed. When the membrane was removed more than 6 weeks after placement in bone graft cases, the amount of new tissue was the greatest; however, there was less effect in cases where the membrane was removed early, even if bone grafts were placed.

Because problems due to early removal and delayed removal are inevitable, bioresorbable membranes are of special interest.

Oral Hygiene and the Amount of Tissue Regeneration

Cortellini et al[35] studied how gained attachment by GTR is influenced by periodic recall and reported 4-year results. Gained attachment was maintained in the group with recall every 3 months, but attachment loss occurred in the group with less-frequent recall (Table 4-6). Because the stability of gained attachment depends on postoperative oral hygiene, periodic maintenance is even more necessary in patients who have undergone GTR than it is with patients with periodontal disease only. In cases of membrane exposure, oral hygiene becomes even more critical.

Table 4-5 Timing and Problems of Membrane Removal[27]

3–5 weeks	6–10 weeks
Problems with early removal	**Problems with delayed removal**
• Less maturation • Less bone • Less gain • Greater recession	• More purulence • Difficult removal • Longer treatment

Table 4-6 Effect of Frequent Periodic Recall in the Maintenance of Gained Attachment (23 patients, 40 sites)[35]

Intrabony defect		Attachment level: Before surgery	Attachment level: 1 y later	Attachment level: 4 y later	Attachment changes between 1 and 4 y
Group A	15 patients, 22 sites (periodic recall every 3 months)	11.6 mm	6.3 mm	6.4 mm	−0.1 mm
Group B	8 patients, 18 sites (patients who received sporadic recall)	9.9 mm	7.5 mm	10.3 mm	−2.8 mm

The author recommends that patients brush the exposed membrane thoroughly with an ultrasoft brush. Plaque build-up on the exposed membrane should be removed by professional tooth cleaning every week. The membrane is removed 4-6 weeks after placement.

Weigel et al evaluated the changes of periodontal tissue treated by GTR during maintenance. They found a correlation between the maintenance of the new attachment and a combination of factors such as number of recall visits during the maintenance phase and patient age. They concluded that control of gingival inflammation is a prerequisite to the long-term maintenance of attachment gained by GTR.

It is necessary to increase recall frequency and to maintain adequate oral hygiene to maintain favorable long-term GTR results because it is those patients who have advanced periodontal diseases who require GTR.

Problems Associated with Cigarette Smoking

Cigarette smoking is a major factor aggravating periodontal disease. Tonetti et al studied the effect of cigarette smoking in results of GTR. The study revealed a significant difference in the amount of attachment gain 1 year after surgery in the smoking and nonsmoking groups. Cigarette smoking, however, is not the sole factor, but those who smoke have poor plaque control (Table 4-7).

Table 4-7 Effect of Cigarette Smoking in Full-mouth Plaque and Bleeding Scores, and Tissue Gain[39]

	Plaque score (%)		Bleeding score (%)		Infrabony defect (mm)	
	Prior to surgery	1 y later	Prior to surgery	1 y later	Tissue gain (membrane removal)	Attachment gain (1 y later)
Smoking group (20 patients, 32 sites)	16.4	9.6	10.5	7.3	6.0	2.1
Nonsmoking group (31 patients, 39 sites)	11.7	7.0	7.6	4.3	7.6	5.2

Surgical Techniques for GTR

While GTR is unique in its use of a membrane, the surgical principle is the same as with flap curettage for tissue regeneration. Namely, complete debridement of root surfaces and postoperative plaque control are required. The special issue is complete primary closure because of the foreign body (the membrane) introduced. Flap design and suture technique require special consideration for complete primary closure.

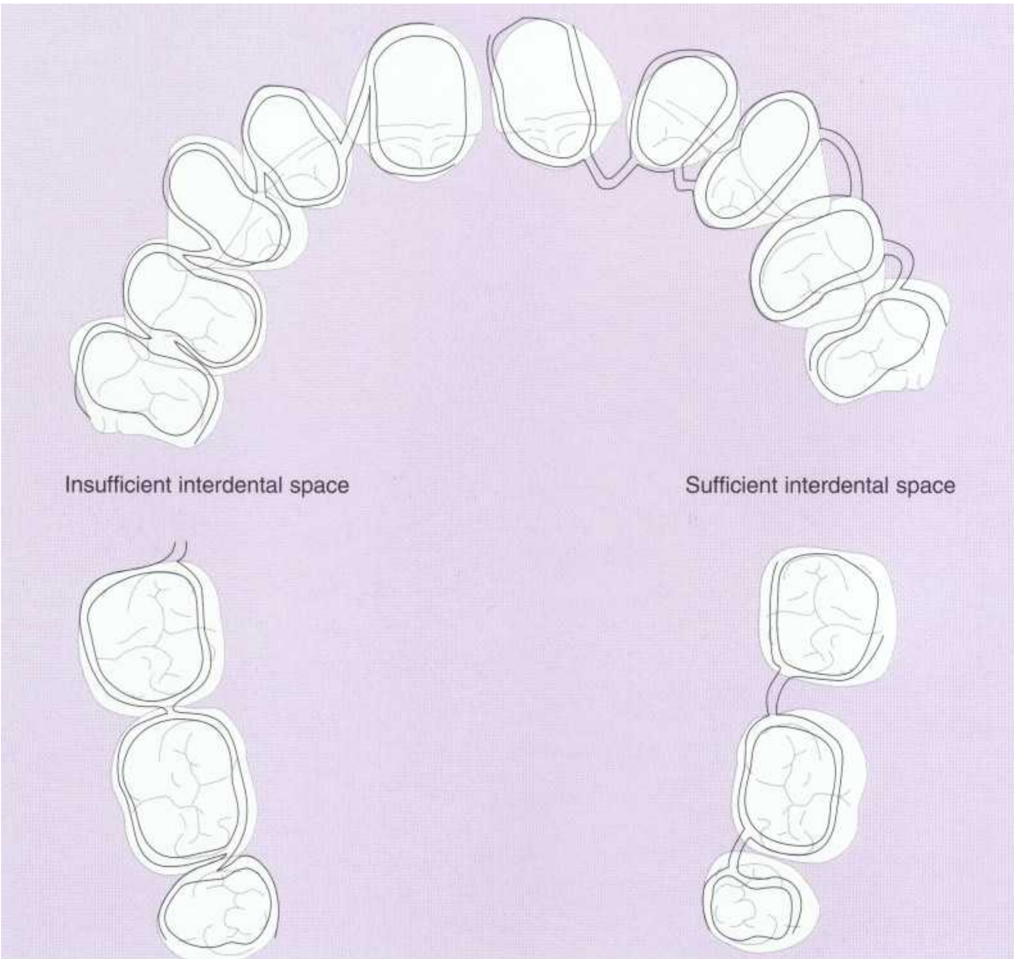
Flap design and suture techniques are described according to particular situations; however, the principles for achieving complete primary closure are described as follows.

Preservation of the Interdental Papilla

The flap design for GTR consists of sulcular incisions and interproximal incisions connecting the sulcular incisions. The interdental papilla should be preserved as much as possible in interproximal incisions. An interproximal incision for maximum preservation of the interdental papilla has variations, depending on whether there is sufficient or insufficient interdental space (Fig 4-13).

A full-thickness flap is prepared 4-5 mm from the crest of the osseous defect, and a combination partial-thickness flap is made apically to facilitate the flap's coronal migration.

Fig 413 Interproximal incision for maximum preservation of the interdental papilla.



Management of the Root and Bone Surfaces

After removal of the granulation tissue of the osseous defect, the calculus is removed with an ultrasonic staler and curette and the root surface finished with a finishing bur. Because subgingival calculus enters the cementum, one layer of cementum is removed.

The root surface, which has undergone adequate debridement, is treated with an application of tetracycline hydrochloride solution for 5 minutes (Fig 4-14).

For exposed bone surface, the cortical bone surface to the cancellous bone is perforated with a 1/2 round bur to facilitate the formation of blood coagulum on the bone surface after complete removal of granulation tissue in the osseous defect.

In GTR, new attachment is acquired on the root surface covered by a membrane, and bone regeneration is expected in the osseous defect area. However, in wide and deep osseous defects, one-wall osseous defects in which spacemaking is difficult, and osseous defects with extensive furcation involvement, bone grafts may be used to make space for regeneration (Fig 4-15).

Fig 414 Management of the bone surface for GTR.

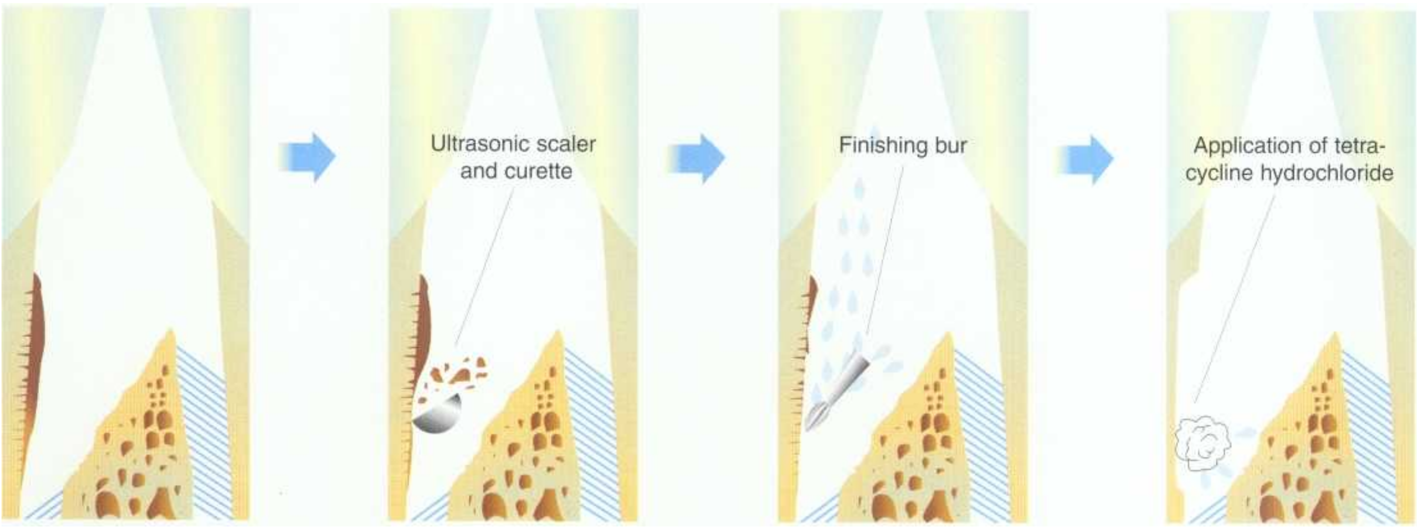


Fig 415 Management of the bone surface for GTR and bone grafts for spacemaking.

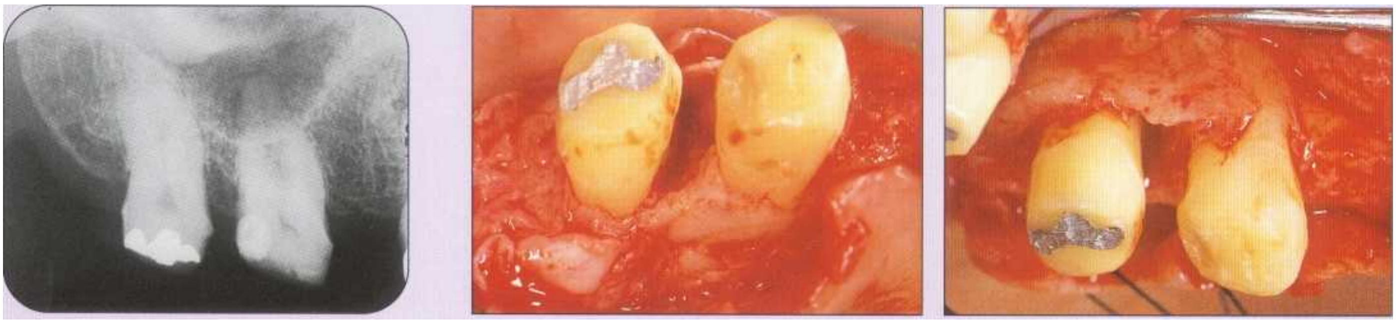
Selection of the Barrier Membrane

Nonabsorbable and bioabsorbable barrier membranes are available for GTR (Table 4-8). GTR with an e-PTFE membrane, widely used clinically, is a highly predictable regenerative procedure. Titanium-reinforced membranes are also available.

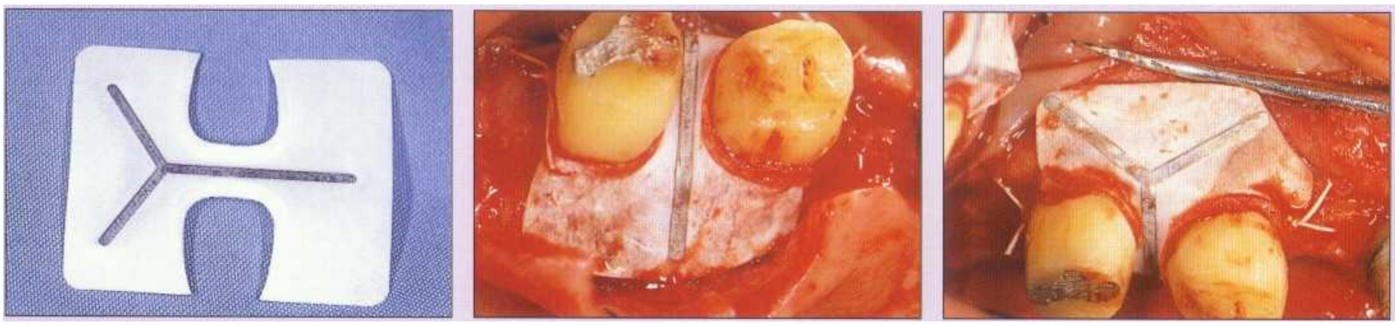
Nonabsorbable membranes have some problems. e-PTFE membranes should be removed 4-6 weeks after surgery. A second surgery is required for membrane removal, and immature new tissue may enter and adhere to the membrane. Mechanical damage to new tissue affects its healing process. If new tissue cannot be covered completely by flaps during the second surgery, there will be less regenerated tissue. It is difficult to cover the new tissue completelywith flaps if membrane exposure is extensive.

Bioabsorbable membranes do not require a second surgery, thus reducing patients' and practitioners' burden (Fig 4-17). For these reasons, many bioabsorbable membranes have been developed (Table 4-8). There have been

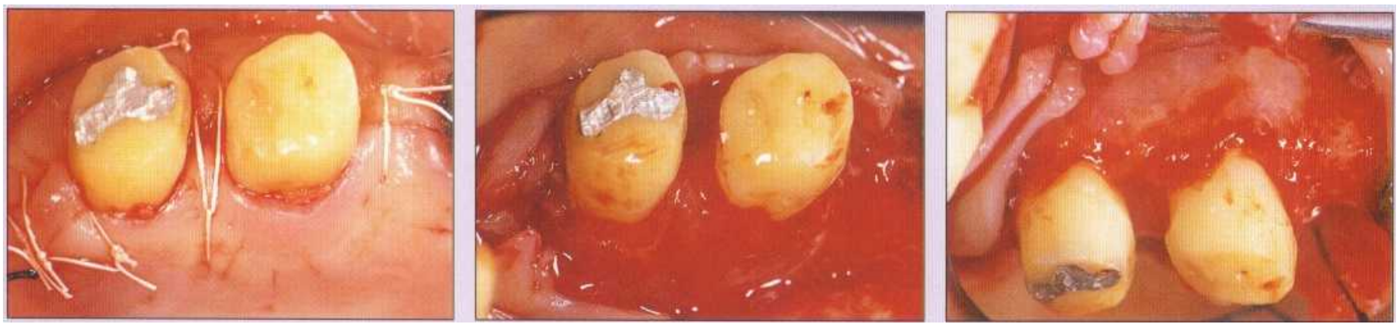
Fig 416 Titanium-reinforced membrane in an interdental two-wall intrabony defect.



a. The probing depth is 5.5 mm buccally and 5 mm palatally on the mesial aspect. There is a deep and wide two-wall intrabony defect in the interdental area of 2 and 3 and about 6 mm of osseous dehiscence on the mesiobuccal root of 3 (46-year-old woman).



b. The interproximal-type titanium-reinforced membrane (TRI2, WL Gore) is adjusted and trimmed. The titanium frame in the membrane provides formability over the osseous defect. The membrane is sutured. Note that the membrane is placed right under the prepared tooth margin. Bone grafts are used for spacemaking in the osseous dehiscence area of 3.

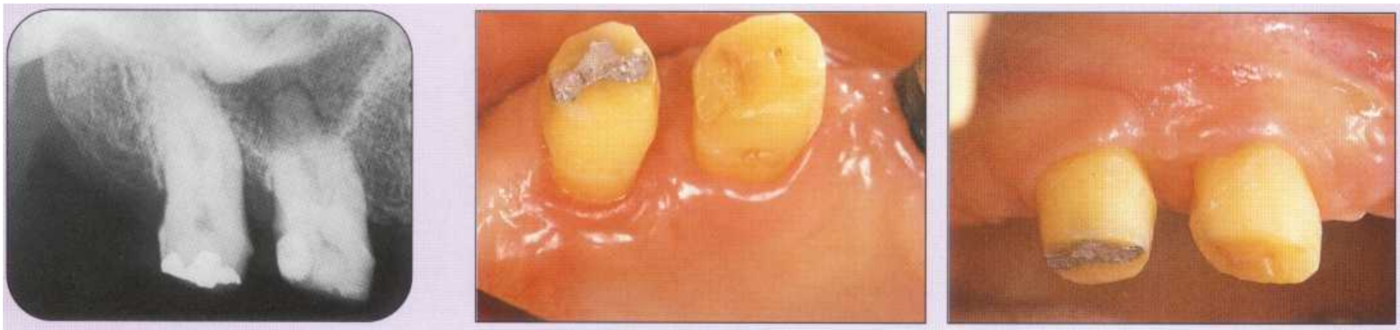


c. The membrane is covered by flaps and sutured.

d. New tissue on membrane removal 4 weeks after surgery. The distance from the prepared tooth margin of 2 to the coronal side of the new tissue is 2 mm buccally and palatally. Note the white osseous tissue in the dehiscence area of 3.

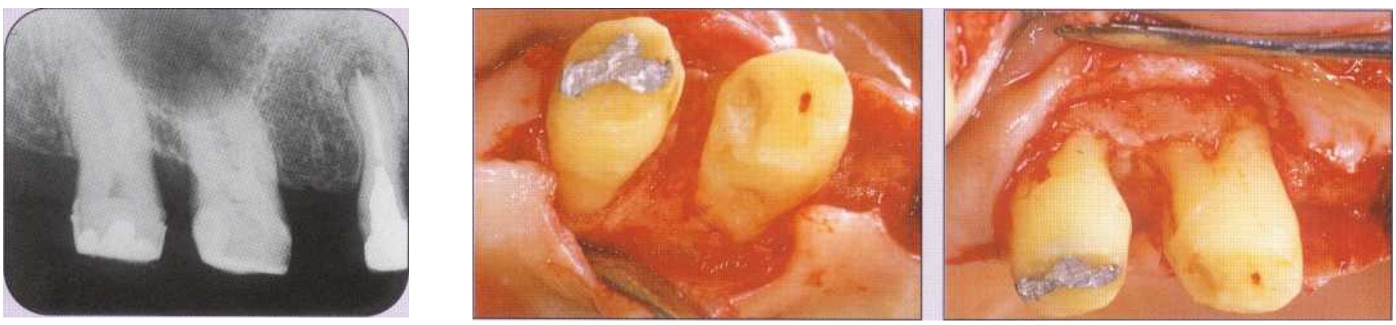
Table 4-8 Barrier Membranes for GTR

1. Nonabsorbable
   a. Polytetrafluoroethylene (e-PTFE) type
      - GORE-TEX regenerative materials (WL Gore)
   b. Titanium-reinforced polytetrafluoroethylene type
      - Titanium-reinforced e-PTFE membrane (WL Gore)
2. Bioabsorbable
   a. Collagen type
      - KOKEN tissue guide (Koken)
      - Paroguide (Lyon)
   b. Synthetic polymer type (lactate-glycol compound)
      - GC membrane (GC)
      - Resolute (WL Gore)
      - Vicryl (Ethicon)
      - Atrisorb (Atrix)
      - Guidor (Guidor)



e. Four months after surgery.

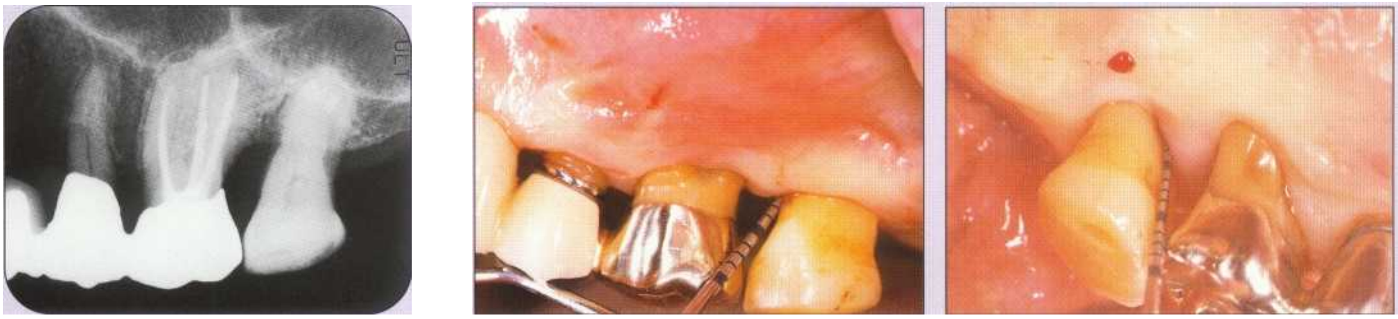
f. About 1 year after GTR. Note the remarkable bone fill on radiography; it is slightly insufficient on the bone crest area, however.



g. About 1 year and 5 months after surgery. Note the continuous radiopaque line, indicating the possibility of new bone formation. The probing depth is 2 mm buccally and palatally on the mesial aspect. Note the remarkable bone fill in the two-wall osseous defect area after flap reflection; however, a shallow, craterlike osseous defect remains. Later this defect is eliminated by osseous resection and the interdental bone flattened.

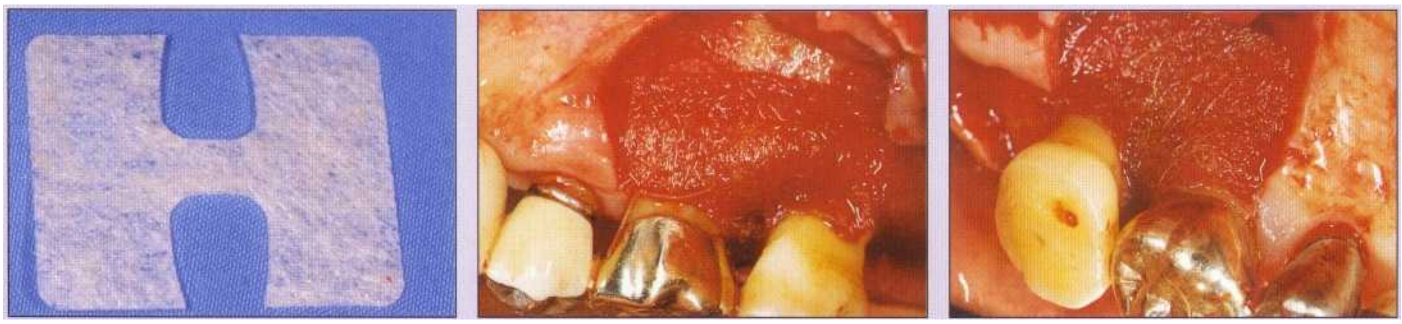
concerns about whether bioabsorbable membranes may interfere with the formation of new tissue. However, Cortellini et al" compared the clinical results of a bioabsorbable membrane (Resolute, WL Gore) and a nonabsorbable e-PTFE membrane and reported no difference in the amount of attachment gain. Becker et al also reported favorable results with attachment gain 1 year later using GTR with a bioabsorbable membrane.

Fig 417 Bioabsorbable membrane for a wide and shallow osseous defect.

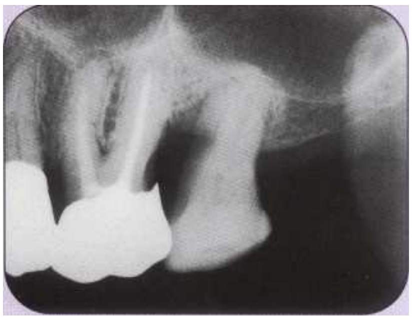


a. Note the intrabony pocket on the mesial aspect of 15 (6 mm buccally and 5 mm palatally). Covering the membrane by flaps is difficult because of the large amount of gingival recession due to a flap surgery 12 years earlier (68-year-old man).

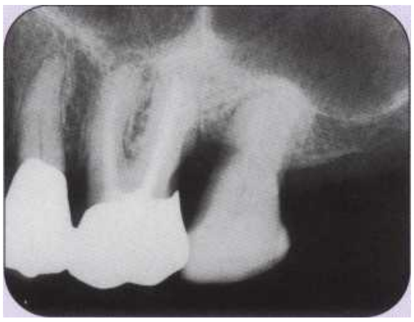
b. Osseous defects after flap reflection. After debridement of the palatal osseous defects, the maxillary sinus was perforated. The osseous defects (except the perforated area) were considered shallow and wide. Note the two-wall osseous defects.



c. Because of the morphology of the osseous defect (low predictability of bone regeneration) and in order to close the perforated maxillary sinus at the bottom of osseous defects, a bioabsorbable membrane is used (R12, WL Gore). The membrane is fixed with absorbable suture material after bone grafts are placed for spacemaking. The membrane cannot be covered completely by flaps.



d. Five months after surgery. Note the closure of the perforated maxillary sinus area.



e. Nine months after surgery. Bone fill is becoming apparent.

f. Eleven months after surgery. Gingival recession has occurred due to exposure of the bioabsorbable membrane, but there is remarkable bone fill.

Problems of Bioabsorbable Membranes

With bioabsorbable membranes, only one surgery is required, and mechanical damage to new tissue or problems of new tissue coverage after membrane removal are avoided. However, the greatest advantage of bioabsorbable membranes is that a problem particular to e-PTFE membranes is avoided. With e-PTFE membranes, there may be exposure at the coronal aspect 4 weeks after surgery (because the wound is an open system in GTR)." Especially if an interproximal-type membrane is used in deep interdental intrabony defects, the flap may slough, or partial necrosis may occur where the membrane contacts bone tissue because of decreased blood supply (Fig 4-18).

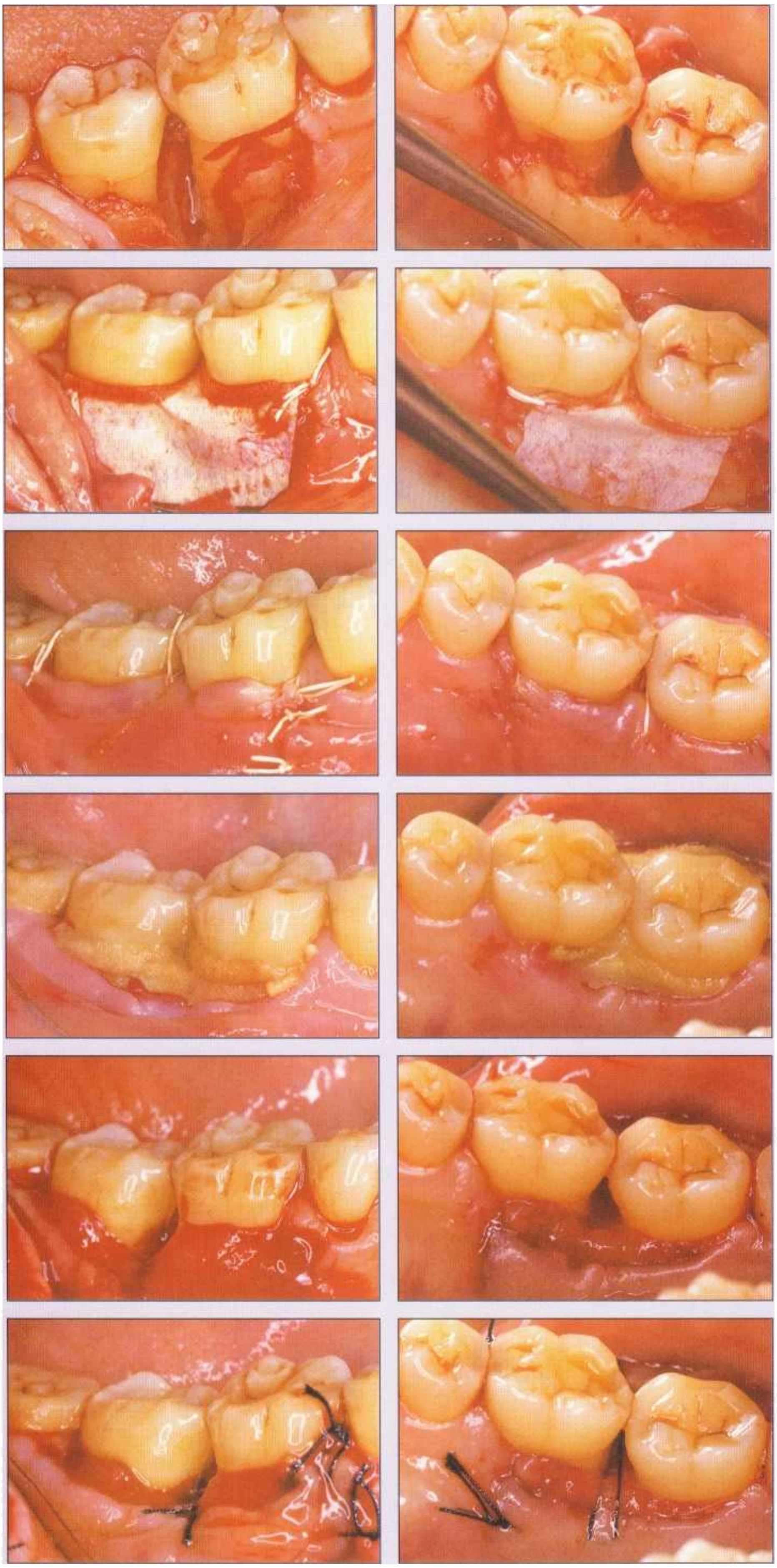
Difficulty of complete coverage of the membrane by the flap is one cause of exposure interdentally; however, sometimes the membrane becomes exposed even if primary closure of the wound has been achieved. Cortellini et al reported membrane exposure in five of twelve cases when bioabsorbable or nonabsorbable membranes were used in deep intrabony defects. Hugoson et al studied 38 patients who had Class II furcation involvement in both arches; they used bioabsorbable membranes in one defect and nonabsorbable membranes in the contralateral defect. Results revealed membrane exposure one month after surgery with both membrane types (14 of 38 sites with Bioabsorbable membranes and 20 of' 38 sites with nonabsorbable membranes). Membrane exposure is a frequent complication of GTR.

While membrane exposure does not mean failure of GTR, the risk of bacterial infection is heightened. Infection will decrease the amount of tissue regeneration achieved.⁴⁴ Therefore, if membrane exposure occurs, thorough postoperative hygiene management and early membrane removal, with prevention of the spread of infection to the regenerated tissue, are necessary.

A major disadvantage of bioabsorbable membranes is that they cannot be removed upon exposure. Consequently, infection spreads to the regenerated tissue under the membrane (because bacteria pass through the membrane). If membrane exposure occurs in GTR using a nonabsorbable membrane, the membrane can be removed and new tissue growth confirmed. With Bioabsorbable membranes, it takes time to evaluate whether new tissue has formed under the membrane, how much new tissue has been gained, and whether GTR has been successful or not. Bioabsorbable membranes have their own problems in predictability and reliability. Therefore, when selecting a membrane (Bioabsorbable or nonabsorbable), full understanding of the advantages and disadvantages, defect morphology, and surgical area must be considered.

Becker et al 'z determined that nonabsorbable membranes should be used in cases of difficult primary closure. In other words, Bioabsorbable membranes should be limited to areas with minimal gingival recession and sufficient width and thickness of keratinized gingiva, where primary closure is sure to be achieved. Furthermore, the risks related to healing, such as the patient's plaque control or smoking habit, require more attention with bioabsorbable membranes than with nonabsorbable membranes.

Fig 418 Membrane exposure causing inability to cover new tissue on second surgery .



a. Note the severe osseous defect (16-18 mm) from the CEJ to the bottom of the osseous defect on the distal of 30.

b. Placement of interproximal-type nonresorbable membrane.

c. Suture. Primary closure of the wound in the interdental area is incomplete.

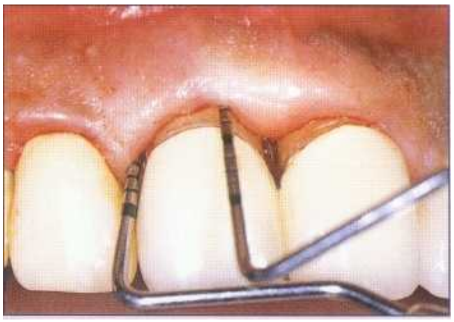
d. Five weeks after membrane placement. Membrane exposure is remarkable.

e. New tissue is evident under the membrane.

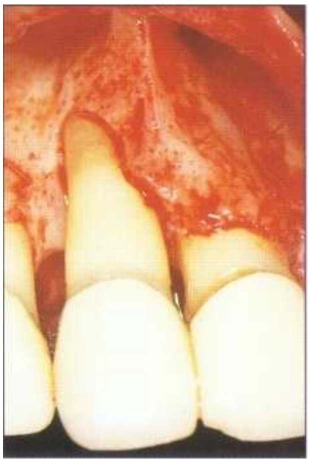
f. The large amount of membrane exposure prohibits complete coverage of new tissue with flaps.

Also, with a nonabsorbable membrane, new tissue can be covered by coronal migration of the flap, and gingival recession caused by exposure can be reduced after membrane removal. With a bioabsorbable membrane, such cannot be achieved. Therefore, bioabsorbable membranes are not suitable for deep intrabony defects with severe attachment loss in the maxillary anterior region where esthetics are of particular concern (Fig 4-19). GTR using a bioabsorbable membrane is indicated only where esthetics is not a consideration.

Fig 419 Bioabsorbable membrane failure in the maxillary anterior region.



a. The probing depth on 8 is 7-12 mm. The gingiva is thick, and the width of the keratinized gingiva is sufficient.



b. A one-wall osseous defect with severe osseous dehiscence.

c. A bioabsorbable membrane (GC) is placed after spacemaking with bone grafts.

d. Flaps are displaced coronally and the membrane covered completely without tension. Primary wound closure is achieved with a vertical mattress suture and an interrupted suture. Membrane exposure is not expected.

e. Eleven days after surgery, a part of the membrane is exposed.

f. Three weeks after surgery. Interdental membrane exposure has increased, and the gingival morphology is craterlike. All thread is removed except the vertical mattress suture.

g. Thirty-nine days after surgery. The remaining suture threads are removed. Note the inflammation in the surrounding gingiva due to the exposed membrane on the center of the gingival crater and the plaque accumulation.

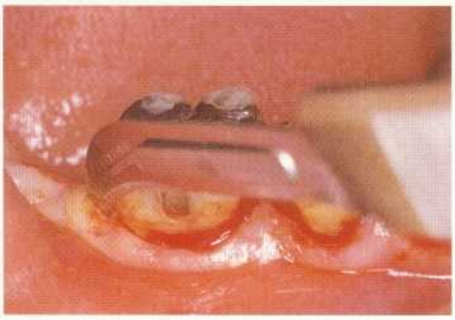
h. Two months after surgery. Note the immature, red granulation tissue where the membrane was. Residual, seedlike membrane is seen in several places. The gingival crater is resolving, but the gingival recession is advancing.

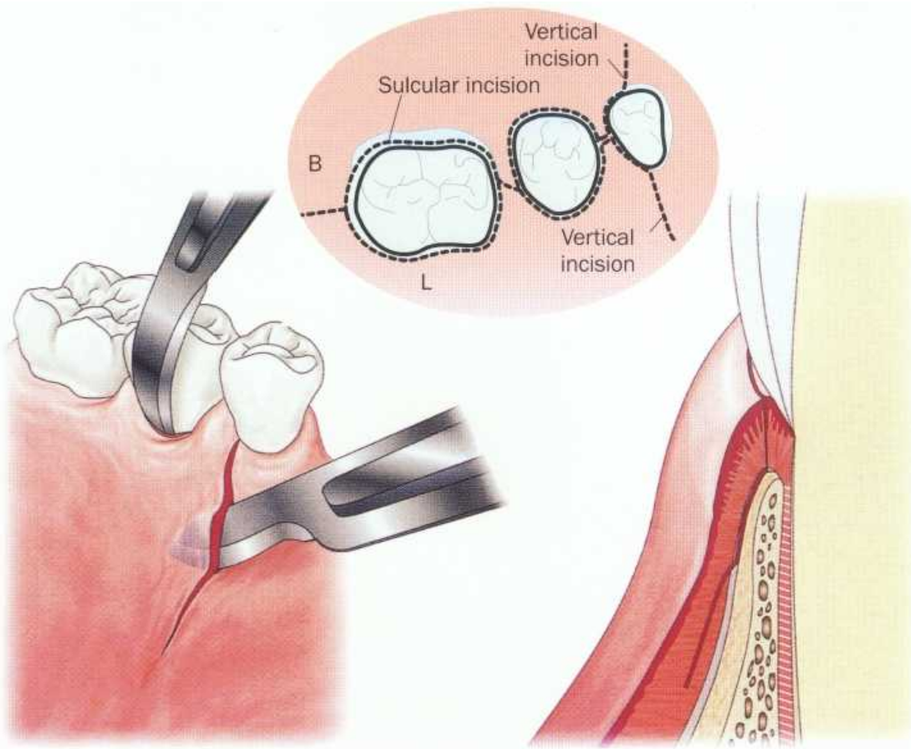
Case 4-1 Treatment of intrabony defects using GTR/Placement of the barrier membrane and suturing

Note the deep intrabony pocket (8 mm buccally and 6 mm lingually) with a vertical osseous defect on the mesial aspect of 30 after initial therapy. Plaque control is good, and there is no inflammation on the gingival surface (57-year-old woman).

Flap design for GTR

c1-1 Sulcular incision.



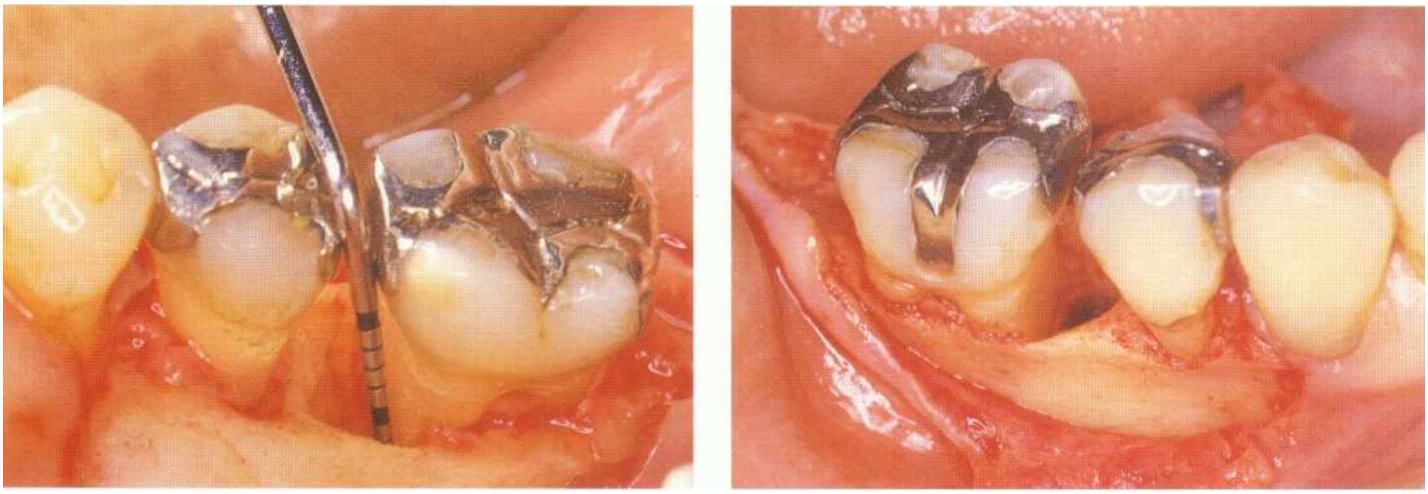


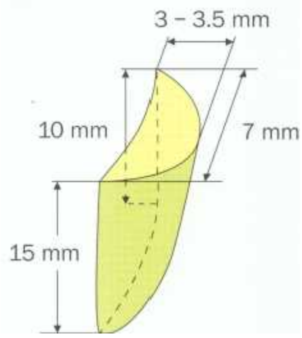
Key points

1. Prepare thick flaps to prevent necrosis and perforation.
2. Prepare an incision to preserve the interdental papilla as much as possible in order to cover the membrane completely.
3. Extend the incision 1-2 teeth mesiodistally for access and sufficient blood supply during surgery.
4. Add a vertical incision 1-2 teeth mesial to the defect area if necessarv.
5. Reflect the flaps properly apical to the mucogingival junction.
6. Remove the gingival sulcus epithelium inside the flap with a new blade, gingival scissors, curette, and bur to facilitate bonding of the membrane and flaps after flap reflection.
7. Make a partial-thickness flap apical to the mucogingival junction (MGJ) for complete membrane coverage and coronal migration of *flaps.*

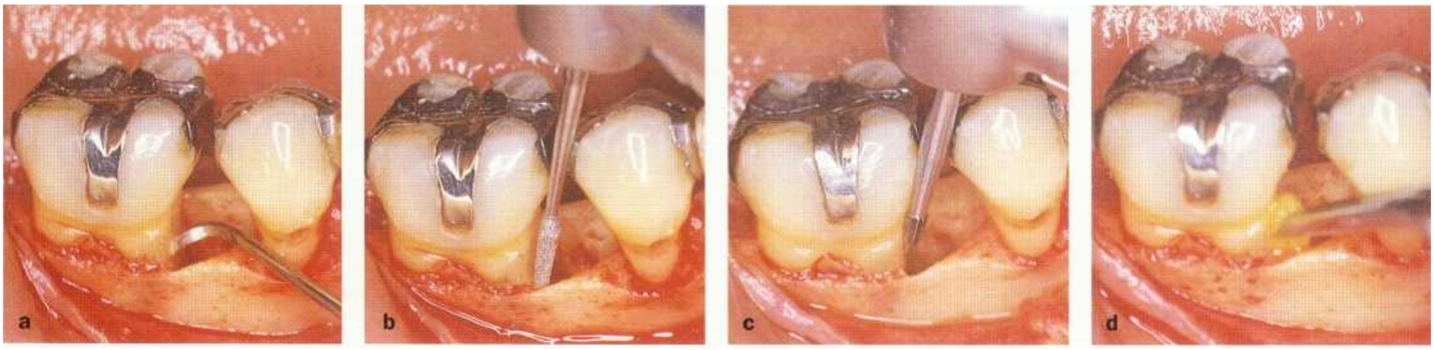
Debridement of defect area

c1-2 Morphology of intrabony defect. Note the deep and wide three-wall intrabony defect on the mesial aspect of 30 after a vertical incision on the distal line angle of 28 is made and the flap reflected.





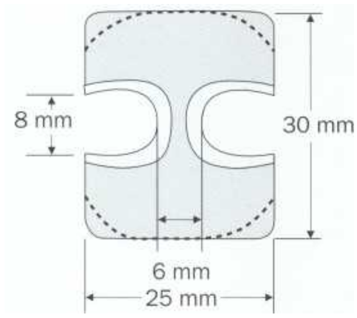
c1-3 Debridement of defect area. With a curette and file, the granulation tissue is removed from the osseous defect. An ultrasonic sealer, curette (a), and finishing bur (b, c) are used for debridement of the root. Tetracycline solution is then applied to the root surface (d).



Key points

Membrane selection and trimming

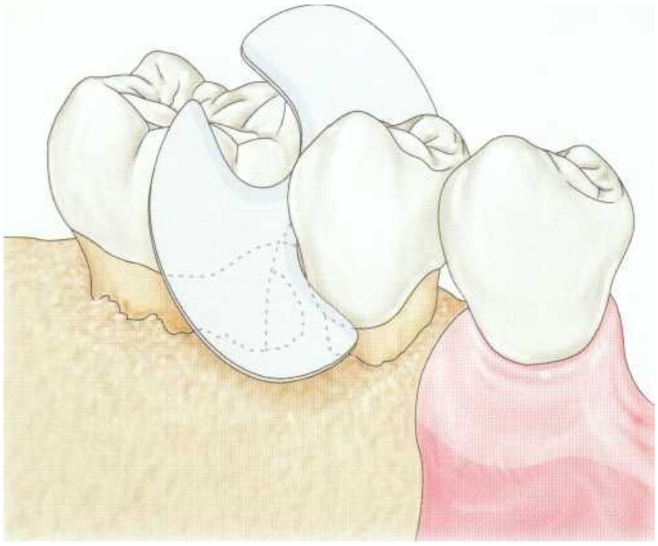
1. Choose the most suitable membrane for the defect area and its morphology and trim the membrane accordingly. The membrane should be made as small as possible because the membrane interferes with the flap's blood supply.
2. Trim the membrane to cover the osseous defect 3-5 mm past the osseous defect margin. The margin of the membrane should adapt closely to the surrounding sound bone. Special attention is required to avoid for overcoverage of bone with intcrproximal-type membranes.
3. In a case, for example, where the membrane extends from the distal line angle of 30 to the mesial line angle of 29, trim the margin of the membrane so that it does not cover the distal aspect of 30 and the mesial aspect of 29 interdental alveolar bone, which is important for the flap's blood supply.
4. In most cases, the membrane's size can be adjusted by trimming the side and apical part. The collar portion should be left intact as much as possible. Do not leave a sharp angle on the membrane's margin because it may perforate the flaps.



Placement of membrane and suture

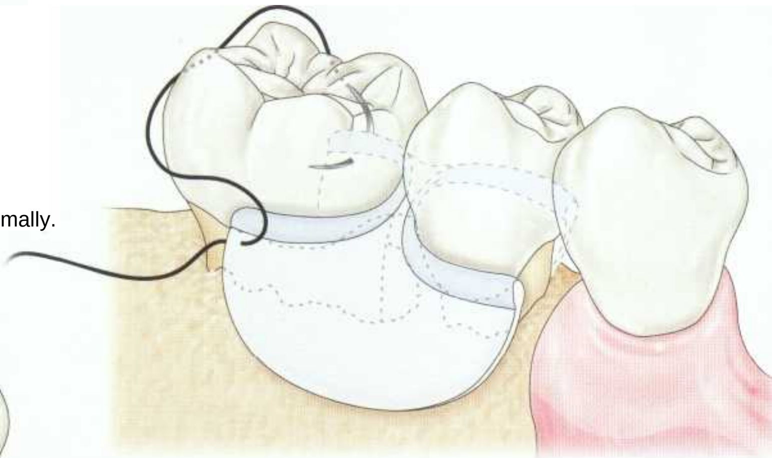
c1-4 Procedures of membrane suture.

a. Trim the membrane to proper size.

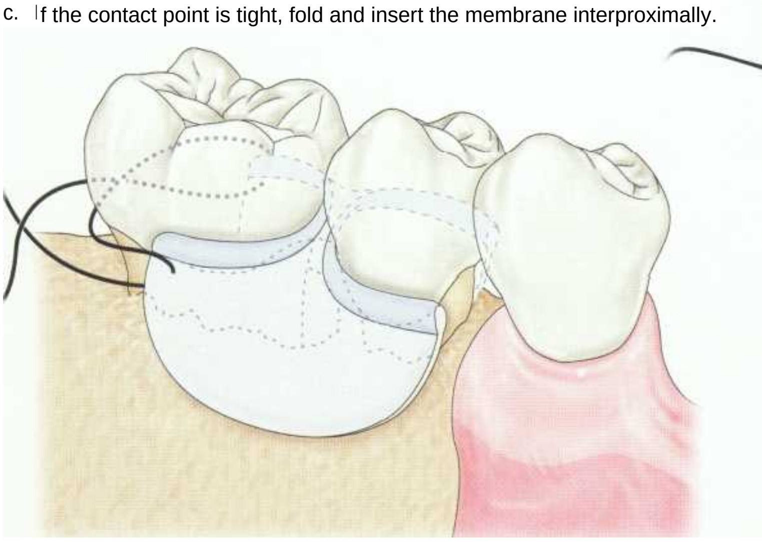


b. Insert the membrane gently from the coronal aspect.

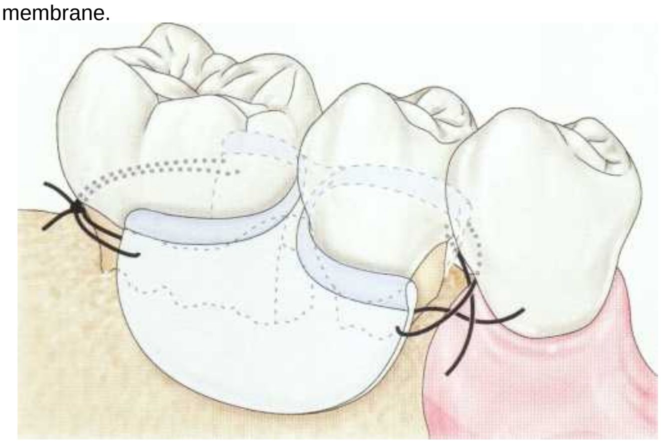
c. If the contact point is tight, fold and insert the membrane interproximally.



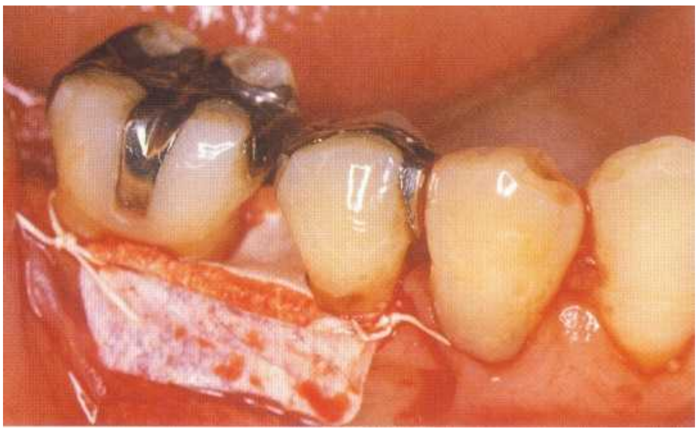
d. Insert the needle from the outside and 1-2 mm from the side of the membrane (right under the collar) for a suspensory sling suture in the defect area. Pass the thread through interproximally, from distal to lingual, and insert the needle from the outside of the lingual membrane.



e. Pass the thread interproximally and pull it to the buccal aspect. Bring the knot to the line angle to avoid untying of the knot. If Teflon thread is used, add one more knot after two single loops because knotted Teflon is more likely to loosen than silk.



f. Suture and stabilize the other end of the membrane in the same way.



g. Completion of suture and stabilization.

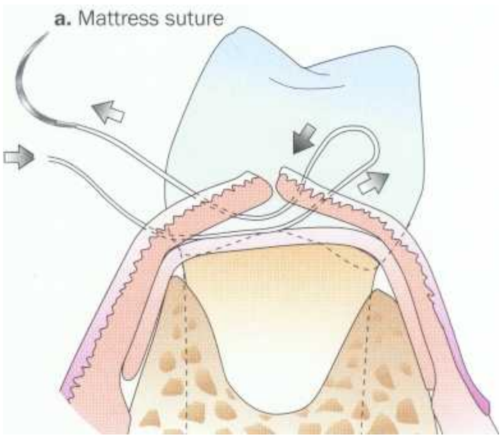
Key points

Considerations for membrane suture

1. If the contact point is tight, insert the folded membrane interproximally,
2. Curve the membrane to follow the bone morphology.
3. Start the suture from the tooth in the defect area.
4. Make a suspensory sling suture and tie three times to avoid loosening and to bring the knot to the line angle area.

Suture of flap

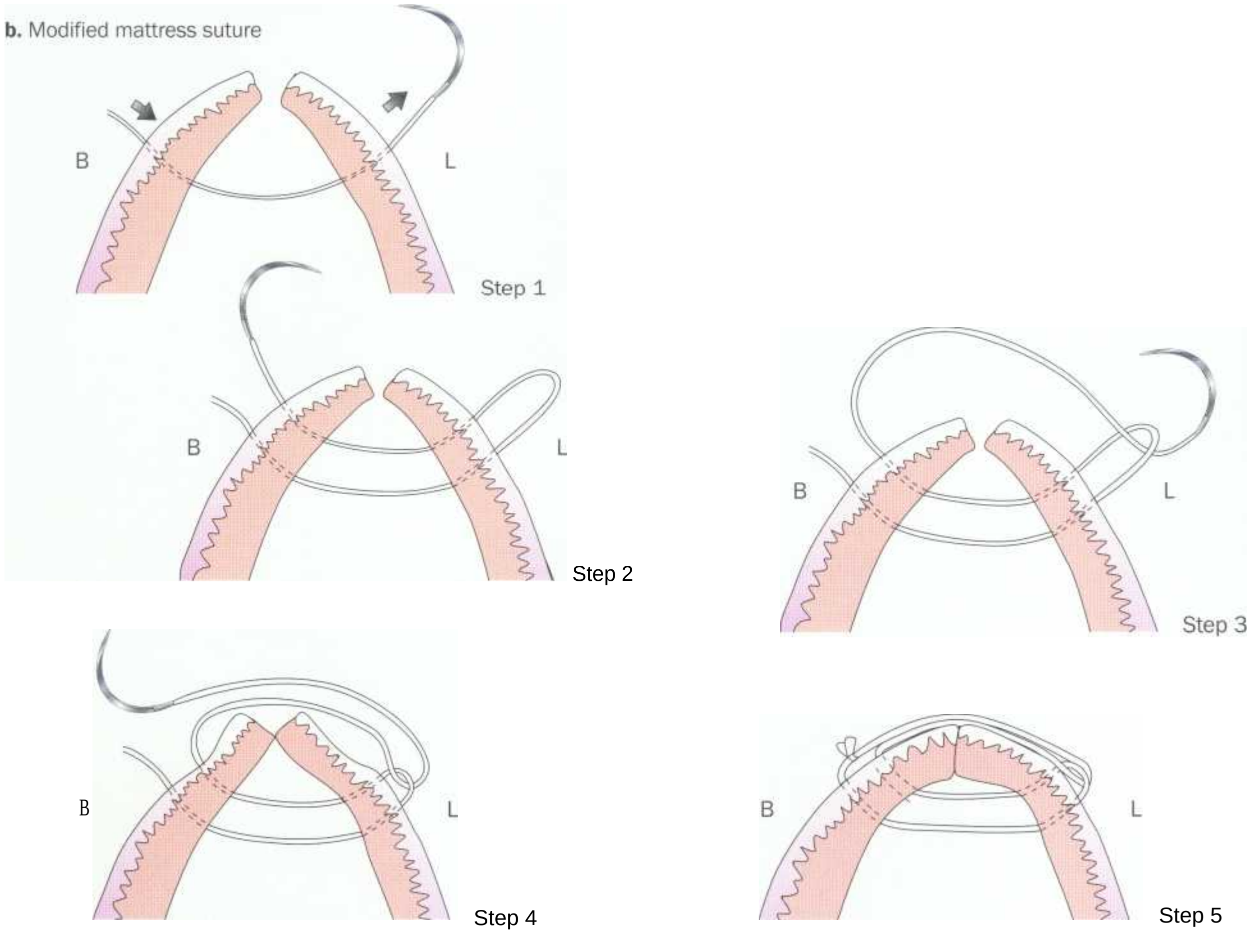
c1-5 **Suture method** of flap. The flaps in the interdental papilla covering the osseous defect area are sutured by a modified mattress suture. The area is closed completely. The flaps in the osseous defect area are sutured first, then the vertical incised area is sutured and closed.



Key points

Considerations for flap suture

1. Because blood coagulum inside the flap interferes with vascularization, rinse away the coagulum with physiologic saline solution before suture. The inside of the flap and collar portion should contact fresh blood.
2. Suspend the flap 2-3 mm coronal from the membrane margin and cover the membrane completely. This is not always possible; however, it is especially difficult to use an interproximal-type membrane in the maxillary molars.
3. If membrane coverage is insufficient, make a releasing incision of the periosteum apical to the flap, which facilitates coronal migration.
4. Take special care not to suture the membrane and flap together on flap suture.
5. Because there is a risk of compressing the membrane into the defect area, do not place a periodontal dressing.

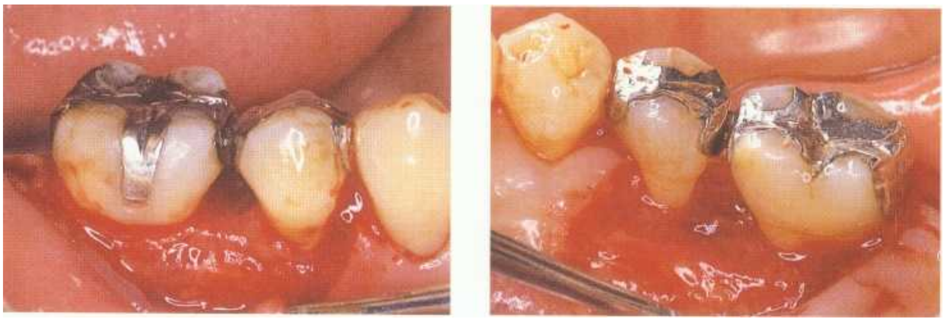


Membrane removal

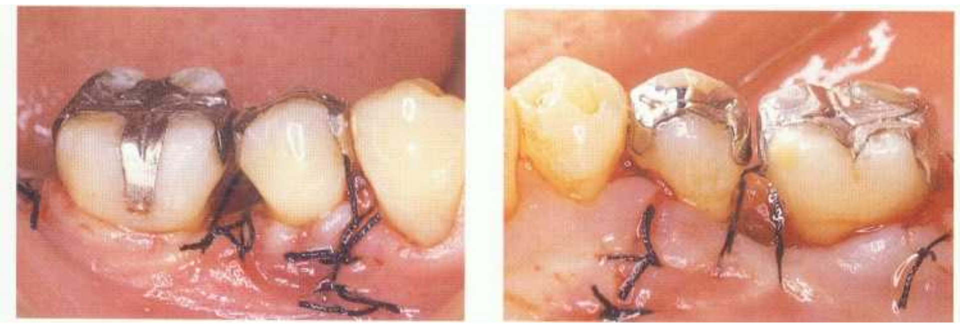
c1-6 **After membrane placement.** Membrane exposure 4 weeks after surgery. In case of membrane exposure, the patient brushes the exposed membrane area thoroughly with an ultrasoft brush.

Key points

1. Prescribe antibiotics for 5-7 days after surgery.
2. Instruct the patient to return weekly for tooth cleaning until membrane removal (usually 4-6 weeks).
3. Let the patient brush with an ultra-soft toothbrush beginning 1 week alter surgery.
4. If an interproximal-type membrane is used, postoperative hygiene is especially important because membrane exposure occurs earlier with this type than with other types.



c1-7 **After membrane removal.** The membrane is removed 4 weeks after surgery. The distance from the inlay margin to the coronal side of the new tissue is 4 mm buccally and lingually.



c1i-8 New tissue coverage by flaps.

Key points

Membrane removal

Remove membrane 4-8 weeks afer.surgery.

1. Separate the membrane from the inner layer of the flap with a partial-thickness incision.
2. Reflect flaps, cut the knot suturing the membrane, and remove the membrane carefully. Special care is required to avoid damaging new tissue (see Case 4-2).
3. Check that the membrane has been removed completely If part of the membrane remains, it may cause abscess formation.
4. Remove the epithelium covering the inside of the flaps before suturing.
5. Cover the new tissue with flaps and suture with silk thread. Place a periodontal dressing.

Prognosis

cl-9 After membrane removal.

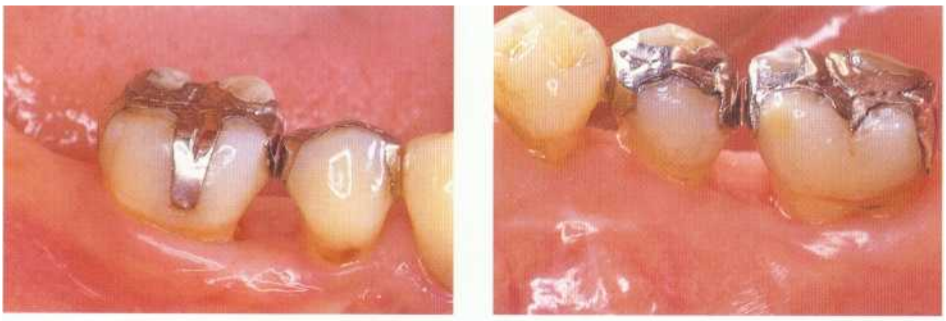
a. Six days after surgery.

b. Six weeks after surgery.

c. Eight weeks after surgery.

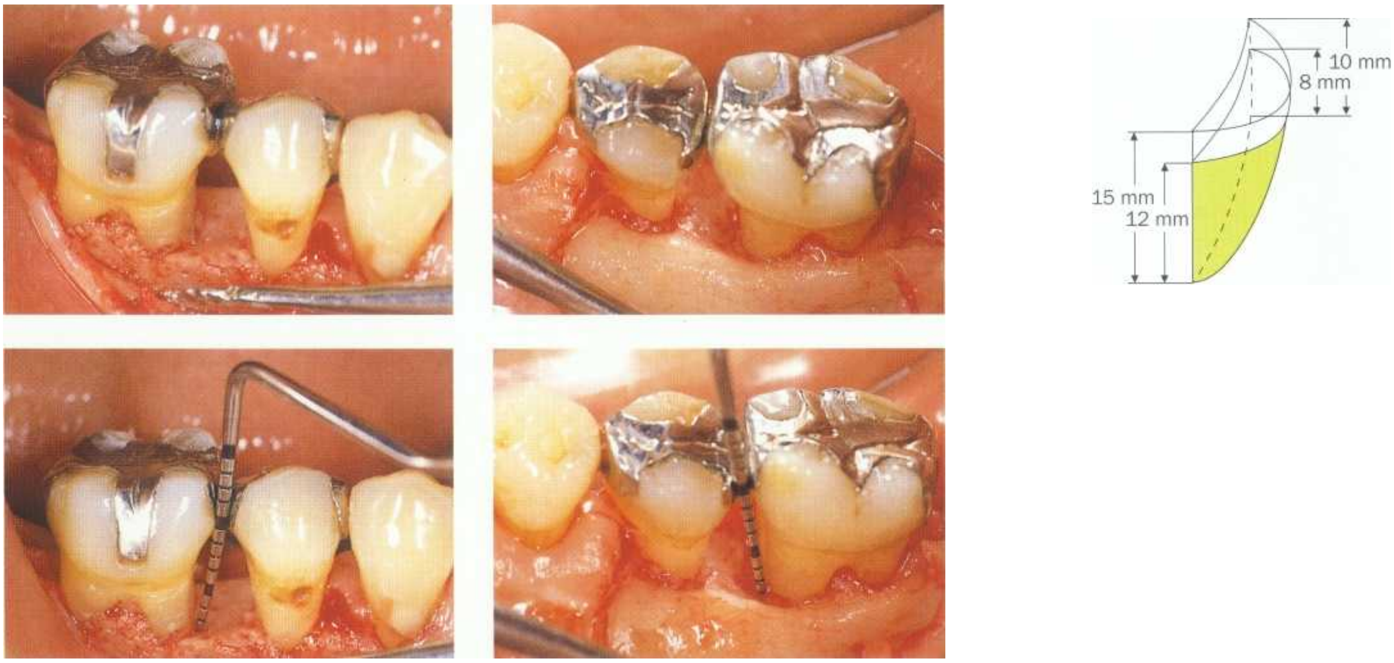
d. Nineteen weeks after surgery. Calcification progression is evident.

e. Fourteen weeks after surgery.

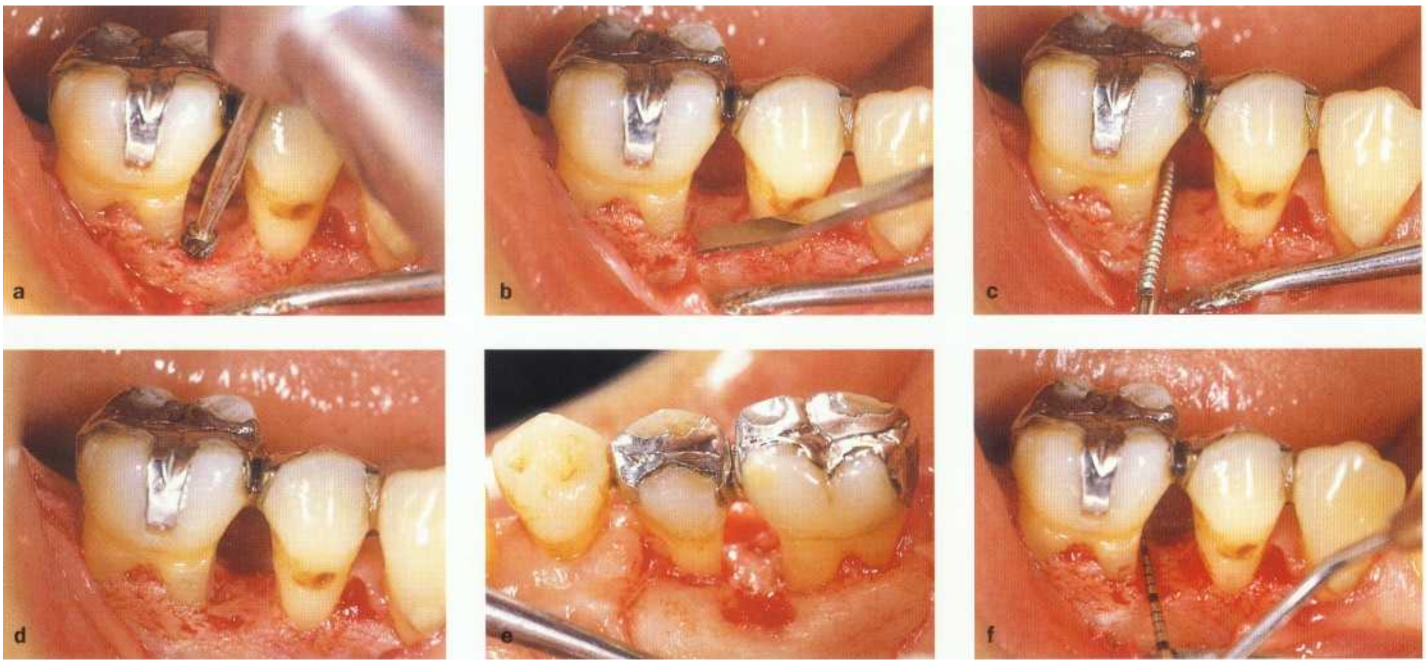


f. Twenty-one weeks after surgery.

g. On re-entry 1 year and 3 months after surgery. Bone fill is remarkable radiographically. The probing depth is 2 mm buccally and 3 mm lingually on the mesial aspect.

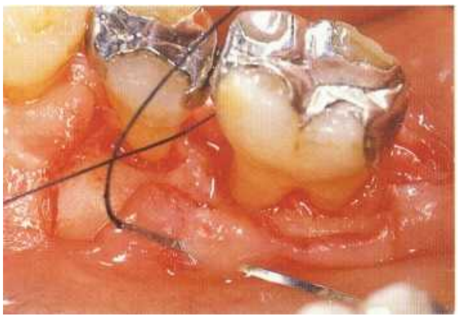


cl-10 Re-entry 1 year and 3 months after surgery. Note the remarkable bone regeneration approximately 12 mm buccally and 8 mm lingually on flap reflection (see c1-2).



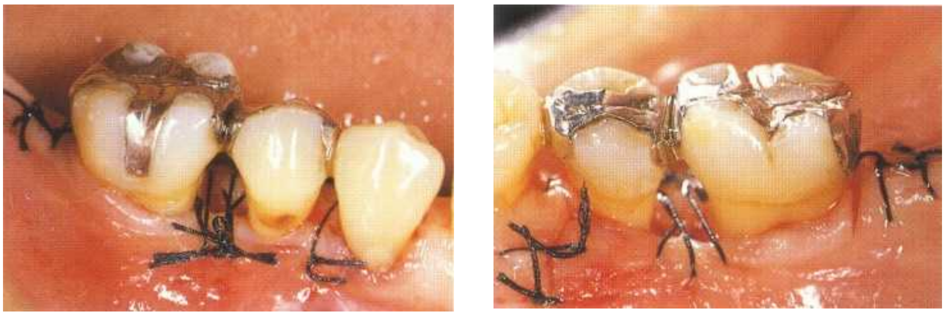
c1-11 Osseous resection to remove residual osseous defects. While there is remarkable improvement of the osseous defect, a shallow, crater-like osseous defect remains. A large, round bur is used to remove the buccal and lingual walls of the interproximal crater to the bottom of the defect (a). A Wedelstaedt chisel (b) and Sugarman file (c) are used for osteoplasty of the bone margin. The osseous defect is eliminated. Note the flattened interdental bone (d-f).

a. Vertical mattress suture on the buccal flap.



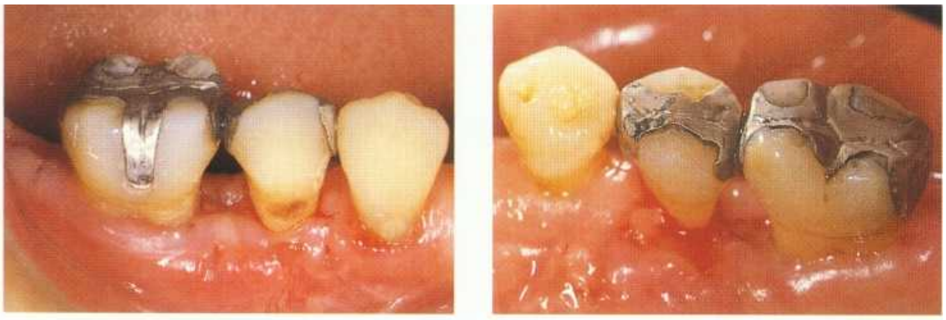
b. Horizontal mattress suture on the lingual flap.

cl-12 Suture of flaps.



c. Completion of suture (buccal, left; lingual, right).

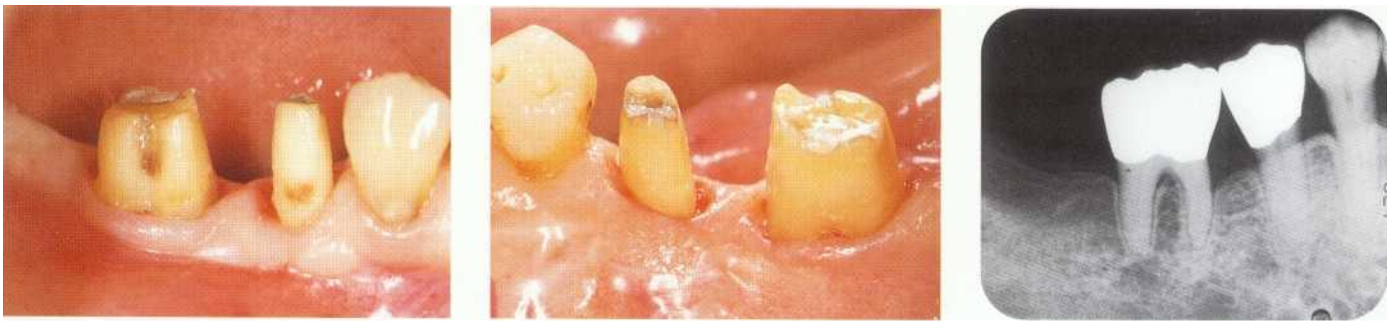
c1-13 Prognosis.



a. One week after surgery (buccal, left; lingual, right).

b. Twenty-two weeks after surgery (buccal, left; lingual, right).

c. A free autogenous gingival graft is performed on 29, 39 weeks after surgery.

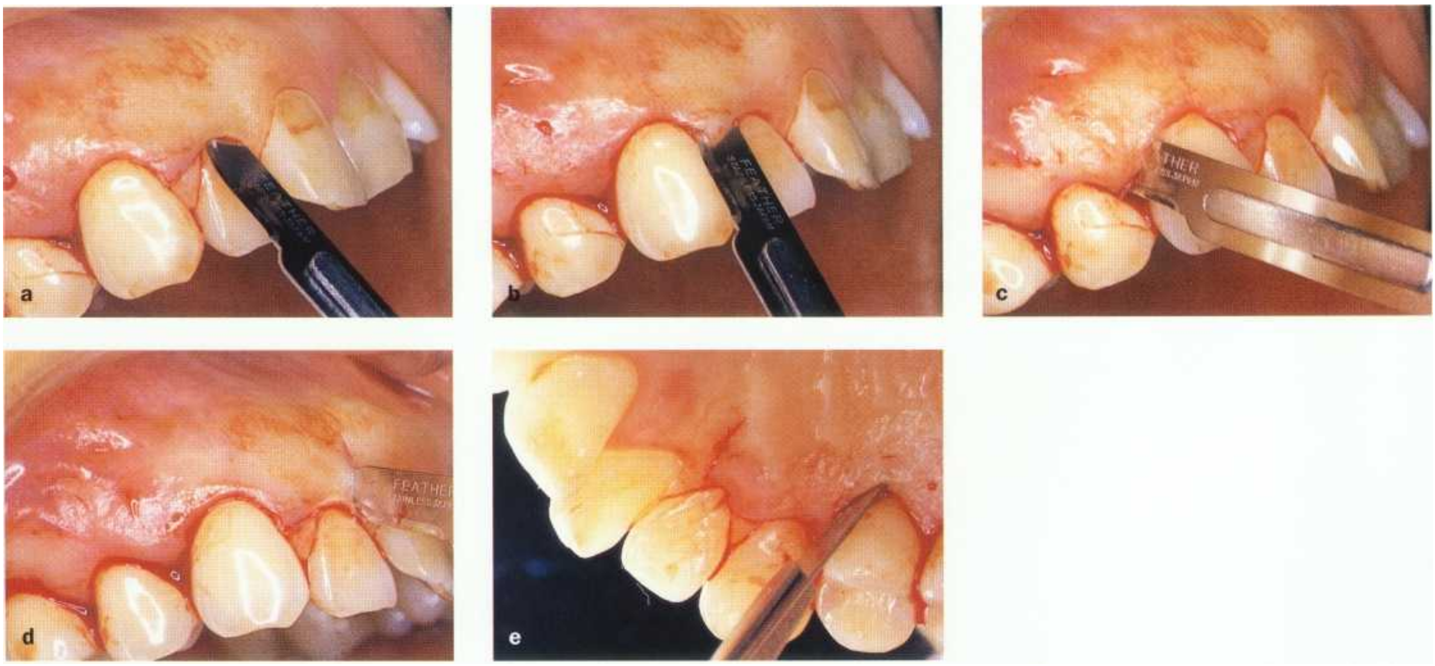


d. Forty-seven weeks after surgery (buccal, left; lingual, middle).

e. Fifty weeks after surgery. Restorations are placed on 29 and 30 (single restorations because periodontal support has been improved by GTR).

Case 4-2 Treatment of combined-type intrabony defects using GTR/Membrane removal technique

Note the intrabony pocket with a vertical osseous defect (10 mm buccally and 9 mm palatally) on the mesial aspect of 5. The attachment level is 10 mm buccally and 9 mm palatally because of the absence of gingival recession. Note the limited vertical osseous defect with thick gingiva and sufficient width of keratinized gingiva. Tissue regeneration can be expected by GTR (39-year-old woman).

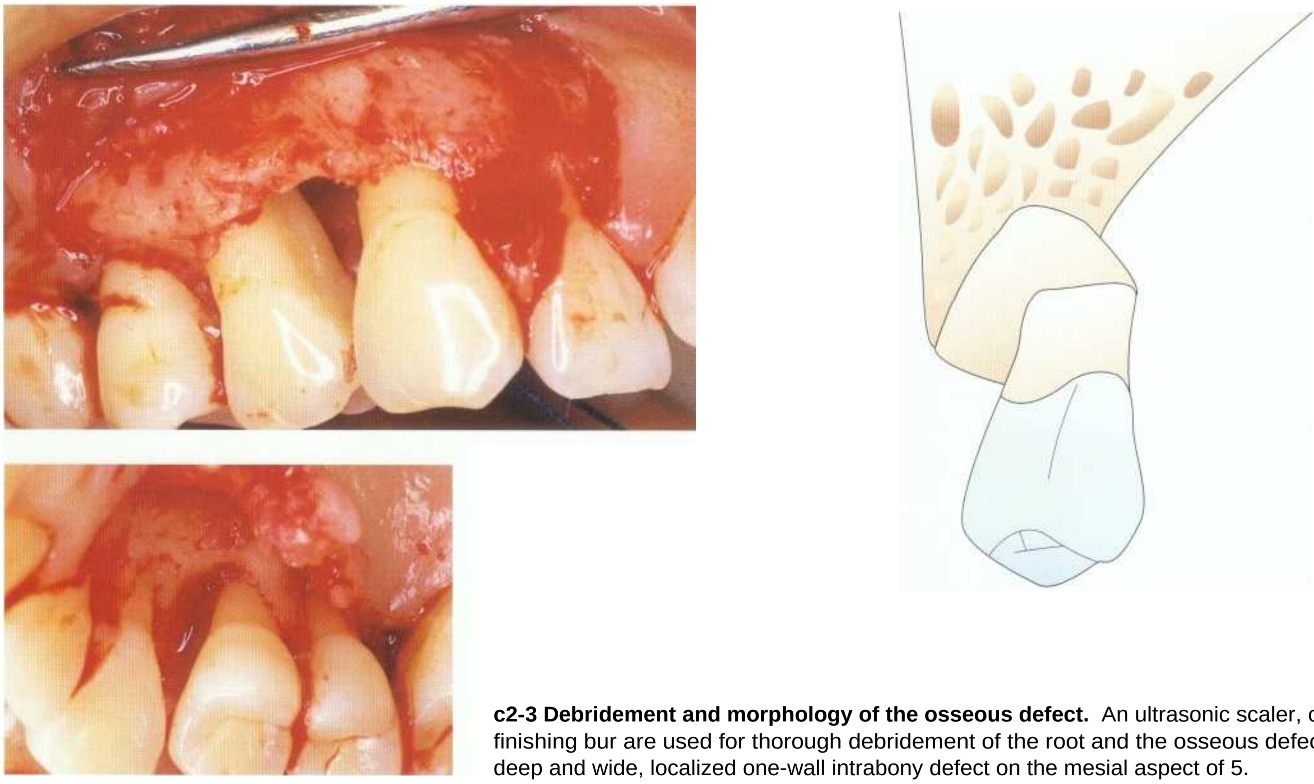


c2-1 Flap design. A no. 15 blade is used to make a sulcular incision from the mesiobuccal line angle of 7 to the alveolar crest (a,b). The blade tip is advanced while contacting the alveolar crest. Maximal preservation of the interdental papilla is sought for complete coverage of the membrane by flaps and for primary closure (c). Flaps are made as thick as possible to prevent necrosis and perforation. Never make an incision in which the tissue is thinned or partially dissected. Special care is needed in the buccal and lingual (palatal) gingiva because it is thinner than interdental papilla. A vertical incision is made on the mesial line angle of 7, which is two teeth mesial to the defect area (d, labial; e, palatal).

Key point

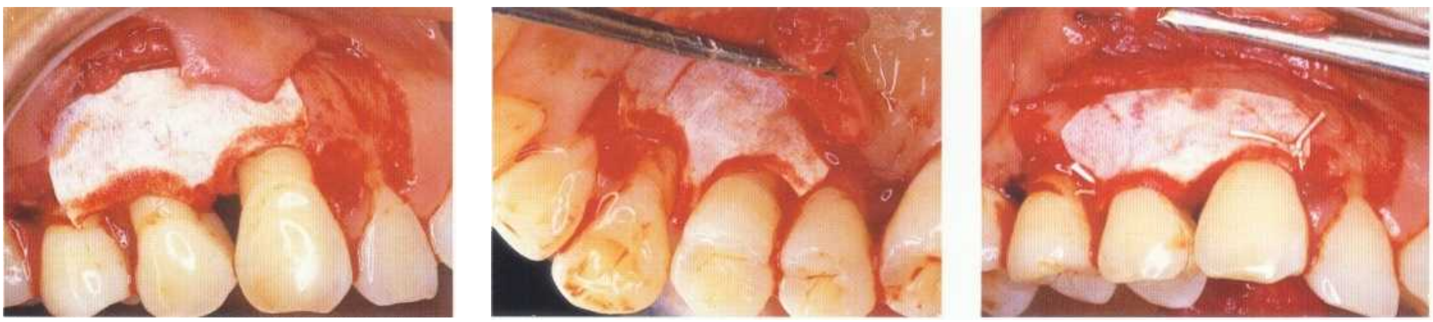
To prevent flap necrosis and perforation, make the flaps as thick as possible. Never make an incision in which the tissue is thinned or partially dissected. Gingiva is thinner buccally and lingually than interdentally; therefore, special caution is required.

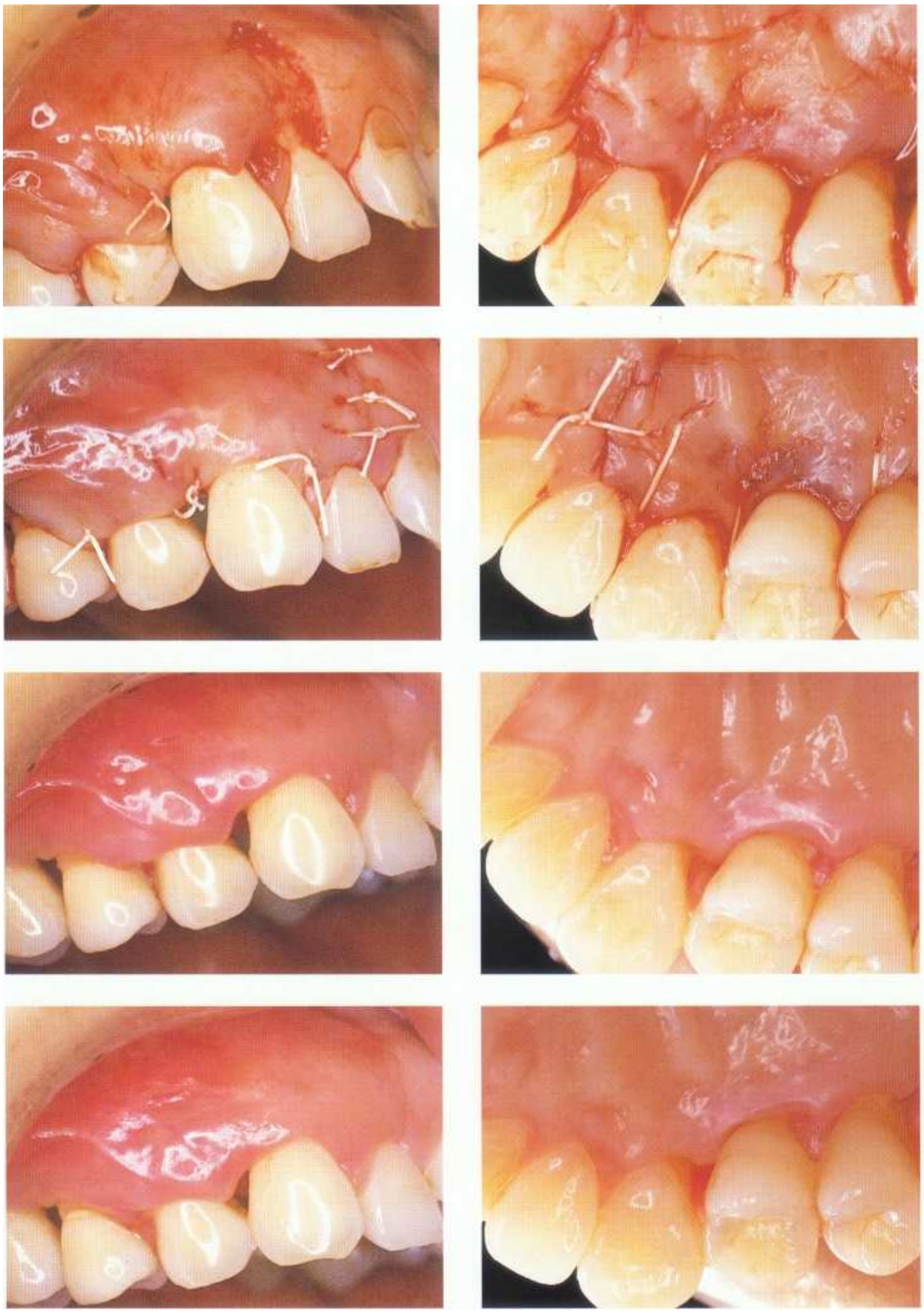
c2-2 Flap reflection. A small periosteal elevator is used to reflect the full-thickness flap apically and expose bone surface (a). The flap is full thickness coronal to the MGJ and partial thickness apically (b,c). Note the subgingival calculus on the mesial and mesiopalatal line angle root surfaces of 5 (d,e).



c2-3 Debridement and morphology of the osseous defect. An ultrasonic scaler, curette, and finishing bur are used for thorough debridement of the root and the osseous defect. Note the deep and wide, localized one-wall intrabony defect on the mesial aspect of 5.

c2-4 Suture of membrane.





c2-5 Suture of flaps.

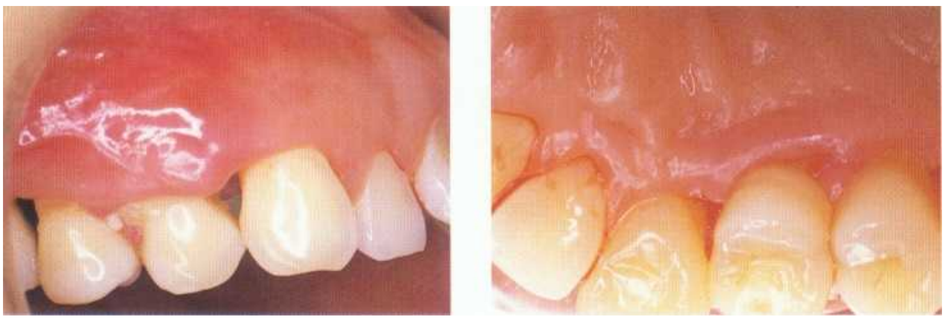
a. For incision closure, the interdental papilla covering the defect area is sutured first. A releasing incision of the periosteum is made apically if coronal migration of the flaps cannot be achieved. The flaps are placed coronally more than 3 mm from the membrane margin and sutured (left, labial; right, palatal).

b. Suture the rest of the flaps interproximally and at the level of the vertical incision. The membrane is now covered completely by flaps.

c. The suture material is removed 12 days after surgery.

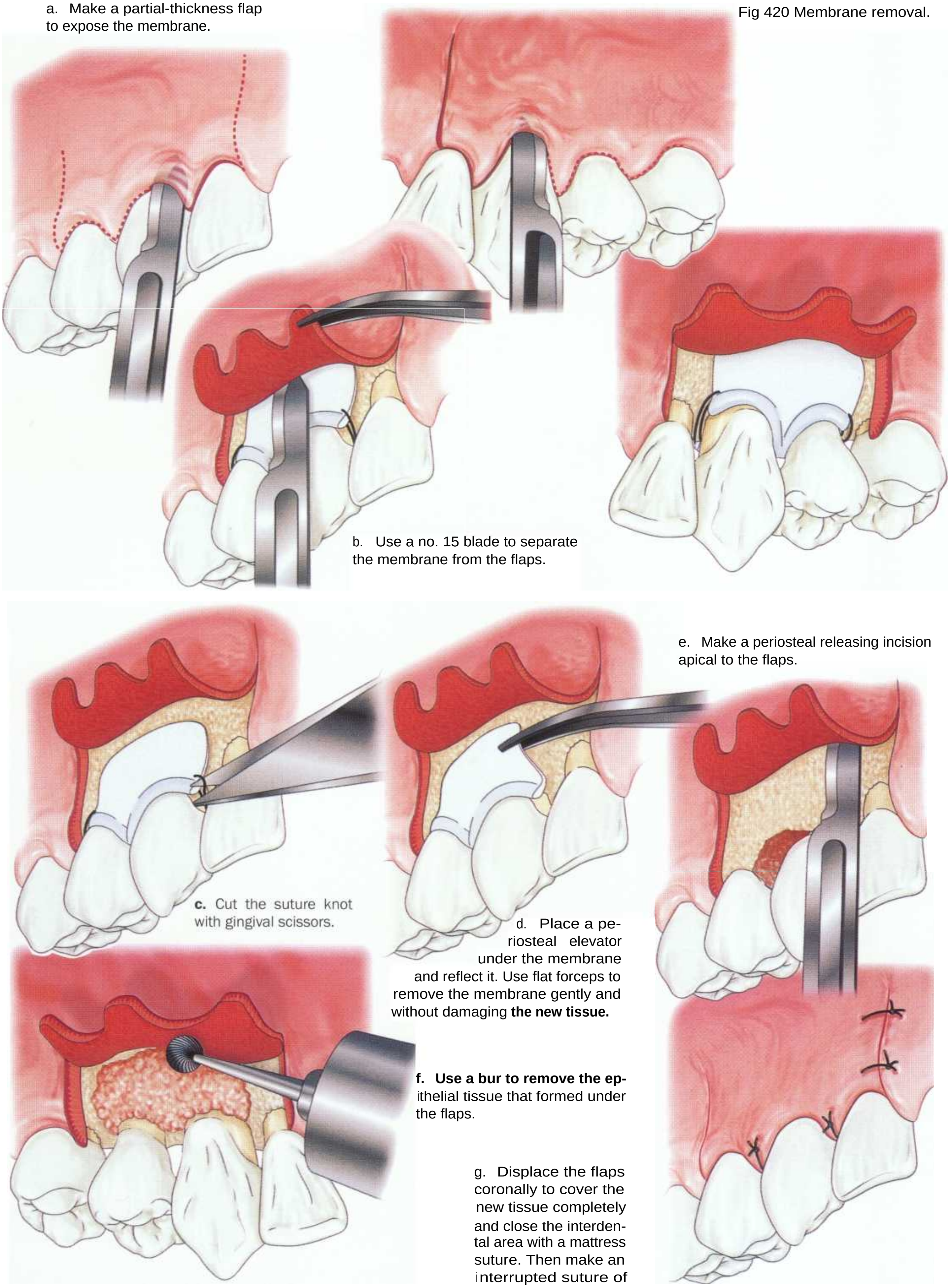
d. Twenty-two days after surgery.

Membrane removal surgery



c2-6 Membrane removal.

a. Note the membrane exposure 40 days after placement.



a. Make a partial-thickness flap to expose the membrane.

b. Use a no. 15 blade to separate the membrane from the flaps.

c. Cut the suture knot with gingival scissors.

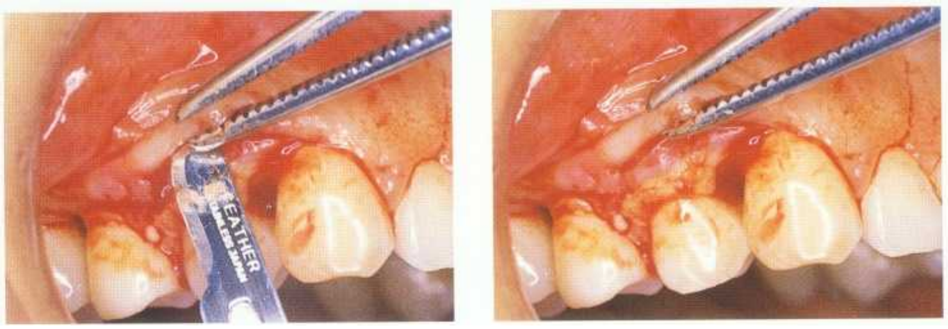
d. Place a periosteal elevator under the membrane and reflect it. Use flat forceps to remove the membrane gently and without damaging **the new tissue.**

e. Make a periosteal releasing incision apical to the flaps.

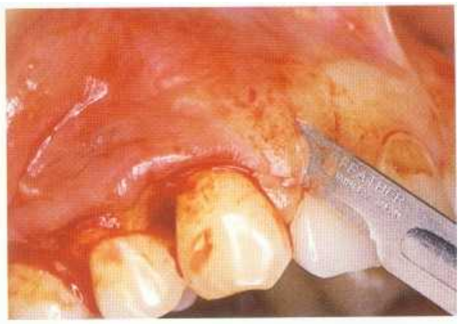
f. Use a bur to remove the ep-ithelial tissue that formed under the flaps.

g. Displace the flaps coronally to cover the new tissue completely and close the interdental area with a mattress suture. Then make an interrupted suture of the vertical incision.

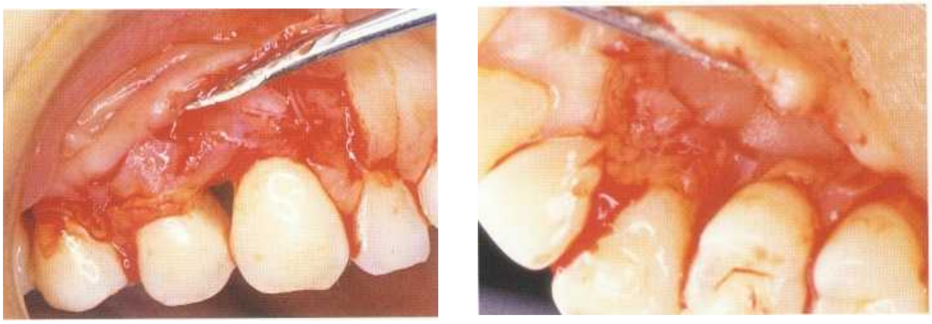
Fig 420 Membrane removal.



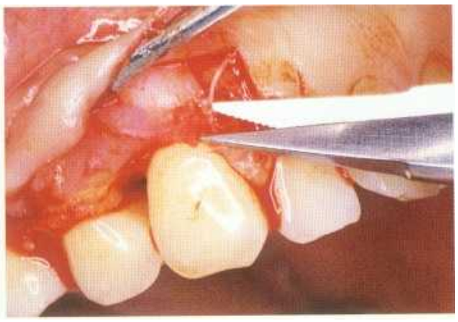
b. The flap margin is held with small tissue forceps and a no. 15 blade is used to separate the membrane from the flap with a partial-thickness incision.



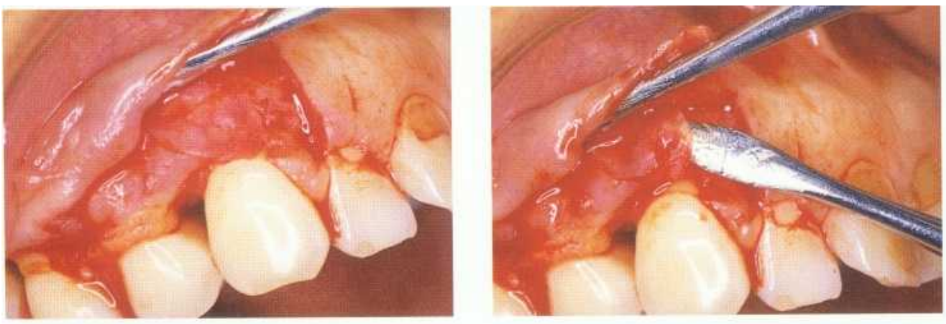
c. A vertical incision is made to the mesial line angle of the buccal and palatal aspects of 6.



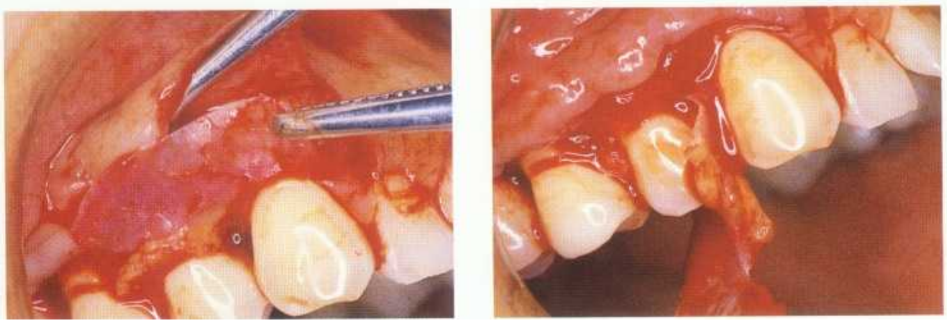
d. The **flaps are reflected slowly and the** membrane exposed.



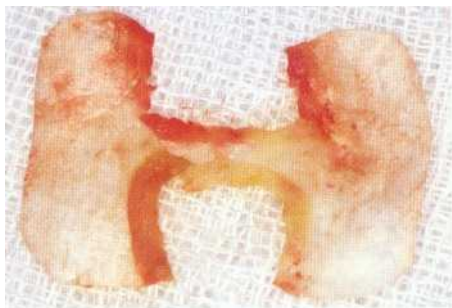
e. The **suture knot that fixes the membrane to the tooth is cut with scissors.**



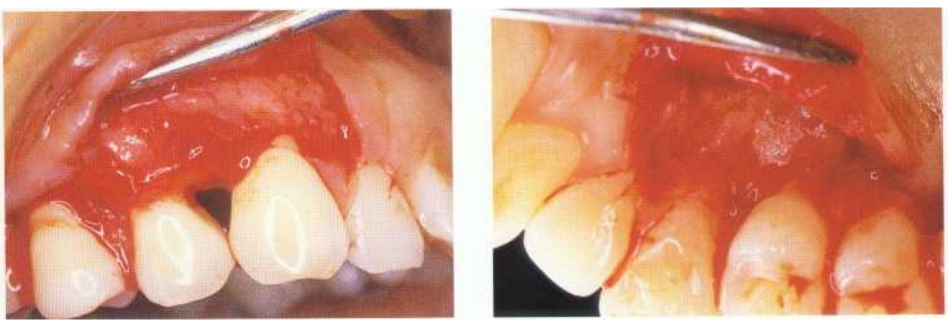
f. A small periosteal elevator is inserted to the mesial line angle margin of the membrane and the flap reflected without damaging the new tissue.



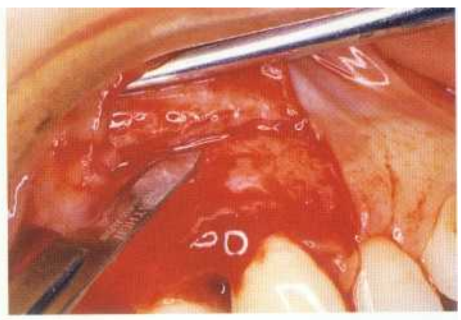
g. Flat forceps are used to hold the reflected membrane



h. The removed membrane.

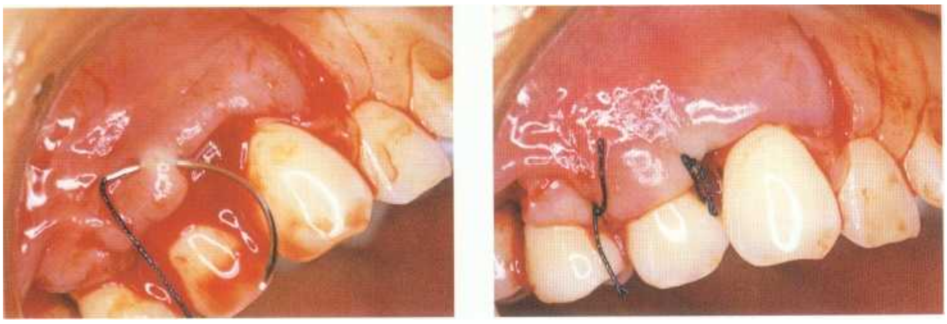


i. The new tissue on the mesial aspect of 5 extends to the CEJ, and the presence of this new tissue may indicate that the attachment level is improved.

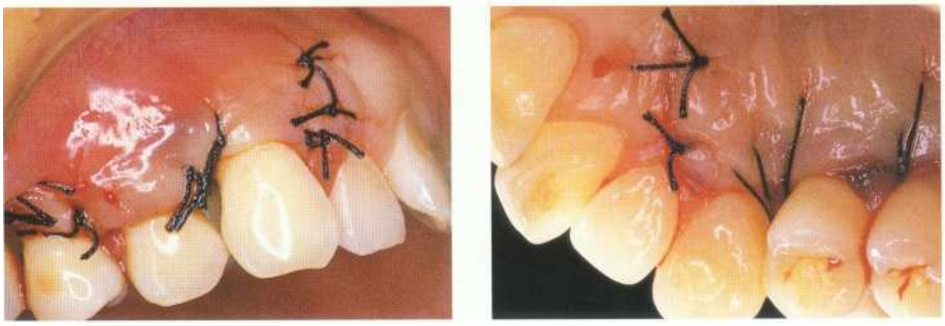


j. A releasing incision of the periosteum is made to the mucogingival area for complete coverage of new tissue between 5 and 6. A vertical incision is made on the distal line angle of 5.

c2-7 Suture of flaps.



a. The new tissue is completely covered by flaps. A mattress suture is made to close the flap between 5 and 6 first.



b. An interrupted suture of the rest of the interdental area is prepared, and then the vertical incised area is sutured.

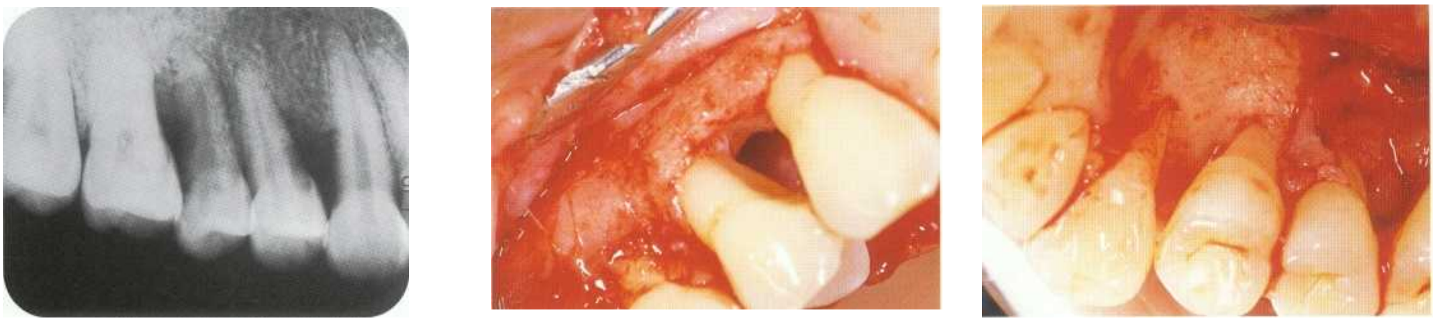
c. Placement of the periodontal dressing.

c2-8 After membrane removal.

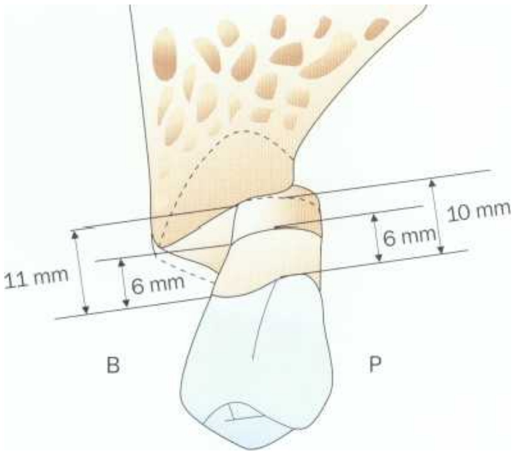
a. Nine days after membrane removal (left, buccal; right, palatal).

b. Twenty-six days after surgery.

c. Thirty-six weeks after surgery.



d. **Re-entry 50 weeks after surgery.** The probing depth on the mesial aspect of 5 is 3 mm. The one-wall intrabony defect has been eliminated. Note the remarkable improvement on radiography.

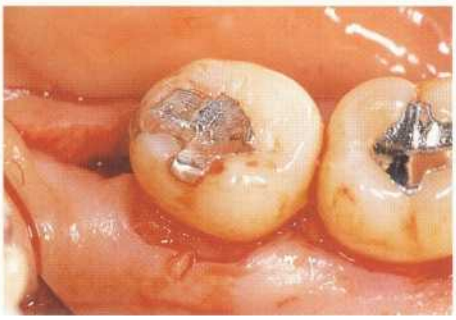


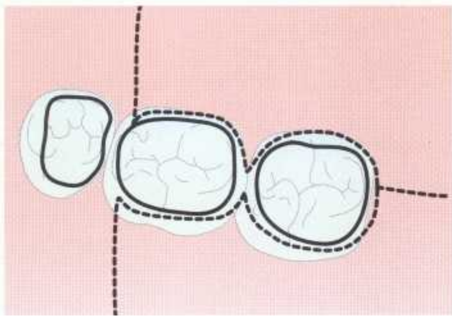
e. Sixty-six days after re-entry.

	Probing depth (mm)		Attachment level (mm)	
	BM	PM	BM	PM
Before surgery	10	9	10	9
On re-entry (50 weeks)	3	3	4	4
	Probing depth reduction		Attachment gain	
	7	6	6	5

Case 4-3 Treatment of circumferential osseous defects using GTR

Note the vertical osseous defect on the distal aspect of 18 after initial therapy. The probing depth is 10 mm lingually and 8 mm buccally. The attachment level is 12 mm lingually and 11 mm buccally (40-year-old woman).

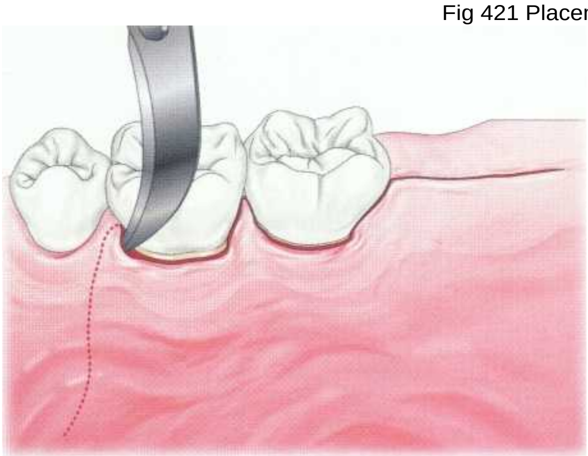




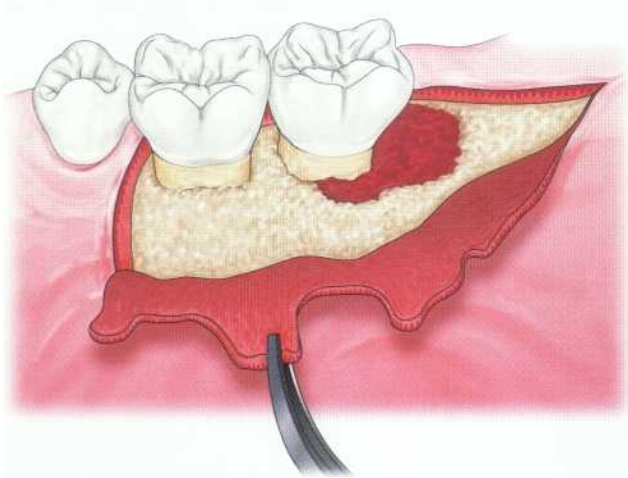
c3-1 Incision. With a no. 15 blade, a full-thickness flap is prepared using a sulcular incision to preserve the interdental papilla. A vertical incision is made on the mesial line angle of 19 to gain access to the surgical area,

c3-2 Osseous defect after debridement. Note the wide three-wall intrabony defect extendingfrom the distal to the lingual aspect of 18. The mesiodistal width of the osseous defect is 5 mm, the buccolingual width is 8 mm, and the depth is 5-6 mm.

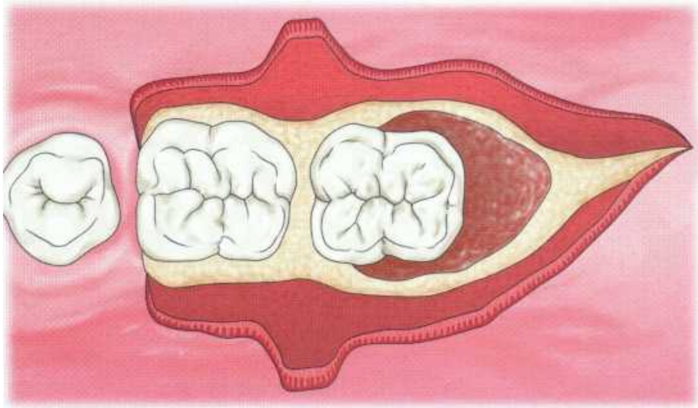
Fig 421 Placement of wraparound membrane.



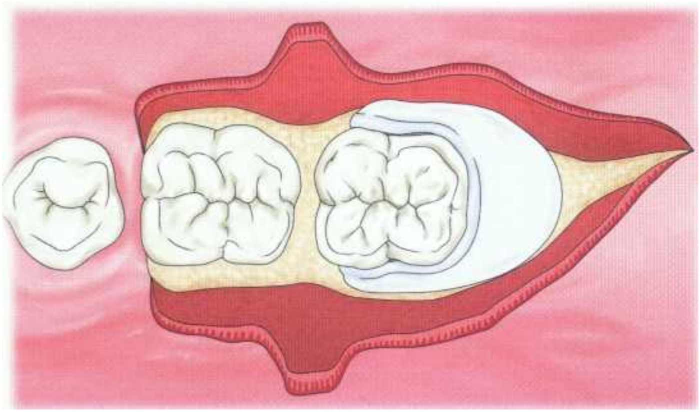
a. Make a sulcular incision to preserve the interdental papilla and make a vertical incision.



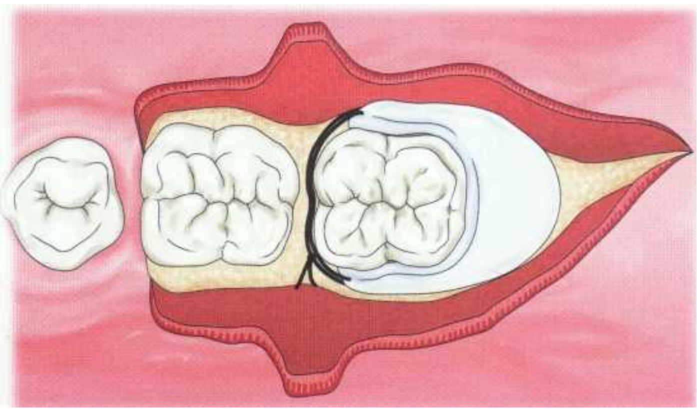
b. Prepare a full-thickness flap.



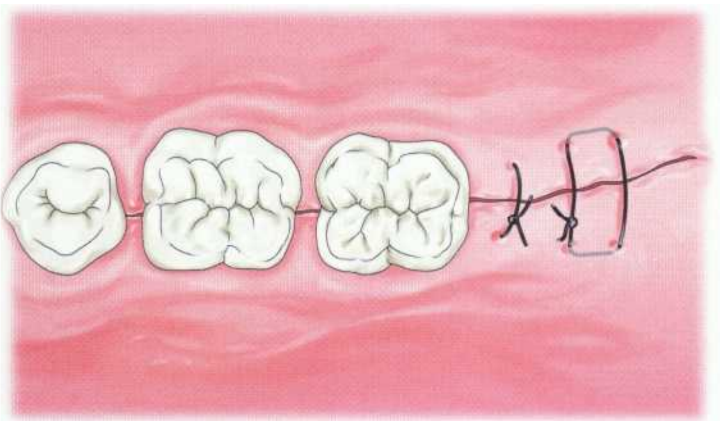
c. Place bone grafts after thorough debridement of the osseous defect.



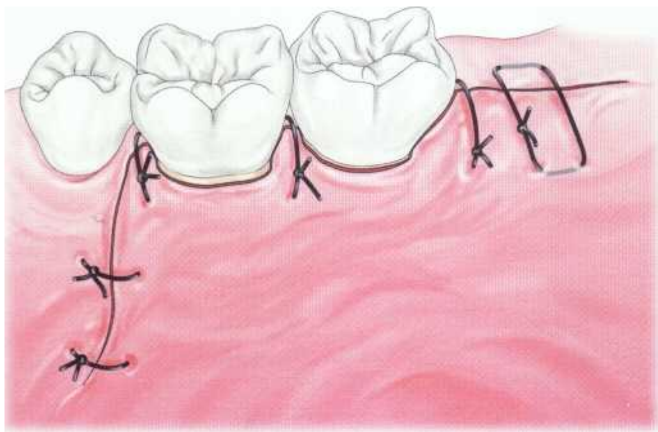
d. Place a wraparound-type membrane.



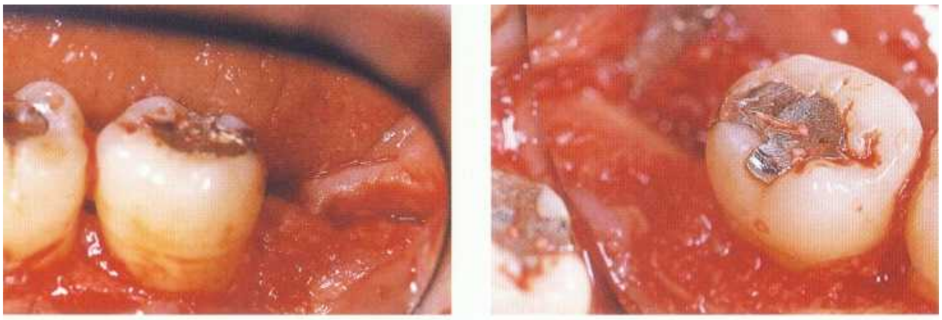
e. Suture the membrane with a suspensory sling suture.



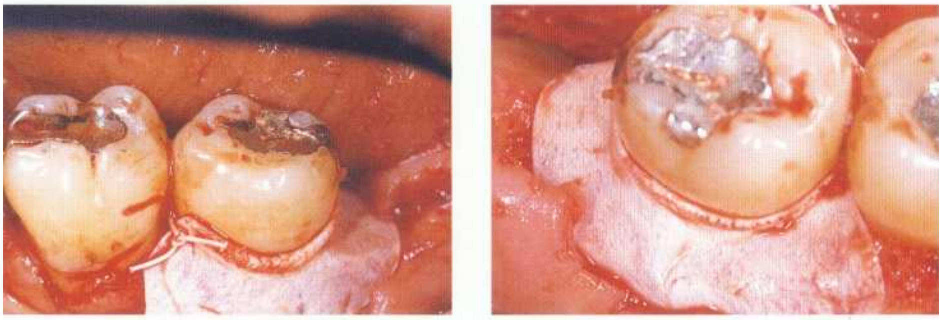
f. The membrane is covered completely and sutured.



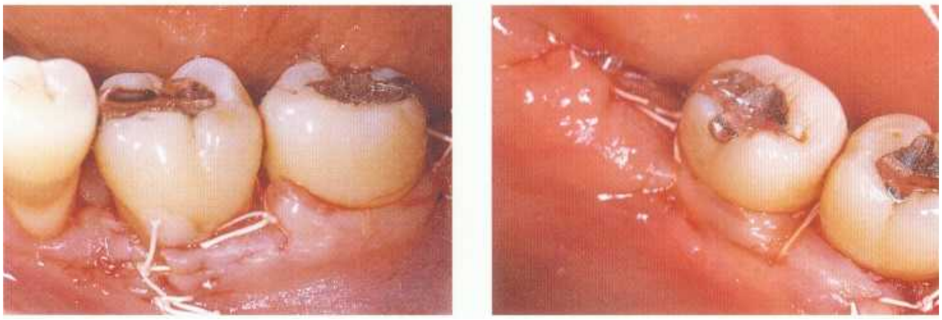
g. Make an interrupted suture of the vertical incised area and the interdental area.



c3-3 Bone grafts. After thorough debridement, bone grafts are placed on the osseous defect.



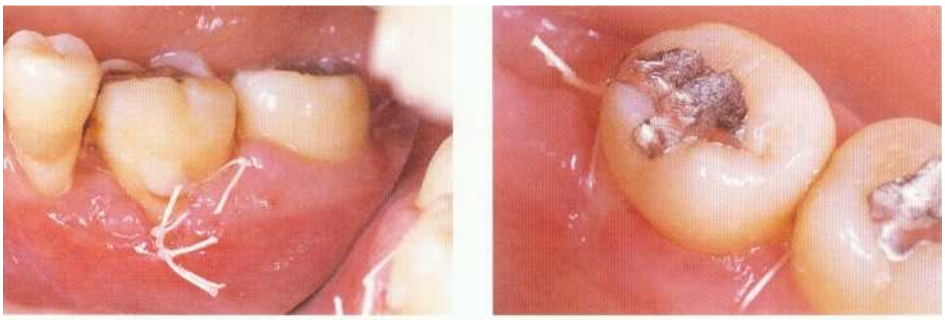
c3-4 Membrane placement. The entire defect area is covered by a wraparound-type membrane (WL Gore), and the membrane is sutured with a suspensory sling suture made at the CEJ with Teflon thread.



c3-5 Suture. The membrane is covered completely by flaps and sutured.

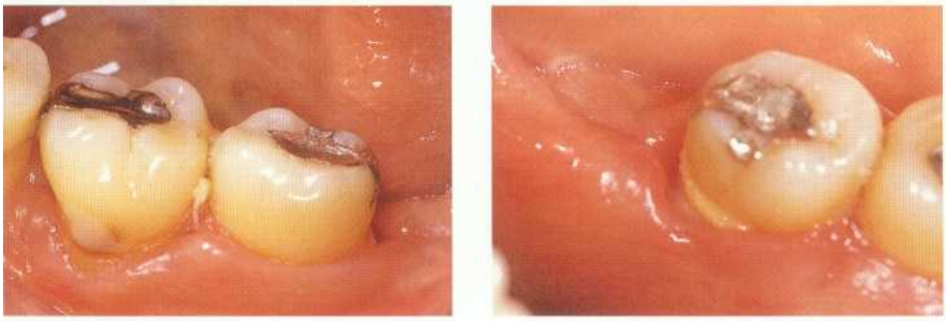
Prognosis

c3-6 After membrane placement.

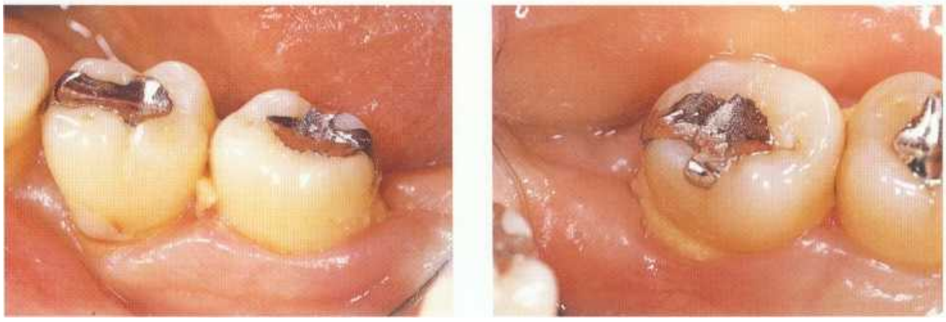


a. One week after surgery (left, buccal; right, lingual).

b. Two weeks after surgery. The membrane is exposed at the distolingual line angle of 18.



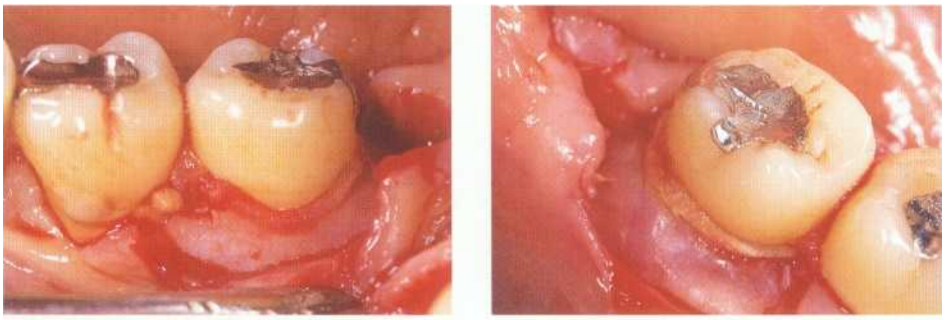
c. Thirty-eight days after surgery. Membrane exposure is increasing.



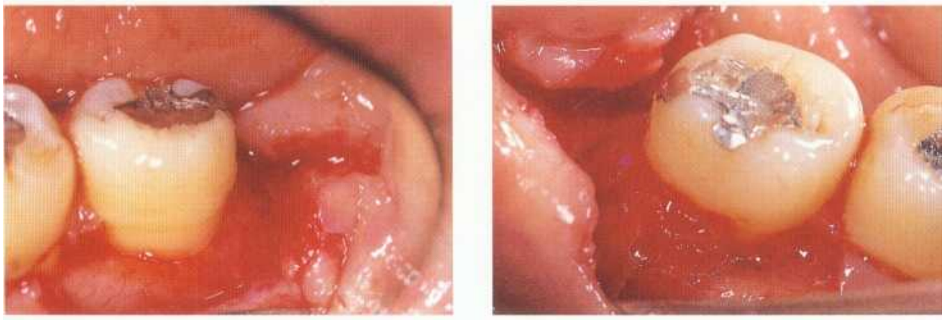
d. Forty-five days after surgery.

e. Sixty-two days after surgery.

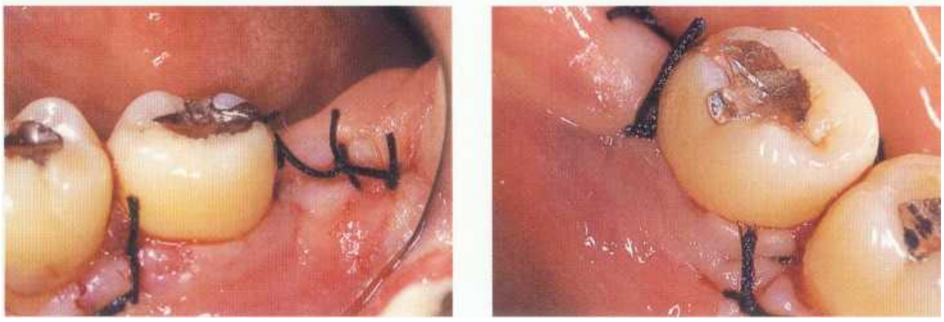
c3-7 Membrane removal 62 days after surgery.



a. Partial-thickness flaps are reflected and the membrane exposed. There is no depression of the membrane, which lies firmly on the root surface.

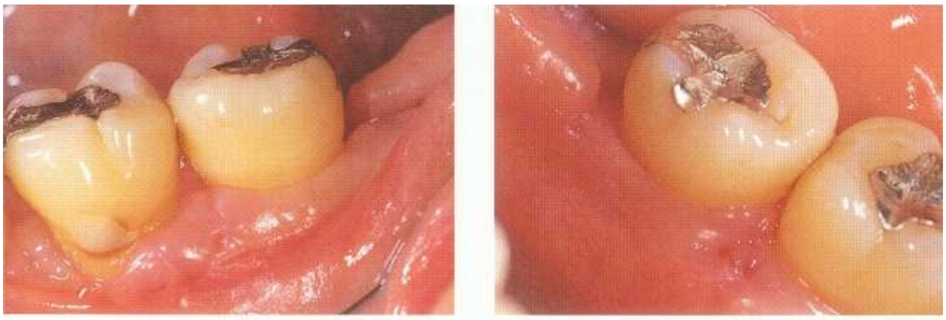


b. Membrane removal reveals complete coverage of the osseous defect area with new tissue. The new tissue is formed to the level of the CEJ.



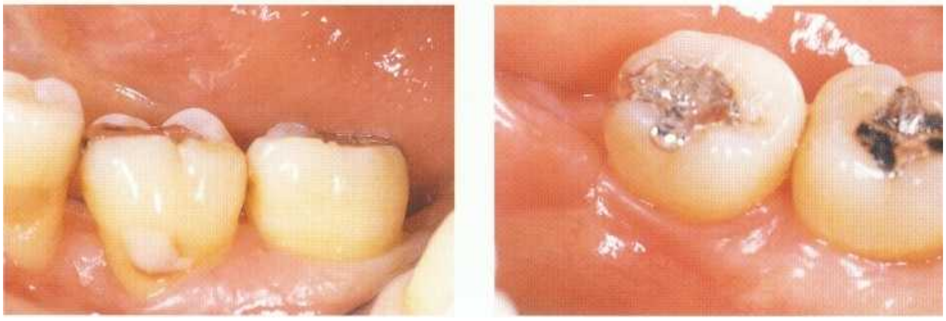
c. The new tissue is completely covered by flaps, which are sutured with 3.0 silk thread. A periodontal dressing is placed.

c3-8 After membrane removal.



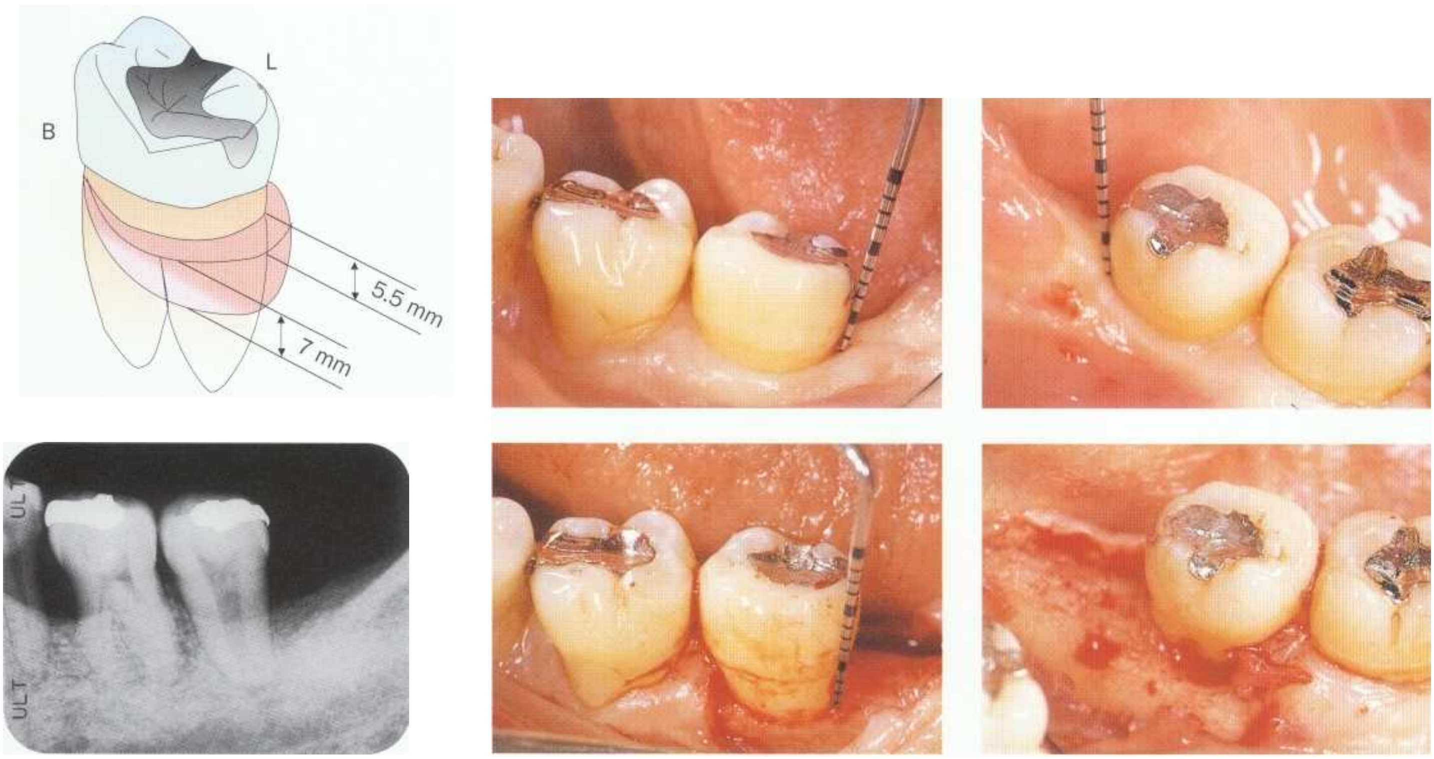
a. One week after membrane removal.

b. Remarkable osseous reconstruction evident radiographically 78 days after surgery.



c. Seventy-two days after surgery.

d. One hundred fourteen days after surgery.



c3-9 Re-entry. Forty-seven weeks after surgery. Note the improvement of the attachment level on the distal aspect (6.5 mm lingually and 5 mm buccally). The probing depth is 2 mm. Note the improvement of the osseous defect (5.5 mm lingually and 7 mm buccally).

Guided Tissue Regeneration for Furcation Defects

Comparison of Flap Surgery and GTR

Pontoriero et al'[45] used GTR for furcation involvement in mandibular molars. They performed GTR on one side and flap surgery on the other side and compared attachment gain in patients with Class II or Class III furcation involvement on both sides. Six months later, in 14 of 21 sites with Class II furcation involvement, furcation defects were completely resolved and horizontal probing measurements were improved to within the normal range, except in two sites, in the GTR group. In the flap surgery group, on the other hand, only two of 21 furcation defects were completely resolved. Additionally, 8 of 21 sites had complete or partial closure of furcation defects with GTR in Class III furcation involvement. In the flap surgery group, there was no complete closure of furcation defects and half were Class III, through and through. And furcation defects at the test teeth were completely closed where the entrance size of furcation involvement was within 4 mm. The investigators stated that size and morphology of furcation defects are related to treatment effect in GTR.

Lekovic et al" and Caffesse et al performed similar studies and reported better results using GTR than flap surgery in Class II furcation involvement in mandibular molars.

Morphology of Osseous Defects and Bone Regeneration

How defects are surrounded by bone walls influences the predictability of regeneration in furcation defects as it does in intrabony defects. Attachment gain and predictability of bone regeneration is extremely low in Class III furcation involvement (Fig 4-22).

In Class II furcation involvement, predictability is fairly high if the interdental bone level is coronal to the furcation or if the height of the buccal bone wall is coronal to the furcation (Fig 4-22). However, as with flap curettage, whether thorough debridement of the furcation can be achieved or not will determine the regeneration results in furcation defects. Additionally, the length of the root trunk influences attachment gain in the furcation (Fig 4-23).

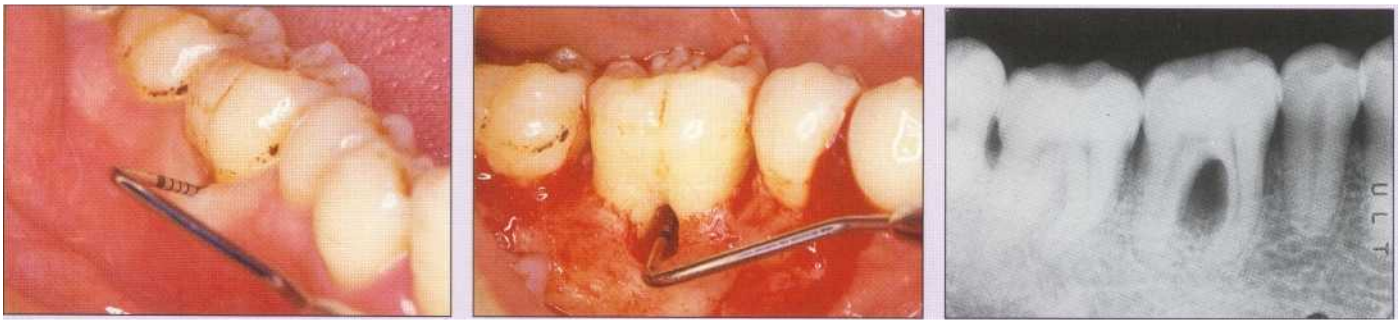
Predictability of Furcation Involvement in Maxillary Molars

Compared to mandibular molars, the success rate for the treatment of furcation involvement in maxillary molars is extremely low by GTR. Pontoriero and Lindhe examined patients who had Class II or Class III furcation involvement in both left and right maxillary molars. They performed GTR on one side and flap surgery on the other side and evaluated the results 6 months later. In Class III furcation involvement in maxillary molars, complete closure of furcation defects was not achieved with GTR or flap surgery.'"

In Class II furcation involvement, complete closure in buccal furcations was observed in two of 10 GTR cases and 1 of 10 flap surgery cases. However, there was no complete closure in distal furcation defects, and only one case of 10 had complete closure using GTR in mesial furcations."

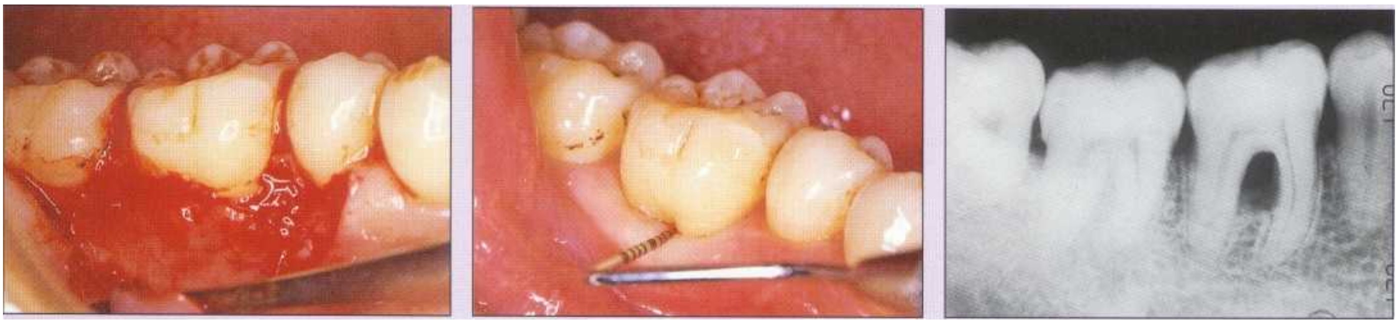
The treatment results of GTR in maxillary molars is less optimal than in mandibular molars because of the anatomic complications of maxillary furcations: deep root grooves in the furcation area, limited access to the root, and less residual tissue.

Fig 422 GTR in Class III furcation involvement.



a. Note Class III furcation involvement on tooth 30 (53-year-old man).

b. The furcation defect is through and through on flap reflection.



c. Eight weeks after membrane placement on the buccal and lingual areas of the furcation. The furcation is filled completely by new tissue after membrane removal.

d. One year and 3 months after surgery. There is no improvement in the furcation. The predictability of GTR seems to be low in Class III furcation involvement even if clinical progress is good with no postoperative membrane exposure.

Fig 423 Morphologic characteristics of furcation defects influencing the predictability of tissue regeneration.

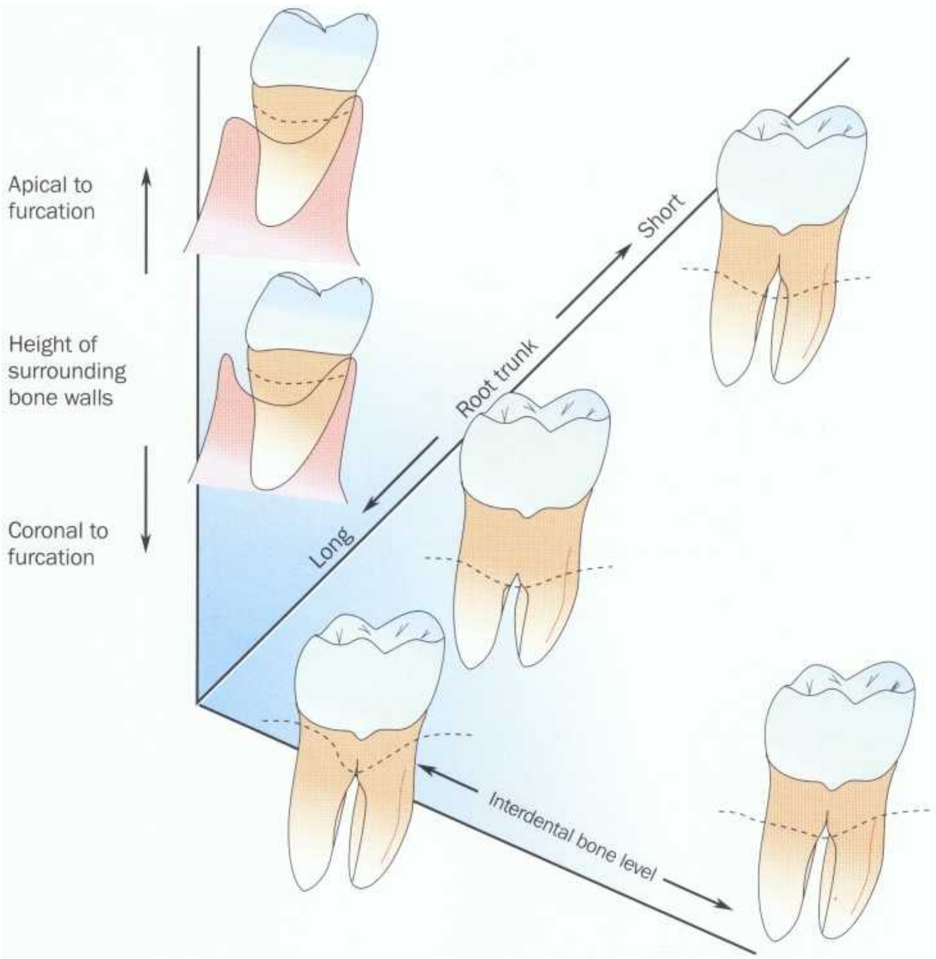
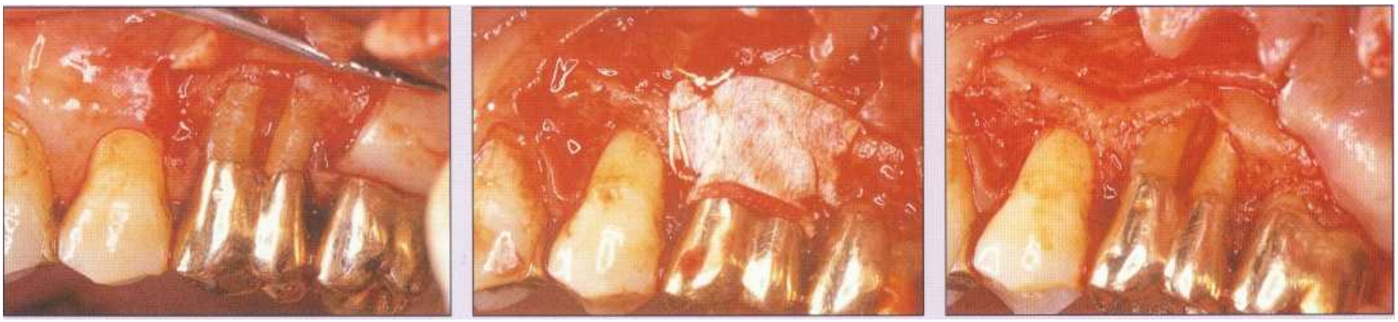


Fig 424 GTR in Class II furcation involvement.



a. Note the Class II furcation involvement on the buccal aspect of 14. The root trunk is short, and the opening of the furcation is right under the crown margin.

b. Membrane placement.

c. About 10 months after surgery. Note that the bone regeneration in the furcation is sub-optimal.

Fig 425 GTR in maxillary furcation involvement.

a. Note the Class II furcation involvement and osseous defect (14 mm) on the buccal aspect of 15.

b. New tissue in the furcation opening area is evident after membrane removal.

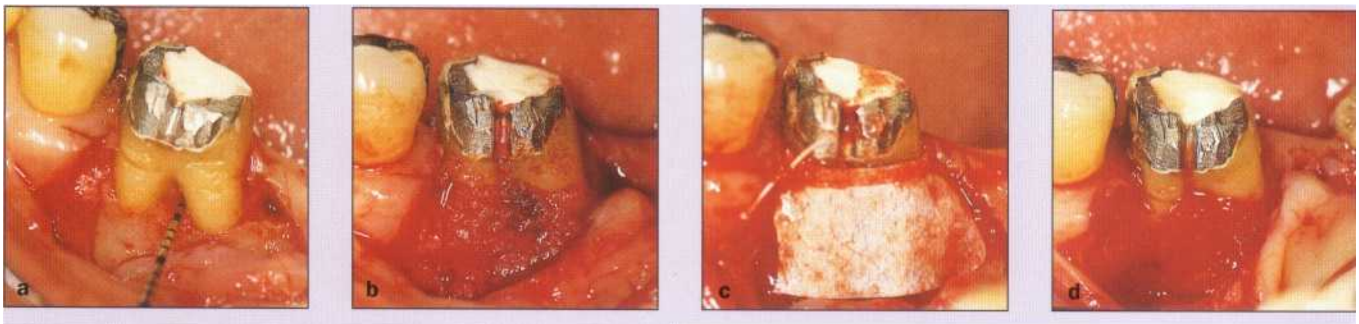
c. About 9 months after surgery. The vertical probing depth is improved, but there is no bone regeneration even though the furcation area is filled with dense and elastic connective tissue.

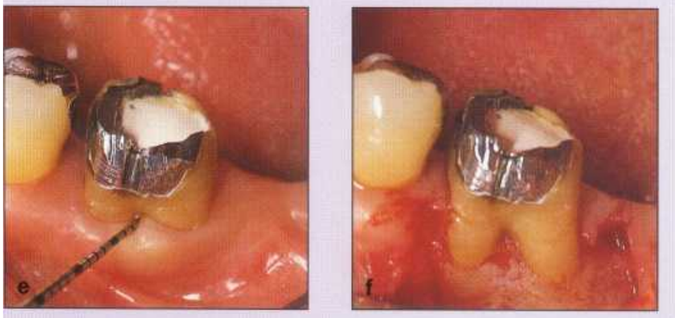
GTR with Bone Grafts in Furcations

The predictability of connective tissue attachment gain is high using GTR for furcation involvement, but new bone formation is not always predictable in the same area.[10,12,52] Bone grafts have been used in combination with GTR for new bone formation (Fig 4-26). Schallhorn and McClain reported complete closure of furcation defects in 33 of 44 sites using GTR with bone grafts. Anderegg et al performed GTR with bone grafts for furcation defects and obseived vertical bone fill of 3.5 mm and horizontal bone fill of 2.4 rum. When a membrane alone was used, the bone fill was 1.7 mm vertically and 1.0 mm horizontally. Many reports show that bone regeneration is increased by the use of bone grafts.

McClain and Schallhorn" undertook a long-term clinical evaluation of GTR combined with bone grafts and the application of citric acid to the root surface for furcation involvement. The 5-year follow-up revealed that the average 4.4 mm attachment gain decreased to 4.0 mm in areas where bone grafting was combined with GTR and that the attachment gain decreased from 3.7 mm to 1.8 mm where bone grafting was not combined with GTR. Complete closure of furcations was maintained in 25 of 27 sites where GTR was performed with bone grafts. Thus, the stability of 5-year postoperative attachment level, the amount of bone regeneration in the furcation area, and the stability of the result are better in GTR combined with bone grafts (Table 4-9).

Fig 426 Combining GTR with bone grafts in furcation involvement.





a. Furcation defect on flap reflection. The horizontal probing depth is 4 mm.
b. Bone graft to defect area.
c. The furcation is covered by a single-tooth-wide membrane.
d. Forty days after surgery. The membrane is removed and the furcation filled with new tissue.
e. Re-entry 1 year and 2 months after surgery. The probing depth of the furcation is 0.5 mm horizontally and 1 mm vertically.
f. The furcation is completely filled with new bone.

g. Before surgery. Obvious radiolucency in furcation.
h. One year and 2 months after surgery. The radiolucency in the furcation has disappeared. GTR has been successful.

Table 4-9 Five-year Results in Combining GTR with Bone Grafts for Furcation Involvement (32 patients, 76 sites)[55]

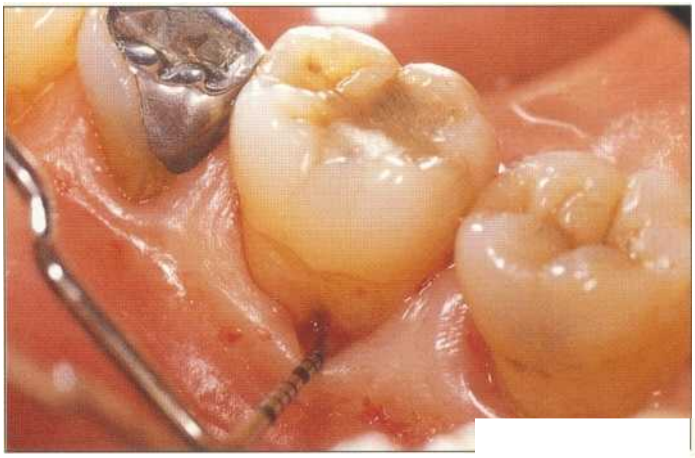
		Attachment level (mm)			Probing depth (mm)			Complete furcation closure
		GTR	5 y later	Changes	GTR	5 y later	Changes	
GTR only	19 sites	3.7	1.8	−1.9	4.5	2.5	−2.0	2 sites/5 sites
GTR with bone graft/ citric acid	57 sites	4.4	4.0	−0.4	5.1	3.7	−1.4	25 sites/27 sites

There are various conjectures about the effect of GTR combined with bone grafts. The success is likely due to the fact that bone grafts facilitate spacemaking and membrane placement. Therefore, GTR combined with bone grafts is recommended in defects where spacemaking is needed, characterized by having few bone walls, such as a wide and very deep intrabony defect or a one-wall intrabony defect. It is also recommended for large furcation involvements.

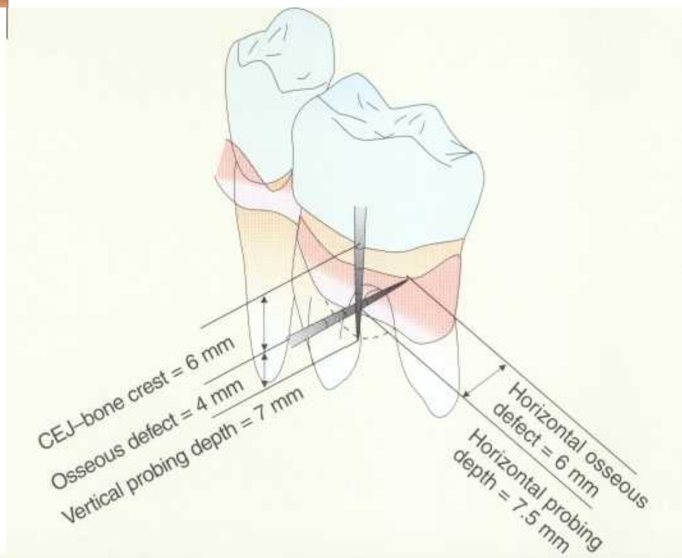
Murphy=' described the indications of GTR combined with bone grafts as follows:

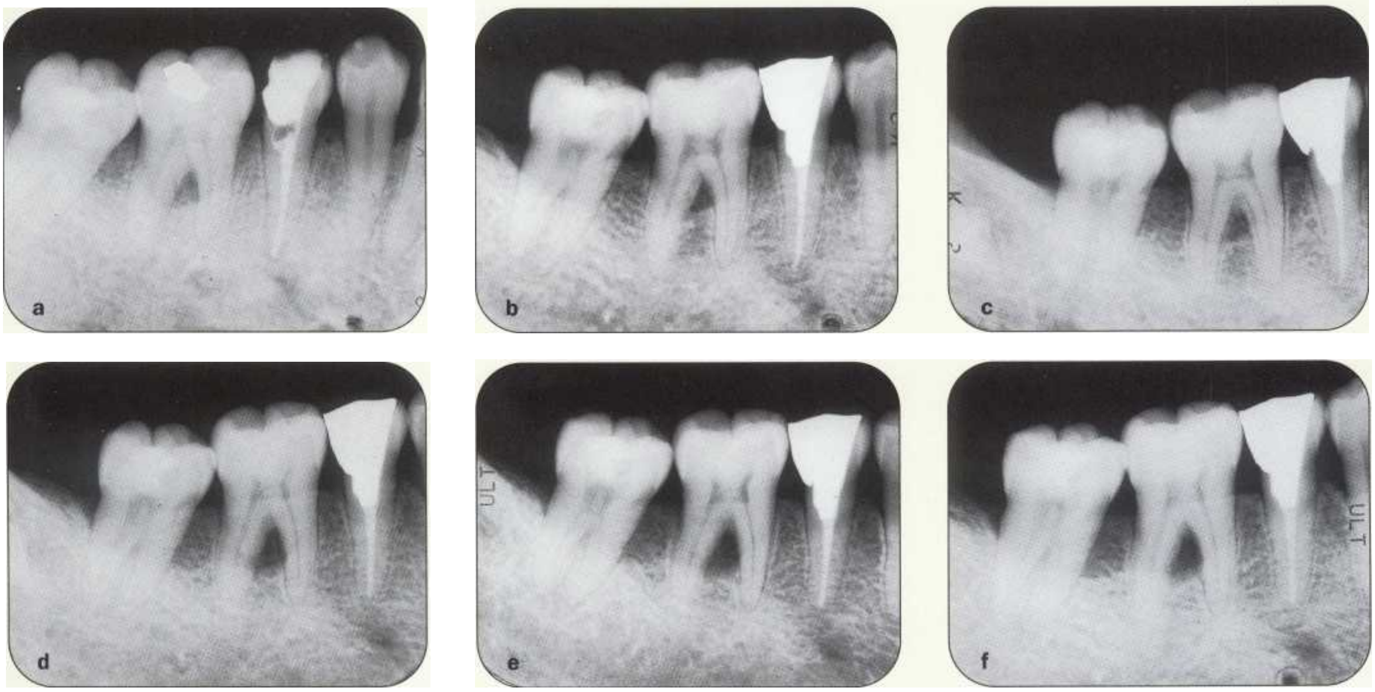
1. Osseous defects of 7-8-min depth. With deeper osseous defects, the effect of combining GTR with bone grafts diminishes because of spontaneous bone fill.
2. Deep osseous defects where space must be formed and maintained under the membrane.

Case 4-4 Treatment of Class 11 furcation-involvement defects in mandibular molars using GTR



The horizontal probing depth is 7.5 mm (53-year-old woman).



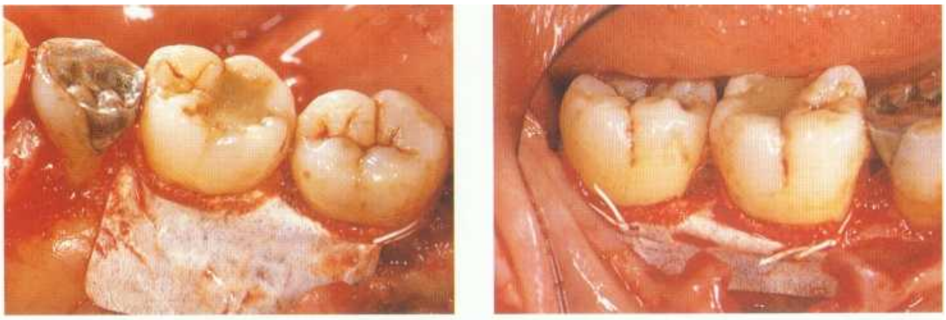


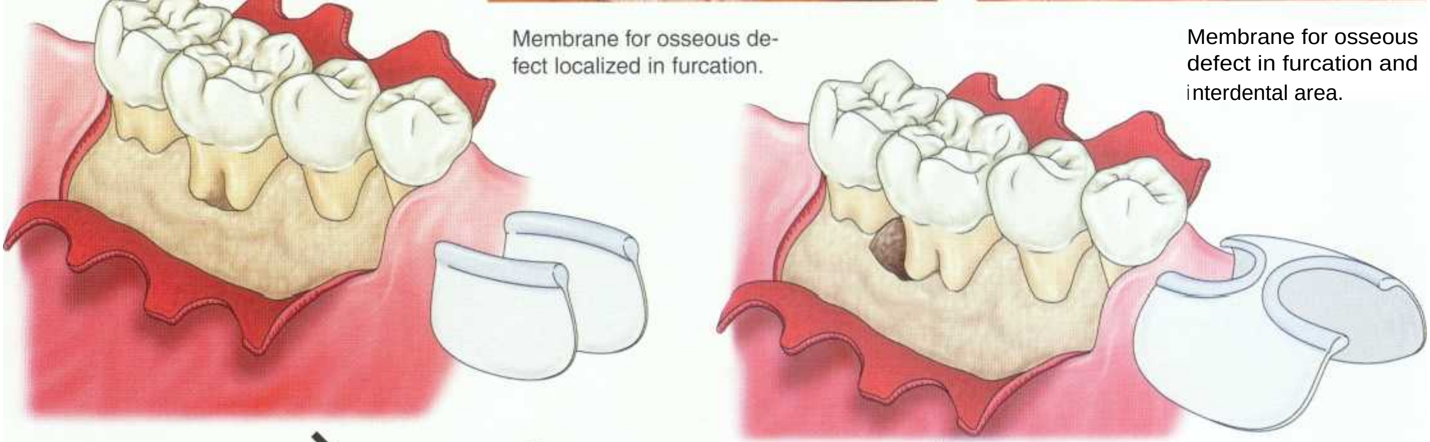
c41 Prognosis of furcation involvement. Note the Class II furcation involvement at initial examination (1982). Flap curettage was performed 6 weeks later (a). There was no progression of the furcation involvement on radiography 2 years and 3 months after surgery (b) and 5 years and 5 months after surgery (c), but progression was observed 11 years and 2 months after flap curettage (1993) (d). Four months later, a periodontal abscess has formed and the lesion has progressed remarkably (e). Twelve years and 3 months after initial examination (f), immediately before GTR.

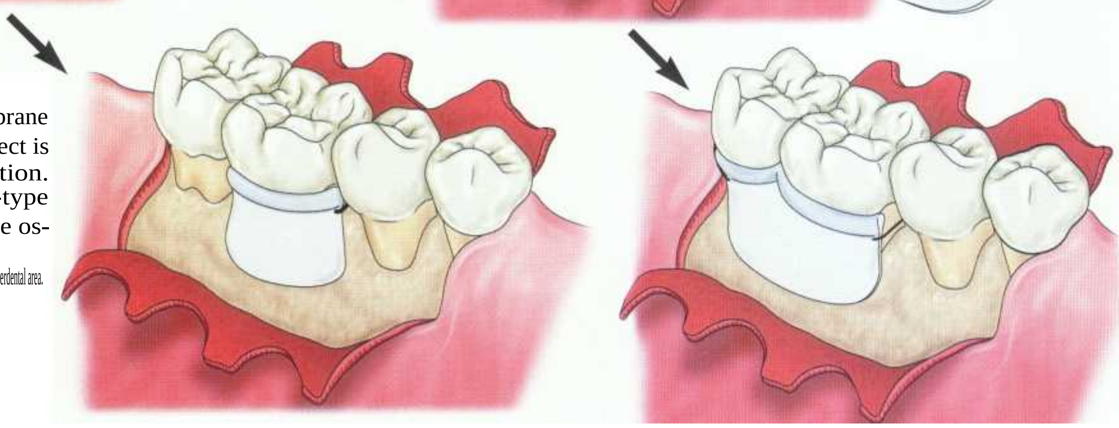
Membrane placement

c42 Debridement of the osseous defect. The lingual root trunk of 30 is short on flap reflection. The horizontal osseous defect of the lingual furcation of 30 is 6 mm, and the depth from the CEJ to the bottom of the bone is 10 mm. Note the deep osseous defect on the mesial aspect of 31.

c43 Membrane placement. After the application of tetracycline solution to the root surfaces (3 minutes), the bone graft is completed and an interproximal-type membrane sutured.



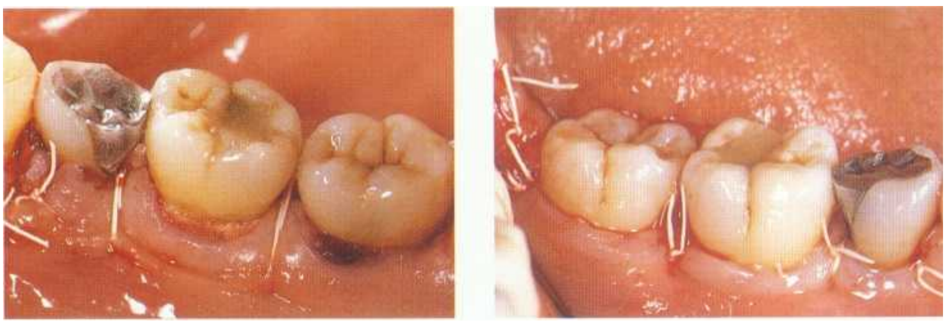




Key point

Use a single wide membrane (left) if the osseous defect is localized in the furcation. Use an interproximal-type membrane (right) if the osseous defect is in the furcation and interdental area.

c44 Flap suture. The collar portion of the membrane is exposed on the center of the lingual aspect of 30 on suturing.

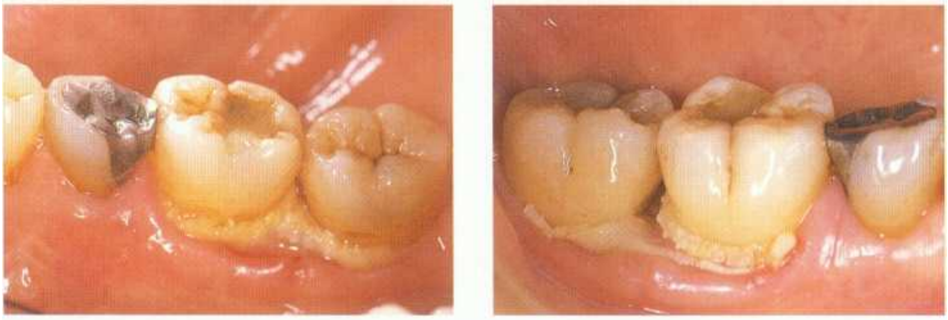


Prognosis

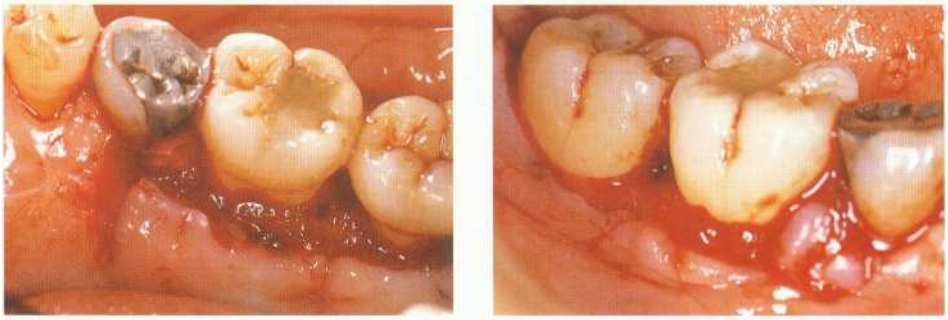
c45 **Prognosis after membrane placement.**

a. Eight days after surgery. The patient may brush with an ultrasoft brush.

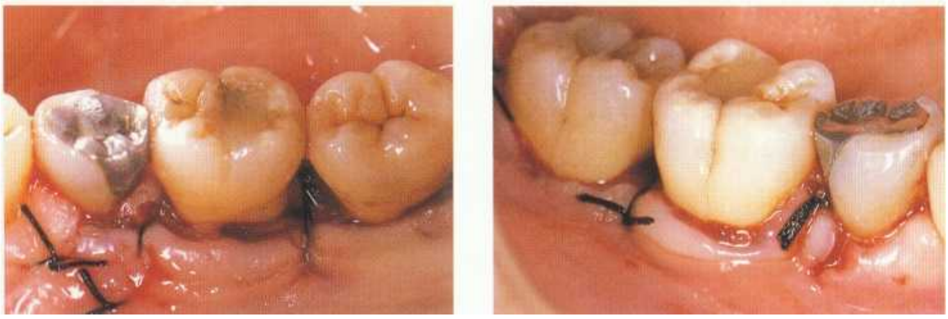
b. Fifteen days after surgery.



c. Fifty days after surgery.



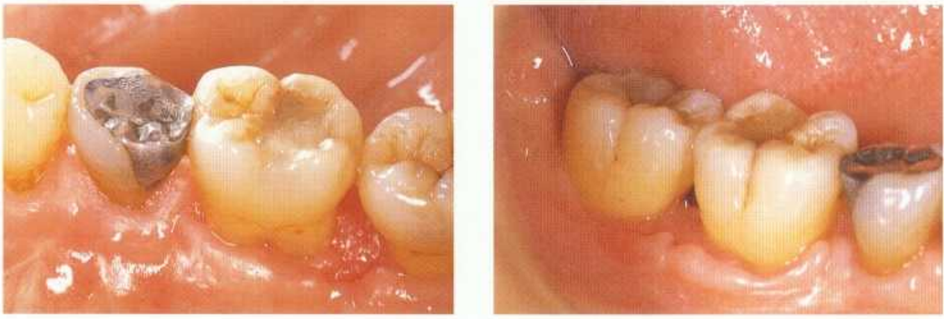
c4-6 **Membrane removal 59 days after surgery.** Note the new tissue under the membrane which reaches the level of the CEJ.



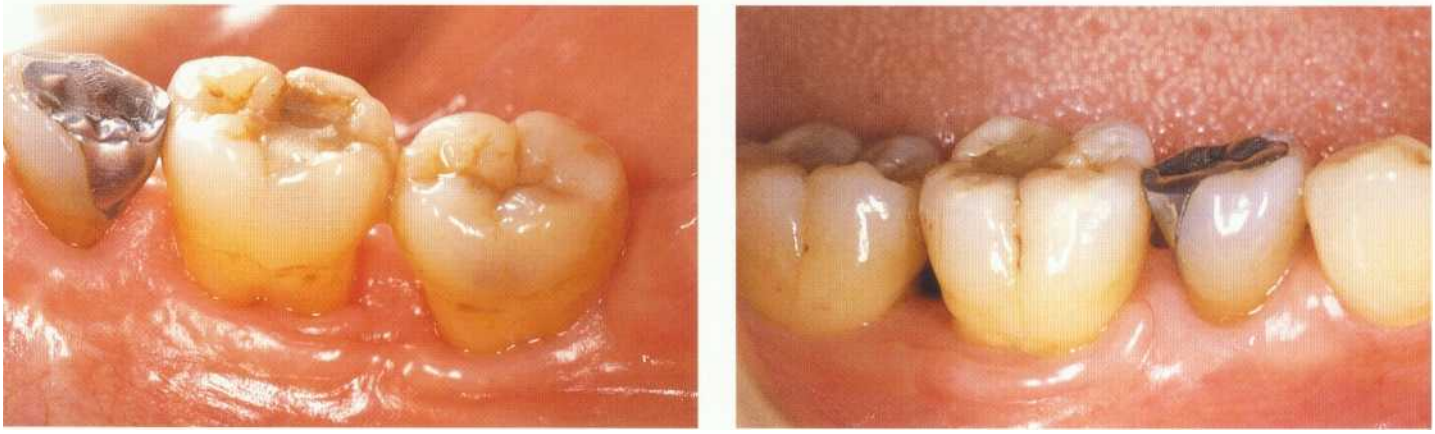
c47 **Suture of flap.** The new tissue is covered as completely as possible and the flap sutured.

c48 After membrane removal.

a. Two weeks after membrane removal.



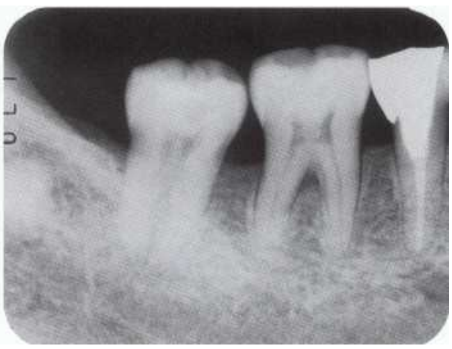
b. Three weeks after surgery.



c. Nine weeks after surgery.

d. Bone fill of furcation is obvious radiographically 27 weeks after surgery.

e. One year after surgery.



f. One year and 6 months after surgery.

Tooth 30 on midlingual aspect	Probing depth	Attachment level	Horizontal probing
Before surgery	7.0 mm	10.0 mm	7.5 mm
1 year after surgery	1.5 mm	4.0 mm	1.5 mm
Attachment gain		5.0 mm	6.0 mm

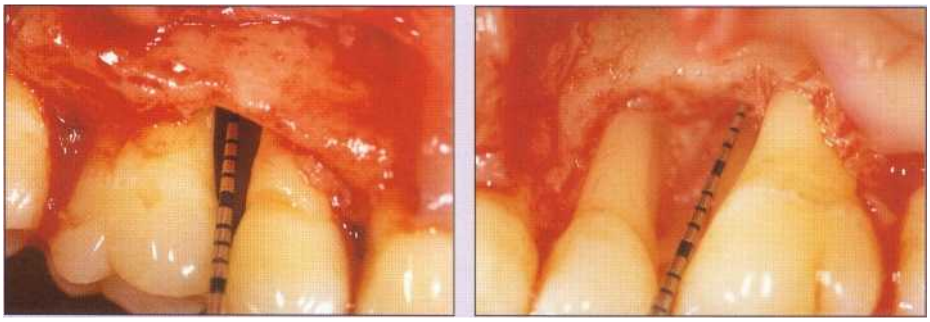
Possibilities and Limitations of New Attachment with GTR

Much progress has been made in regenerating periodontal tissue and regaining lost attachment with GTR. Success, however is limited to cases of deep and narrow vertical intrabony defects surrounded by bone walls or osseous defects with Class II furcation involvement in the mandibular molars. In these cases, some degree of regeneration may also be achieved by conventional flap curettage.

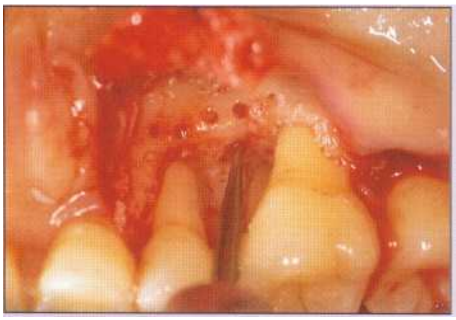
GTR in the treatment of one-wall osseous defects

Fig 427 GTR in deep one-wall osseous defects (a-k).

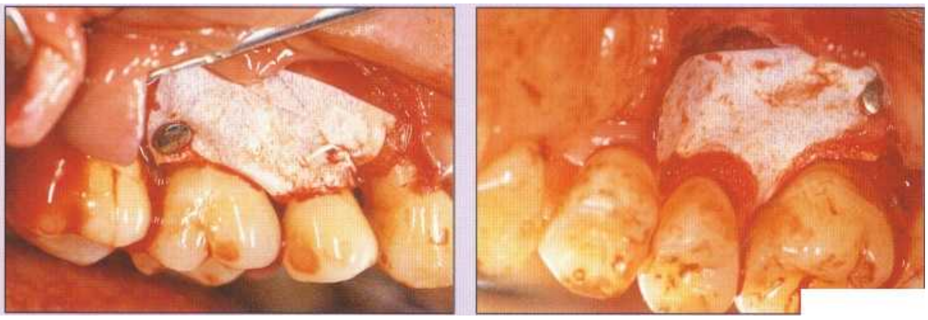
a. Preoperative status (after initial therapy). Note the absence of interdental papilla between teeth 3 and 4 (40-year-old woman).



b. Osseous defect on flap reflection.



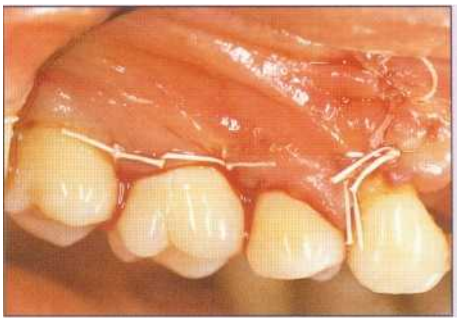
c. The cancellous bone is perforated with a small, round bur to facilitate bleeding to the osseous defect area.



d. The membrane is placed as coronally as possible. The graft material is filled to near the CEJ to prevent depression of the membrane. The membrane is fixed with a titanium fixation screw (Frios augmentation system, Friatec).

For osseous defects that do not meet these conditions, a favorable result may be expected if there is space under the membrane and the defect is surrounded by only one wall (Fig 4-27). The possibility of resolving a deep peri odontal pocket rises with GTR. Regeneration results may be limited in defects surrounded by bone walls.

Cases 4-5 to 4-7 show that some improvement can be achieved in cases with conditions unfavorable for GTR, if primary wound closure is achieved and if plaque is well controlled.




e. Suturing. Complete primary closure cannot be achieved in the area between 3 and 4 because the interdental papilla is absent.

f. Eight days after surgery. One part of the membrane is exposed in the interdental area.

g. Two weeks after surgery. Membrane exposure has increased.

h. Three weeks after surgery.

1. Forty-four days after surgery.


j. New tissue after surgery.

k. Suturing of flaps. The new tissue in the interdental area is covered by the membrane.

Fig 427 (continued) GTR in deep one-wall osseous defects (l-t).

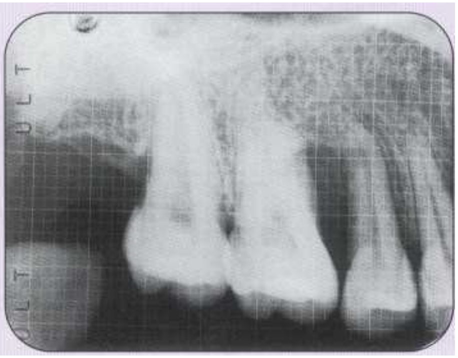

l. Two months after membrane removal.


m. About 8 months after membrane removal.

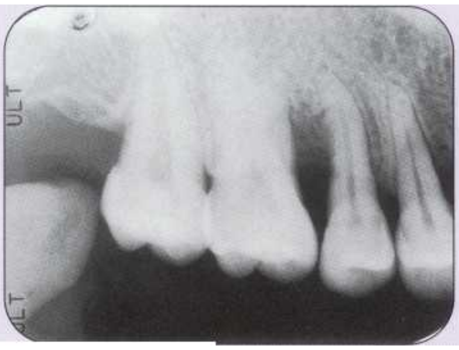

n. One year and 10 months after GTR. Attachment gain is 3 mm on the distobuccal aspect of 4 and 4 mm on the mesiobuccal aspect of 3.

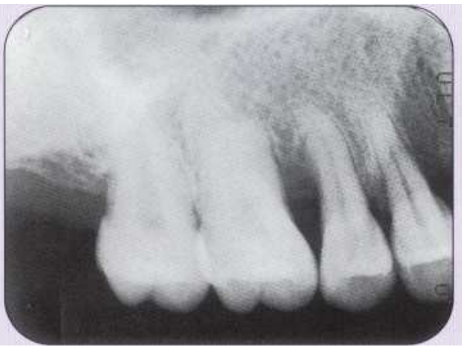

o. On initial examination.


p. About 1 year after initial examination.


q. Immediately after GTR.


r. Four months after GTR.


s. Ten months after GTR. Bone reconstruction is obvious.

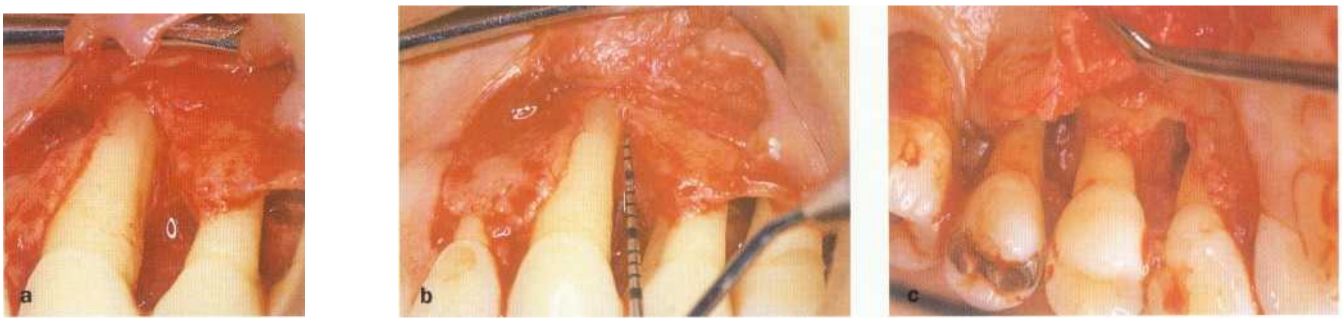

t. One year and 10 months after GTR. Note the vertical bone fill.

Case 4-5 Treatment of one-wall intrabony defects using GTR

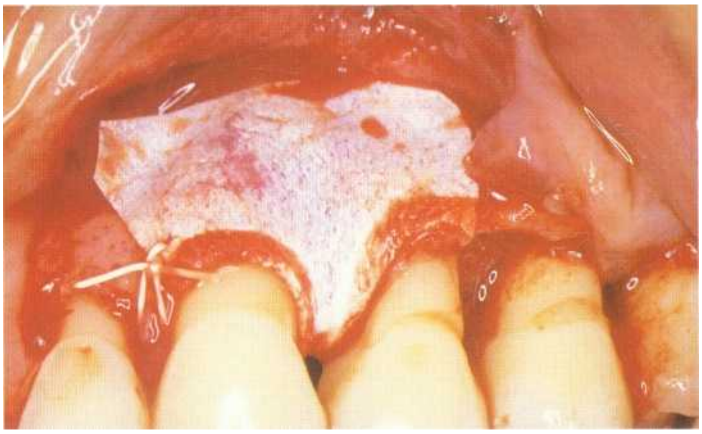
Note the severe gingival inflammation and periodontal abscess at initial examination (38-year-old woman).

Ten months after initial examination. After initial therapy, inflammation has been eliminated and gingival shrinkage is observed.

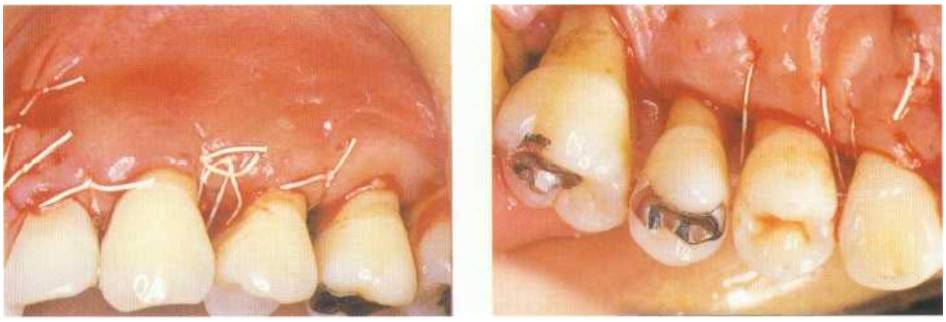
c5-1 Incision. An intrasulcular incision is made with no. 12 and 15 blades in preparation for a full-thickness flap. The interdental papilla is preserved as much as possible. The sulcular incision is extended one tooth mesiodistally, and a vertical incision is made on the mesial aspect of 10.



c5-2 Flap reflection. Note the residual subgingival calculus on the distal root surface of 11 after flap reflection (a) and the partial-thickness flap apically (b). After debridement, there is a one-wall intrabony defect on the distal aspect of 11, and the distance from the CEJ to the bottom of the osseous defect is 13 mm. The interdental osseous defect on the distal aspect of 12 (c) is remarkable.



c5-3 Membrane placement. The interproximal-type membrane (WL Gore) is trimmed according to the morphology of the osseous defect, placed, and sutured.



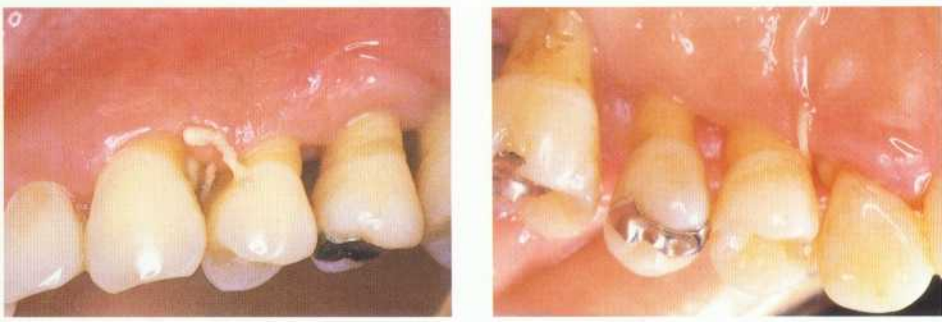
c5-4 Flap suture. The flaps are displaced coronally and the membrane covered. The suture is begun from the distal interdental papilla of 11 with a vertical mattress suture. An interrupted suture of the interdental area is made and then the vertical incision sutured.

Prognosis

c5-5 After membrane placement.

a. Nine days after surgery.

b. Twenty-three days after surgery. The suture material is removed except in the distal interdental area of 11.

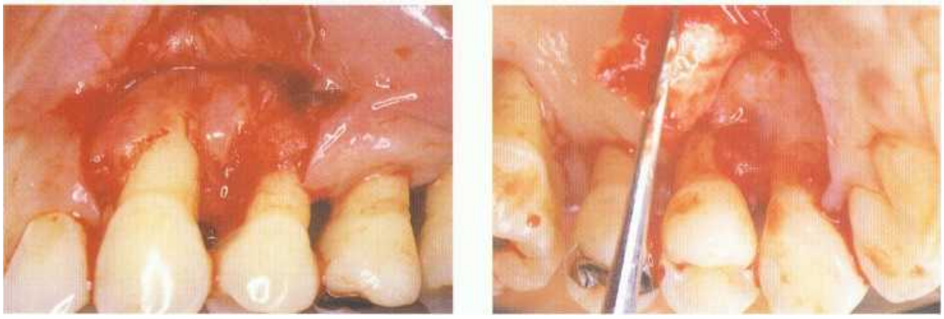


c. Thirty days after surgery. The membrane is exposed on the distal interdental area of 11.

c5-6 Membrane removal.

a. Forty days after surgery.

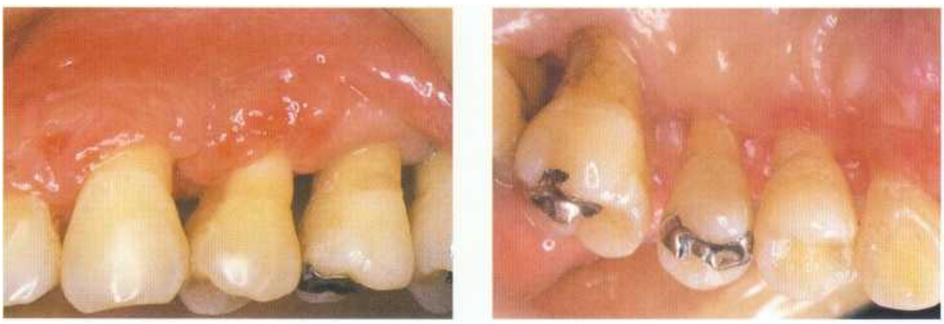
b. An incision is made for membrane removal. Two vertical incisions are made on the buccal and palatal aspects and partial-thickness flaps are separated from the membrane. The membrane is closely adapted to the root without depression.



c. The membrane is held with small tissue forceps and removed gently without damaging the new tissue. Note that the osseous dehiscence on the buccal aspect of 11 is covered by new tissue. The distance of the new tissue from the CEJ to the coronal aspect is 4 mm. The attachment gain is approximately 9 mm.

d. The epithelium inside the flaps is removed. A releasing incision of the periosteum is made on the flap base and the flaps displaced coronally. A suture with 3.0 silk thread is made to cover the new tissue and a periodontal dressing is placed.

c5-7 After membrane removal.



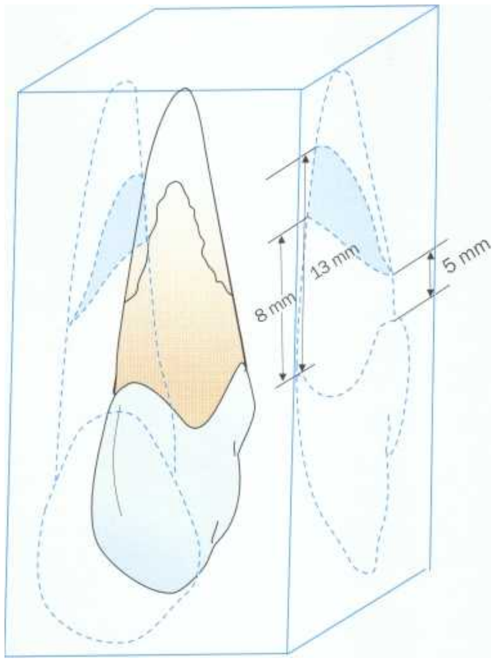
a. Eleven days after removal.

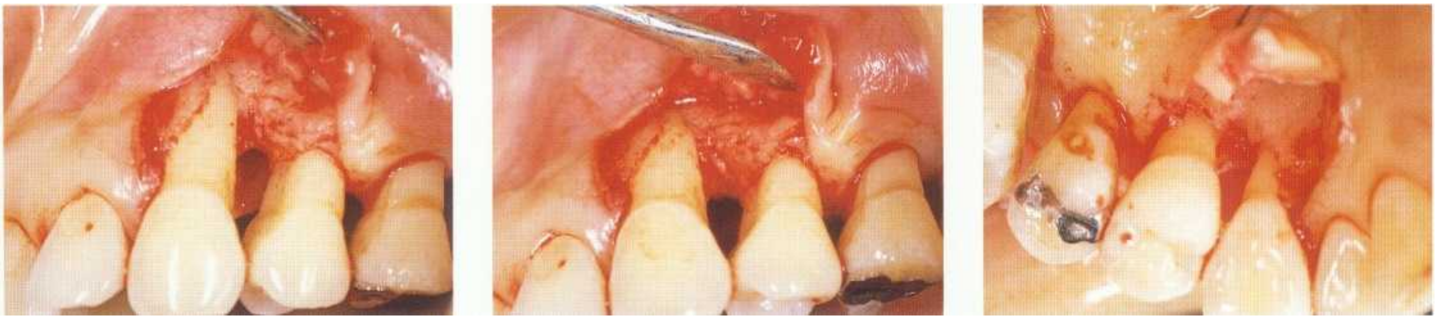
b. Three months after removal.

c. The probing depth is 4 mm 11 months after surgery.

d. Fourteen months after removal.

	Probing depth	Attachment level
Before surgery	8.0 mm	10.0 mm
Re-entry (1 y, 5 mo)	3.0 mm	6.0 mm
	Probing depth reduction	**Attachment gain**
	5.0 mm	4.0 mm



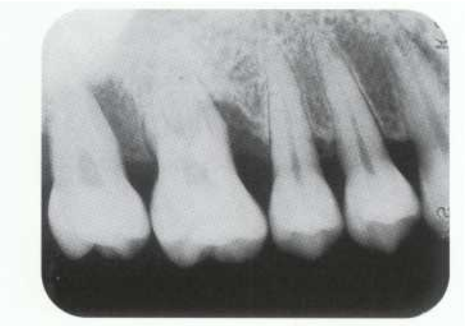


c5-8 **Re-entry 1 year and 5 months after membrane placement.** Note the approximately 5-mm bone regeneration on the buccal aspect. Bone regeneration cannot be expected in a one-wall osseous defect if flap curettage alone is performed.

c5-9 **About 7 months after re-entry.**

Case 4-6 Treatment of deep and wide one-wall intrabony defects using GTR

Flap curettage



c6-1 **Flap curettage for** one-wall osseous defects.

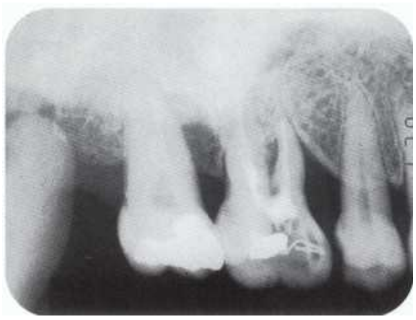
a. Note the deep vertical osseous defect in the interdental area of 2 and 3 (initial examination, 1982).

b. Flap curettage about 6 months after initial examination.

c6-2 After flap curettage.

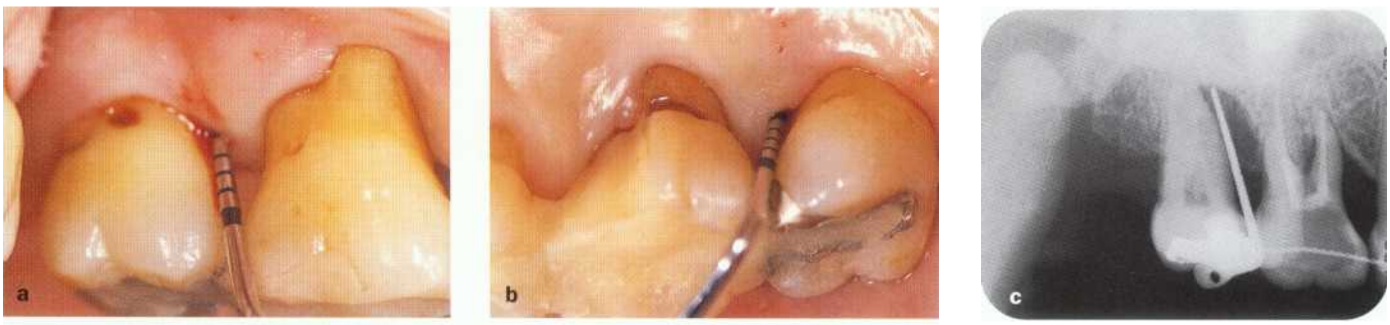
a. One year and 4 sgery.

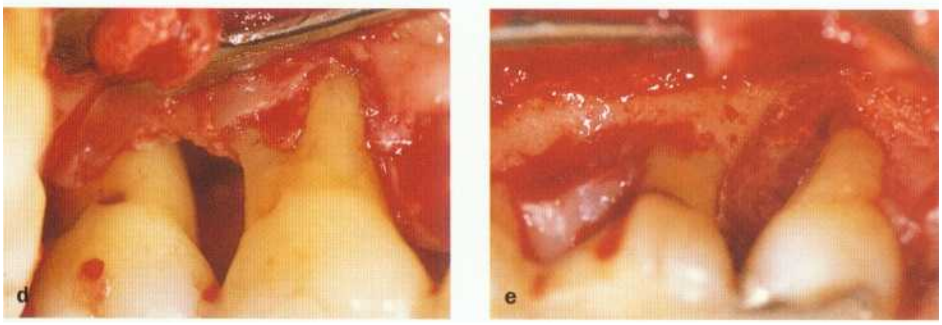
b. Four years and 10 months after surgery.



c. Eleven years and 8 months after surgery. Note the extended osseous defect on the mesial aspect of 2.

Regenerative procedures using GTR

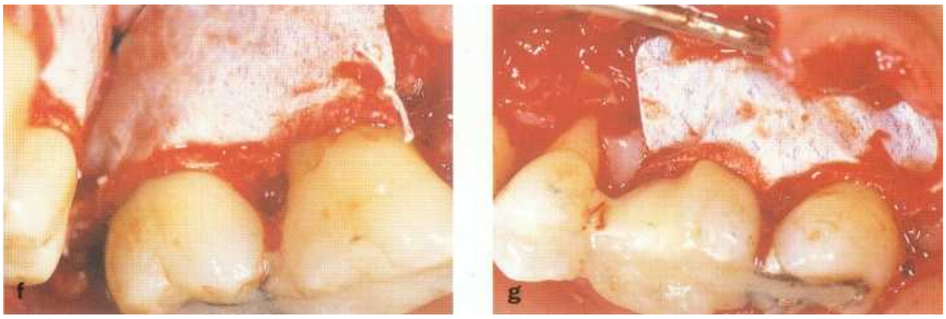




c6-3 GTR procedures.

a-c. Twelve years after flap curettage (52-year-old patient). The interdental osseous defect on the mesial aspect of 2 nearly reaches the apex. The probing depth on the mesial aspect of 2 is 10 mm.

d,e. Note the deep and wide one-wall intrabony defect on flap reflection.

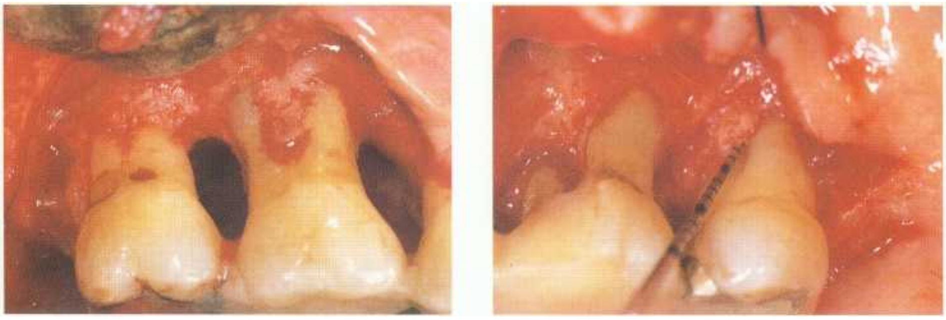


f,g. After bone grafting, an interproximal-type membrane is sutured near the CEJ.

c6-4 Membrane removal. The membrane is removed 6 weeks after placement (a, b). Radiograph 8 weeks after membrane placement (c).

c6-5 Re-entry.

a. Forty-one weeks after membrane placement. The probing measurement of 2 is 3 mm buccally and 4 mm palatally. Note the pocket reduction of 7 mm and 6 mm.



b. Remarkable vertical bone regeneration (approximately 7 mm) is evident on flap reflection.

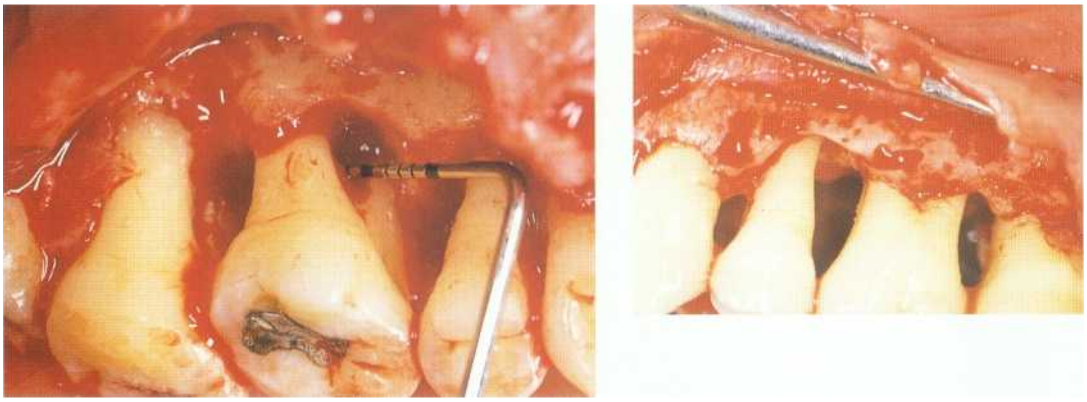
	Probing depth		Attachment level	
	BM	**PM**	**BM**	**PM**
Before surgery	10 mm	10 mm	10 mm	14 mm
Re-entry	3 mm	4 mm	3 mm	7 mm
	Probing depth reduction		**Attachment gain**	
	7 mm	6 mm	7 mm	7 mm

Case 4-7 Treatment of deep osseous defects with furcation involvement using GTR

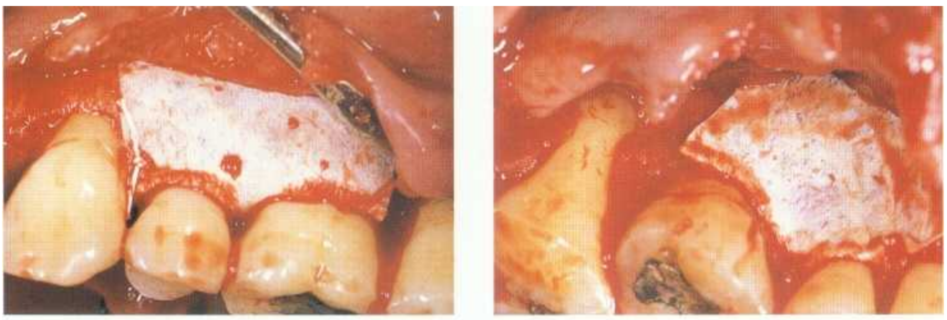
Note the deep periodontal pocket around 14 on initial examination (36-year-old man).

Regenerative procedures using GTR

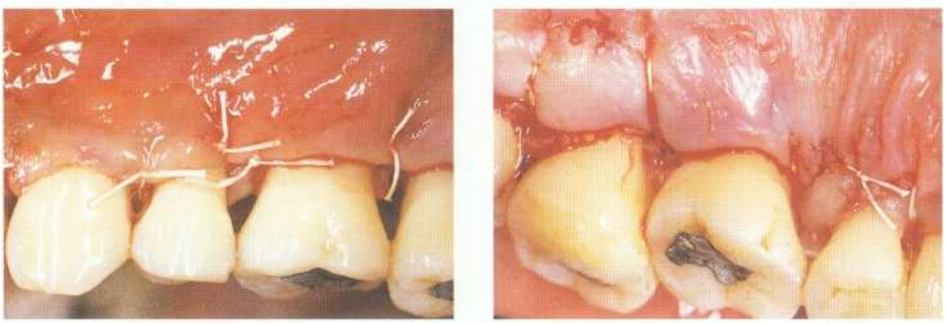
c7-1 On flap reflection. Note the intrabony defects between the mesial and distal aspects of 14, on the buccal and palatal aspects of 13, and the mesial furcation involvement on 14 (the horizontal osseous defect is 8-9 mm).



c7-2 Membrane placement and suture. After bone grafting, an interproximal-type membrane is sutured. Only bone grafting was performed on the distal part of the osseous defect of 14.



c7-3 Flap suture. The membrane is covered with flaps and sutured.

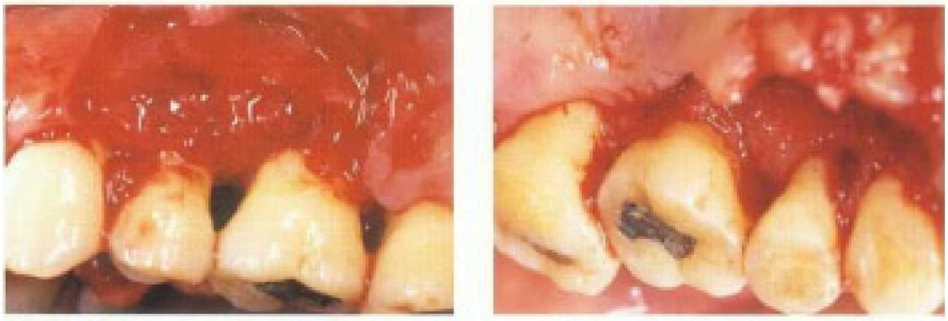


Prognosis

c7-4 **After membrane placement.**

a. Eight days after surgery.

b. Thirty-two days after surgery. The membrane has become exposed.



c7-5 **New tissue on membrane removal.** Fifty-eight days after surgery. The distance from the CEJ to the new tissue on 14 is 3 mm buccomesially and 1 mm palatomesially. On 13 this distance is 1.5 mm buccodistally, 3.0 mm midpalatally, and palatodistally the tissue is at the same level of CEJ.

c7-G After membrane removal.

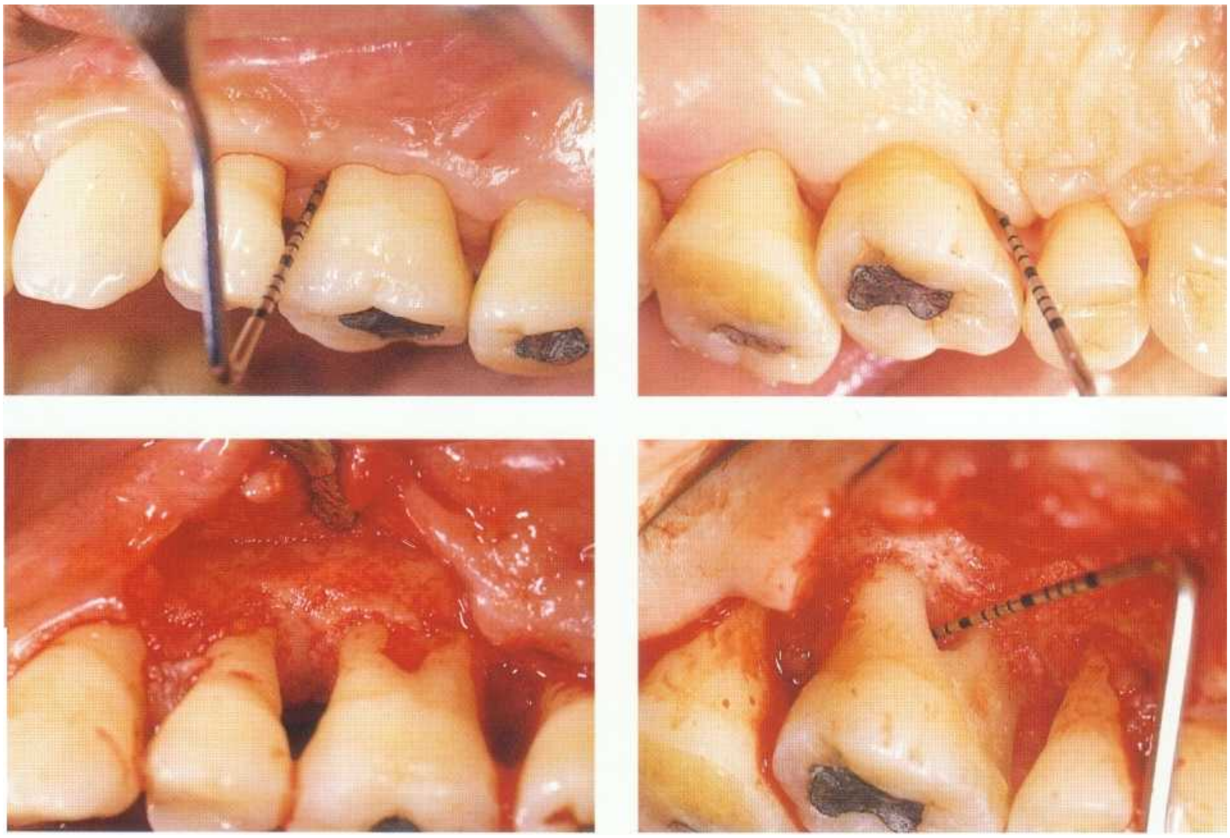
a. Sixty-five days after membrane removal.

b. Radiograph 113 days later.

c. One hundred seventy-one days after surgery.

d. Note bone regeneration on radiography.

e. About 9 months after surgery.

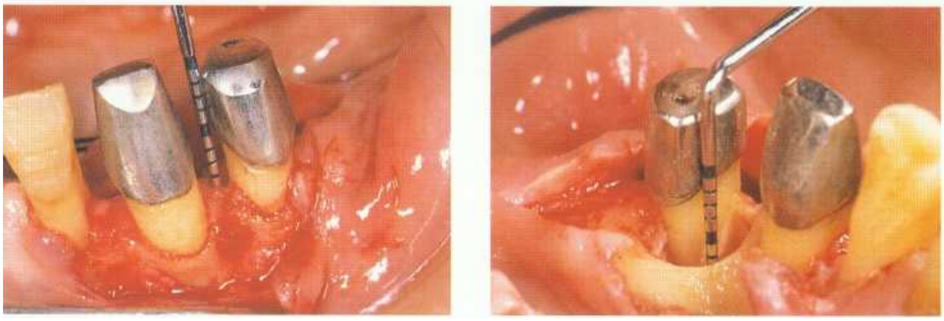


c7-7 **On re-entry.** One year and 10 months after GTR. The intrabony defects around 13 and 14 are completely resolved. The horizontal probing depth on the mesial furcation of 14 is 3-4 mm after reflecting flaps. Note the 5-mm improvement compared to c7-1 (on GTR).

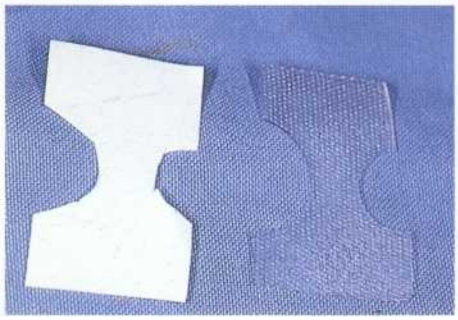
Case 4-8 Bioabsorbable membranes in the treatment of circumferential osseous defects

GTR procedures

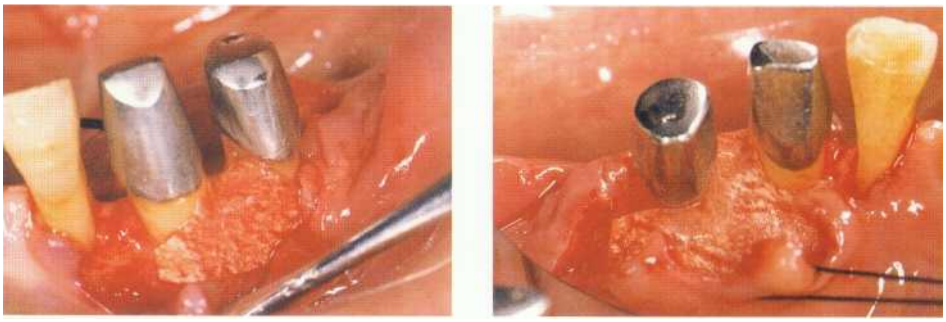
c8-1 Before surgery. There is an intrabony pocket on the mesial aspect of 21. The attachment level is 5 mm buccally and 7 mm lingually from the margin of the prepared crown.



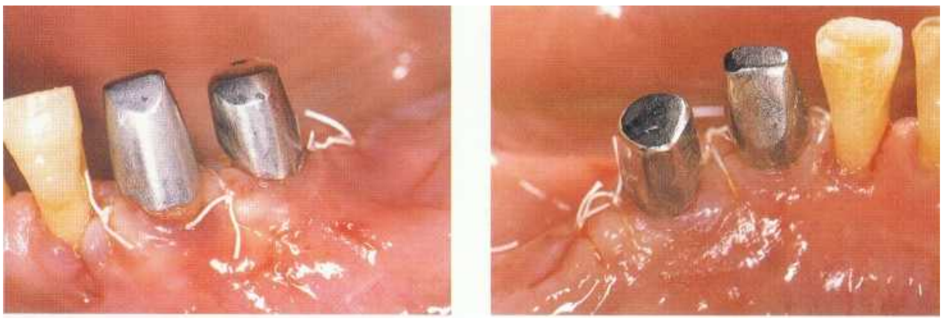
c8-2 Osseous defects after flap reflection. Note the three-wall osseous defect on the mesial and lingual aspects of 21. The distance from the margin of the prepared crown to the bottom of the osseous defect is 14 mm and 6 mm to the alveolar crest. The depth of the osseous defect is 8 mm lingually and 5.5 mm buccally.



c8-3 Membrane trimming. After the trial membrane is trimmed according to the morphology of the osseous defect, the membrane is trimmed.



c8-4 Placement and stabilization of membrane. A bioabsorbable membrane (GC) covers the osseous defect area completely 3-5 mm over the osseous defect margin. The membrane is sutured and stabilized with bioabsorbable suture thread.



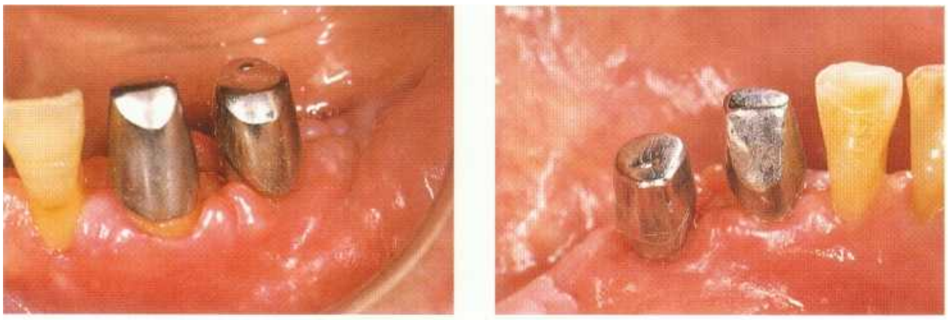
c8-5 Flap suture. The flaps are displaced coronally and sutured with nonabsorbable suture thread for complete membrane coverage.

Key point

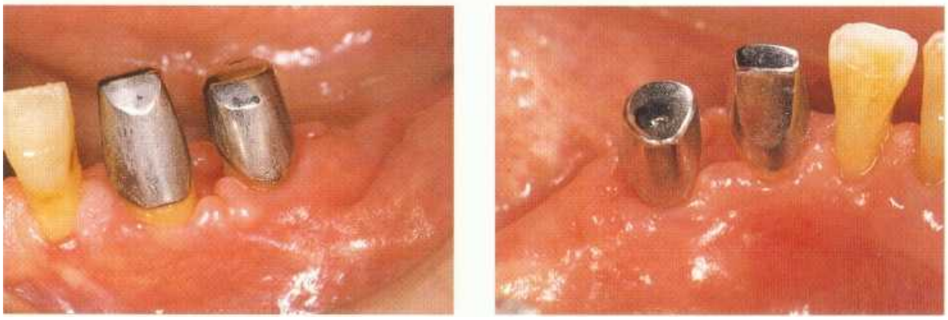
Always use a trial membrane first to prevent a decrease in the bioabsorbable membrane's strength due to absorption of saliva and blood on membrane adjustment.

Prognosis

c8-6 **After membrane placement.**

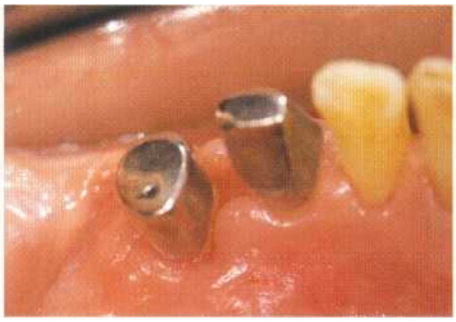


a. Twenty-two days after surgery. The membrane in the interdental area has become exposed.



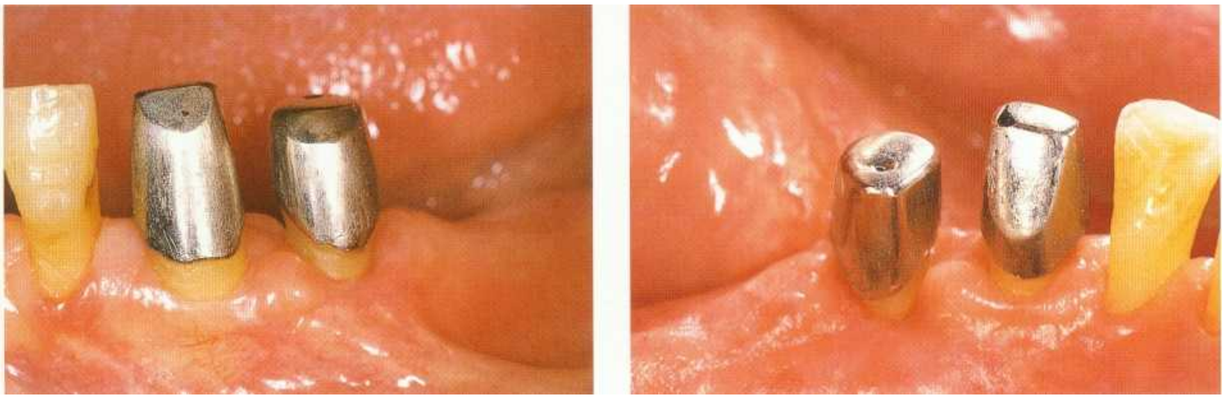
b. Fifty days after surgery. The exposed membrane has resorbed.

c. Seventy days after surgery. The exposed membrane has completely resorbed, and the interdental gingival crater is remarkable.



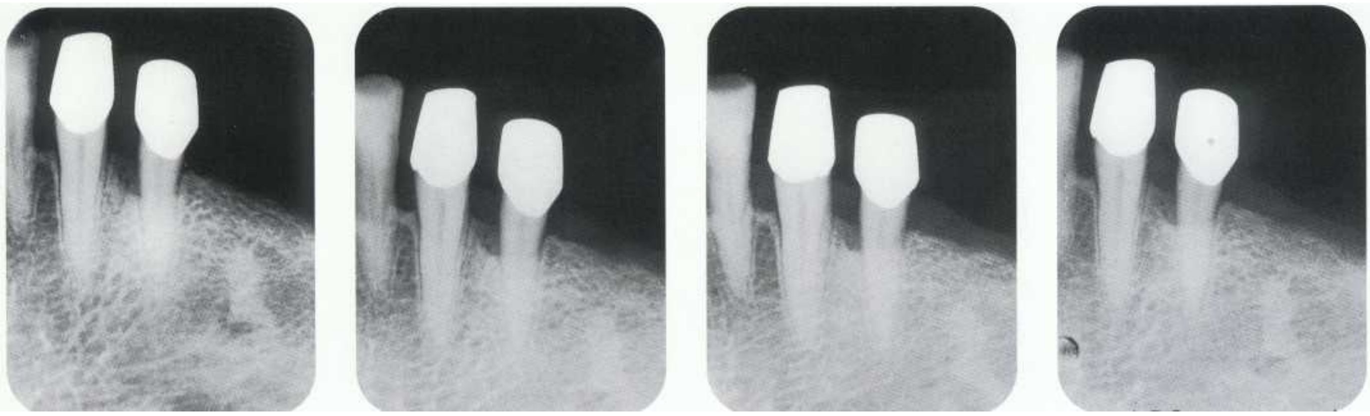
d. Eighty-four days after surgery.

e. Ninety-nine days after surgery. The gingival crater has improved.



f. Seven months after surgery. There is a slight gingival crater. The probing depth is 3 mm buccally and 3 mm lingually on the mesial aspect.

c8-7 Radiographic observation of prognosis.



a. Eighty-four days after surgery.

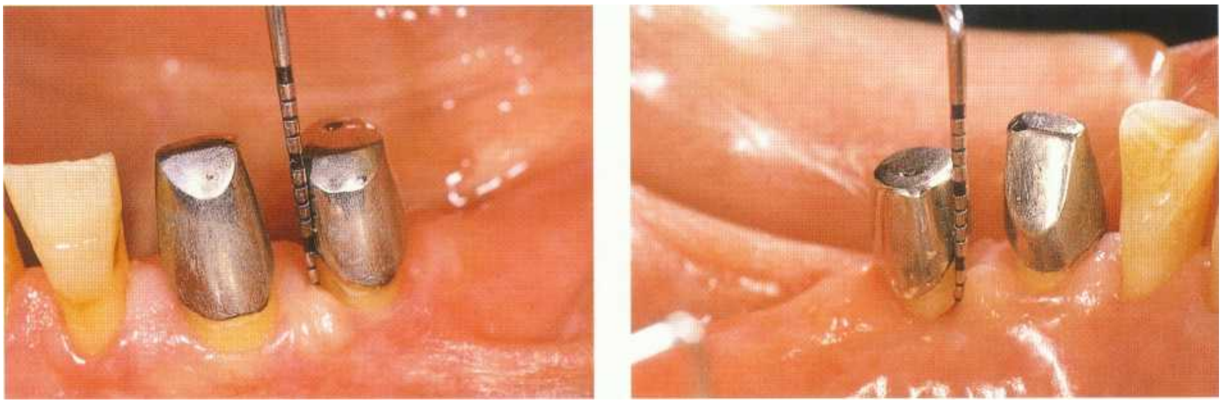
b. One hundred forty-nine days after surgery.

c. Two hundred twenty-eight days after surgery.

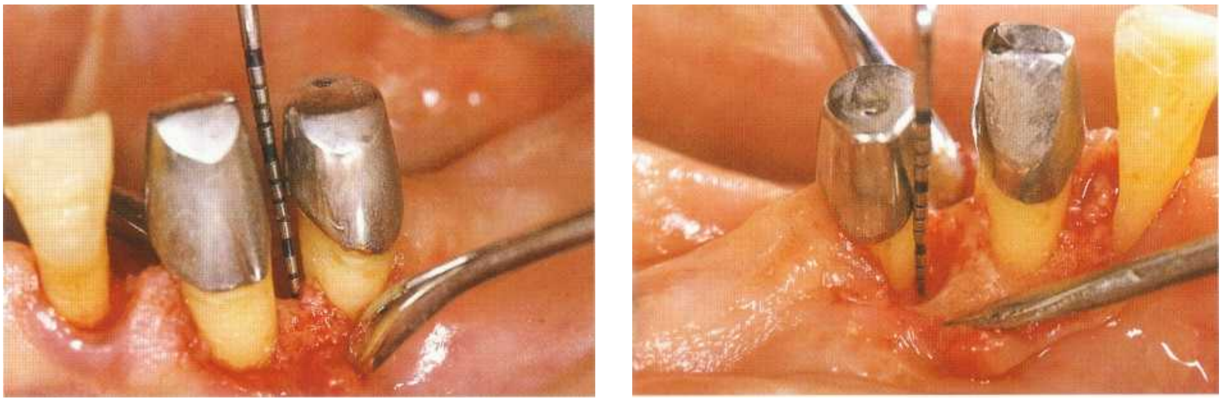
d. On re-entry 1 year and 2 months after surgery.

	Probing depth (mm)		Attachment level (mm)		CEJ–osseous defect (mm)		CEJ–alveolar crest (mm)		Depth of osseous defect (mm)	
	BM	LM	BM	LM	BM	LM	BM	LM	BM	LM
Before surgery	5	7	5	7	8	14	2.5	6	5.5	8
Re-entry (1 y, 2 mo)	2	3	4	5	6	8	3	6.5	2	1.5
Attachment gain			1	2						

c8-8 **Re-entry.**



a. One year and 2 months after surgery, immediately before re-entry.



b. Note approximately 3 mm of bone regeneration on the buccal aspect and 6.5 mm on the lingual aspect.

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5

Guided Bone Regeneration

What Is Guided Bone Regeneration?

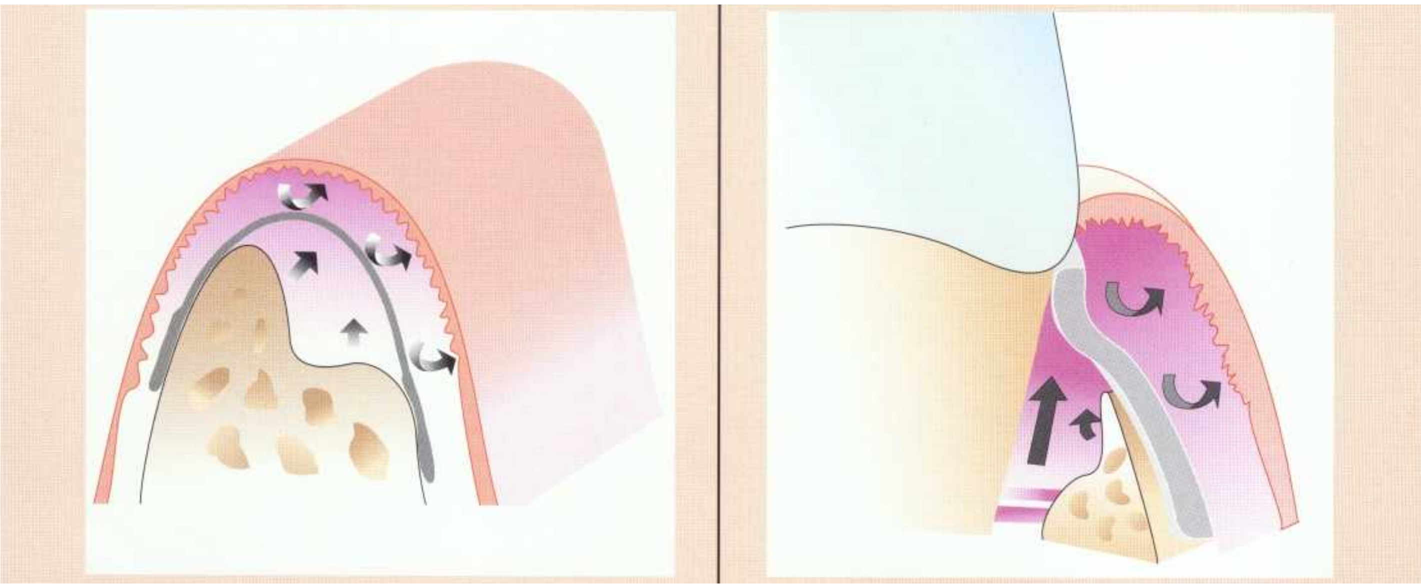
Implant therapy, based on the principles of osseointegration, has become highly predictable." It is now possible to place the most suitable fixture from esthetic and functional perspectives. Implant success depends on establishing an environment in which bone remodeling can occur, with close contact of the fixture surface and bone. For this reason, optimizing the condition of the recipient site was sought following principles of guided tissue regeneration (GTR); this technique is called guided bone regeneration (GBR).

In GBR, the osseous defects are covered with a barrier membrane, which is adapted closely to the surrounding bone surface. Nonosseous cells (epithelial cells and fibroblasts) are inhibited and space is preserved between the bone surface and membrane. Osteoblasts derived from the periosteum and bone are selectively induced on the osseous defect area, facilitating new bone formation.

Fig 5-1 GBR and GTR.'

GBR

GTR



GBR:

- Wound completely covered by flap (closed system)
- Sterile condition maintained during healing
- Membrane stable
- Adaptation of membrane easy
- Spacemaking easy
- High predictability

GTR:

- Open wound (open system)
- Sterile condition not maintained
- Membrane stabilization difficult
- Adaptation of membrane difficult
- Spacemaking difficult
- Low predictability

While GTR is for the regeneration of periodontal tissue of natural teeth (root cementum, periodontal membrane, alveolar bone), GBR is for the regeneration of supporting bone. In GTR, the membrane is exposed and a closed wound is hard to achieve because GTR is applied to the teeth. In GBR, on the other hand, the wound can be completely covered. Because of less membrane exposure, the chance of infection is decreased making bone regeneration highly predictable.

GBR makes it possible to optimize fixture installation from esthetic and functional perspectives, widening the indications of implant therapy.

Many studies on bone regeneration using membranes have been reported. Dahlin et al' reported on the use of an expanded polytetrafluoroethylene (e-PTFE) barrier membrane with the fixture partially exposed at the bone surface. In this experimental rabbit study, the bone and fixture were covered with an e-PTFE barrier membrane on the experimental side; on the contralateral side, the flap was closed without a membrane. Results revealed that on the experimental side, all exposed screw threads were covered with new bone, but little bone regeneration was observed on the other side (mostly connective tissue was gained). In other studies, the fixture was placed in the socket immediately after extraction and covered by an e-PTFE barrier membrane to preserve space for the formation of a blood clot and new bone. As a result, new bone was observed around the fixture. Using a membrane, it is possible to place a fixture immediately after extraction.

Also reported" was the use of an e-PTFE membrane in dehiscence or fenestration bone defects around the fixture on installation to facilitate bone regeneration (osseous defect average 4.7 mm on fixture placement and 1.1 mm on re-entry). Membrane use contributed to implant osseointegration.

Buser et al introduced surgical procedures using autogenous bone grafts with a supporting screw to achieve localized ridge augmentation.

GBR using a barrier membrane has become widely used for bone regeneration of osseous dehiscences and fenestrations and for localized ridge augmentationand immediate implant placement.','

When determining the amount of bone required for a fixture site, not only the vertical height but the buccolingual width of the bone should be considered. The fixture should contact cortical bone as much as possible, and at least 1 mm of bone should remain on the buccal and lingual aspects of the fixture. Therefore, it is necessary to have 5-6-rum bone width and 7 mm of bone vertically around the fixture. However, areas requiring implants often fail to meet these conditions.

If the fixture is placed in an area without sufficient bone width, there is the risk of a dehiscence or fenestration at the fixture site due to resorption of the alveolar ridge. In an area with insufficient bone, fixture placement position and path of insertion may be compromised, resulting in suboptimal function and esthetics. Alveolar ridge augmentation using GBR enables the fixture to be properly positioned in depth and direction, widening the scope of implant indications and making functional and esthetic results possible.

Guided Bone Regeneration in Implant Therapy

GBR in implant therapy is especially useful for fixture placement with dehiscence defects or fenestration defects. In alveolar ridges with marked facial/buccal depressions or in knife-edge alveolar crests, the position and direction of fixture placement is restricted. Improvement of alveolar ridge morphology becomes possible, however, with GBR.

Fixture placement in extraction sockets was once considered unpredictable because it is difficult to achieve reliable primary stabilization and to position the fixture neck properly against the bone. However, GBR increases the predictabil ity of bone regeneration, as it preserves the height of the alveolar bone lost in the healing of an extraction socket. Hence immediate implant placement using GBR is used increasingly. Immediate implants using GBR and fixture placement after postextraction mucosal healing are described later in the chapter.

Simultaneous Approach and Staged Approach

There are two approaches to GBR in implant therapy: GBR at fixture placement and GBR before fixture placement to increase the alveolar ridge.

1. Simultaneous approach Fixture placement and GBR are performed simultaneously to create increased bone around the fixture.
2. Staged approach-GBR is used to increase the alveolar ridge or improve ridge morphology before fixture placement. The fixture is placed after healing.

Buser et al' `" stated that the simultaneous approach is indicated only when the osseous defect around the fixture is not extensive and proper prosthetic placement and good primary stabilization can be achieved.

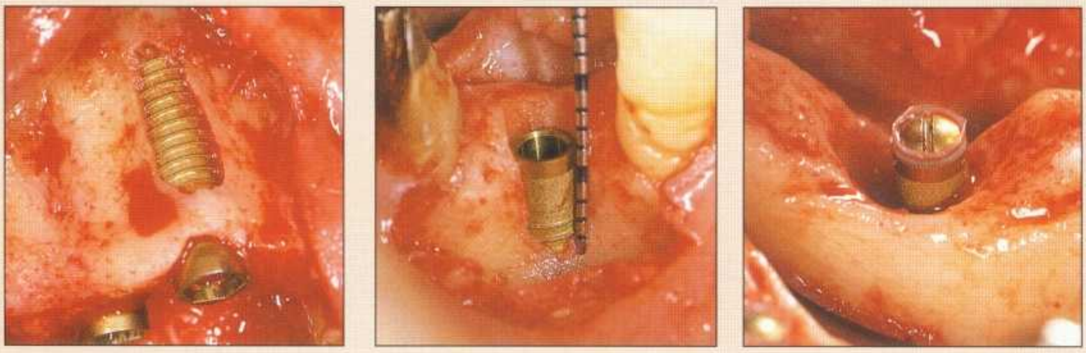
If these conditions are not met, localized ridge augmentation using GBR before fixture placement is necessary. Belser described the procedure guidelines, based on the width of the bone defect for a single tooth (Table 5-1).

Table 5-1 Treatment Guidelines in Maxillary Anterior (Single Tooth)[29]

	Width of bone defect	Treatment	
Class I	> 5.0 mm, no atrophy on buccal bone	Possible to place buccolingually in ideal position	Provide ideal emergence profile
Class II	> 5.0 mm, slight atrophy on buccal bone	Place palatally	Provide ridge-lap shape for a restoration
Class III	< 5.0 mm, osseous defect-like crater on buccal aspect	GBR simultaneous approach	
Class IV	< 5.0 mm, large and flat osseous defect	GBR staged approach	

Fig 5-2 Indications for GBR in implant therapy

Indications for simultaneous approach

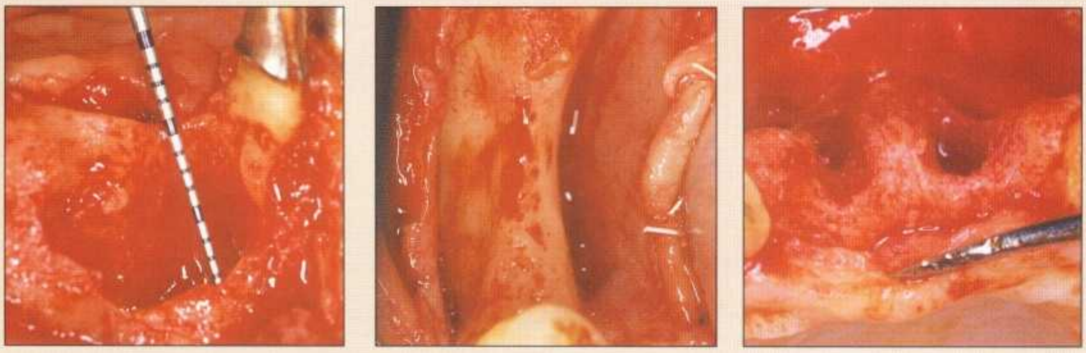


a. Fenestration defect on fixture placement.

b. Dehiscence defect.

c. Fixture head project from bone margin or a large space around extraction socket wall.

Indications for staged approach



d. Major damage of extraction socket on extraction.

e. Extreme facial or buccal collapse or knife-edged alveolar crest morphology restricting the position and direction of fixture placement.

f. Marked resorption of the alveolar process.

Indications of the Simultaneous Approach

Because facial or buccal collapse may occur in the extraction sockets of anterior teeth, dehiscence or fenestration defects may result. In the simultaneous approach, bone is regenerated using a barrier membrane in the osseous defect around the fixture.

If more than one wall around the fixture is lost and if more than 5 mm of fixture surface is exposed through dehiscence or fenestration defects a membrane should be used (Fig 5-2a, b). Bone regeneration using a barrier mem brane is also necessary when there is space between the extraction socket wall and the fixture or the fixture head projects from the bone margin (Fig 5-2c).

In marked resorption of the alveolar process, the fixture must be placed facially or buccally to the alveolar process due to the maxillomandibular relationship. In such cases, GBR is necessary. However, if the bone around the fixture is thin, complete bone regeneration on the fixture surface may not be achieved even if GBR is used. In these cases, the treatment plan should be changed to the staged approach, in which the fixture is placed after ridge augmentation.

Advantages of the Staged Approach

In the staged approach, the bone regeneration mechanism is activated on GBR surgery and on fixture placement. Additionally, compared to the simultaneous approach, larger bone surface can contribute to the formation of new bone. A more favorable bone bond is expected because osteoblasts need travel a lesser distance to the fixture surfaces after bone augmentation.

Surgical Technique for Guided Bone Regeneration

Spacemaking

In any surgical technique, it is important to avoid postoperative dead space. However, in GTR or GBR using a barrier membrane, space is made intentionally to be filled by blood clot. Especially in GBR, where bone regeneration is sought, Spacemaking with a barrier membrane is critical." [14,'s,'a,20,27,30-3e] This space should be maintained during healing and the membrane should be stable, but space may be lost because the membrane may be pressed by the soft tissue covering the membrane, leading to membrane collapse and insufficient bone regeneration.

In clinical studies'() [12] of bone regeneration in fenestration defects around fixtures, bone regeneration was insufficient where the membrane contacted the exposed fixture surface directly. The investigators indicated that the space avail able influenced the amount of bone regeneration and restricted its range. Therefore, various methods have been developed to prevent membrane collapse and to preserve and maintain space (Table 5-2). Placing various bone graft materials under the membrane or using mechanical support by screw, pin, or frame for membrane support are among the methods used (Figs 5-3 and 5-4).

Autografts are the best material for Spacemaking because of high biocompatibility and ease of resorption and replacement by new bone. One stud [y-3-1] of' bone graft materials for Spacemaking compared four conditions:

1. The use of e-PTFE membranes with autogenous bone grafts
2. The use of e-PTFE membranes with DFDBA (demineralized freeze-dried bone allograft)
3. The use of e-PTFE membranes with Grafton DBM. (Musculoskeletal Transplant Foundation)
4. The use of e-PTFE membrane alone for a fixture placed in a comparatively new extraction socket

Denser and greater amounts of bone formation were observed in autogenous bone grafts 6 months after surgery. Also, more bone regeneration was observed in areas where Spacemaking materials (autograft, DFDBA, Grafton DBM) were used than in areas where only an e-PTFE membrane was used. Autografts are the best material for spacemaking, but the amount of graft material that can be harvested from the oral cavity is limited. For this reason, Nevins and Mellonig recommended the use of DFDBA.

Buser et al introduced the method in which autogenous grafts are placed under membranes and miniscrews used to fix them. They also introduced the technique of the combined autogenous graft block (consisting of cancellous and cortical bone) and a supporting screw for ridge augmentation in large defect areas. WL Gore, which manufacturers the e-PTFE membrane, developed the titanium-reinforced (TR) membrane. The TR membrane enables the membrane to form according to the shape of the osseous defect, and a large space can be created by bending the titanium frame. The stiffness resists membrane collapse caused by external soft tissue pressure during healing (Fig 5-4).

Jovanovic et al" used the TR membrane in an animal study and evaluated bone regeneration in three groups, including 1) group using TR membrane; 2) group using Gore-Tex augmentation material (GTAM); and 3) group using no membrane.

They reported a marked gain of alveolar bone width with the TR membrane. Another group experimented with vertical ridge augmentation using only the TR membrane. They reported 3-4 mm of vertical bone regeneration. Tinti et al demonstrated an average of 5 mm of vertical bone regeneration 12 months after surgery by GBR using TR membrane and autogenous grafts harvested by a bone filter. Another study reported three cases of localized ridge augmentation using resorbable pins to gain sufficient bone for fixture placement. These pins, used in orthopedics, are used as a support for a tent for spacemaking. While membrane exposure was observed, enough new bone was gained to place implants in the ridge defect area. Biopsy also revealed new bone formation.

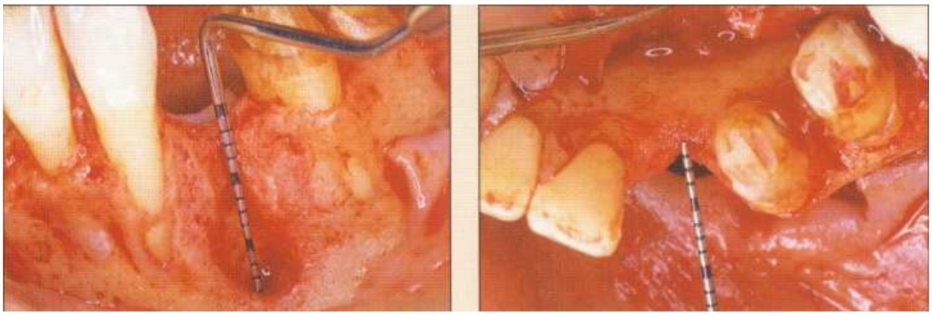
Bone regeneration occurs without bone graft materials if the space under the membrane and stability of the blood clot are maintained. It is needless to say, however, that space is maintained for sure if bone graft materials are filled under the membrane, even in cases when there is bone wall around defects and only the membrane seems to be enough for spacemaking. Therefore, the author usually uses bone graft materials with a TR membrane for best results.

Table 5-2 Bone Defect Morphology and Method of Spacemaking

Indication	Approach		Method of spacemaking
Osseous dehiscence			
Osseous fenestration	Simultaneous	Easy	Only membrane
		Insufficient	BG + membrane
			TR membrane
Localized large bone defect	Staged		M. sup. + BG + membrane
			TR membrane
Extraction socket			
Too large for a fixture	Simultaneous	Easy	Membrane only
		Insufficient	BG + membrane
Less resorption bone crest	Simultaneous		TR membrane
Large bone defect	Staged		BG + membrane
			M. sup. + BG + membrane
Alveolar ridge defect			
Faciobuccal collapse	Staged		BG + membrane
Knife-edged	Staged		TR membrane
Vertical defect	Staged		M. sup. + BG + membrane

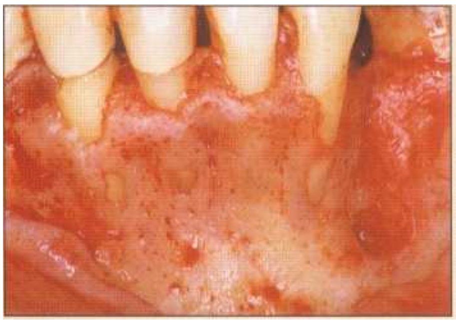
BG = bone grafts; M. sup. = mechanical support; TR = titanium-reinforced.

Fig 5-3 Spacemaking in staged approach 1.

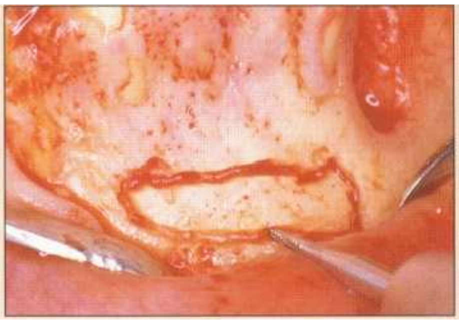


a. Note the complete loss of the facial bone plate of 22, the remarkable facial collapse, and the extremely narrow alveolar ridge. The buccolingual width of the ridge is about 1.5 mm, the depth of the facial osseous dehiscence defect is about 13 mm, and the mesiodistal width of the ridge is 5 mm.

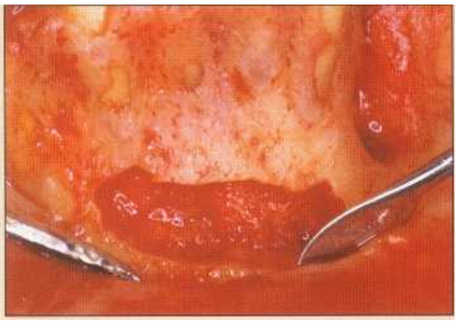
b-d. Harvesting of the autograft.



b. The chin area was chosen as the graft donor site because a large autograft was necessary for spacemaking.

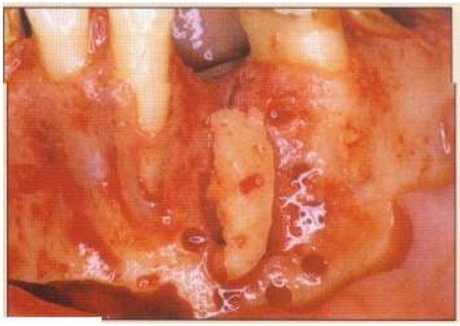


c. A small fissure bur is used to cut the cortical bone while physiologic saline solution is applied.

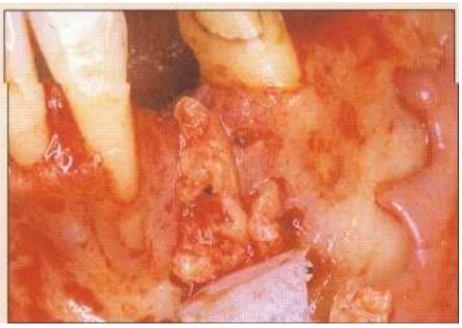


d. A bone chisel is used to harvest the bone block.

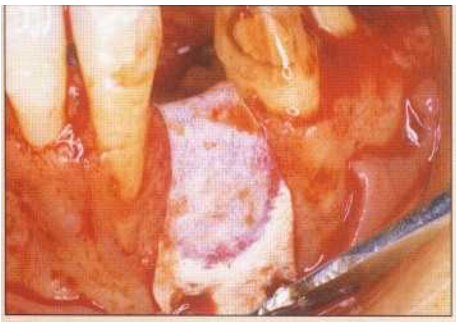
e-i. Bone graft and stabilization of membrane.



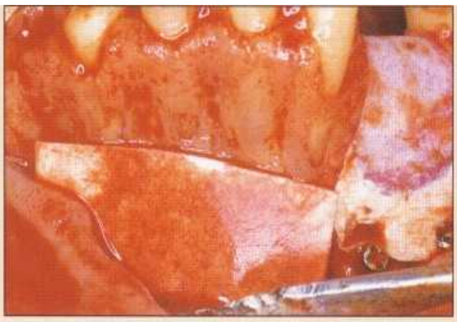
e. A small round bur is used to penetrate the cortical bone on the recipient site. A bone graft is then placed on the area of facial collapse.



f. A small bone chip is harvested from the donor site by bone curette and the defect filled.



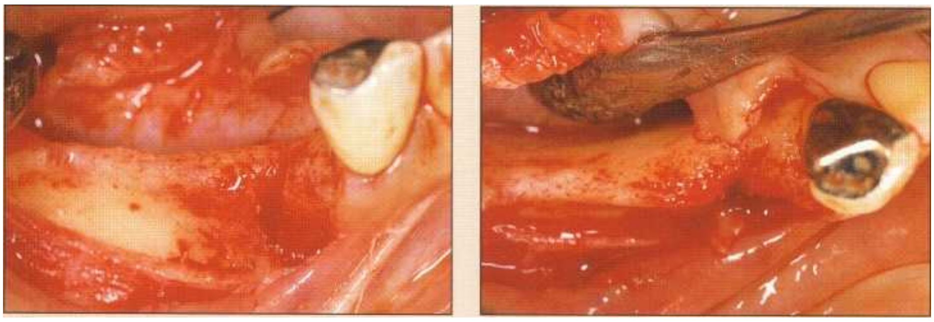
g. Oval 6 GTAM (WL Gore) is trimmed and the defect area is covered.



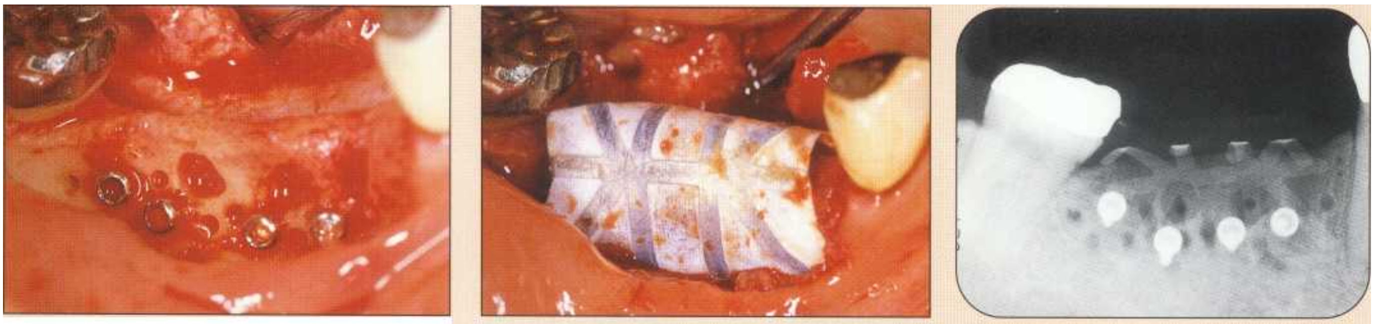
h. The donor area is covered with an absorbable membrane (GC) after bone harvest.

i. Six months after surgery. Sufficient bone has been obtained for fixture placement.

Fig 5-4 Spacemaking in staged approach 2.

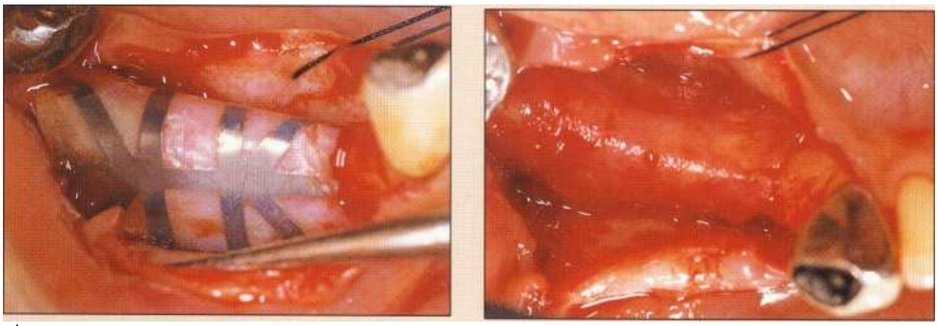


a. Note the dehiscence defect on the buccal aspect of the extraction socket of 28. The alveolar ridge between 29 **and 30 is narrow,** and buccal collapse is observed.



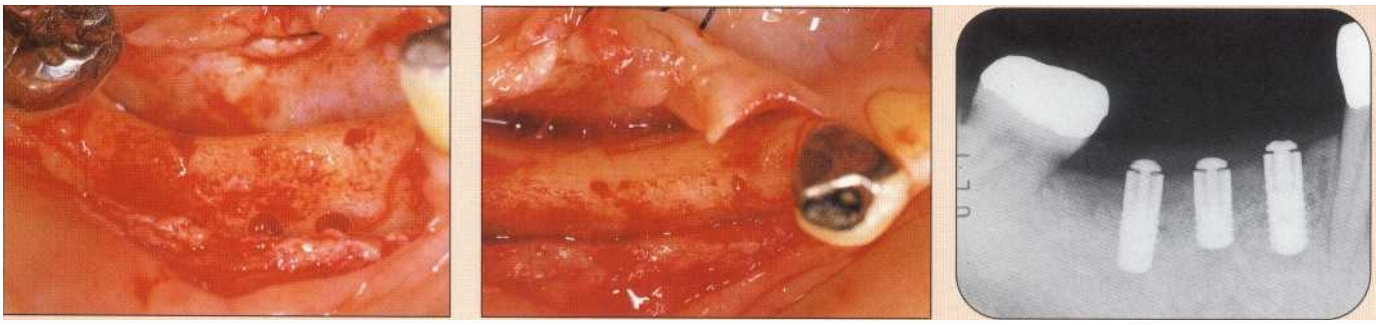
b. Four screws are placed in the collapsed area and the surrounding cortical bone penetrated for horizontal spacemaking and membrane support.

c. Bone graft is placed around the screw and covered with a titanium-reinforced (TR) membrane (WL Gore).



d. Eleven weeks after surgery on membrane removal.

e. New tissue under the membrane.



f. Seven months after GBR. Note the marked bone regeneration on the collapsed area of 29 and 30.

g. Three months after fixture placement (11 months after GBR).

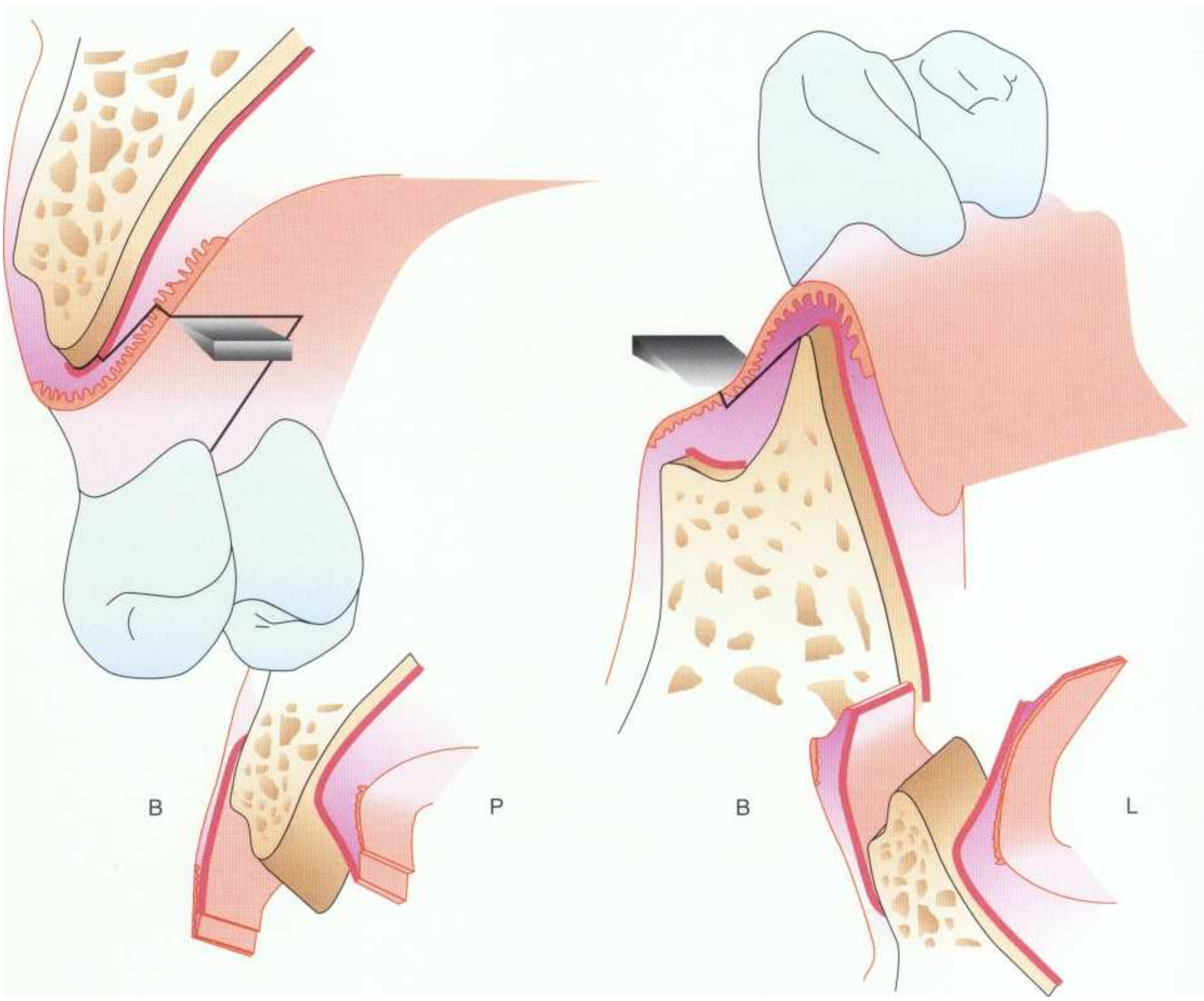
Flap Design

Flap design in GBR requires the covering of the membrane by thick soft tissue with sufficient blood supply and avoiding membrane exposure. Therefore, the flap must include sufficient keratinized mucosa and a mesiodistal extension of more than one tooth.

The vertical incision should be separated at least one tooth (5 mm) from the membrane margin, and its design should emphasize a large base of the flap by means of a divergent vertical relieving incision. Initial wound closure is neces sary to prevent membrane exposure. A midcrestal incision is conventionally used when there is sufficient keratinized mucosa in the edentulous ridge. Making the incision within the keratinized mucosa facilitates incision and suture with less postoperative swelling and discomfort. In the midcrestal incision, the incision extends mesiodistally and a full-thickness flap is made as thick as possible. The envelope flap should be made without a vertical incision, if possible, to maintain blood supply. However, usually the edentulous ridge is narrow and has insufficient keratinized mucosa.

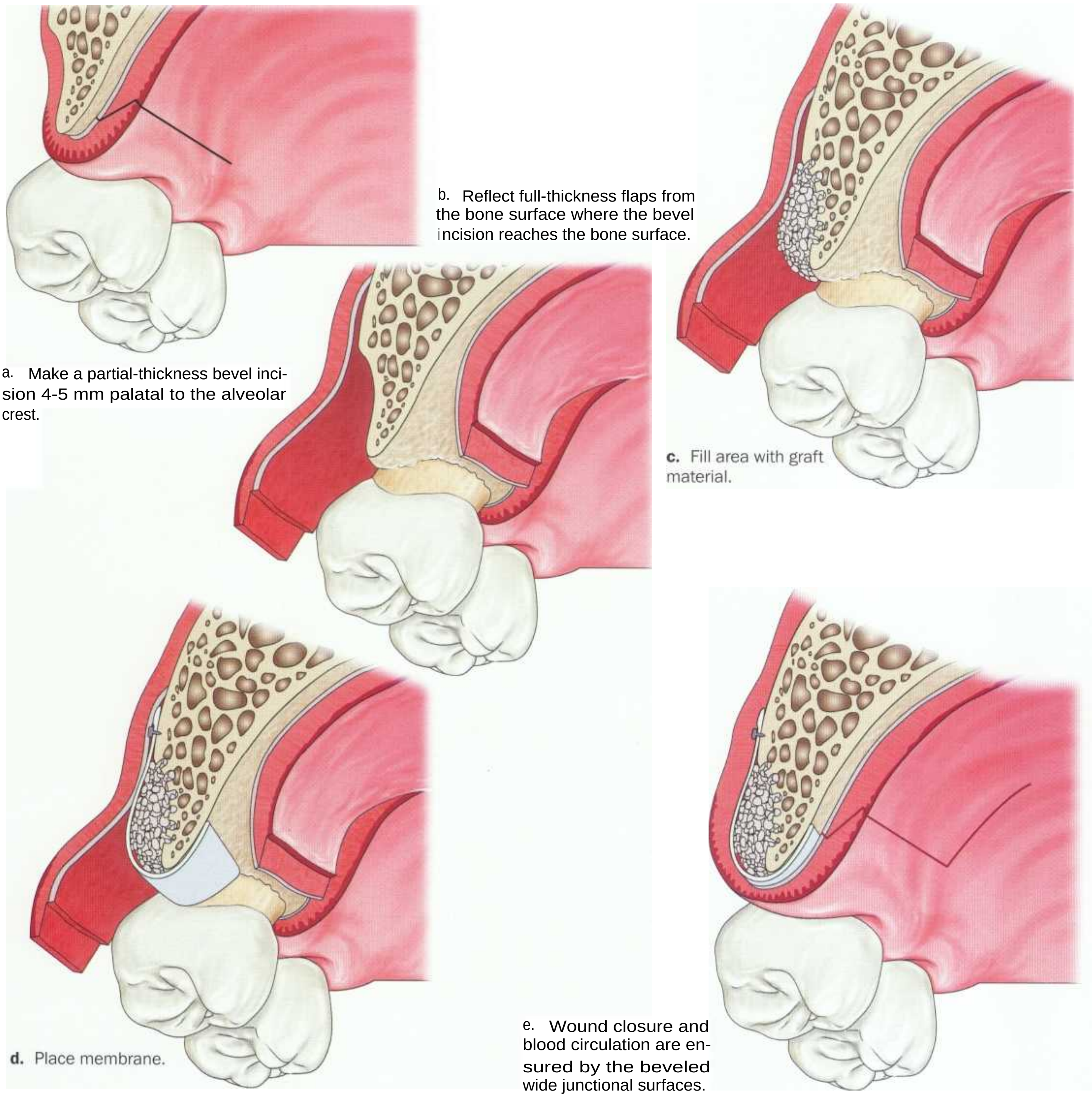
In such cases, it is difficult to obtain reliable primary closure with a midcrestal incision. For this reason, the lateral incision technique, in which a bevel is made on the junctional surface of the flap, facilitating surface contact, was developed (Fig 5-6)

Fig 5-5 Lateral incision technique.



In this technique, make a partial-thickness bevel incision to obtain a wide junctional surface. Make the incision 4-5 mm toward the palatal side of the maxillary crest or 4 mm below the buccal mucogingival junction of the mandibular crest, and prepare a partial-thickness flap. Reflect a full-thickness flap where the bevel incision reaches the bone surface. The wide junctional surfaces obtained by this technique overlap each other, yielding favorable wound closure. A soft tissue dehiscence sometimes occurs because of the tension on the junctional surface due to postoperative swelling; in this technique, however, dehiscence is unlikely because of the double closure. Restoration of blood circulation can be expected because the bevels of the wide junctional surfaces contact each other.

Fig 5-6 Procedures of the lateral incision technique.



a. Make a partial-thickness bevel incision 4-5 mm palatal to the alveolar crest.

b. Reflect full-thickness flaps from the bone surface where the bevel incision reaches the bone surface.

c. Fill area with graft material.

d. Place membrane.

e. Wound closure and blood circulation are ensured by the beveled wide junctional surfaces.

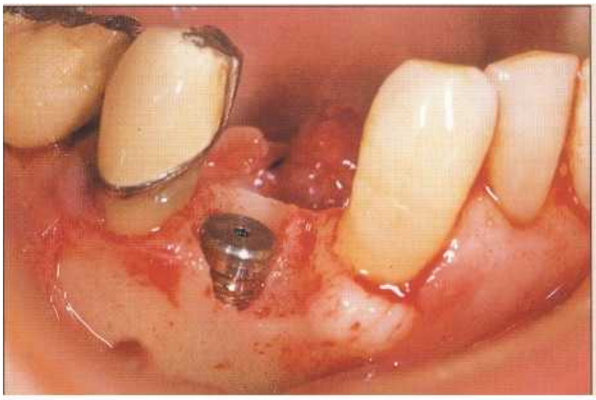
Membrane Trimming

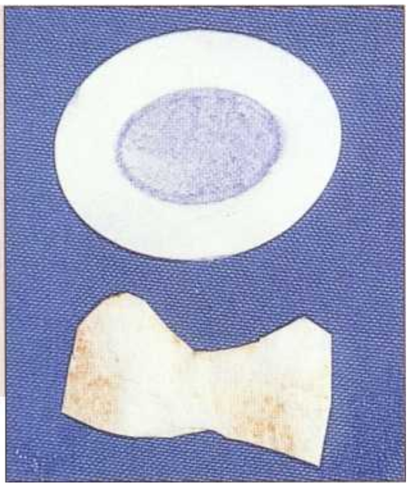
Membranes in GBR should be closely adapted and stabilized to the bone surface around the defect area to shelter the area thoroughly and to prevent cells not derived from bone from invading the tissue. Therefore, it is necessary to trim the membrane and to assure stabilization. With GTAM (WL Gore), the proper size membrane to cover the defect area completely by the inner portion is chosen, then the membrane is cut with 3-5-mm extension laterally and apically from the defect margin to obtain close adaptation to the bone. There should be 1-2 mm separation from the adjacent teeth to prevent infection of the gingival sulcus of these teeth. The membrane margin should be rounded to avoid flap perforation by sharp margins.

Membrane Placement and Stabilization

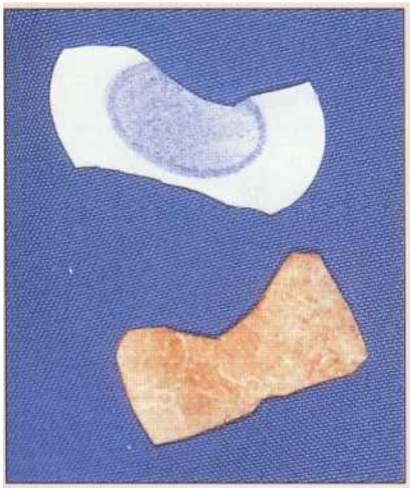
To achieve a predictable result of bone formation, it is important to create and maintain a secluded space underneath the membrane. Figures 5-8 and 5-9 show membrane stabilization with screws and use of autogenous bone grafts.

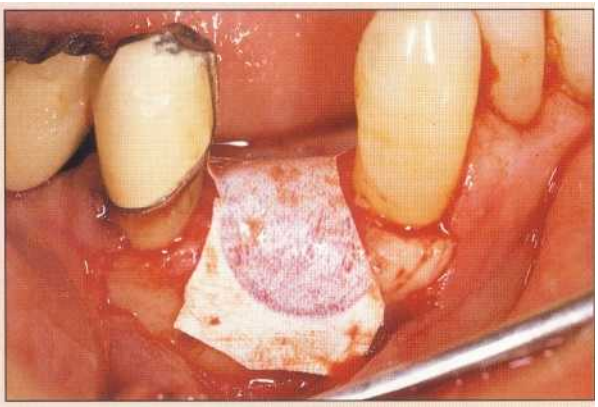
Fig 5-7 Membrane trimming (GTAM).





a. The sterile paper from the suture thread package is placed in the osseous defect area. It is trimmed to the proper size and a paper pattern made. The GTAM (Oval 6) is trimmed following the paper pattern. The pattern is used to avoid contamination of the membrane.

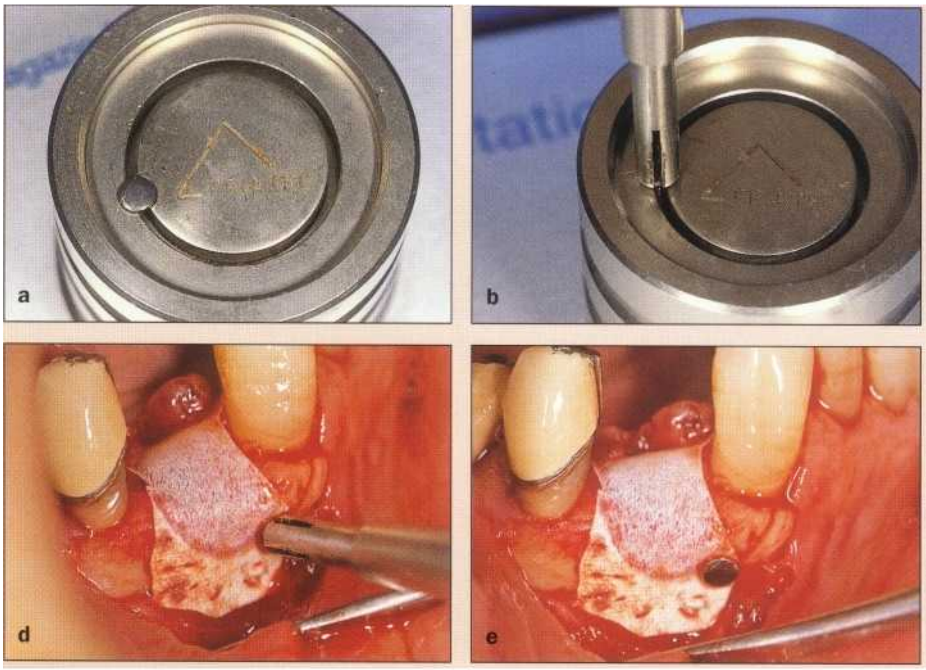




b. Trimmed membrane. The bone margin of the extraction socket is covered with a 3-5-mm extension. The inner portion should not be trimmed if possible.

Table 5-3 GBR Surgical Procedure[17,27]

1. Site selection
   - Sufficient keratinized mucosa to cover the membrane
   - Thick soft tissue to prevent membrane exposure
2. Application of the least invasive surgical procedure
3. Membrane stabilization and close adaptation to surrounding bone
4. Primary healing of soft tissue to avoid membrane exposure
5. Achievement and maintenance of spacemaking under membrane
6. Sufficient healing period for bone regeneration and maturation (6–12 months)
7. Thorough postoperative management during healing



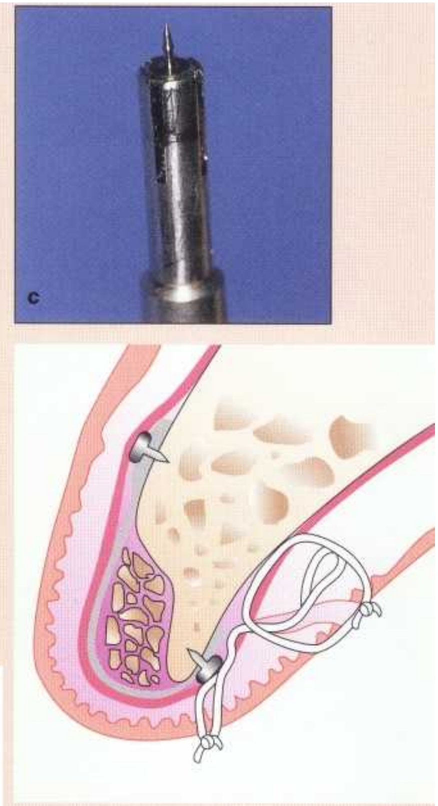
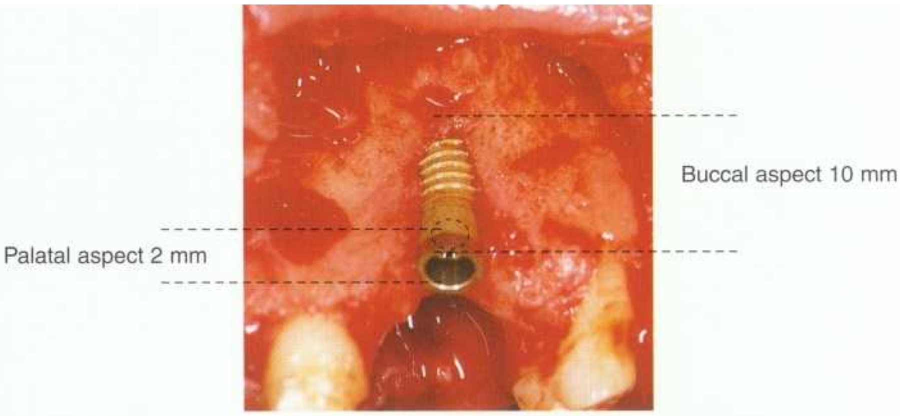


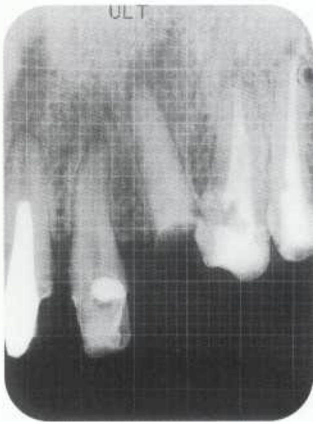
Fig 5-8 Membrane fixation. After membrane trimming, a screw is used to fix the membrane. In the Frios augmentation system (Friatec), an exclusive instrument is used to manipulate the sterile fixation screw. A membrane nail is placed on an attached magazine (a), picked up by the exclusive instrument (b, c), carried into the oral cavity (d), and driven into the proper position by tapping the instrument head lightly (e). Usually with this system, drilling is unnecessary to fix the titanium nail. Compared to other systems, treatment time is reduced because the membrane can be fixed by simply tapping. Removal is also easy.

Fig 5-9 Spacemaking. The autografts harvested from the bone are removed from the thread of the drill with a chisel and kept in physiologic saline water. The harvested bone is transplanted to the exposed fixture surface with a Molt bone curette. The osseous defect area and fixture are covered by the membrane, which is fixed at one end.

Case 5-1 GBR in dehiscence defects in the maxilla



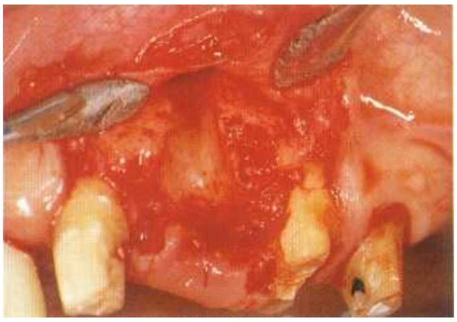




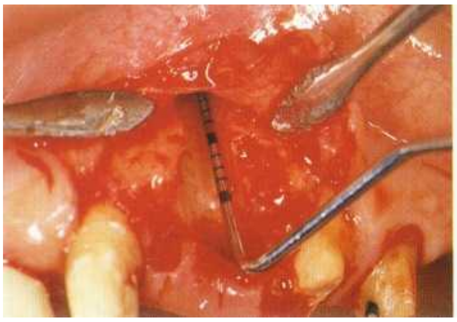
c1-1 Placement of provisional restorations 6 months after initial examination. Note the apical lesion on the residual root of 11 (41-year-old woman).

Extraction

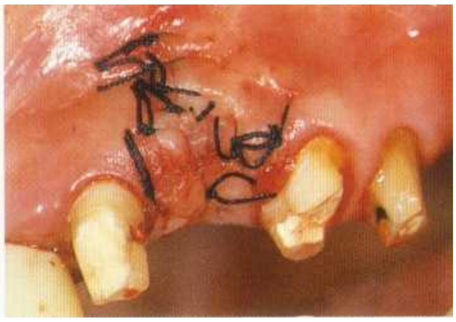
c1-2 Extraction.



a. A sulcular incision is made around 11 for a full-thickness flap. Tooth 11 is extracted without damage to the bone wall of the extraction socket.

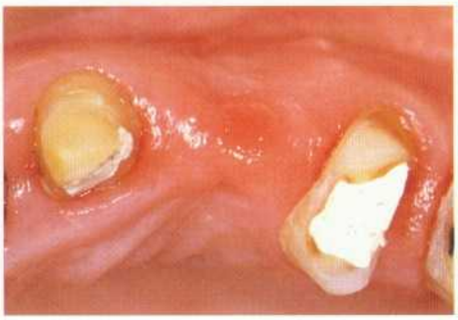


b. The buccal bone wall is destroyed to the level of the apex. Note the 15-mm deep and 5-mm wide osseous defect.

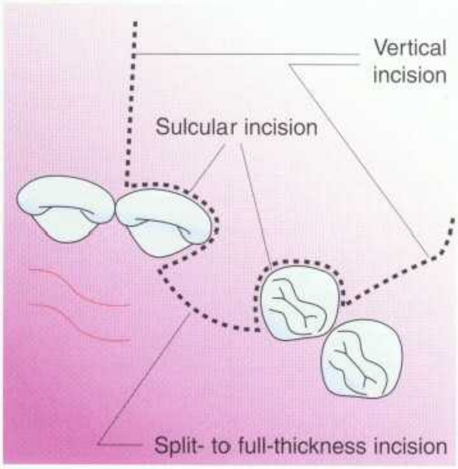


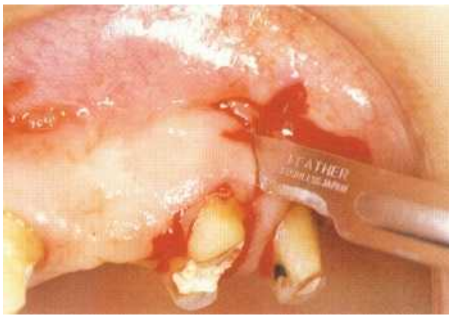
c. After thorough curettage of the extraction socket, the flaps are sutured.

Flap design

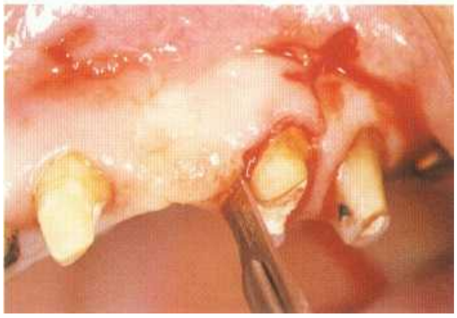




cl-3 Healing of the extraction socket. Six months after extraction, the extraction socket is completely closed. Note the soft tissue collapse on the buccal aspect of 11. The radiograph shows remarkable bone regeneration of the extraction socket.

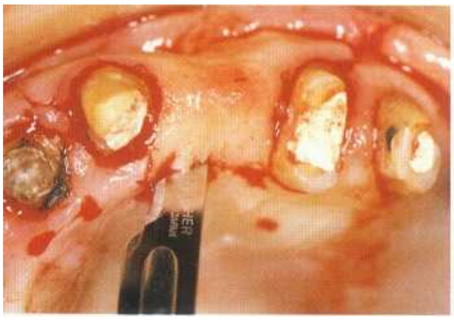




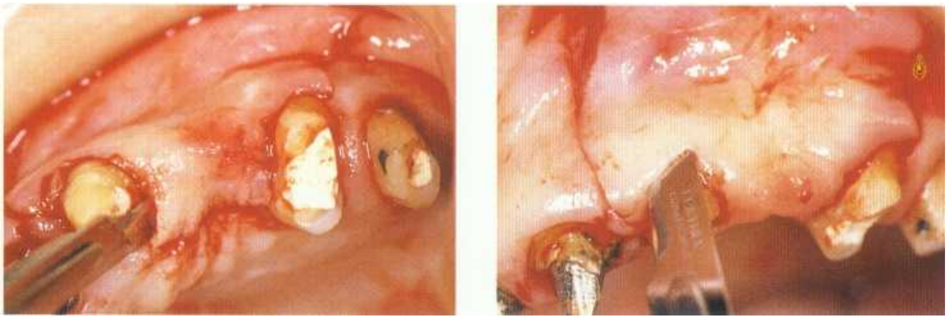
c1-4 Vertical incision. A no. 15 blade is used to make a fan-shaped vertical incision from buccolingual line angle one tooth from osseous defect area. This incision should cross the mucogingival junction and reach alveolar mucosa, and it should be broader at the base.



c1-5 Sulcular incision. The sulcular incision is extended palatally from the buccal aspect of 12.

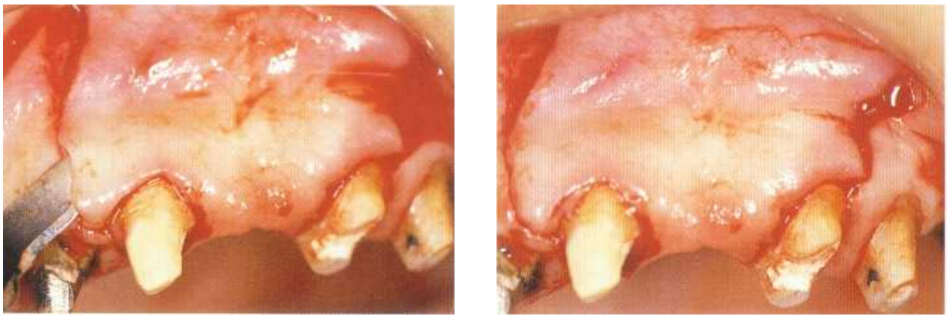


c1-6 Horizontal incision with partial thickness. A partial-thickness horizontal incision is made about 3 mm palatal to the alveolar crest (lateral incision technique). In this technique, the 2-3-mm tip of a no. 15 blade is used to make an incision toward the bone. Only the surface layer of the soft tissue is incised.



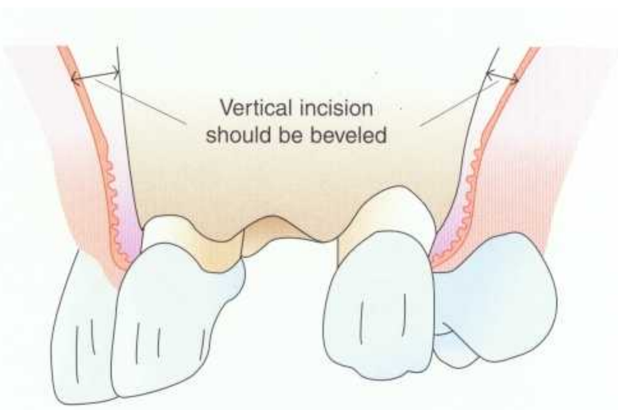
c1-7 Sulcular incision. A sulcular incision is made on the mesiopalatal, mesial, and buccal aspects of 10.

c1-8 Extension of vertical incision. A vertical incision, which is more than 5 mm from the membrane margin and avoids the interdental papilla, is made on the mesiobuccal line angle of 10. A large flap that extends more than one tooth mesiodistally is prepared.



Key point

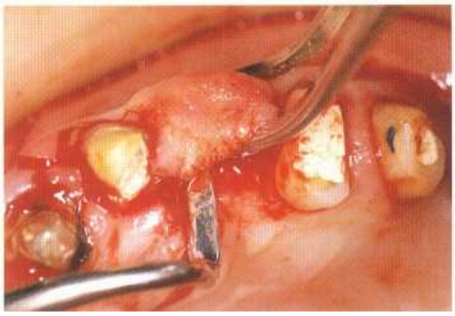
To obtain optimal wound closure, make the vertical incision a bevel incision in which the blade tip is not perpendicular to the bone. Extend the vertical incision sufficiently across the mucogingival junction to make flap mi-gr[illegible]



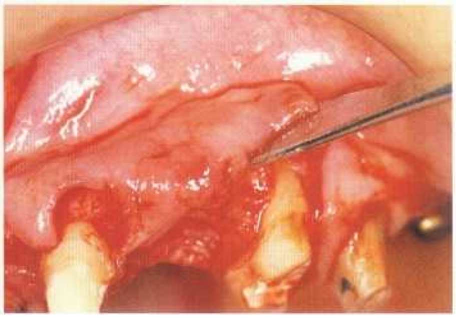
c1-9 *Lateral incision technique.*

a. Insert an Orban interdental knife into the horizontal incision portion of the partial-thickness flap.

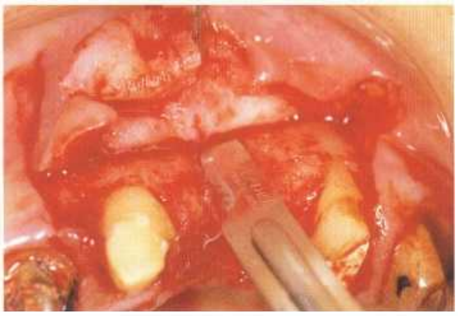
b. Advance the side of the blade along the in side of the flap to reflect the flap buccally.



c. The reflected flap is held with tissue pliers and the incision advanced with tension applied to the connective tissue attached to the periosteum. A partial-thickness flap is made near the alveolar crest while the side of the blade is adapted to the bone to avoid damage to the periosteum.



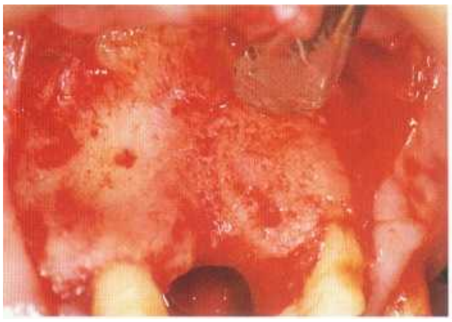
d. A full-thickness flap is carefully made on the buccal part of the alveolar crest with a small periosteal elevator. The buccal flap (combined partial thickness and full thickness) is reflected and the bone surface exposed.



e. While the flap margin is pulled with tissue pliers, a no. 15 blade is brought to the periosteum to prepare a partial-thickness releasing incision of the periosteum on the alveolar mucosa of the flap base.

Key point

Prepare a partial-thickness releasing incision of the periosteum on the flap base. This enables the flap to move coronally for membrane coverage and primary closure without flap tension on wound closure.



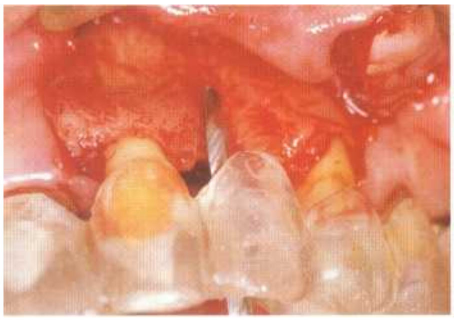
f. The buccal flap is reflected beyond the mucogingival junction.

g. The palatal flap is reflected with full thickness.

Fixture placement

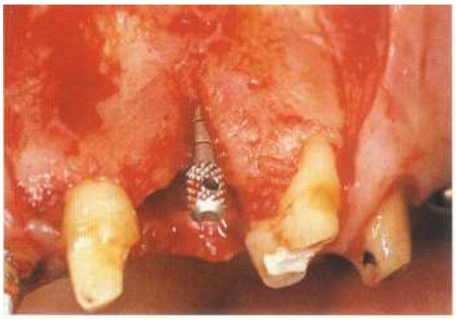
cl-10 Drilling.

a. Bone regeneration of the extraction socket is marked 6 months after extraction; however, the alveolar process is located about 3 mm buccopalatally. Note the osseous collapse on the buccal aspect.



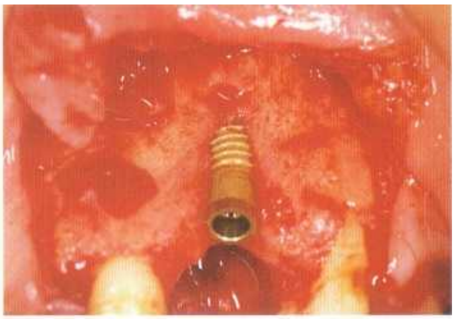
b. A surgical stent and drill are used to make a guide hole. A dehiscence defect is observed on the buccal aspect.

cl-11 Fixture placement.



a. Use an implant depth gauge of adequate length to assure direction and depth of guide hole on radiograph.

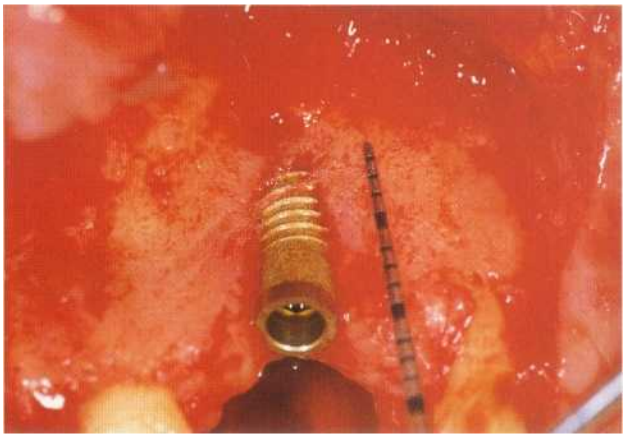
b. After gradual widening of the site, a final try-in of the trial guide is performed according to fixture diameter. The fixture is then installed.



c. Note the remarkable buccal dehiscence defect.

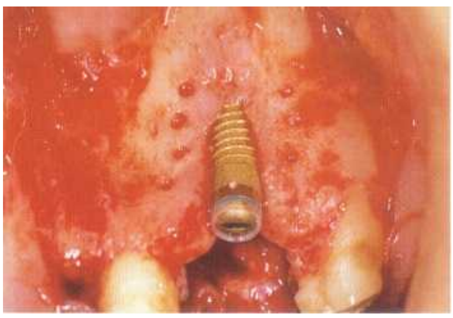
Membrane placement

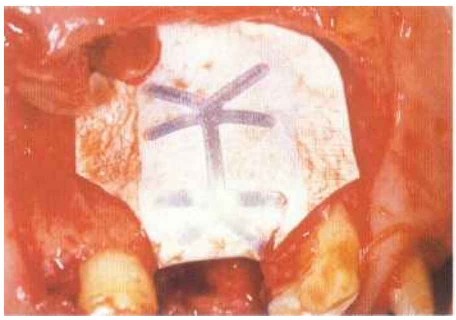
cl-12 Membrane trial.

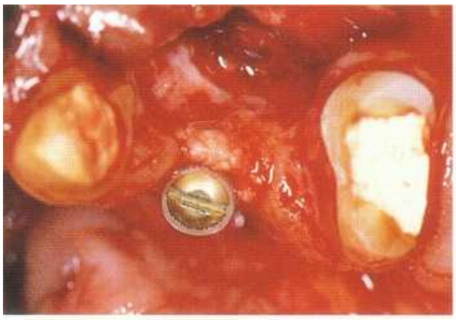
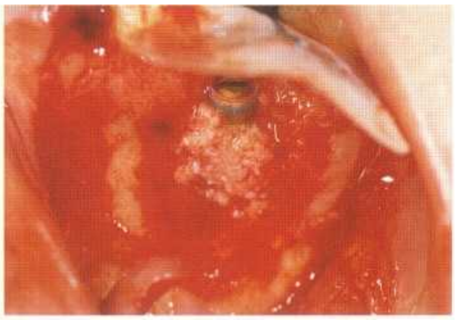


a. Rigid primary stability is obtained following the placement of a P01 three-piece-type implant (19-mm long, 3.7-mm diameter) on the narrow alveolar ridge. The dehiscence defect is 10 mm on the buccal aspect and 2 mm on the palatal aspect.

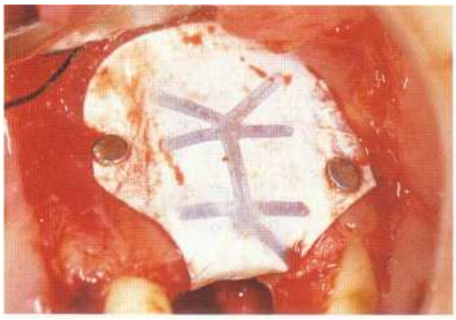
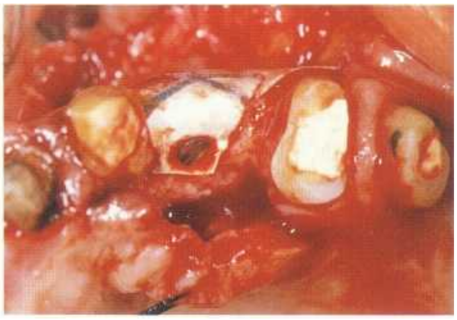
b. To induce bleeding on the cortical bone surface, a few spots of cancellous bone are penetrated with a small round bur. After the titanium-reinforced polytetrafluoroethylene (e-PTFE) membrane (TREY, WL Gore) is trimmed, the shape is adjusted with pliers and the membrane tried in. This membrane is easy to shape according to the shape of the osseous defect, and membrane collapse due to the pressure of the soft tissue during healing period is avoided.





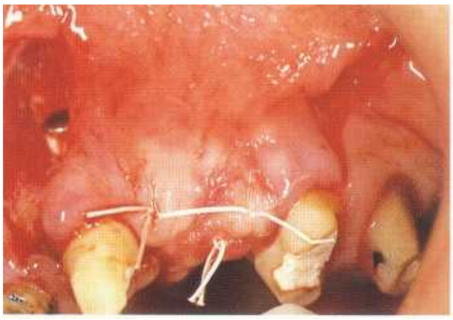




c1-13 Autografts. Bone chips on the drill are harvested and transplanted to the defect area. This helps stabilize the blood clot and preserve space between membrane and implant.

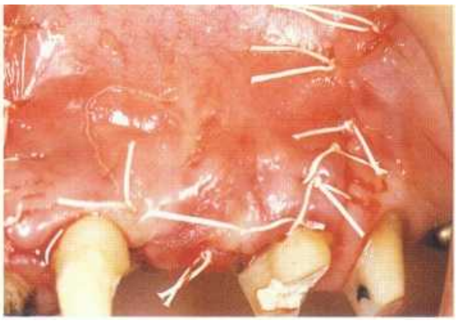



c1-14 Membrane fixation. Two Frios membrane nails (Friatec) are used buccally and one palatally to fix the membrane to reinforce membrane adaptation to the bone surface.

Flap suture



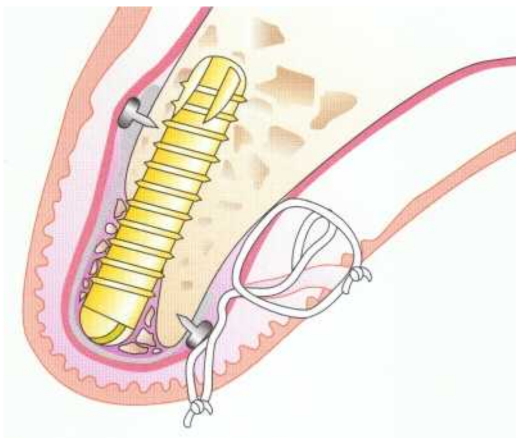
c1-15 Horizontal mattress suture. One horizontal mattress suture with Teflon (WL Gore) is made on the center of the horizontal incision area. One interrupted suture is then made on each the mesial and distal aspects to close the wound.

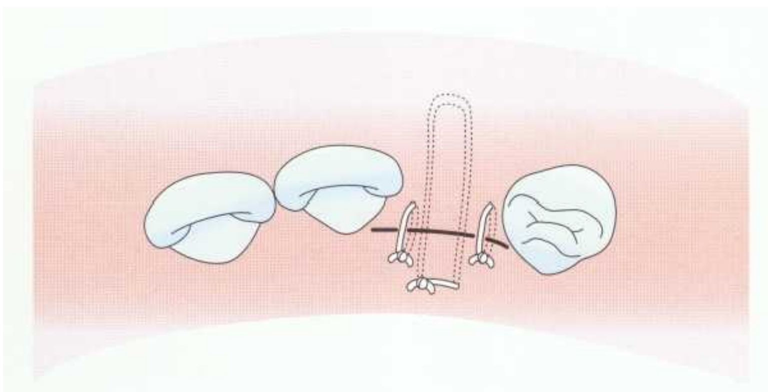


c1-16 Interrupted suture. An interrupted su ture of the vertical incision area is made.

Key po int

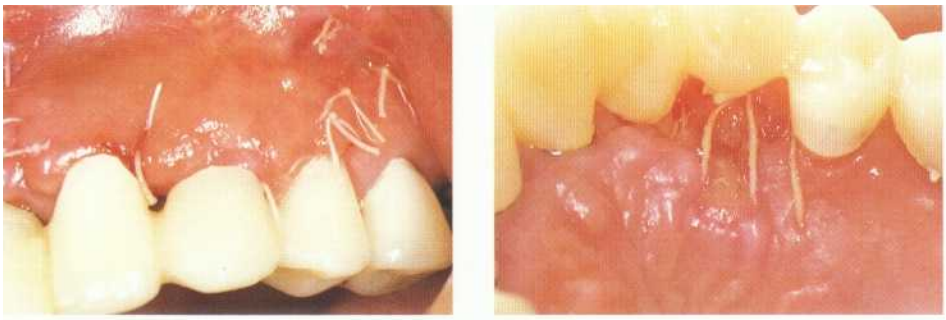
Mattress sutures enable buccal and palatal flaps to overlap with a wide connective tissue bevel, resulting in close adaptation and good recovery of blood circulation in the flaps. Mattress sutures also aid wound closure by avoiding tension on the flap margin due to postoperative swelling. Avoid tight ligatures.





Prognosis

cl-17 Prognosis.



a. Note the favorable healing without necrosis of the flap margin 8 days after surgery. The patient is instructed to brush the surgical area with an ultrasoft brush.

Key point
Make the poetic base shorter to avoid direct pressure on the membrane area during healing. Adjust it to avoid contact vtith the mucosa.

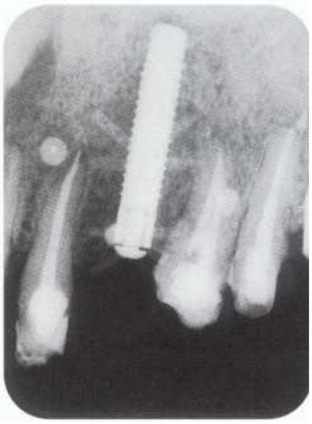
b. The suture is removed 15 days after surgery. The patient is instructed to use a soft brush.

c. Fifteen weeks after surgery.

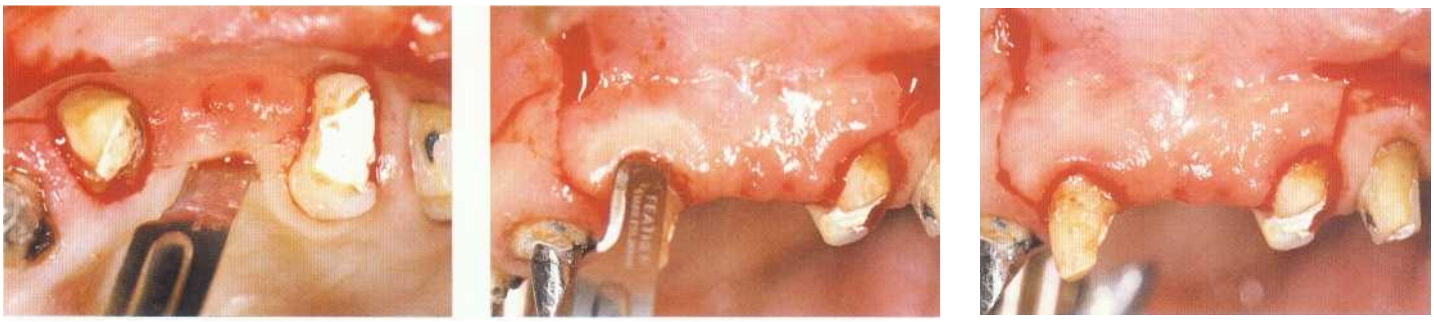
Second-stage implant surgery and membrane removal

cl-18 Seven and one half months after *GBR*.

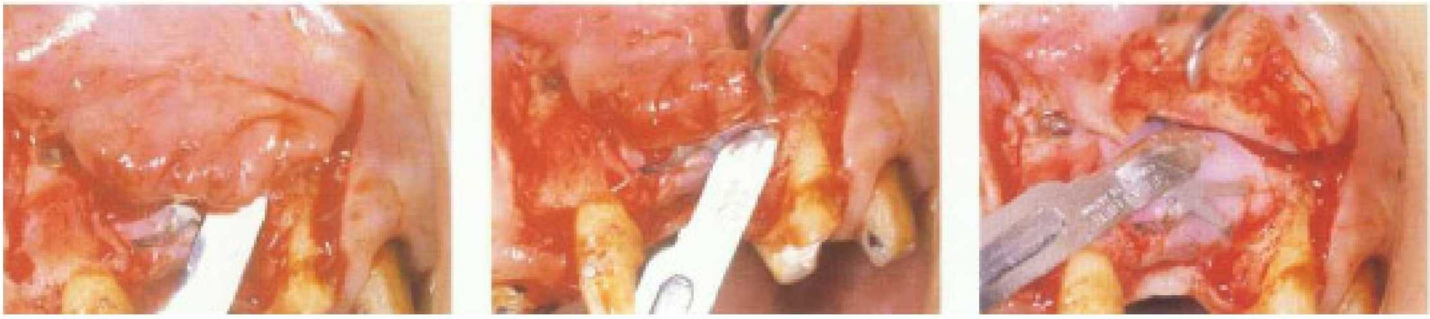
a. There is complete soft tissue coverage without complications.



b. Six months after surgery.

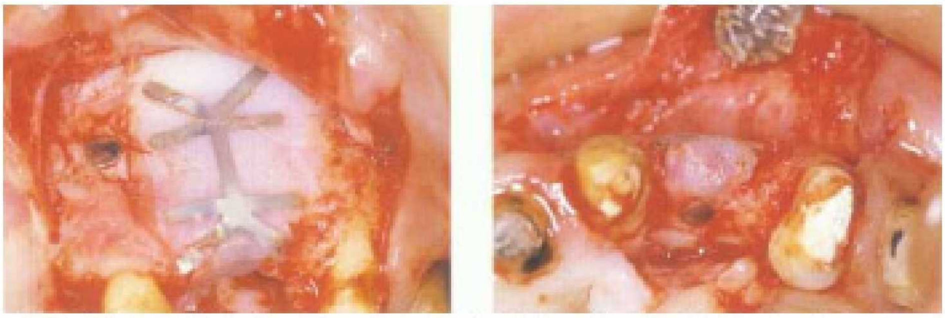


cl-19 Incision. A partial-thickness crestal incision is prepared on the slightly palatal aspect of 11. The incision is connected with the sulcular incision of the adjacent teeth. The incision is extended to the buccal of 10 and 12, and then two vertical incisions are made on the mesiobuccal line angle of 10 and the distobuccal line angle of 12.

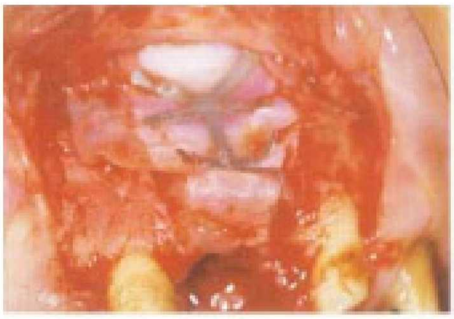


c1-20 Reflecting flap and membrane. A no. 15 blade tip (2-3 mm) is inserted into the crestal incision area and about 3 mm of flap margin is reflected with a partial-thickness incision while the gingiva is lifted with the side of the blade. The flap margin is held with tissue pliers to provide tension, and the side of the blade is adapted to the membrane and the flaps gently reflected from inside.

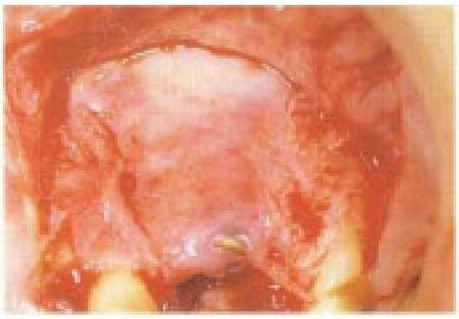
c1-21 Membrane removal.



a. The titanium-reinforced membrane is exposed after flap reflection. The semitranslucent condition (show-through appearance) is maintained without membrane collapse.



b. A curette is used to remove the membrane nail.

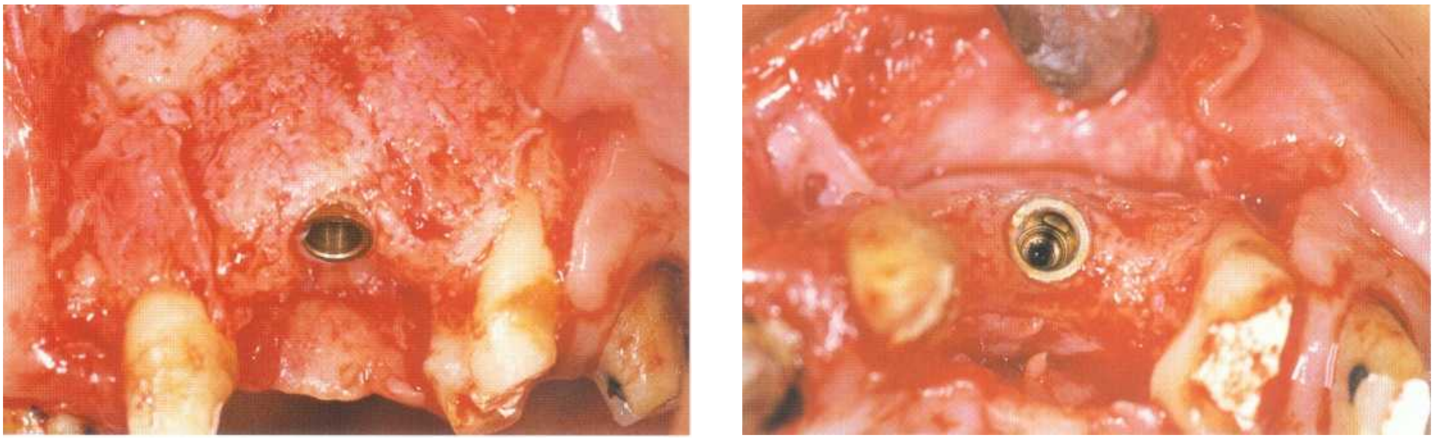


c. Note the soft tissue between the membrane and new bone on membrane removal.

d. The removed clean and semitranslucent membrane.

c1-22 New bone.

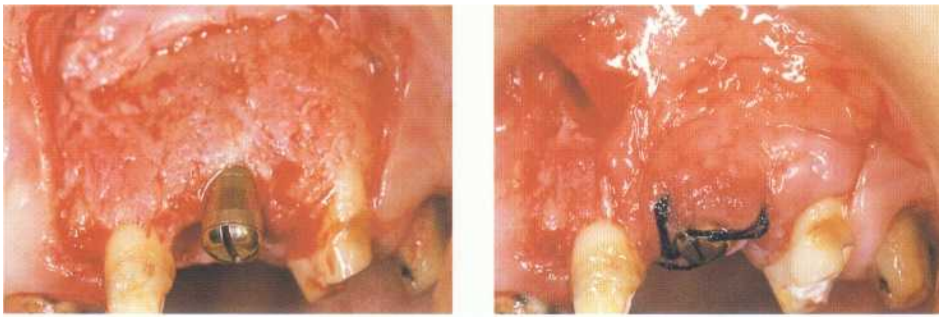
a. After removal of soft tissue, complete bone regeneration on the large dehiscence defect is seen. The buccal bone wall has sufficient thickness.



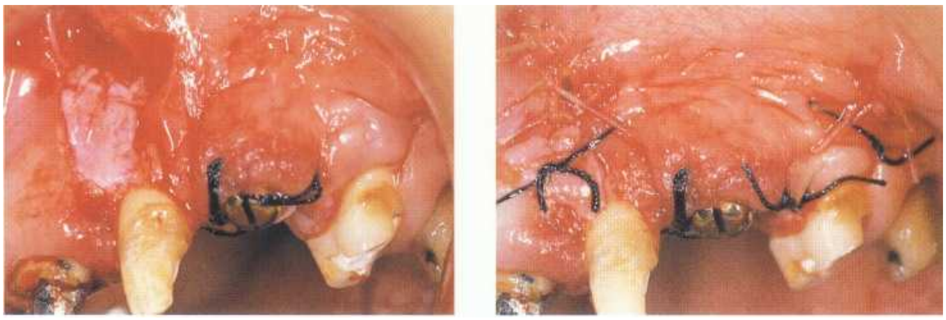
b. Buccal and palatal aspects after removal of fixture cap.

Abutment connection and suture

c1-23 Distal displacement of flaps. The buccal flap of 10 is displaced distally and sutured to connect the abutment and to obtain close adaptation of the flap margin to the abutment.



c1-24 Suture. The **connective tissue is displaced to** the exposed area on the donor site of 10 and sutured.

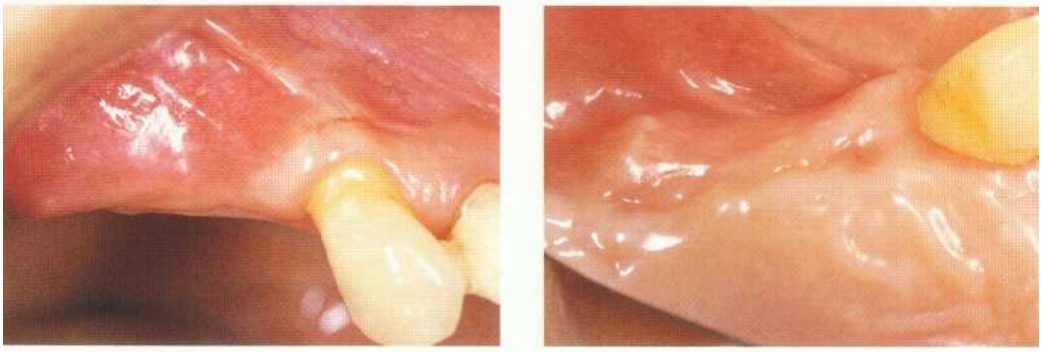


Prognosis

a. Three weeks after surgery.

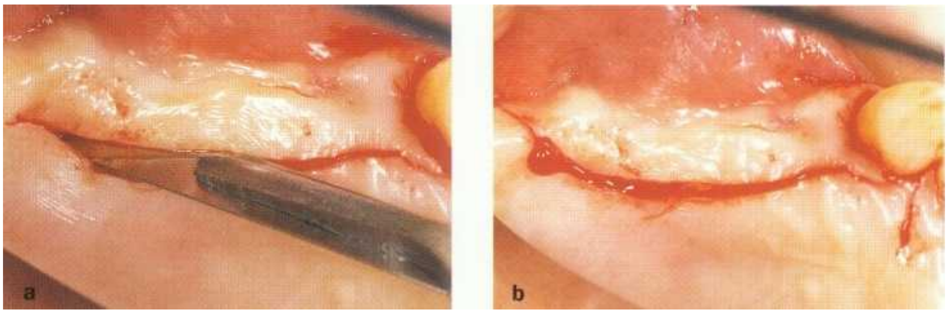
b. Four weeks after surgery.

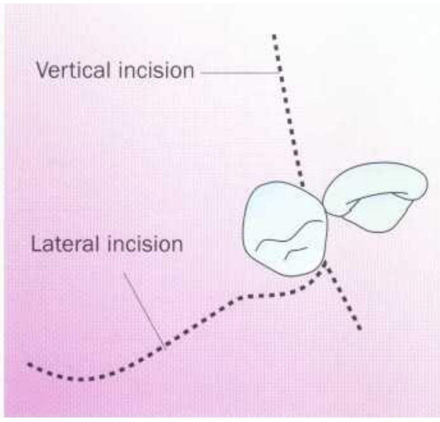
Case 5-2 GBR in fenestration defects in the maxilla



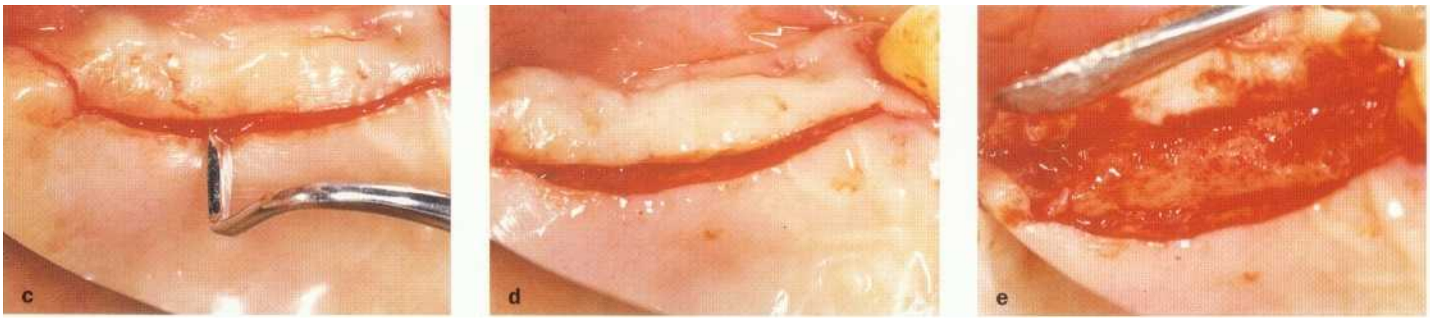
c2-1 Three years and 7 months after initial examination. About 5 months after the extraction of 4 and 5 due to severe periodontitis. The buccal keratinized mucosa is narrow (58-year-old woman).

Flap design





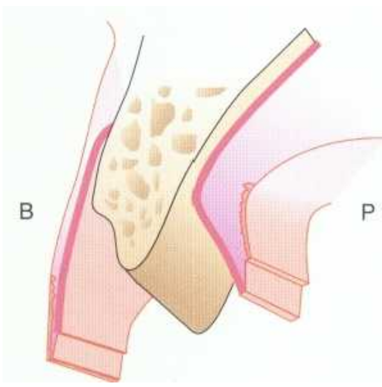
c2-2 Lateral incision. A no. 15 blade is used to make a horizontal partial-thickness incision about 3-4 mm palatal to the alveolar crest. The incision is a shallow 2-3 mm (lateral incision) (a). The incision is extended one tooth mesially, and a vertical incision is made to the mesiobuccal line angle and mesiopalatal line angle of 11(b).



An Orban interdental knife is inserted into the partial-thickness incision area and the partial thickness flap is reflected slowly to near the alveolar crest (c, d). A periosteal elevator is used to reflect the flap, which is partial thickness but full thickness buccally (e).

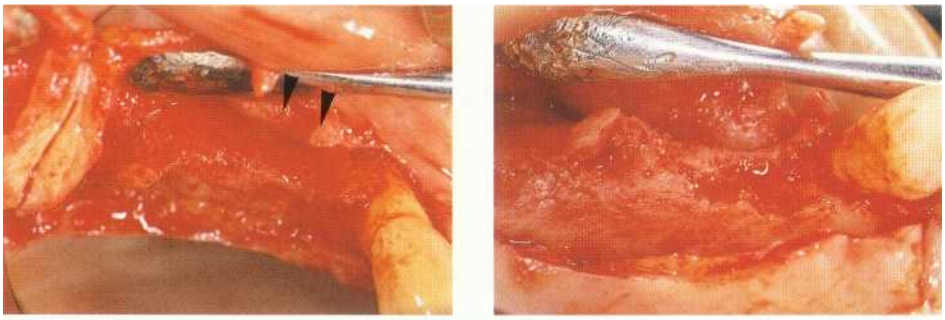
Key point

The bevel is prepared with a bevel incision on the junctional surface of the palatal flap edge.

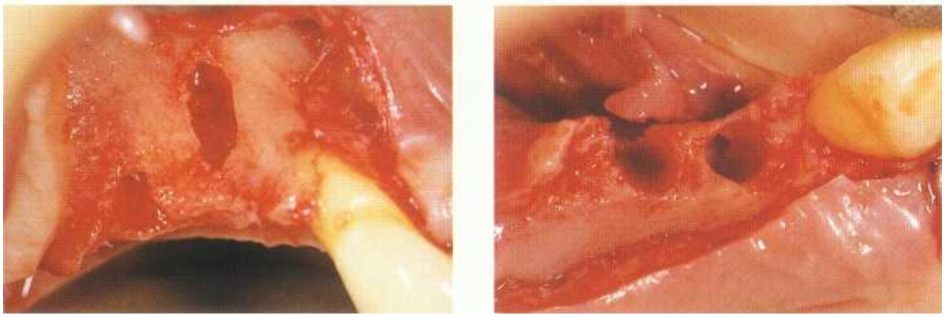


Fixture placement

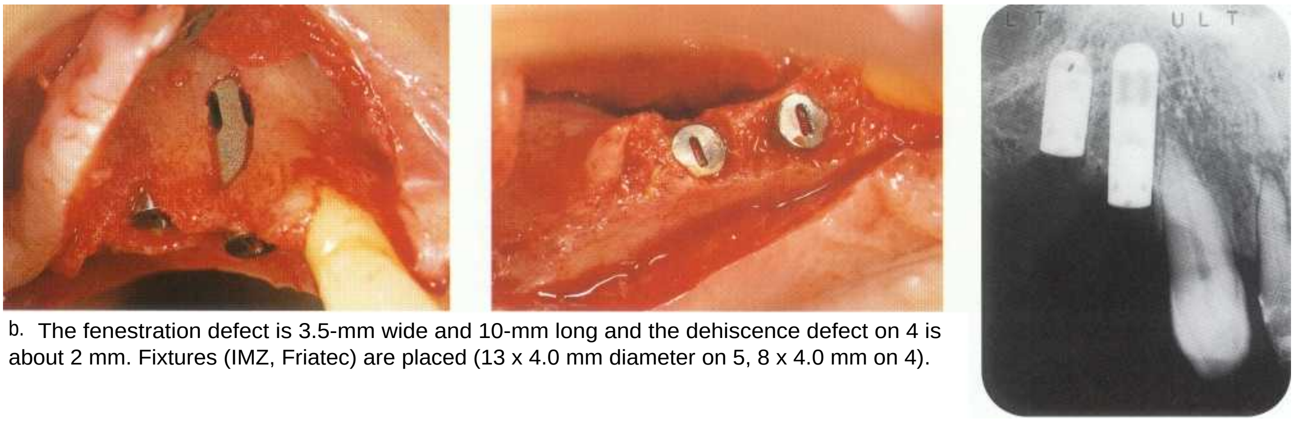
c2-3 Buccal collapse. Note the collapse on the buccal aspect of 4 and 5 where implants are to be placed.



c2-4 Fenestration near site preparation.



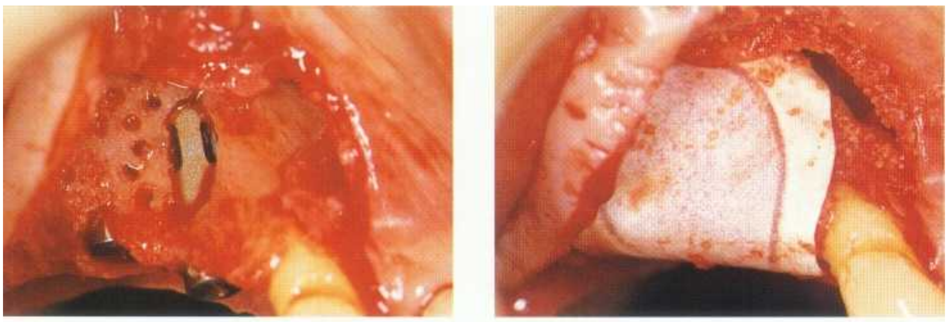
a. After site preparation. Note the dehiscence defect on the buccal aspect of 4 and the fenestration defect on the buccal aspect of 5.



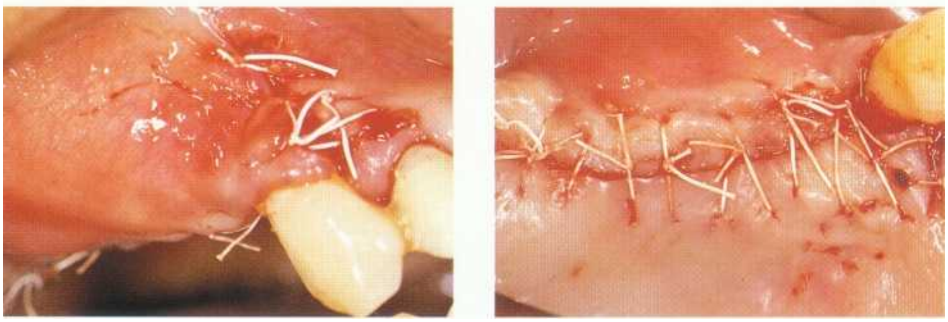
b. The fenestration defect is 3.5-mm wide and 10-mm long and the dehiscence defect on 4 is about 2 mm. Fixtures (IMZ, Friatec) are placed (13 x 4.0 mm diameter on 5, 8 x 4.0 mm on 4).

GBR procedures

c2-5 Penetration of cortical bone and membrane placement. To facilitate bleeding to the bone surface, the cancellous bone is penetrated with a small round bur. Graft material is used for spacemaking on the defect area and a GTAM Oval 9 (WL Gore) is trimmed and placed for close adaptation of the membrane and bone.



c2-6 Suture. The buccal pedicle flap of 6 is displaced for primary flap closure and placed on the membrane. A suture is then made with Teflon (WL Gore).



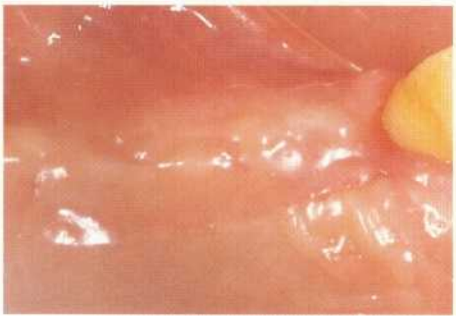
Prognosis

c2-7 After GBR surgery.

a. One week after surgery. Note the partial necrosis of outer layer of epithelium.

b. Two weeks after surgery.

c. Three weeks after surgery.



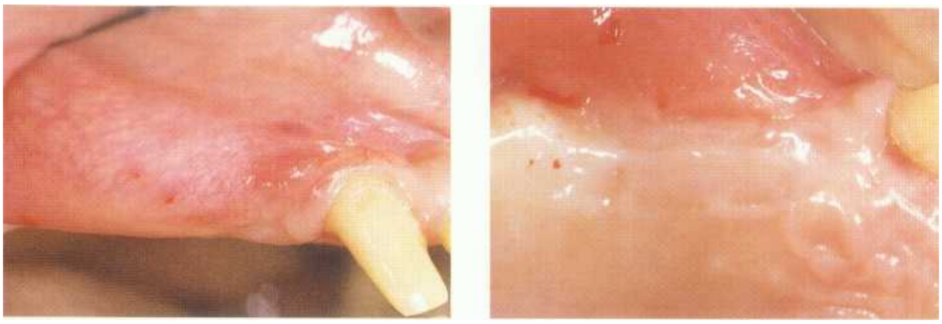
d. Four weeks after surgery.

e. Seven weeks after surgery.

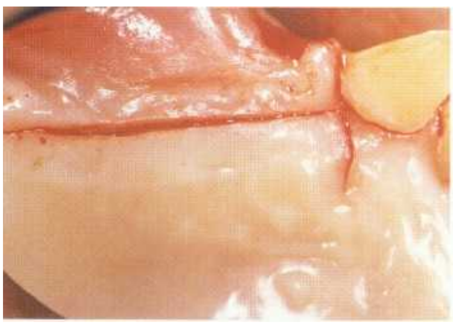
f. About 8 months after surgery.

Second-stage implant surgery

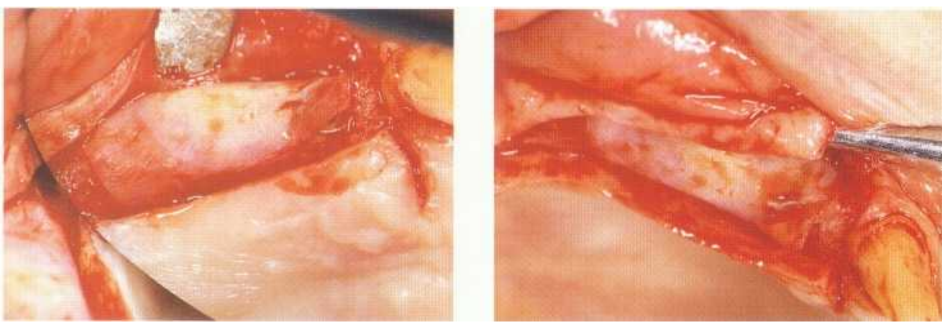
c2-8 Membrane removal.



a. Ten months after surgery (left, buccal aspect; right, occlusal aspect).

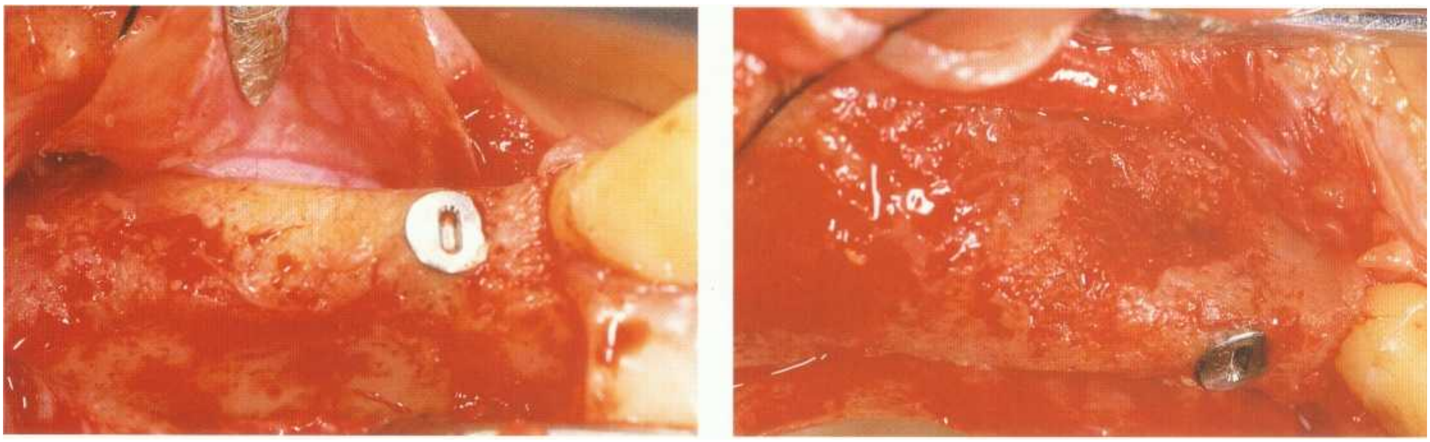


b. The flap is reflected with a crestal incision and a vertical incision.

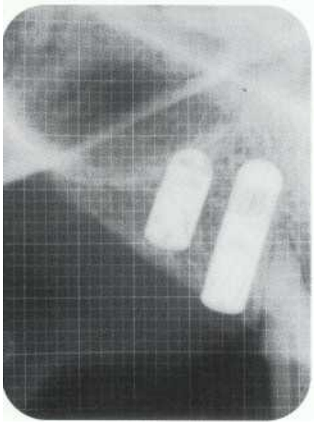


c. The membrane is transparent and has maintained its position (has not collapsed).

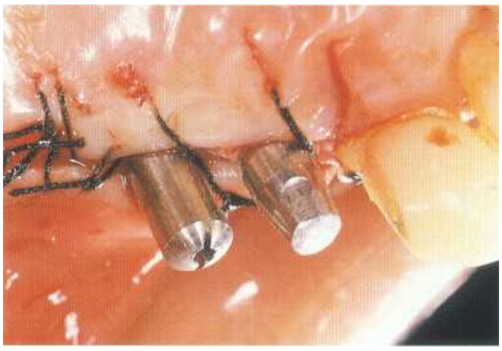
c2-9 After membrane rernovai.



a. Note the expected bone regeneration in the osseous defect area. About 2-3 mm vertical bone regeneration is observed on 4. The cover screw is covered by bone.



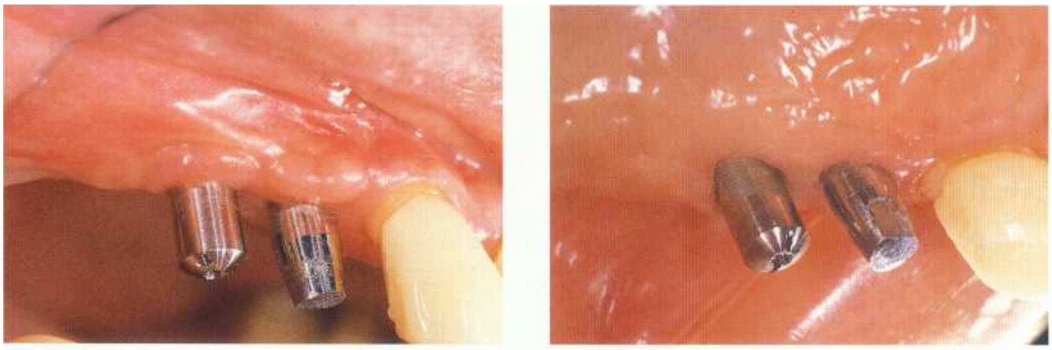
b. Radiograph of same area.



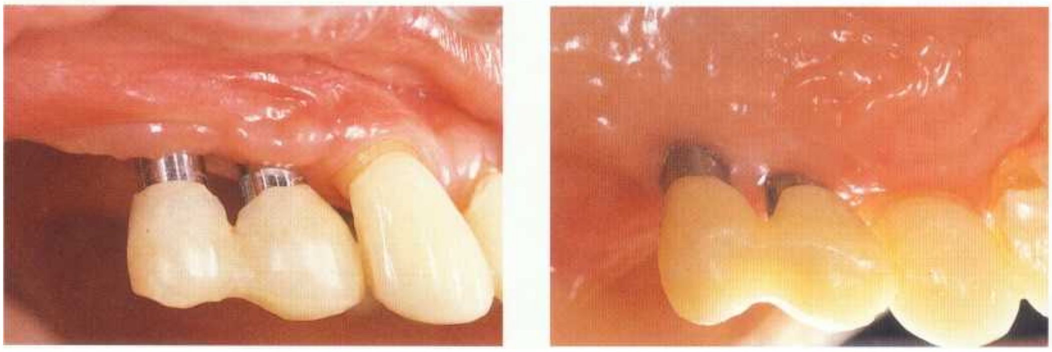
c2-10 Suture. After the placement of temporary abutments, the flap is sutured and temporary restorations placed.

Prognosis

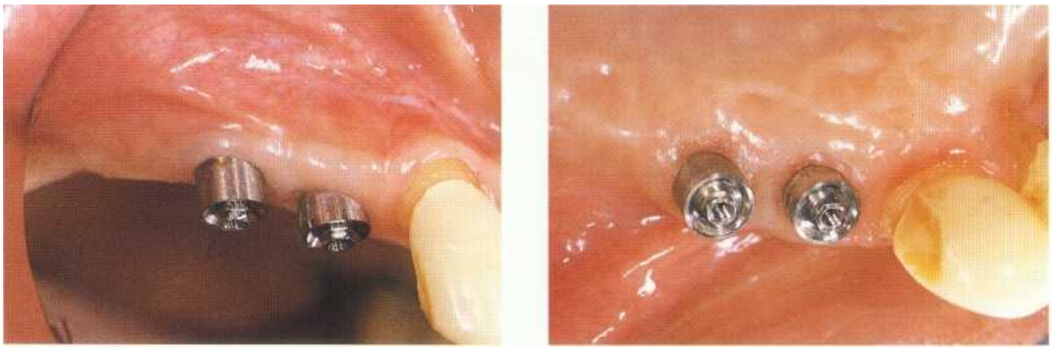
c2-11 Prognosis.



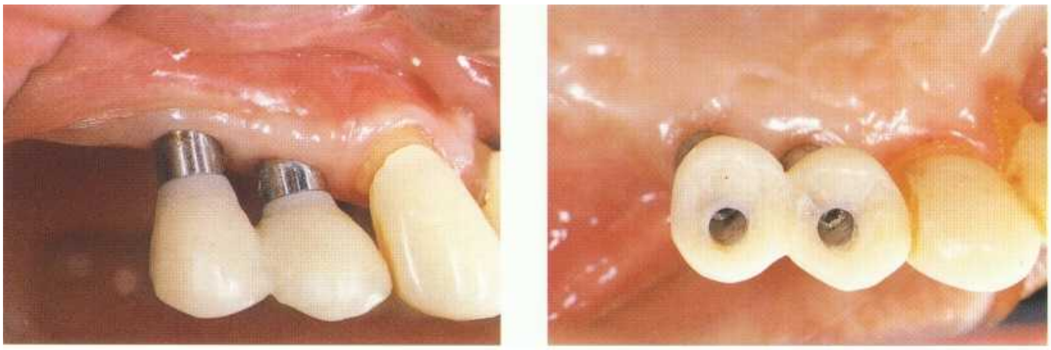
a. Nine weeks after surgery.

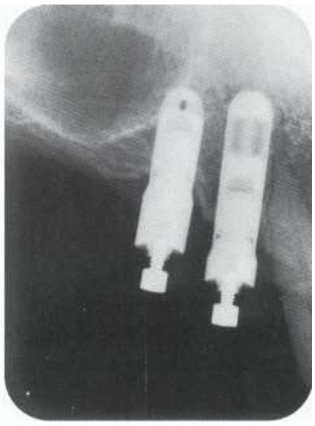


b. Twelve weeks after surgery.

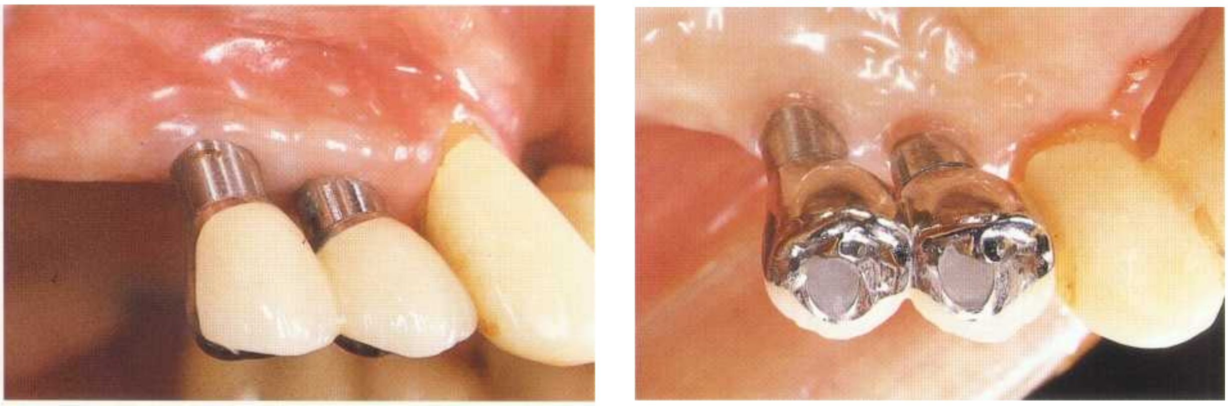


c. Six months after second-stage surgery. Modification abutments (3i) are placed.





d. One year and 6 months after surgery. Screw-retained provisional restorations are placed.

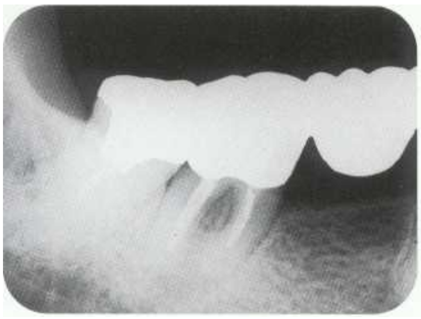


e. Final restorations are placed about 2 years after GBR.

Case 5-3 Lateral incision technique and flap suturing methods for GBR in the mandibular molars

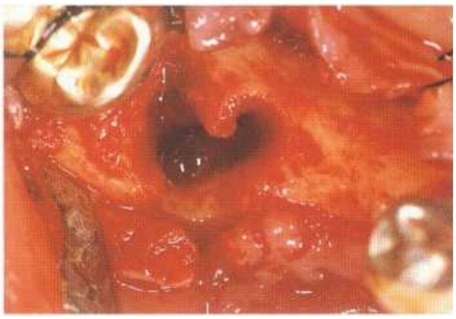
Extraction

c3-1 Preservation of extraction socket wall.



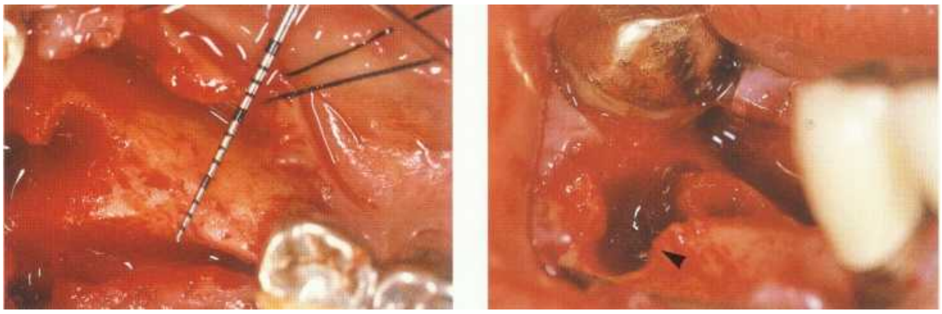
a. Four years and 4 months after the placement of a fixed partial denture. There is a 9-mm periodontal pocket on the mid-buccal aspect of 31 (43-year-old man).

b. The roots are amputated to avoid fracture of the buccal and lingual walls of the socket on extraction (alveolar ridge preservation).



c. An incision is made in the gingival sulcus of the extracted tooth, the flap reflected, the tooth luxated mesiodistally with a small elevator, and the tooth extracted.

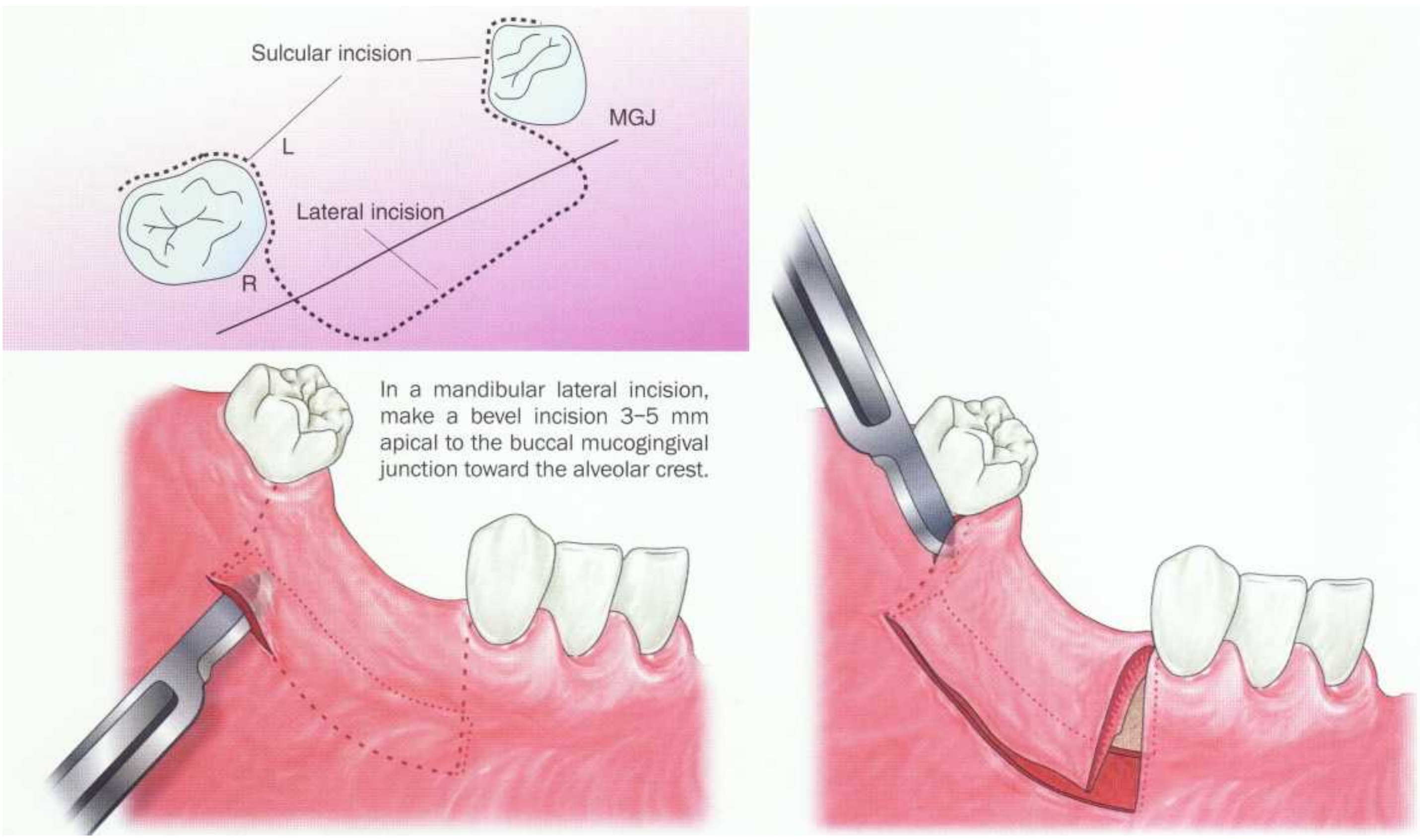
c3-2 Extraction socket condition.

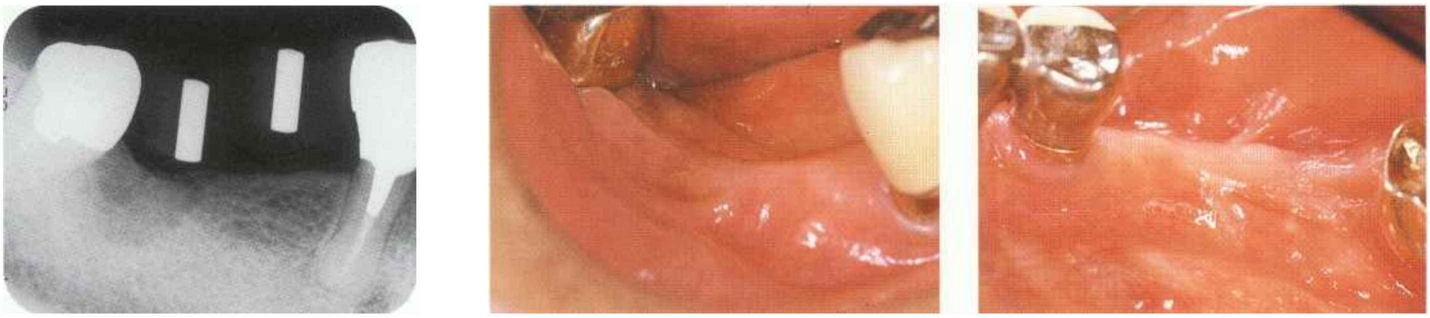


a. Granulation tissue of the extraction socket is removed. The alveolar ridge dimension of 30 is about 6 mm and adequate for fixture placement; however, the buccal wall of 31 (arrow) shows a large defect.

b. The flap is replaced and the wound closed.

Flap design (lateral incision technique)

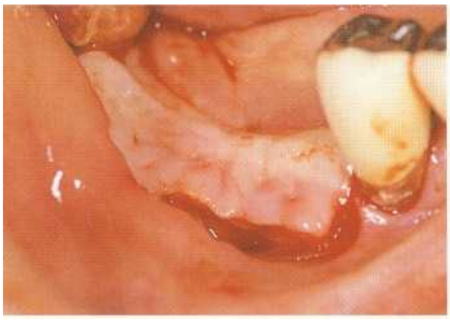




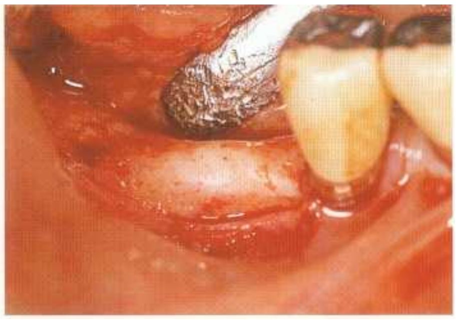
c3-3 Eight months after extraction, the buccal and lingual aspects before surgery for fixture placement. The buccal keratinized mucosa is narrow.

c3-4 Lateral incision.

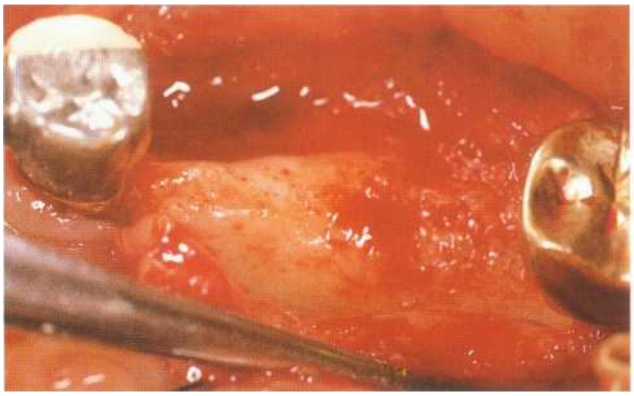
a. A no. 15 blade is used to make a horizontal partial-thickness incision on the buccal alveolar mucosa 3-4 mm apical to the mucogingival junction. The incision is extended coronally to the sulcular incision on the buccodistal aspect of 29 and finished at the mesiolingual line angle.



b. The side of the blade contacts the periosteum and the flap is lifted along the inside of the flap to avoid damage to the periosteum. The flap edge is then reflected.

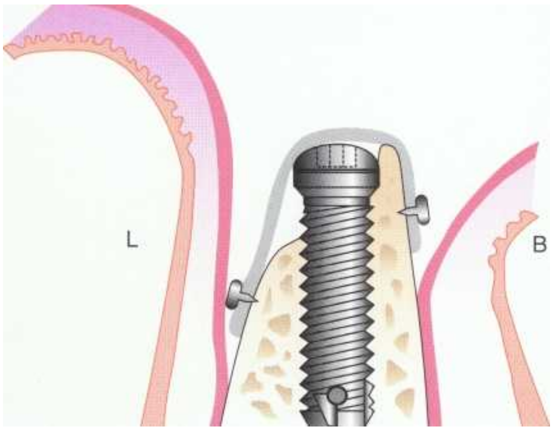


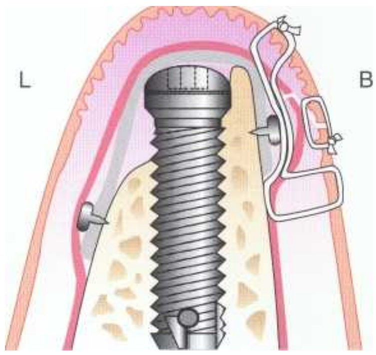
c. While tension is provided to the connective tissue attached to the periosteum by lifting the reflected flap edge with tissue pliers, a partial-thickness flap to the buccal mucogingival junction is prepared. After incising the periosteum close to the midcrest, a small periosteal elevator is used to reflect the combination partial-thickness and full-thickness flap.



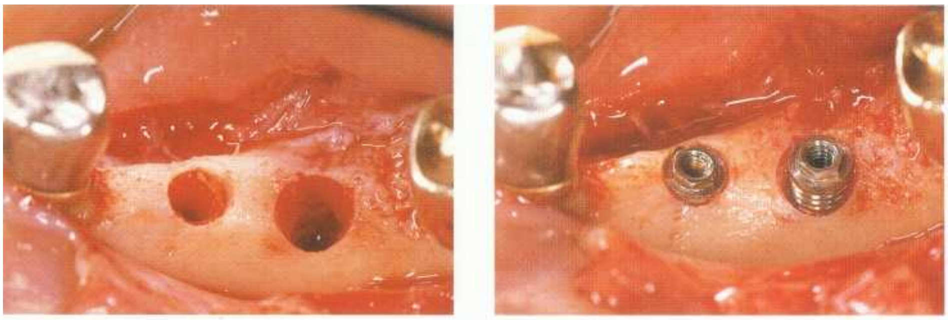
d. A buccal periosteal flap is prepared and the bone surface exposed (lingual aspect).

Fixture placement and membrane preparation

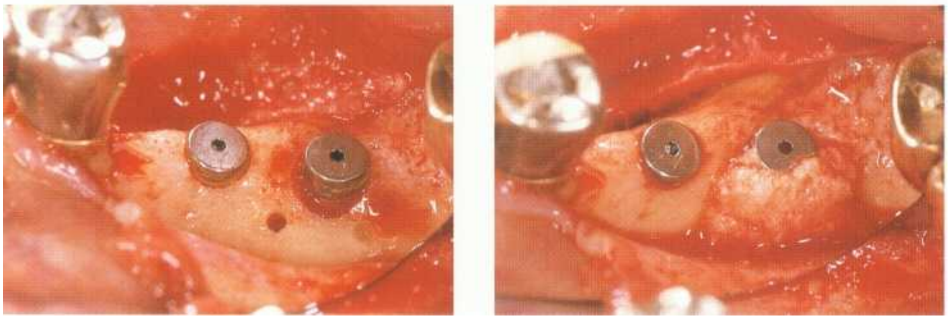




c3-5 Fixture placement. The implant site is prepared. A 10 x 3.75 mm diameter standard screw implant is placed on 30 and a 10 x 4.0 mm diameter implant placed on 31 (Implamed, Harmans). Note the 3 mm deep and 4 mm wide dehiscence defect on the lingual aspect of the fixture on 31.



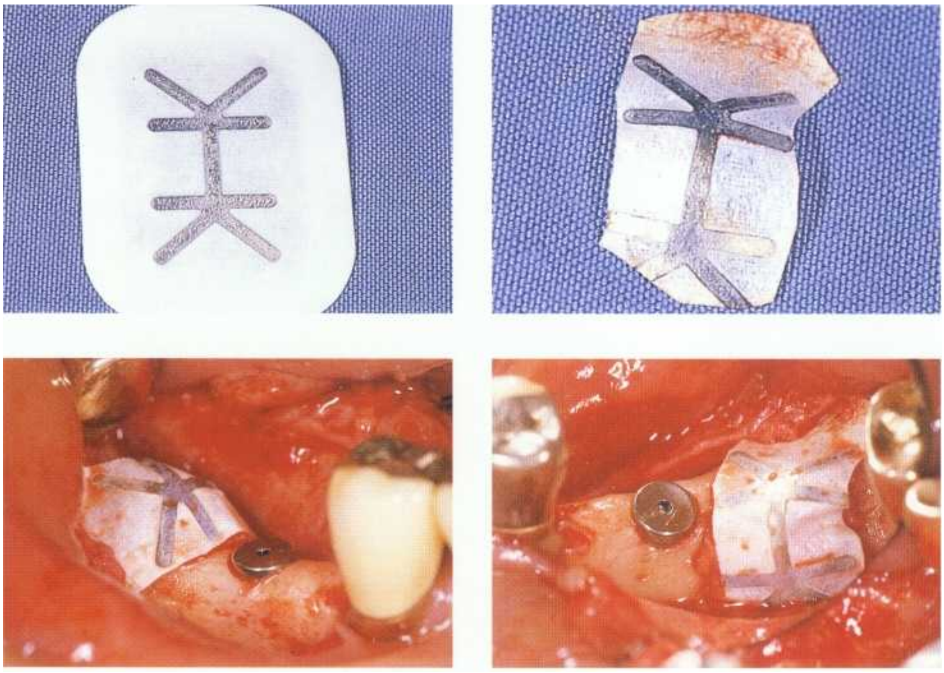
c3-6 Autografts.



a. To facilitate bleeding from the bone surface, cancellous bone is penetrated by a small round bur.

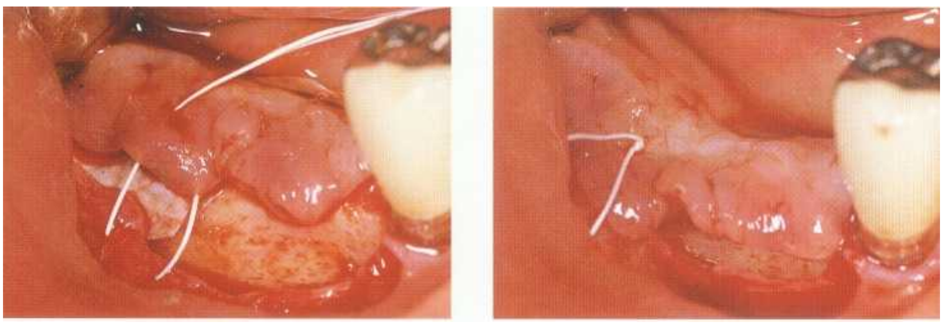
b. Bone chips collected during drilling for site preparation are harvested with an osseous coagulum trap and soaked in physiologic saline solution. The bone harvest is transplanted to the exposed fixture surface for stabilization of the blood clot and preservation of space under the membrane.

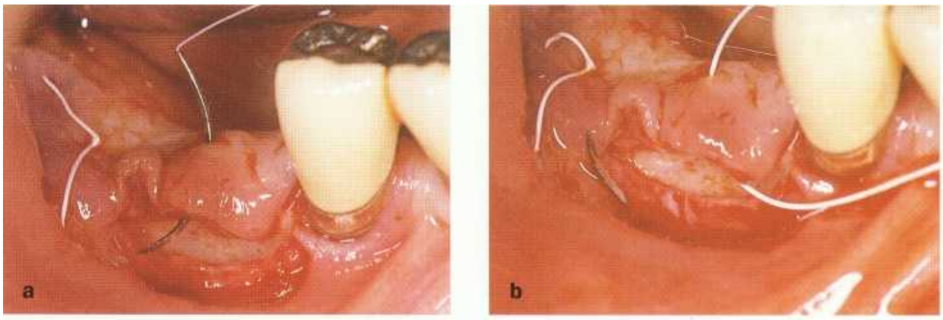
c3-7 Membrane placement. The titanium-reinforced membrane (TREY, WL Gore) is trimmed and bent with pliers and placed on the osseous defect area. The membrane covers the defect margin with 3-4 mm excess and is closely adapted to the surrounding bone. Observe the bulk under the membrane due to the autograft and the titanium-reinforced membrane. Note that the membrane margin does not contact the adjacent teeth.



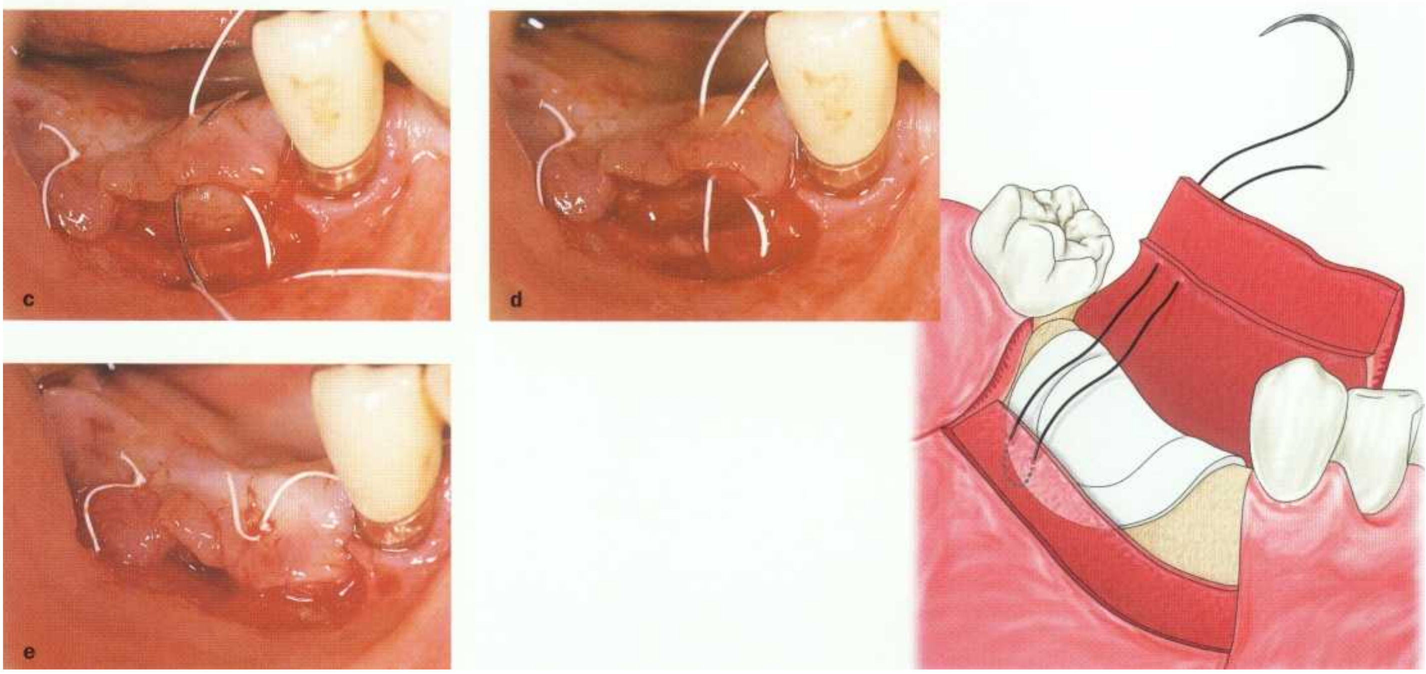
Flap suturing methods in the lateral incision technique

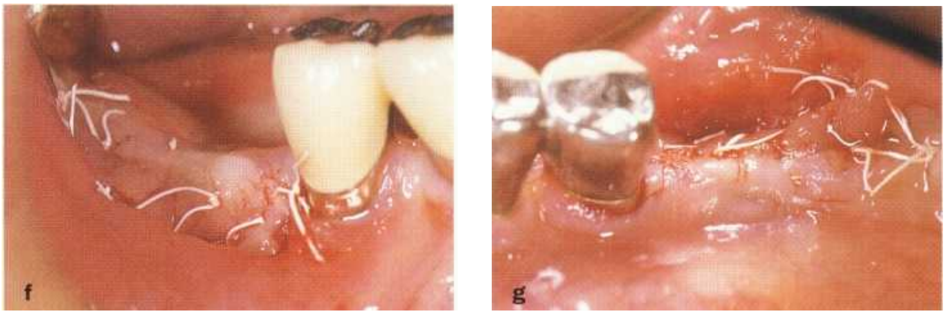
c3-8 Horizontal mattress suture. A horizontal mattress suture of the lingual flap is made near the membrane and buccal periosteal flap with Teflon (WL Gore).



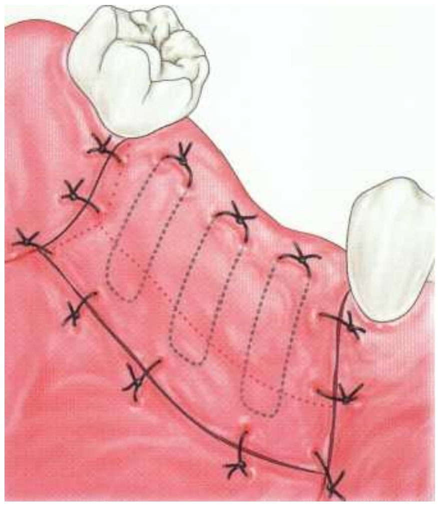


c3-9 Procedure of horizontal mattress suture. The suture needle is inserted from the outside of the lingual flap (a) and the connective tissue of the buccal flap pierced deeply (without engaging the periosteum) (b). The needle is brought back to the original position and inserted from under the lingual flap (c). A ligature with the end of thread is then made (d, e).





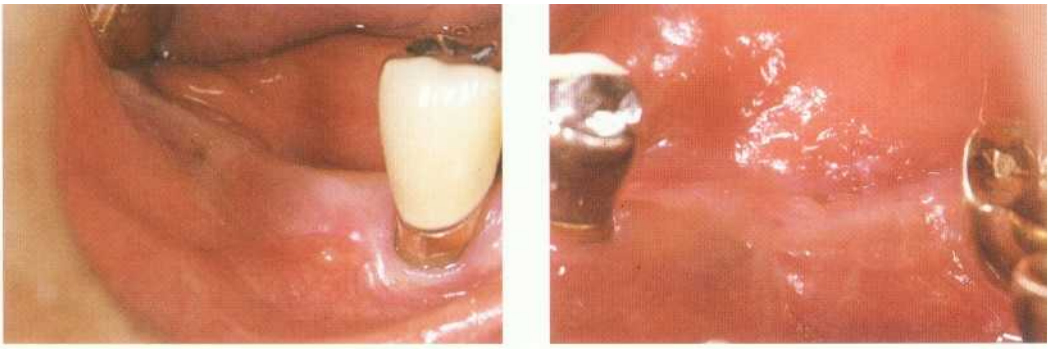
Three such mattress sutures are made, the wound edge of the remaining buccal incision area is closely adapted with an interrupted suture, and flap closure completed (f, g).



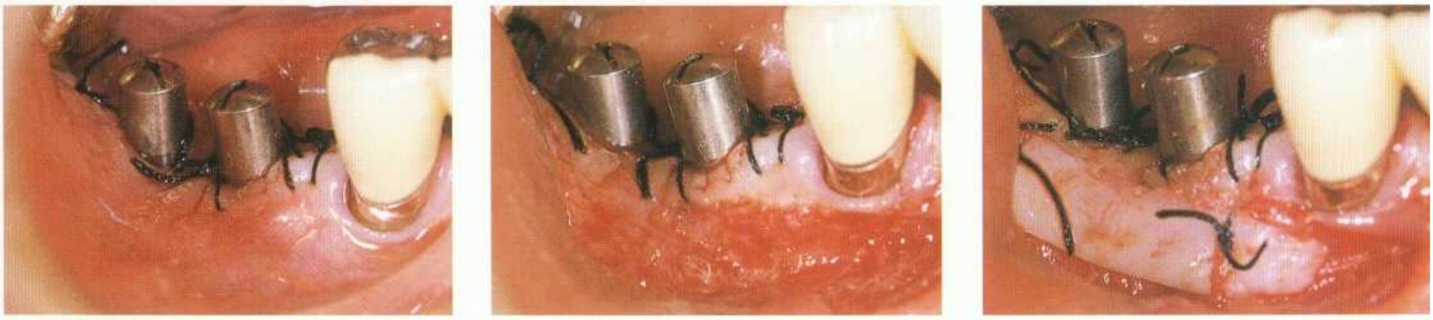
Prognosis

c3-10 Prognosis.

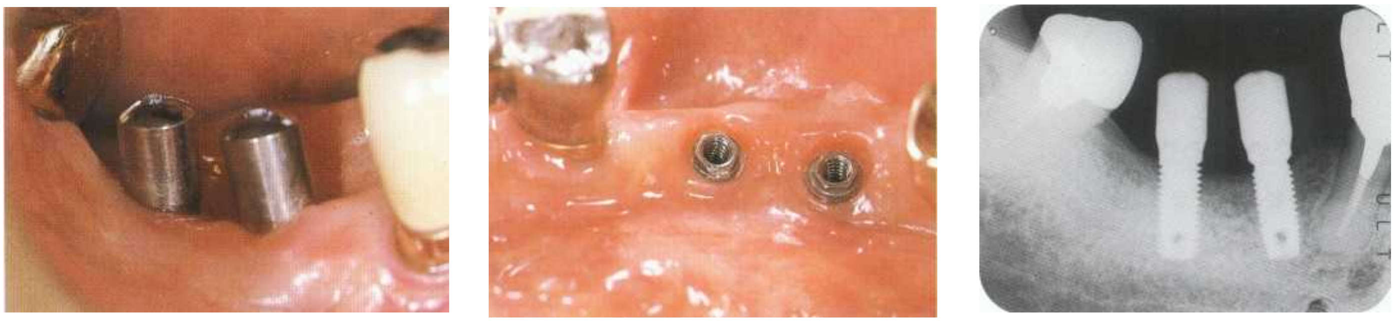
a. The suture thread is removed 17 days after surgery. Compared to the keratinized mucosa, the healing of the buccal suturing area is incomplete (left, buccal aspect; right, lingual aspect).



b. Six weeks after surgery.

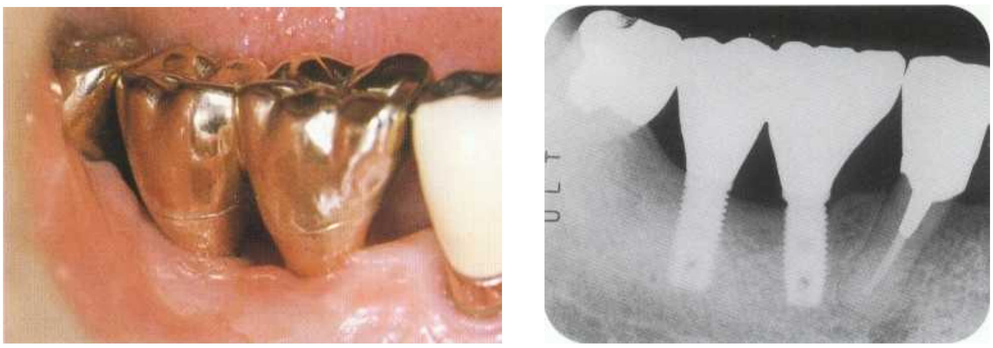


c. After temporary healing abutments are placed at second-stage surgery (8 months after initial surgery), an autogenous free gingival graft is performed to increase the width of the keratinized mucosa.



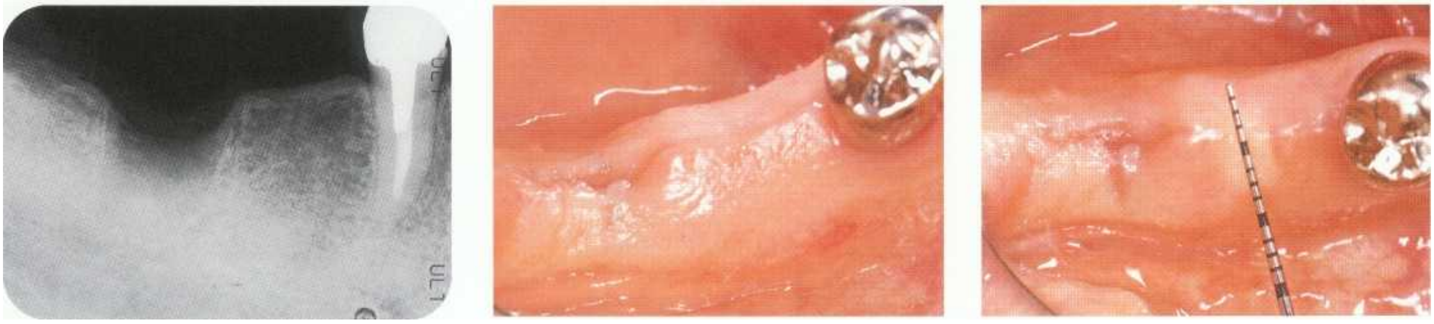
d. Sufficient keratinized mucosa has been obtained 4 months later. The fixture heads are at the level of the gingival margin.

e. Copings are fabricated using gold UCLA abutments and connected to fixtures with screws.



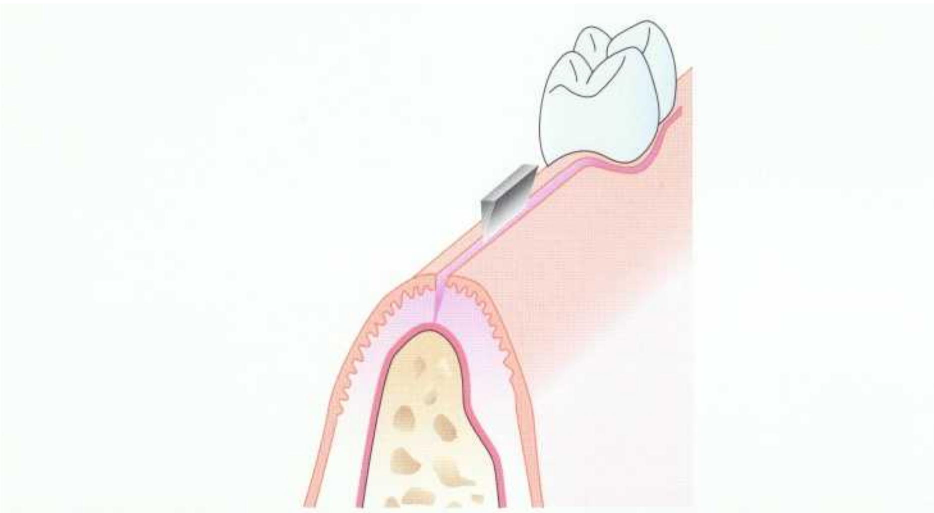
f. Placement of final restorations.

Case 5-4 GBR using the midcrestal incision technique

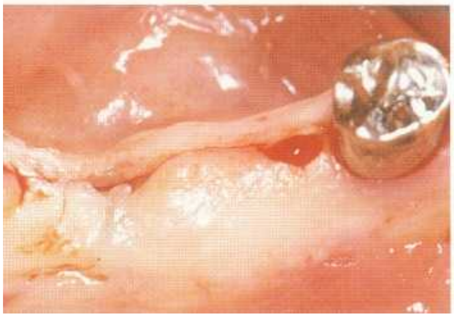


c41 Four months after extraction of 31. The extraction socket is completely covered by soft tissue and the ridge is wide (35-year-old man).

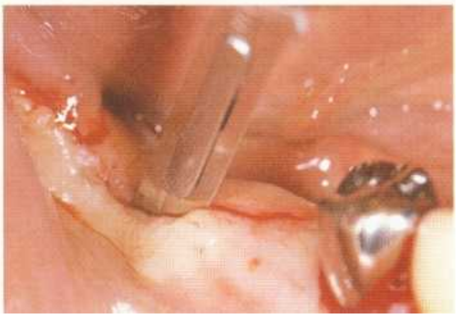
Flap design (midcrestal incision)



c42 Midcrestal incision.



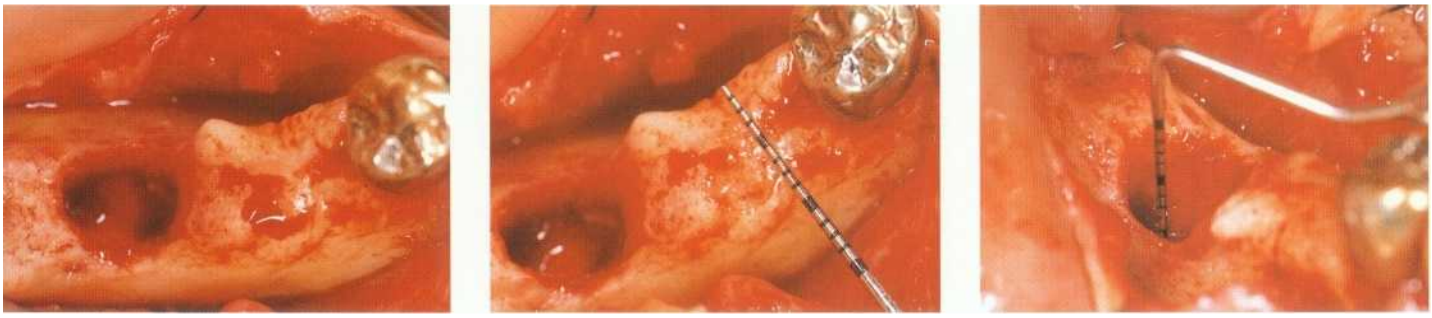
a. A midcrestal incision is made in the non-mobile keratinized mucosa because the keratinized mucosa of the edentulous ridge is thick and sufficiently wide. Incisions made in the keratinized mucosa have less postoperative swelling, edema, and discomfort, and suture manipulation is easier and healing more rapid.



b. An incision is made on the alveolar crest with the tip of a no. 15 blade contacting the bone. The midcrestal incision is extended mesiodistally to make a large full-thickness flap buccolingually.

c. The incision line of the crest is connected with the sulcular incision of 29 and extended to the mesial aspect of 28.

c4-3 Flap reflection and the extraction socket.



a. An envelope flap is made without a vertical incision to preserve blood supply. A small periosteal elevator is used to reflect the flap apically and expose the bone surface.

b. The buccolingual dimension of the ridge of 30 is 8 mm, adequate for implant placement. There is, however, a marked concavity on the buccal aspect, a large extraction socket on 31 (8 mm buccolingually and 11 mm mesiodistally), and extreme collapse of the buccal wall (left, lingual aspect; right, buccal aspect).

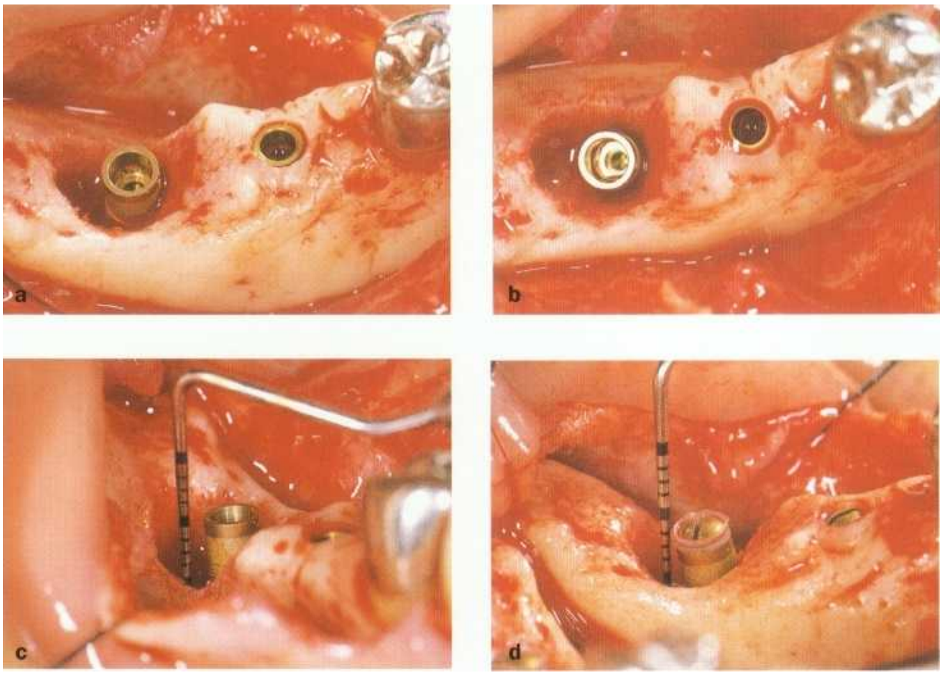
Key point
Reflect the flap beyond the mucogingival junction to maintain access and to make flap migration possible.

Fixture placement

c44 **Relation between fixture and extraction** socket.

a. A P01 three-piece-type implant (Finafix, Kyocera) is placed (30, 15 x 3.7 mm diameter; 31, 11 x 4.2 mm diameter).

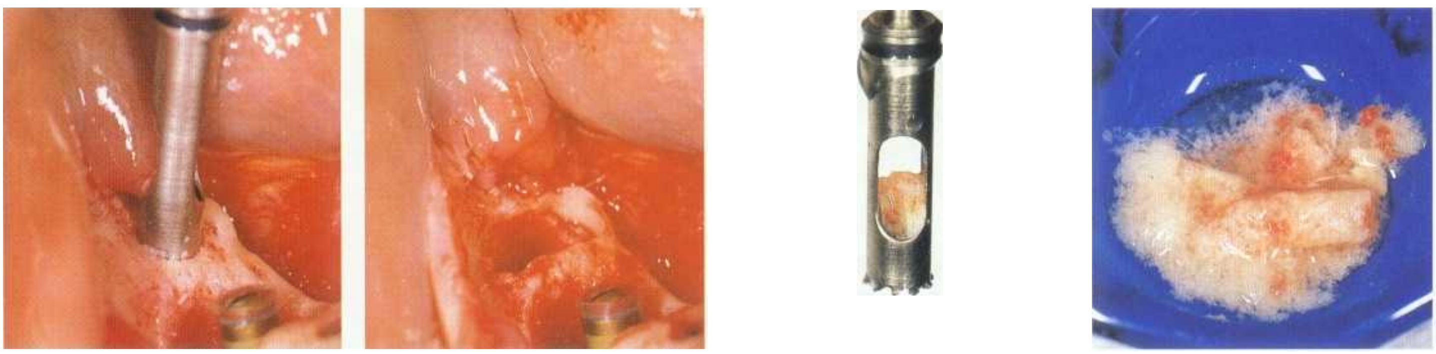
b. The horizontal gap between the extraction socket margin of 31 and the fixture is 5 mm distally, 3 mm buccally, and 2 mm mesially and lingually.



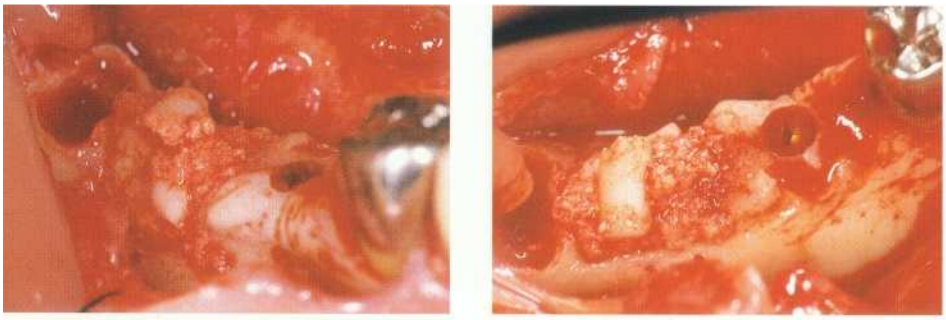
c. The distance from the fixture head to the bottom of the osseous defect is 10 mm on the buccal aspect and 7 mm on the distal aspect. The distance from the fixture head to the bone margin of the extraction socket is 5 mm buccally and 3 mm lingually.

d. The fixture is placed to project from the bone margin because of the remarkable buccal osseous defect.

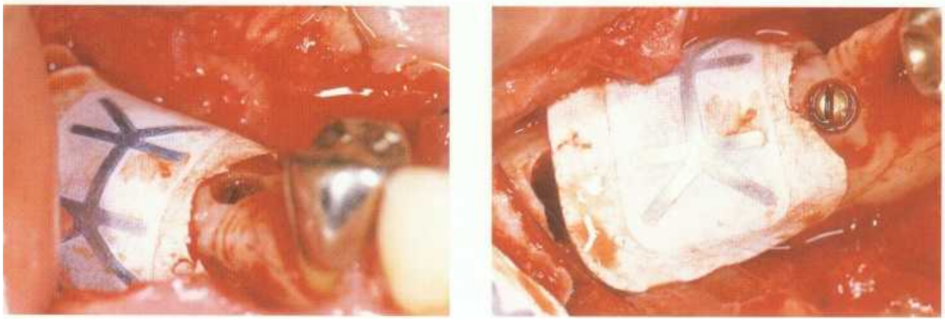
Autografts and membrane placement



c4-5 Harvest of autogenous bone grafts. Because insufficient bone chips were obtained during drilling with the osseous coagulum trap (due to the large osseous defect), bone is harvested from the distal part of 31 using a trephine bur.

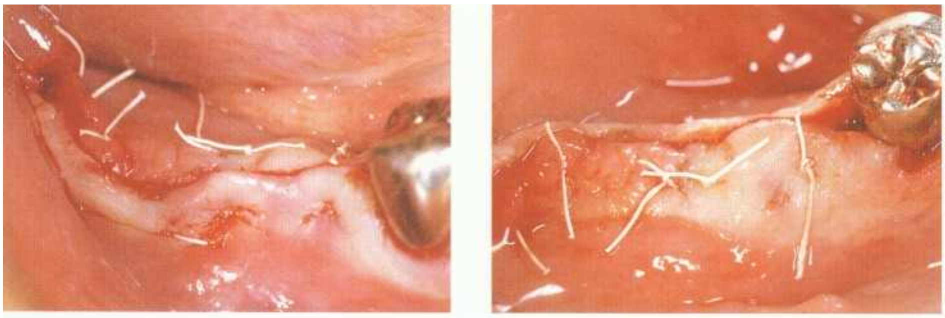


c46 Bone grafts. Autografts cover the defect area and the exposed implant surfaces. Vertical bone regeneration is also necessary in this case.



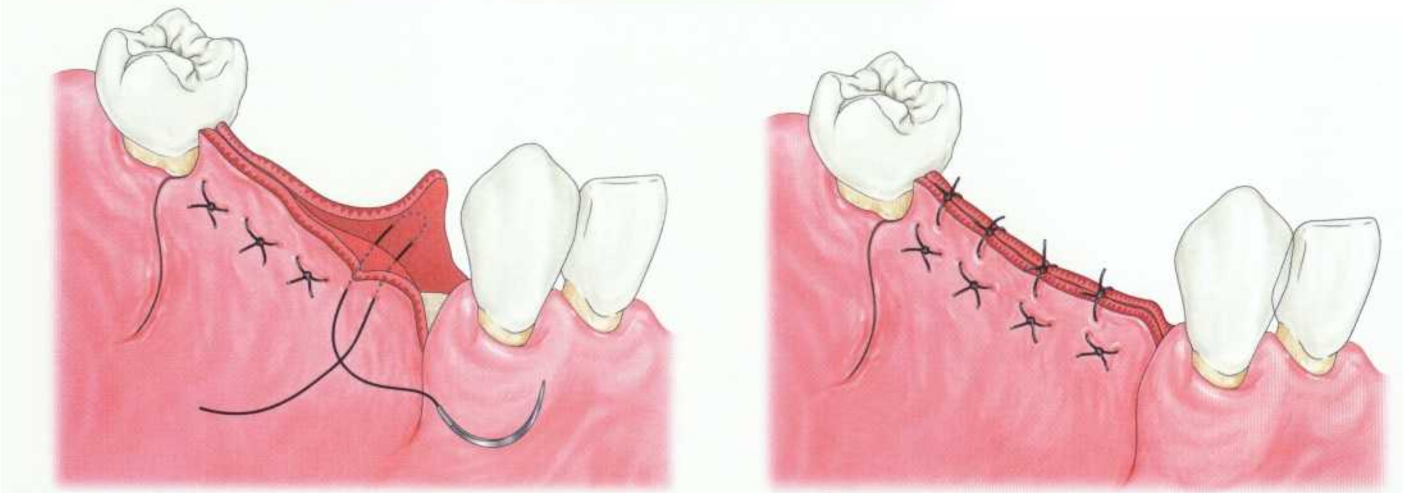
c47 Membrane placement. The TR membrane (TREY, WL Gore) is trimmed and bent and closely adapted to the surrounding bone. The membrane should extend 4 mm beyond the bone margin of the defect area.

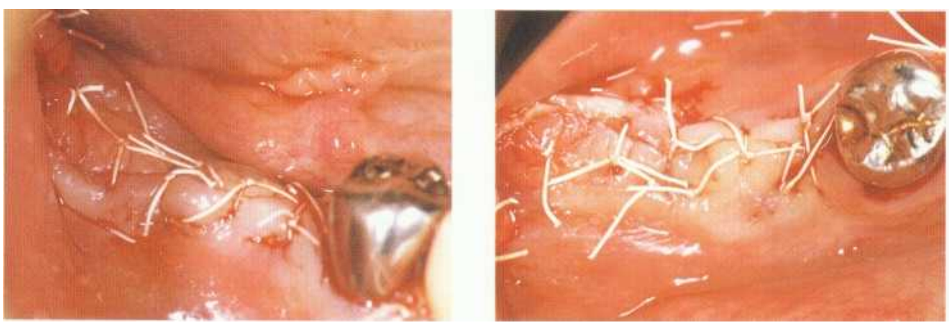
Method of flap suture and prognosis



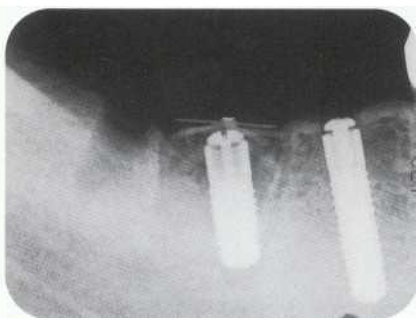
c48 Suture.

a. Five horizontal mattress sutures are made with Teflon (WL Gore).



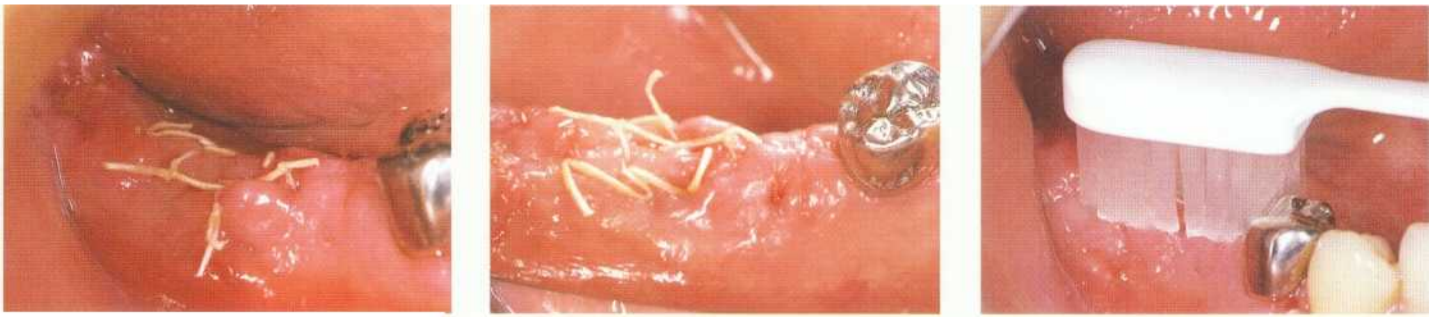


b. Primary closure is achieved with an interrupted suture. Reflecting a large flap beyond the mucogingival junction allows for free flap migration enabling flap suture without tension.



c. On fixture placement.

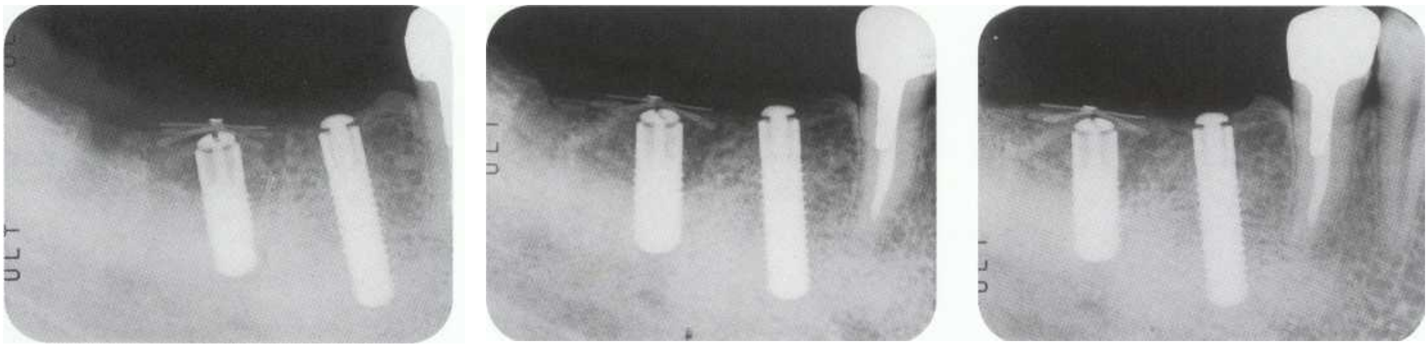
c49 Prognosis of vertical bone regeneration.



a. Eight days after surgery. Midcrestal incisions minimize postoperative pain and swelling and enable rapid healing. The suture thread is removed and the patient is instructed to brush with an ultrasoft brush.

b. Twelve days after surgery.

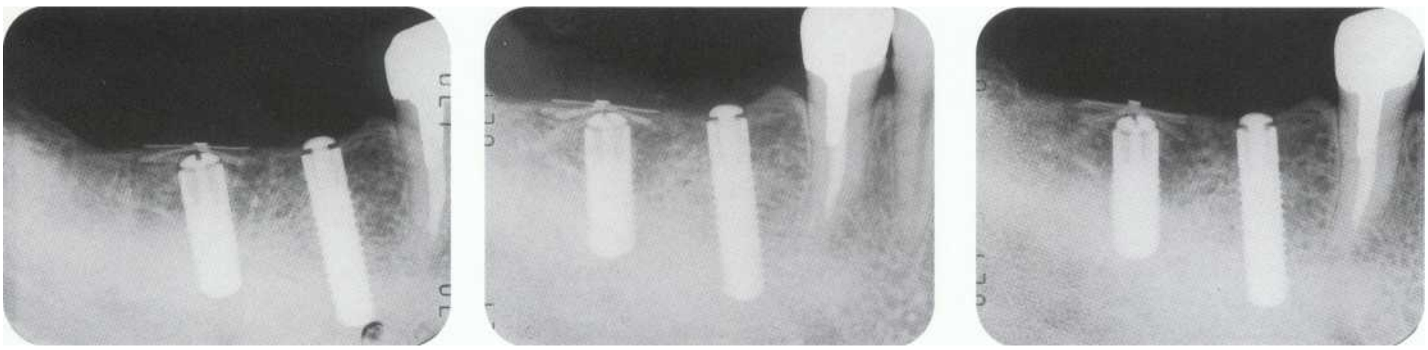
c. Seven weeks after surgery.



d. Two months after surgery.

e. Four months after surgery.

f. Six months after surgery.



g. Seven months after surgery. Note the bone fill on the distal aspect of the fixture on 31.

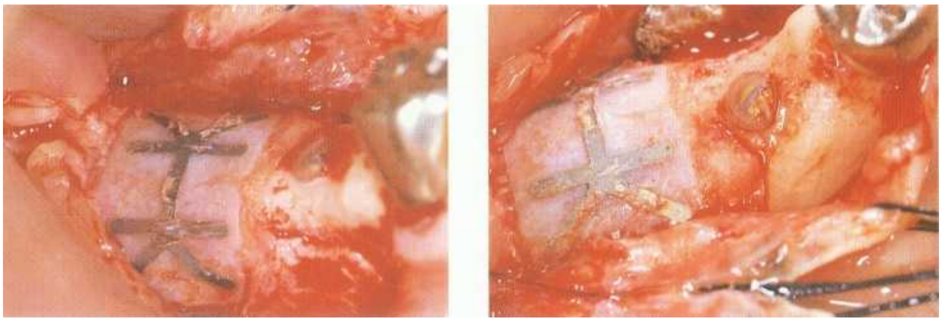
h. The bone fill on the mesial aspect of the fixture on 31 is obvious 9 months after surgery.

i. One year and 4 months after surgery.

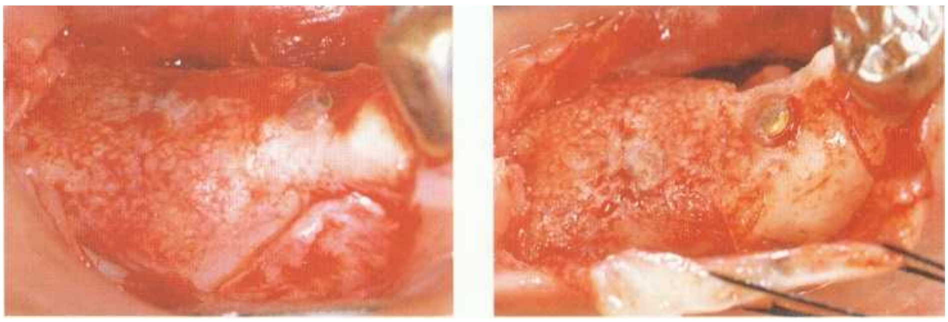
Membrane removal and abutment connection

c4-10 Membrane removal.

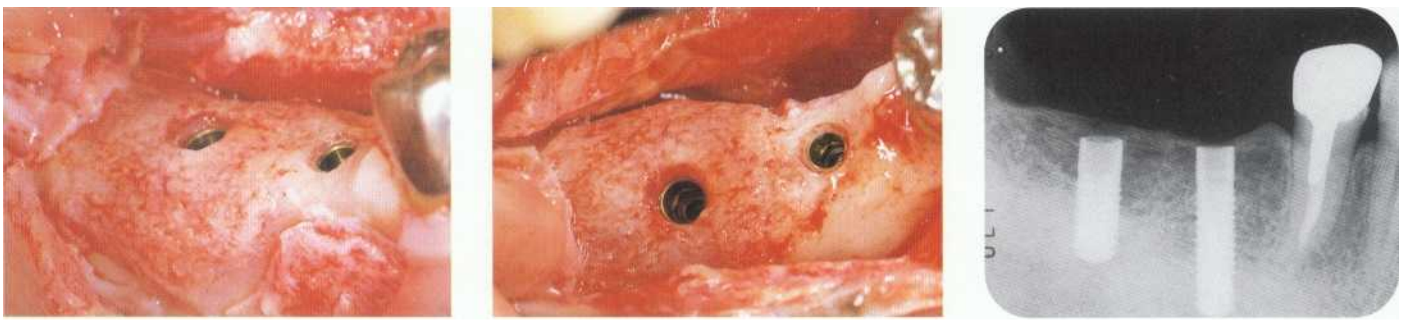
a. One year and 6 months after GBR. There is no membrane exposure and the prognosis is good. Because of the large osseous defect and the expectation of vertical bone regeneration, only when formation of new bone is observed on radiography should treatment proceed with second-stage surgery.



b. After flap reflection using a midcrestal incision. Note how the membrane has maintained its shape without collapse.



c. Membrane removal reveals complete new bone coverage of the fixture on 31 and marked vertical bone regeneration.



d. The fixture cap is removed after the removal of new bone covering the fixture head. Note the suprabony vertical bone fill (about 8 mm buccally and about 6 mm lingually) around the fixture of 31 (compare to c4-4). The fixture head of 31 is obviously below the crest of the bone on radiography.

c411 Placement of final restorations 1 year and 10 months after surgery.

a. Four months after membrane removal surgery.

b. Placement of posts.

c. Final restorations.

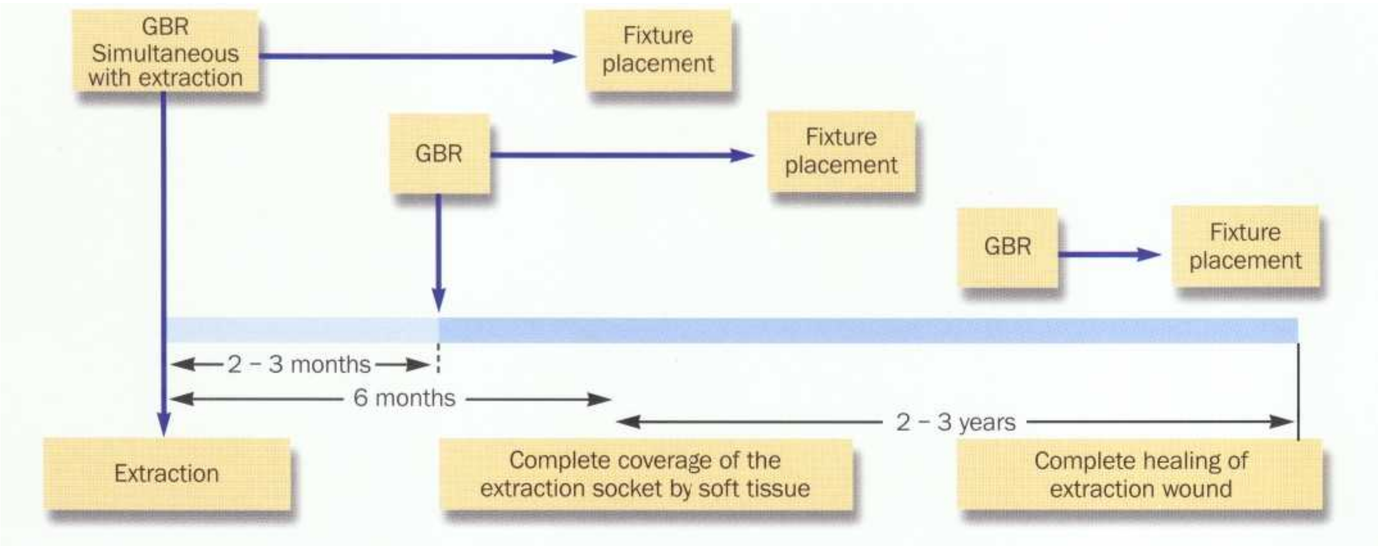
Ridge Augmentation Using Guided Bone Regeneration

Timing of GBR in the Staged Approach

The use of GBR makes the formation of new bone on the exposed fixture after fixture placement possible, resulting in increased predictability of implant therapy. However, in some cases, ridge augmentation using GBR before fixture placement or improving ridge morphology for fixture placement is necessary. Nyman et al " reported augmentation of the buccolingual dimension of the fixture area using GBR before fixture placement. Nevins and Mellonig" advocated simultaneous extraction and ridge augmentation with bone grafts and GBR to prevent the extensive bone resorption that can occur within 1 month of extraction. Buser et al[14] suggested that complete coverage of the membrane by soft tissue, without membrane exposure caused by a soft tissue dehiscence during healing, is key to predictability in bone regeneration. They introduced the staged approach in which GBR is performed after complete healing of the mucosal epithelium 2 to 3 months after extraction. Seven to 9 months later, fixture placement surgery is performed.

In the staged approach, fixture placement with proper position and direction is possible because the alveolar ridge is augmented before fixture placement. This is particularly important in esthetic areas. Also, in the simultaneous approach infection due to membrane exposure may cause implant failure, a risk avoided in the staged approach. Buser et al=' summarized the advantages of the

Fig 5-10 Timing of GBR for the staged approach.



staged approach: bone regeneration is activated twice and optimal site preparation is achieved for the fixture on the ridge augmented by the first surgery.

A disadvantage of this technique, however, is the length of treatment. The treatment period is longer than conventional periodontal-prosthetic treatment (about 6-12 months for bone regeneration after GBR, and 3-6 months for osseointegration after fixture placement). Long treatment times may have adverse effects on the patient.

GBR with Simultaneous Extraction

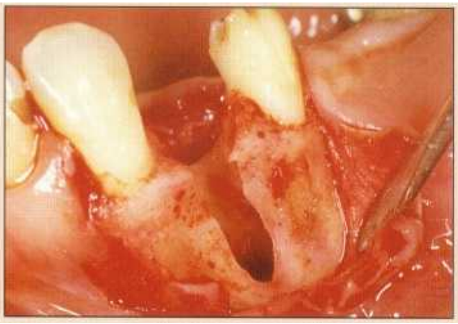
The degree of lost height and width of the alveolar ridge following extraction varies enormously depending on the condition of the extracted tooth. Especially with extraction due to severe periodontal disease or a large apical lesion, loss of the alveolar process due to extensive surgery or trauma with vertical root fracture and tooth luxation cause a marked change of the ridge after extraction. GBR offers ridge preservation and ridge augmentation with simultaneous extraction.

The objectives of GBR with simultaneous extraction are to regenerate bone in the extraction socket, prevent resorption of the extraction socket margin and the loss of thin facial bone plate, and preserve ridge height and width using the vigorous repair mechanism of the fresh extraction socket. This ridge augmentation procedure is effective because it can reduce the problems that may occur on future implant placement (Fig 5-11 and Case 5-5).

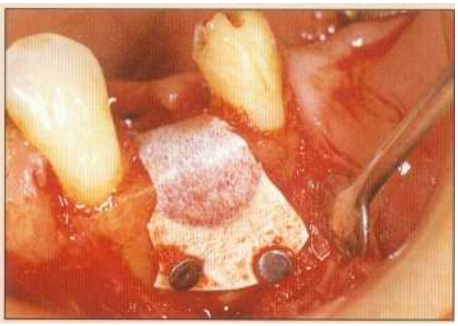
GBR with simultaneous extraction is considered a predictable method of implant placement, but early membrane exposure may occur because of the difficulty of covering the membrane by soft tissue, as can occur in immediate implant placement.

Fig 5-11 Ridge augmentation with simultaneous extraction.

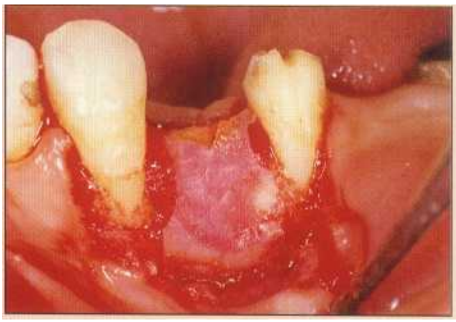
a. Note the 8 mm periodontal pocket on the mesial and buccal aspects of 21. Prosthetic treatment by implant therapy is planned after extraction. Preservation and augmentation of the alveolar ridge on extraction is sought.



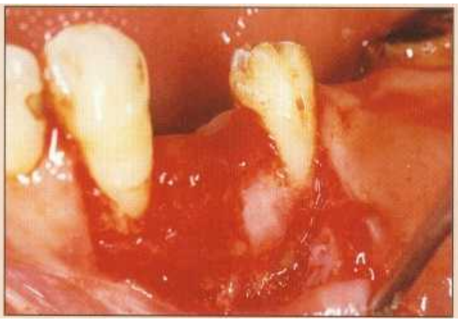
b. Thorough debridement of the extraction socket reveals a dehiscence defect with extreme destruction of the buccal wall. The defect is 4 mm wide and 11 mm deep.



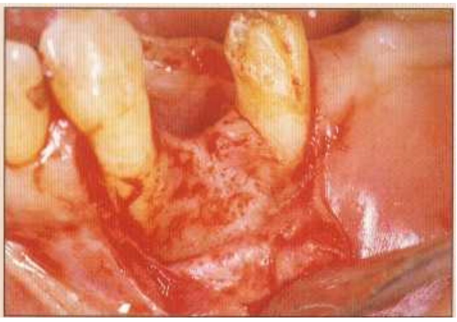
c. After the cortical bone around the dehiscence defect is penetrated, it is covered with GTAM (Oval 6, WL Gore).



d. Membrane on flap reflection 19 weeks after surgery.



e. Note the new tissue under the membrane.

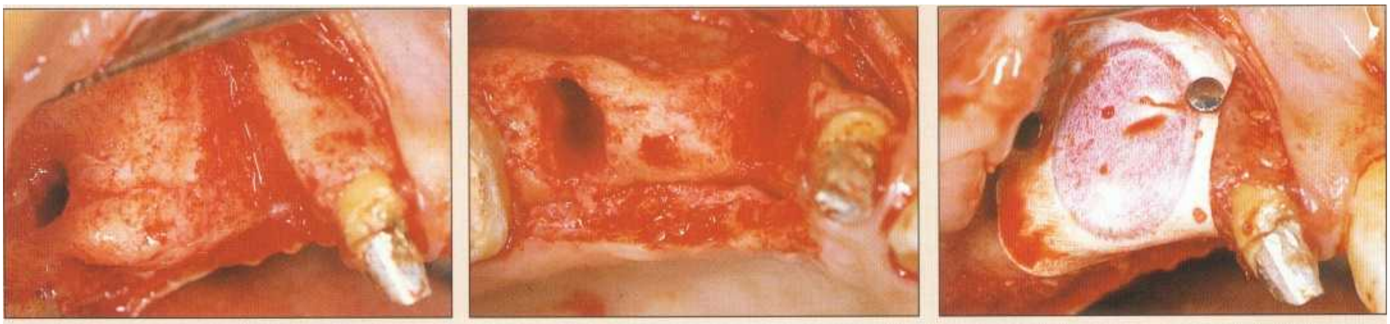


f. Nine months after GBR.

Also, because of the demands of primary wound closure, the extent of coronal migration of the flap may be greater than desired and the mucogingival junction may be displaced coronally after surgery. Subsequently, problems of the mucogingiva and narrow buccal oral vestibule may occur. Therefore, if complete debridement of the lesion is difficult due to an extensive ridge defect related to the extraction socket after extraction (Fig 5-13), GBR should be performed after healing of the socket.

And GBR with simultaneous extraction with an absence of keratinized tissue around the extraction socket causes extensive coronas migration of the flap for membrane coverage, causing the mucogingival junction to move coronally. This creates severe postoperative mucogingival problems. A large releasing incision of the periosteum made at flap base is likely to cause postoperative discomfort. Furthermore, primary flap closure following GBR is especially difficult, with early membrane exposure a possible result. The probability of membrane exposure due to a soft tissue dehiscence then becomes high with consequent apical recession of the soft tissue, an esthetic problem. Therefore, GBR should be performed after healing of the mucosal epithelium of the extraction wound (2-3 months after extraction) (Case 5-6).

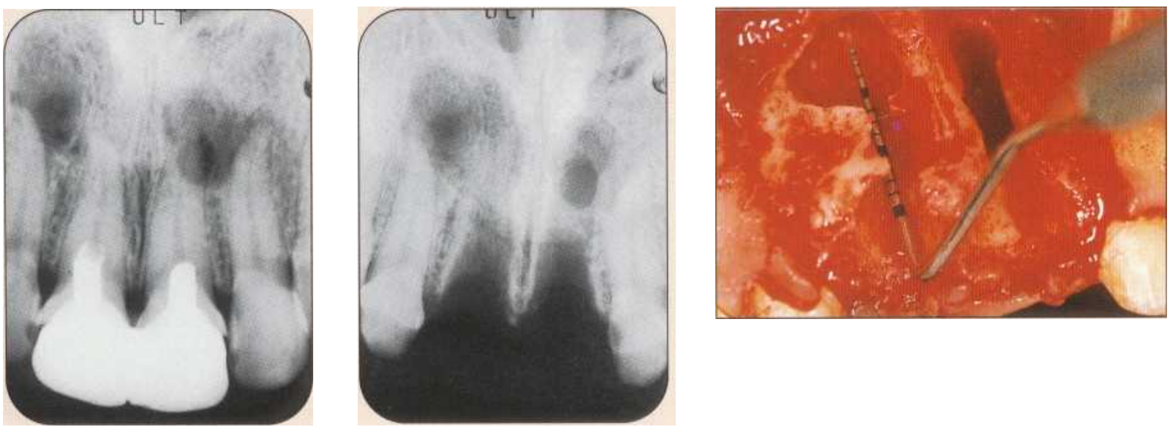
Fig 5-12 Indication for the staged approach.



a. Eight weeks after an extraction performed elsewhere. Flap reflection reveals complete loss of the facial bone plate on 6 and a 15 mm dehiscence defect. Curetting of the extraction socket of 4 caused communication of the maxillary sinus and the bottom of the socket and an osseous fenestration on the buccal wall.

b. A bone graft for spacemaking is performed on the osseous defect area of 6. The bone graft is covered with GTAM (Oval 6, WL Gore). Because the extraction socket of 4 is a four-wall osseous defect, the bone graft material is placed without a membrane following thorough debridement. Ridge augmentation of 9 by GBR and of 4 by bone graft only is performed. This is a staged approach; implant placement will follow reconstruction of the alveolar ridge.

Fig 5-13 Indication for the staged approach.



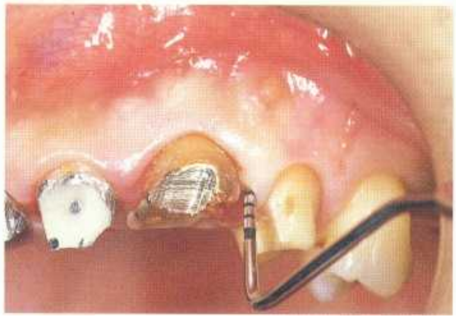
a. Note the gingival fistula.

b. Extraction of 8 and 9 reveals complete loss of the facial bone plate, communication with an apical lesion, and severe bone destruction. GBR with simultaneous extraction is suspended because complete debridement of the osseous defect area is difficult on extraction; therefore, GBR is planned for 2-3 months after extraction.

Case 5-5 Immediate ridge augmentation using GBR

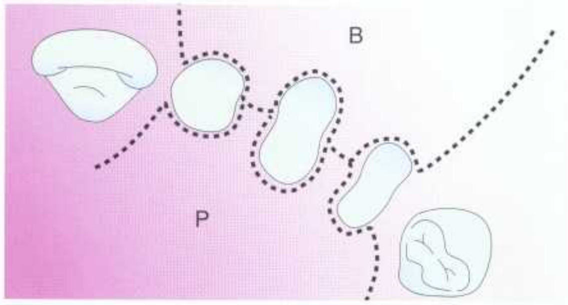
c5-1 Before surgery (after initial therapy).

a. Note the fracture of the distal root of 11 and severe bone loss distally (37-year-old man).

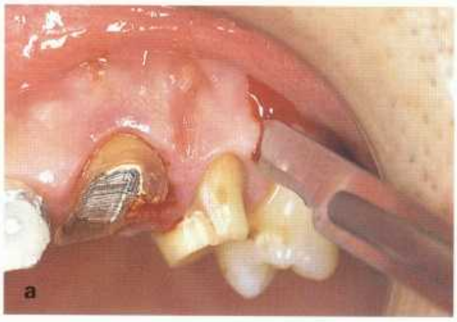


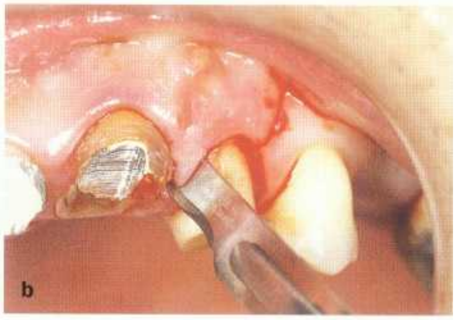
b. The periodontal pocket on the distal aspect of 11 is 11 mm. There is a fistula on the gingiva near the apex.

Flap design of GBR on extraction

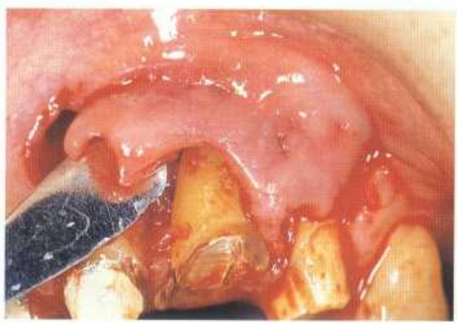


c5-2 Vertical incision and sulcular incision. A no. 15 blade is used to prepare a vertical incision on the distobuccal line angle of 12 beyond the alveolar mucosa. This incision should be broader at the base (a). The vertical incision is connected with a sulcular incision on 12 (b) and extended to the mesiobuccal line angle of 10 (c, d). A vertical incision is made on the mesiobuccal line angle of 10. The vertical incision should be more than one tooth from the membrane margin and made broader at the base (e).



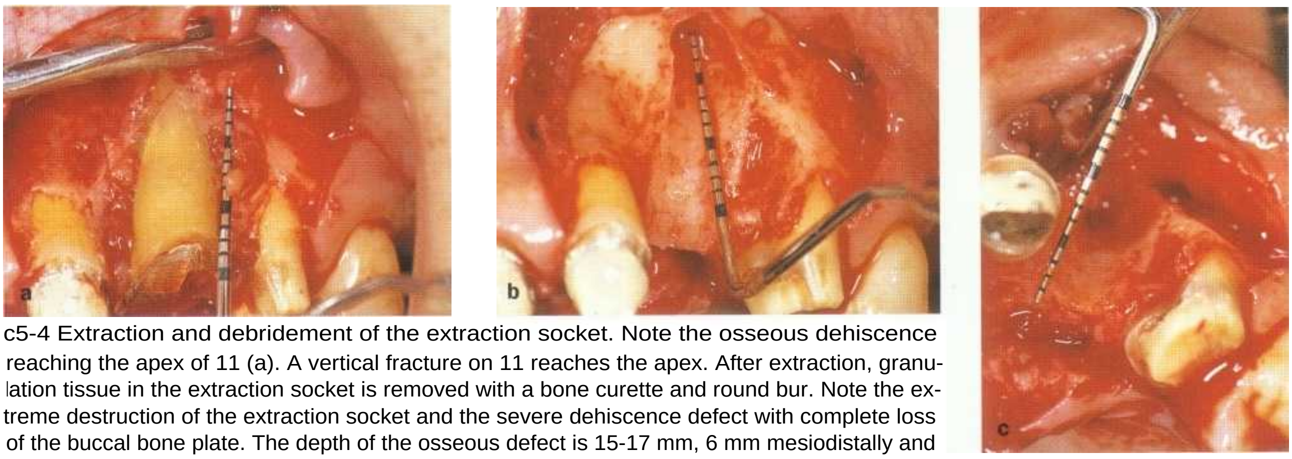


c5-3 Flap reflection. A periosteal elevator is used to reflect the full-thickness flap.



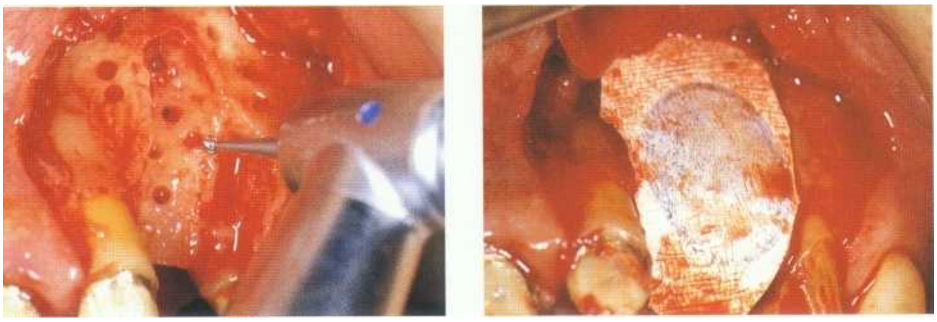
Key point

Prepare the flap as thick as possible, including sufficient keratinized tissue. Preserve as much mesiodistal interdental papilla as possible on the tooth planned for extraction.



c5-4 Extraction and debridement of the extraction socket. Note the osseous dehiscence reaching the apex of 11 (a). A vertical fracture on 11 reaches the apex. After extraction, granulation tissue in the extraction socket is removed with a bone curette and round bur. Note the extreme destruction of the extraction socket and the severe dehiscence defect with complete loss of the buccal bone plate. The depth of the osseous defect is 15-17 mm, 6 mm mesiodistally and 10 mm buccopalatally (b, c). Because of the extensive osseous defect, a staged approach (ridge augmentation using GBR) is used before implant placement.

GBR procedure

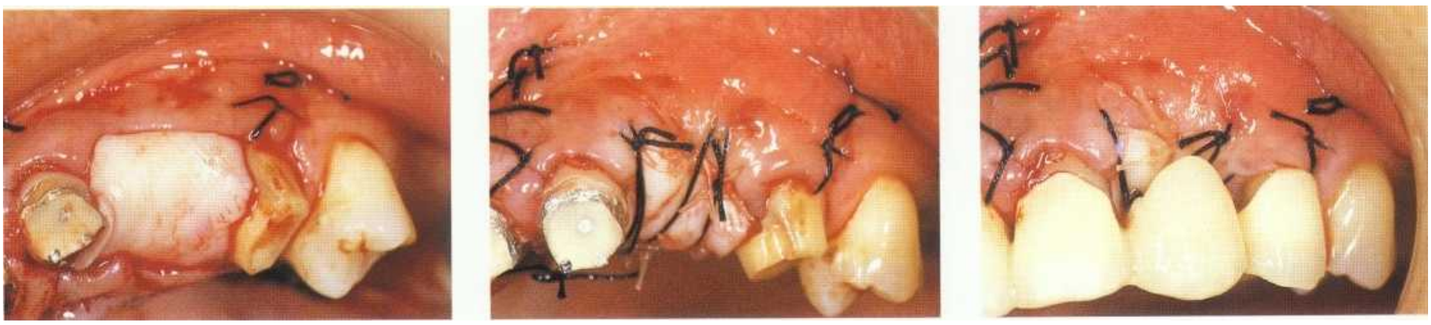


c5-5 Membrane placement.

a. The bone around the osseous defect and palatal wall of the extraction socket is penetrated with a small round bur. Cancellous bone is exposed to facilitate bleeding from the bone surface.

b. Bone grafts are placed on the defect area. GTAM (Oval 6, WL Gore) is trimmed and placed to closely adapt to the bone.

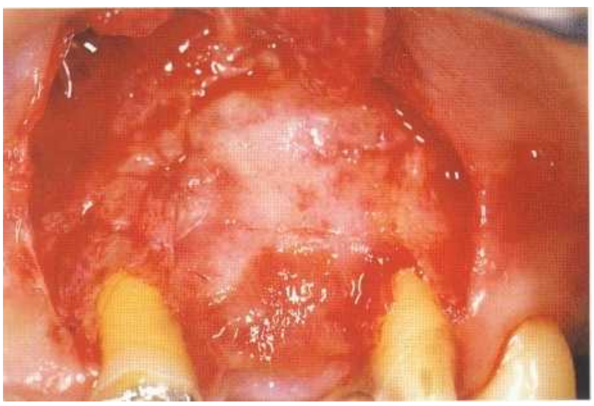
c5-6 Flap suturing.



a. Thick free gingival grafts harvested from the palate are placed on the membrane and sutured to the buccal and palatal flap with bioresorbable material.

b. For better adaptation of the graft and membrane, suture material is tied on the buccal and palatal aspects of the grafts, with slight tension, using a mattress suture.

c. The base of the pontic is reduced to u pressure to the membrane.



c5-7 Membrane removal. Because of exposure of the membrane margin, the membrane is removed 7 weeks after surgery. Note the new tissue under the membrane.

Key point

A problem of GBR with simultaneous extraction is the difficulty of complete membrane coverage and wound closure. To avoid this problem, cover the exposed part of the membrane with gingival grafts. Using grafts eliminates the need for a large periosteal releasing incision on the flap base and coronal migration of flap, and aids wound closure. Consequently, there is minimal postoperative swelling after GBR, and sufficient width of the keratinized mucosa and depth of the oral vestibule is maintained.

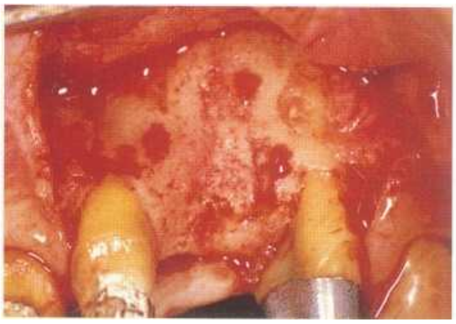
Implant surgery and prognosis

c5-8 Seven months after GBR (extraction).

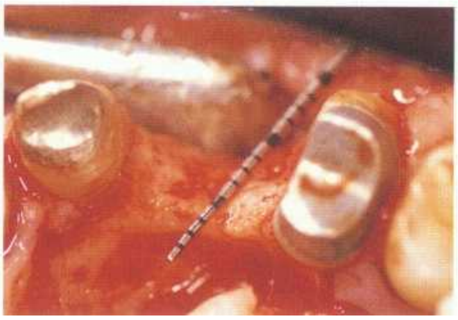
Key point

Because free autogenous gingival grafts are used with GBR, there is no coronal migration of the flap and, therefore, no coronal migration of the mucogingival junction. The width of the keratinized tissue of 11 is also sufficiently preserved.

c5-9 Bone regeneration.



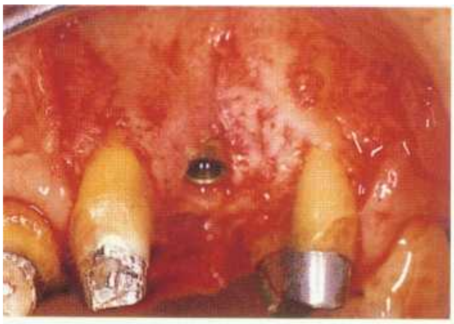
a. Note the marked bone regeneration of the buccal plate of the extraction socket achieved by the combination of bone graft and membrane.



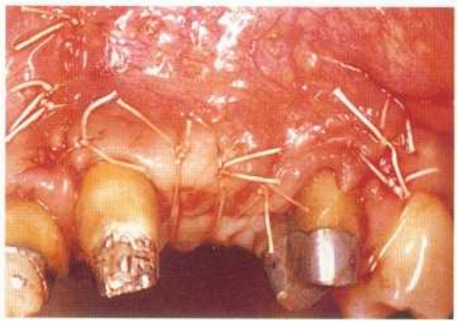
b. Note the slight collapse on the buccal bone. There is, however, sufficient bone width and morphology for implant placement.

c. About 7 months after surgery.

c5-10 Fixture placement.

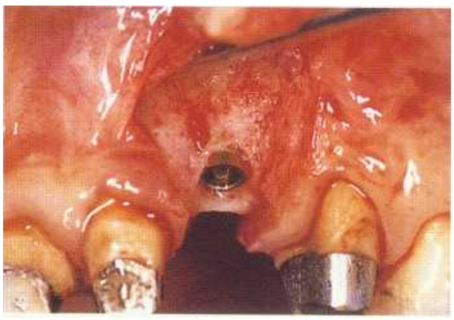


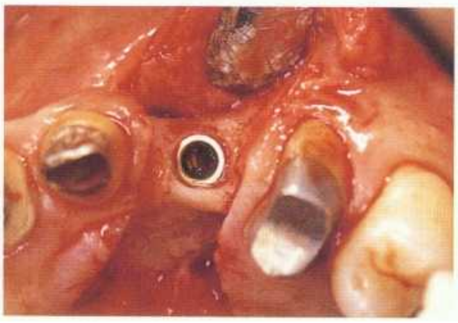
a. A P01 three-piece-type implant (13 x 3.7 mm, Finafix, Kyocera) is placed. Because of the small osseous dehiscence on the buccal aspect of the fixture, a bone graft is performed.



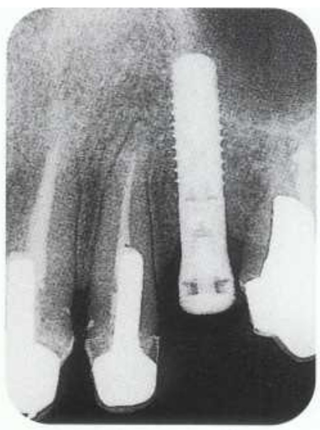
b. Flap suturing.

c5-11 Second-stage implant surgery.





a. The buccal and palatal aspects of the fixture on second-stage surgery 7 1/2 months after fixture placement. Note the improvement of the buccal osseous dehiscence.

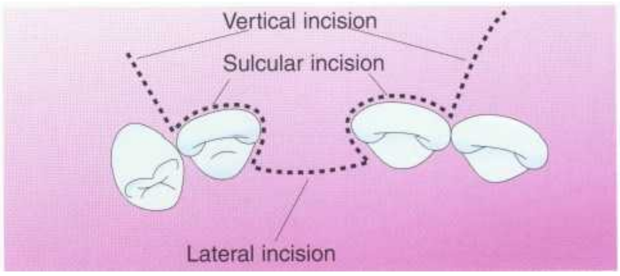


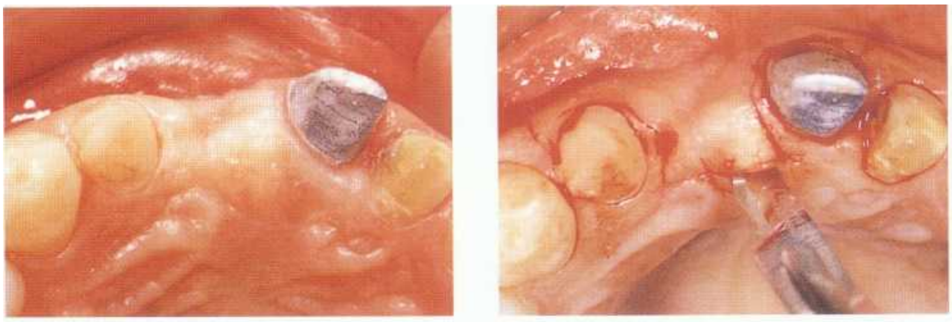
b. Abutment connection 1 year and 4 months after GBR.

Case 5-6 Ridge augmentation using GBR after soft tissue healing of the extraction wound

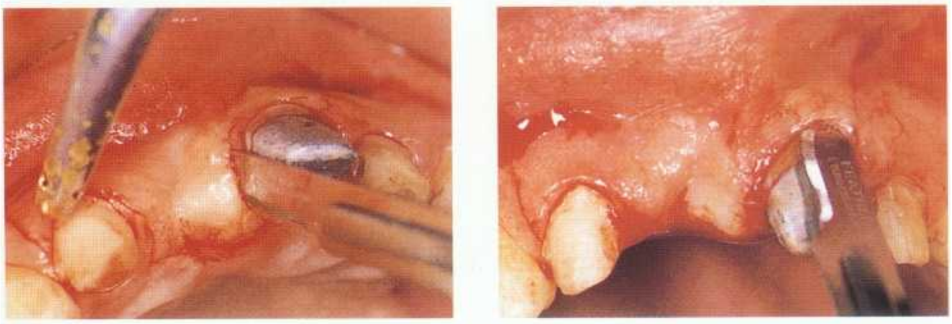
c6-1 Two and one half months after initial examination, after initial therapy. Note the edentulous ridge collapse on 8 (36-year-old man).

Flap design and incision procedures

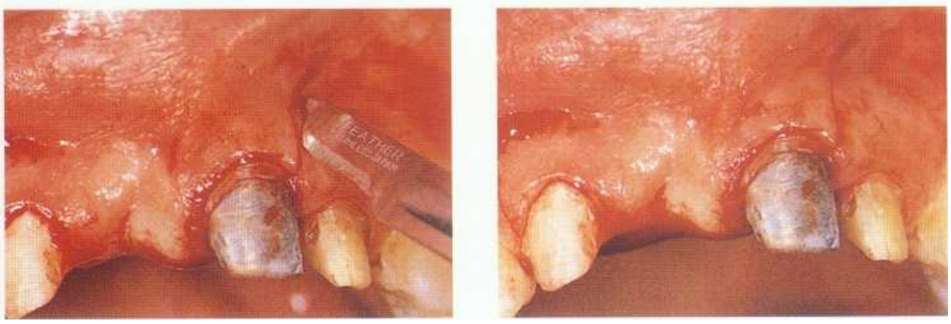




c6-2 Lateral incision. With a no. 15 blade, a partial-thickness incision is prepared on the palate about 3 mm from the alveolar crest (lateral incision).



c6-3 Sulcular incision. The incision is extended to the sulcular incision on 7 and 9.

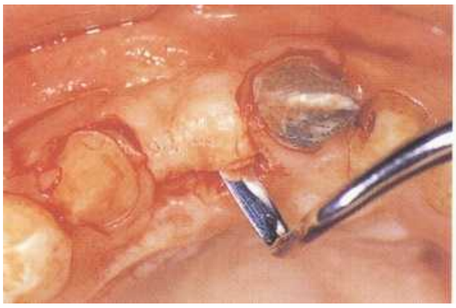


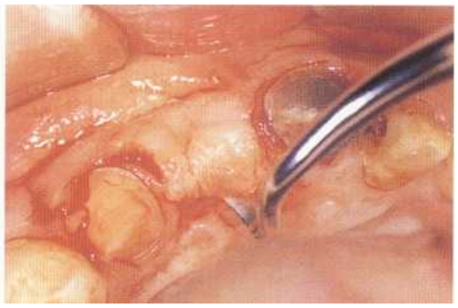
c6-4 Vertical incision.

a. A vertical incision is made on the buccodistal line angle of the adjacent tooth, extending to the alveolar mucosa beyond the mucogingival junction. The incision should be broader at the base. The blade tip should be beveled against the bone surface (left).

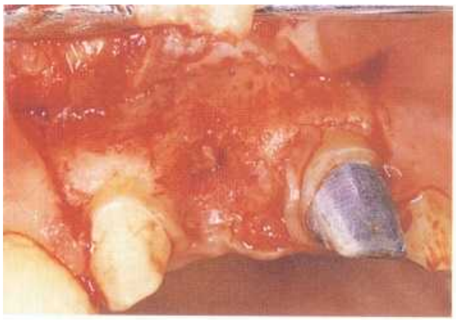
b. A large flap extending more than one tooth mesiodistally with sufficient blood supply is prepared (right).

c6-5 Partial-thickness flap with lateral incision. An Orban interdental knife is inserted into the vertical incision (partial-thickness). A partial-thickness flap with a wide bevel is prepared on the margin near the alveolar crest. Flap penetration must be avoided.

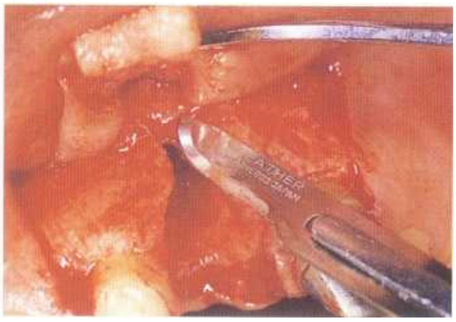




c6-6 *Full-thickness* flap with lateral incision.



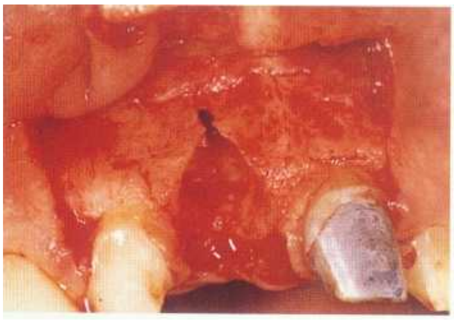
a. A small periosteal elevator is used to reflect a combination partial- and full-thickness flap toward the buccal aspect.



b. The flap margin is lifted with tissue pliers. A releasing incision of the periosteum is carefully made at the bottom of the flap for free coronal migration of the flap.

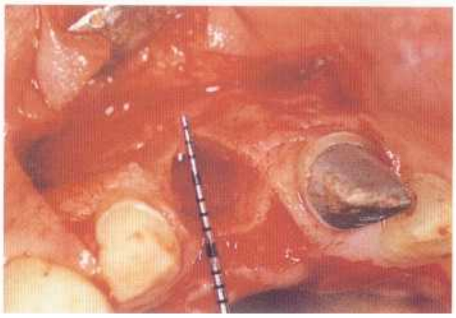
Osseous defect in extraction socket

c6-7 Osseous defect.



a. Note the remarked destruction of the buccal wall of the extraction socket.

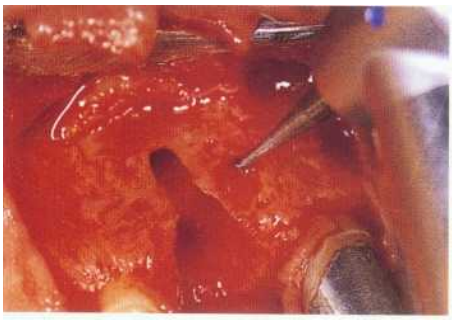
b. The depth of the osseous defect in the extraction socket is about 7 mm on the distal wall, about 15 mm on the mesial wall, and about 11 mm on the buccal wall. The length of the buccal osseous dehiscence is about 10 mm.

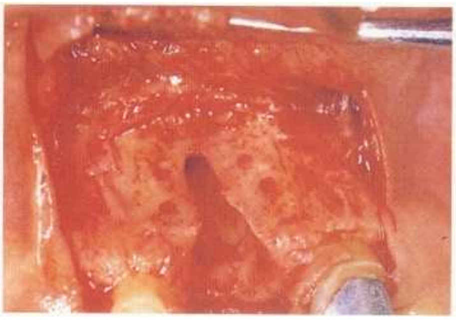


c. The osseous defect is 6 mm buccopalatally and 7 mm mesiodistally. The bone will be regenerated by GBR and proper ridge morphology reconstructed for implant placement.

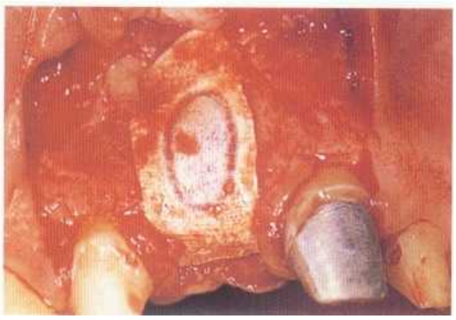
Localized ridge augmentation using GBR

c6-8 Penetration of cortical bone, bone graft, and membrane placement.



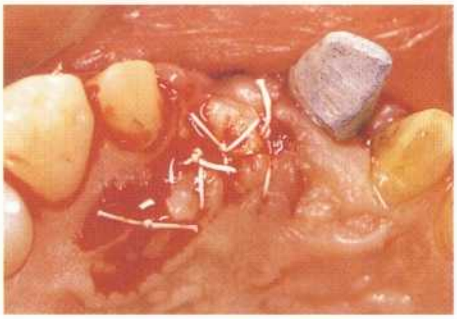


a. A small round bur is used to penetrate the cortical bone.

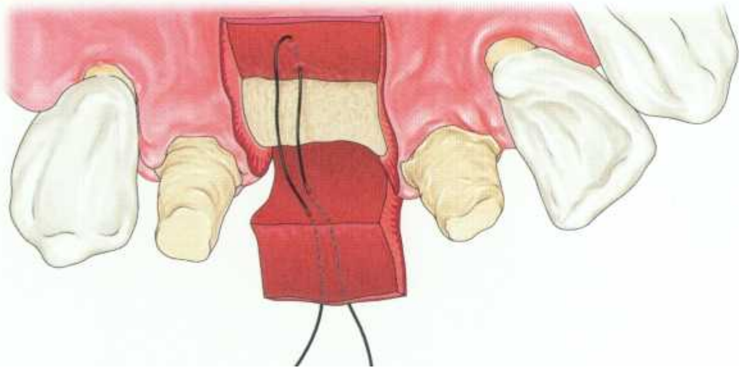


b. After bone grafting, the GTAM (Oval 4, WL Gore) is adjusted and placed to cover the grafted bone and surrounding bone with 1 mm separation from the adjacent teeth.

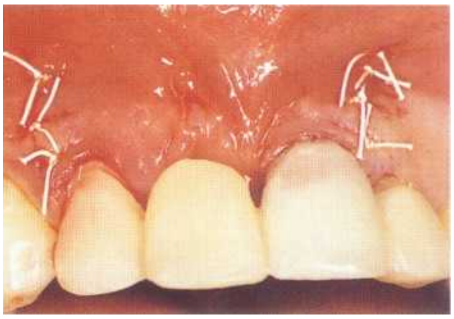
Flap suturing

c6-9 **Vertical mattress suture.** Two vertical mattress sutures are made on the horizontal incision area with Teflon (WL Gore). The membrane is covered with interrupted sutures without tension and primary closure of the wound obtained.



c6-10 **Temporary restoration.**

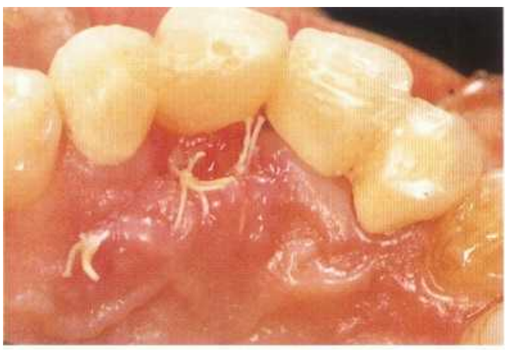


a. The base of the pontic of 8 is adjusted to avoid pressure to the area treated by GBR.

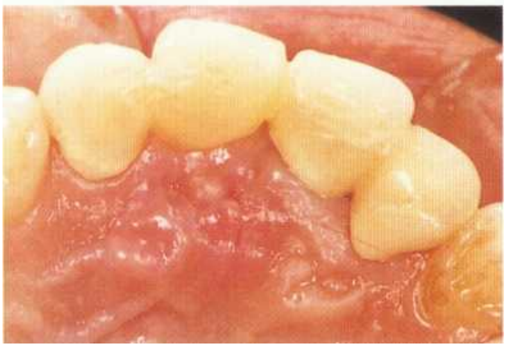
b. On completion of GBR.

Prognosis of localized ridge augmentation (GBR)

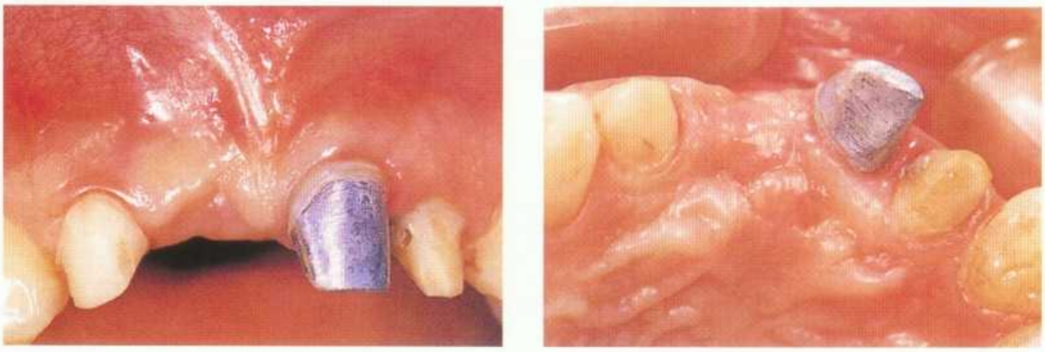
c6-11 **After** *GBR.*

a. One week after surgery.

b. Two weeks after surgery.

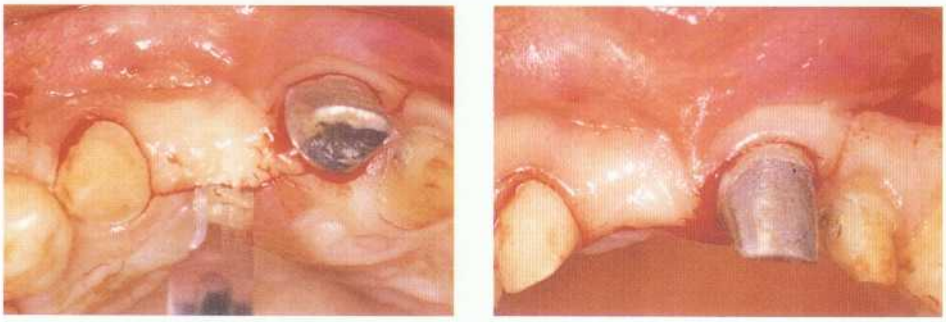


c. Four weeks after surgery.

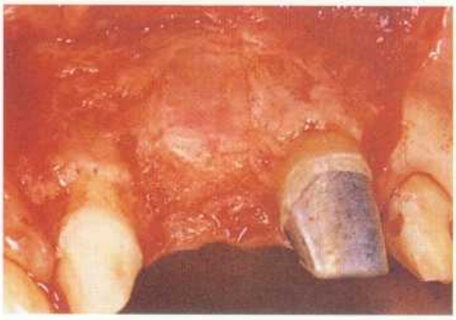
Fixture placement

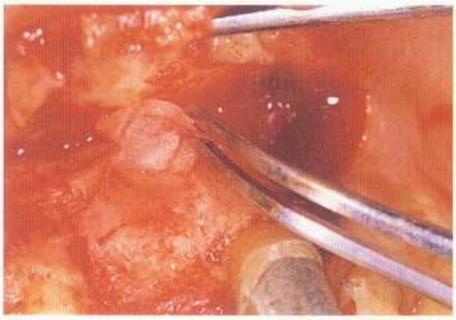
c6-12 Membrane removal.

a. About 7% months after GBR.



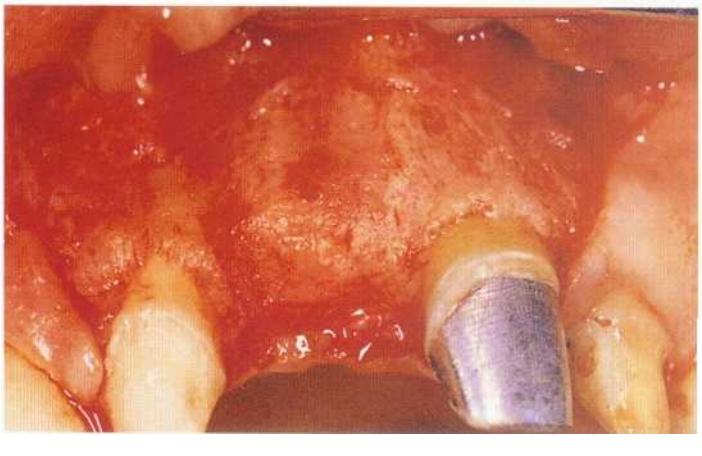
b. A flap consisting of a lateral incision and two vertical incisions on the distobuccal line angle of the adjacent teeth is prepared.

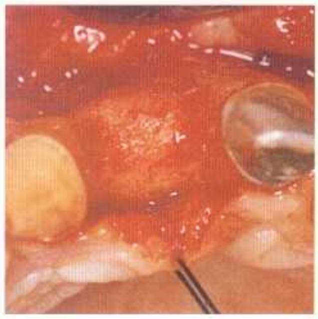




c. Note the semitranslucent membrane after flap reflection, but no membrane collapse (left).

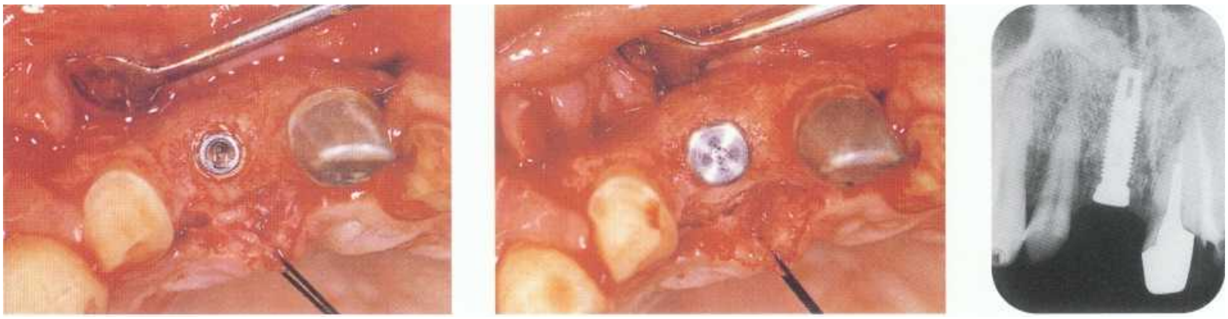
d. There is a soft tissue layer between the membrane and new bone after careful membrane removal (right).





e. Note the remarkable bone regeneration. The buccal **osseous dehiscence** is improved. The ridge is 6 mm buccolingually and proper ridge morphology for implant placement has been obtained.

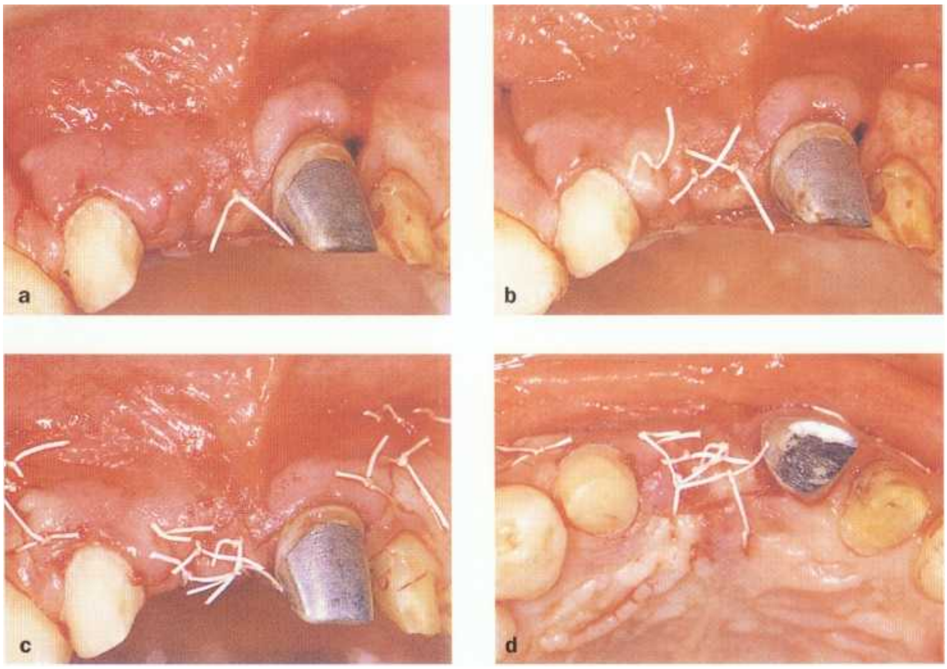
c6-13 Fixture placement.



a. A self-tapping threaded implant (3i) (15 mm x 3.75 mm) is placed. More than 1 mm of bone wall exists on the buccal aspect of the fixture.

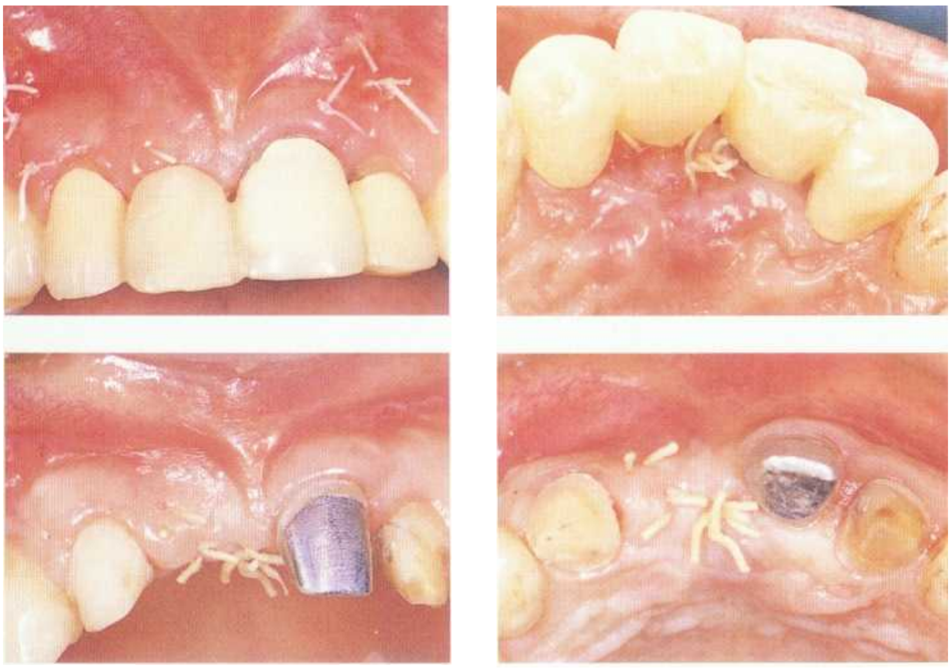
b. A cover screw is placed.

Flap suturing



c6-14 Suture. After two vertical mattress sutures have been made on the horizontal incision part of the palate (a, b), the flap is closed with interrupted sutures (c, d).

Prognosis of fixture placement

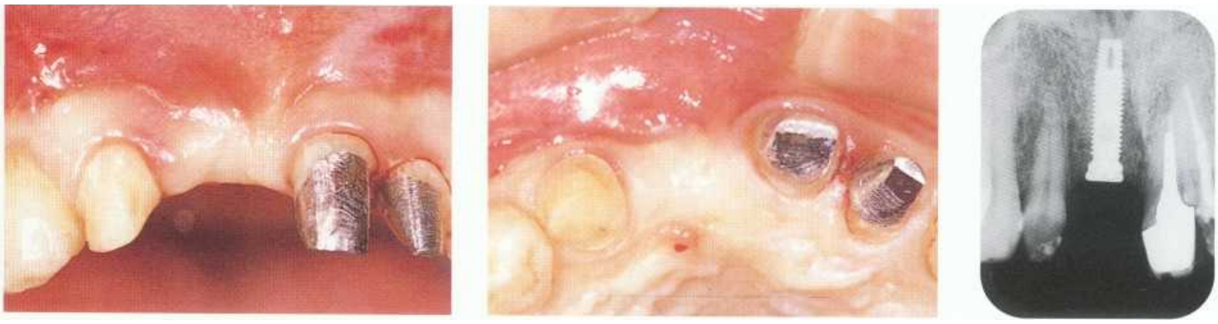


c6-15 Suture removal.

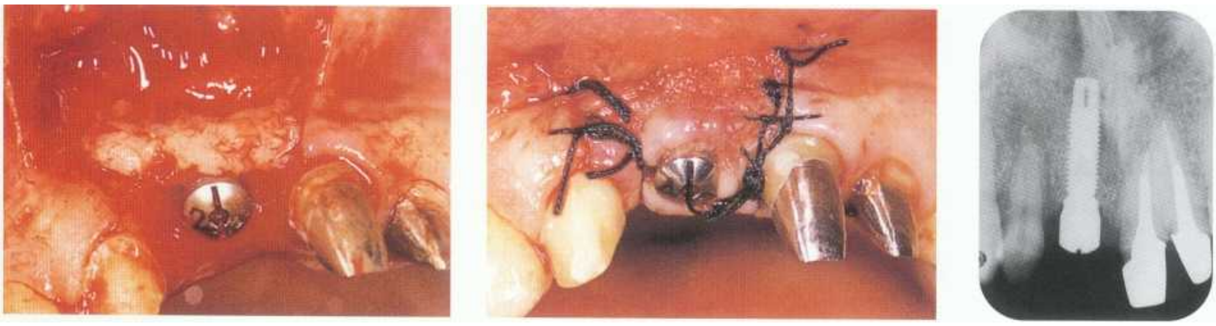
a. Suture materials are removed except mattress sutures 10 days after surgery.

b. Mattress suture threads are removed 16 days after surgery.

c6-16 Second-stage implant surgery.



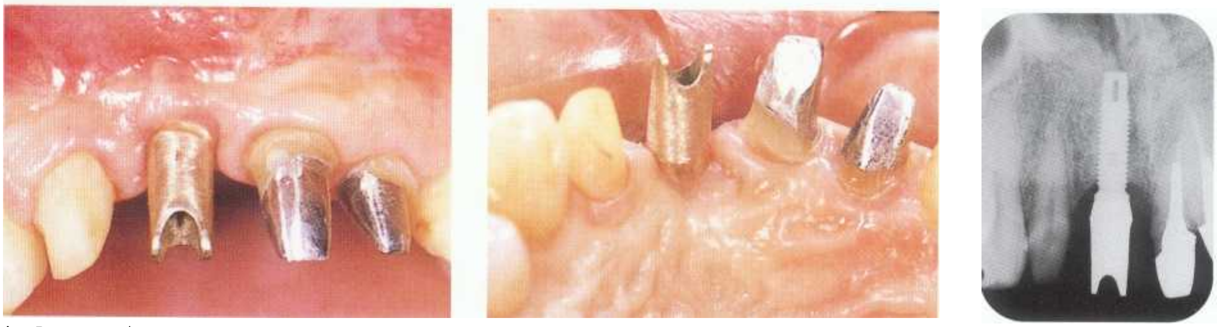
a. Before second-stage surgery. Note the soft tissue collapse on the labial aspect of 8.



b. After the temporary healing abutment is connected, connective tissue is transplanted to the labial aspect of 8 and sutured.

c6-17 UCLA **abutment connection.**

a. One year and 2 months after second-stage surgery.



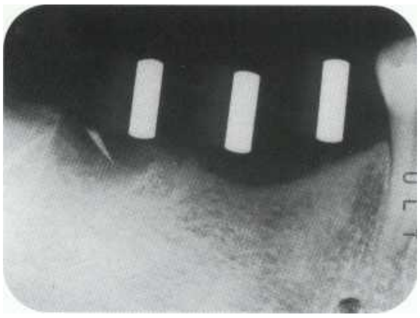
b. P ping is fabricated using a gold UCLA-type abutment and connected to the fixture.

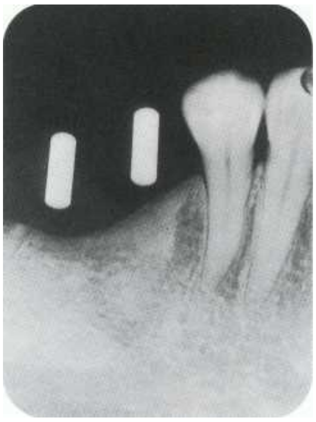
c. Final restorations.

Case 5-7 Localized ridge augmentation in the mandibular molars using GBR

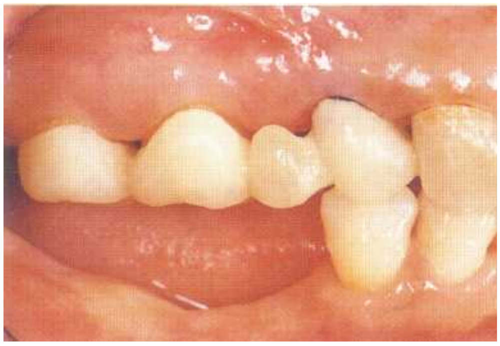
c7-1 Initial examination. Note the large apical lesion on 31. Tooth 32 almost touches the maxillary tuberosity because of remarkable extrusion. The occlusal plane requires correction because of the extruded maxillary right molars (43-year-old woman).

c7-2 Implant treatment plan.





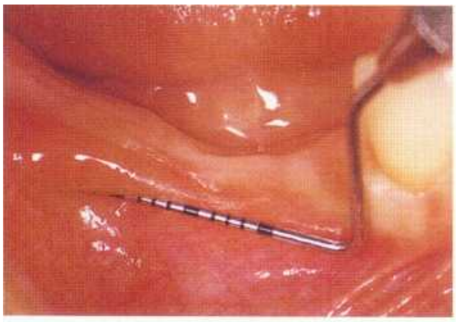
a. Tooth 31 was extracted because endodontic treatment had an unfavorable prognosis, and 32 was extracted due to the marked extrusion. The treatment plan has been changed to the placement of implant-supported restorations for 29, 30, and 31(2 years and 9 months after initial examination).

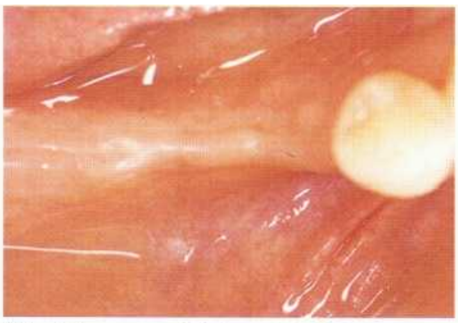


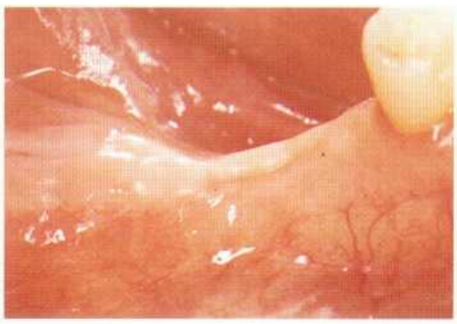
b. Maxillary provisional restorations are placed with correction of the occlusal plane.

Flap design

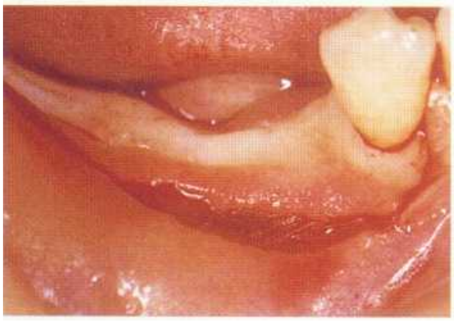
c7-3 Lateral incision.

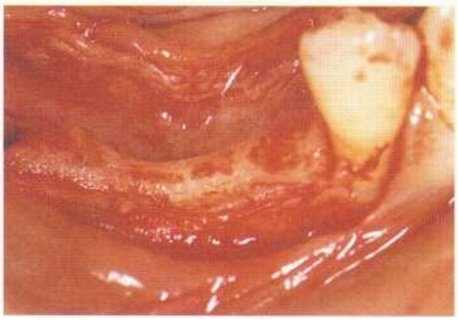






a. Three months after extraction. The ridge and width of the nonmobile keratinized tissue are narrow.

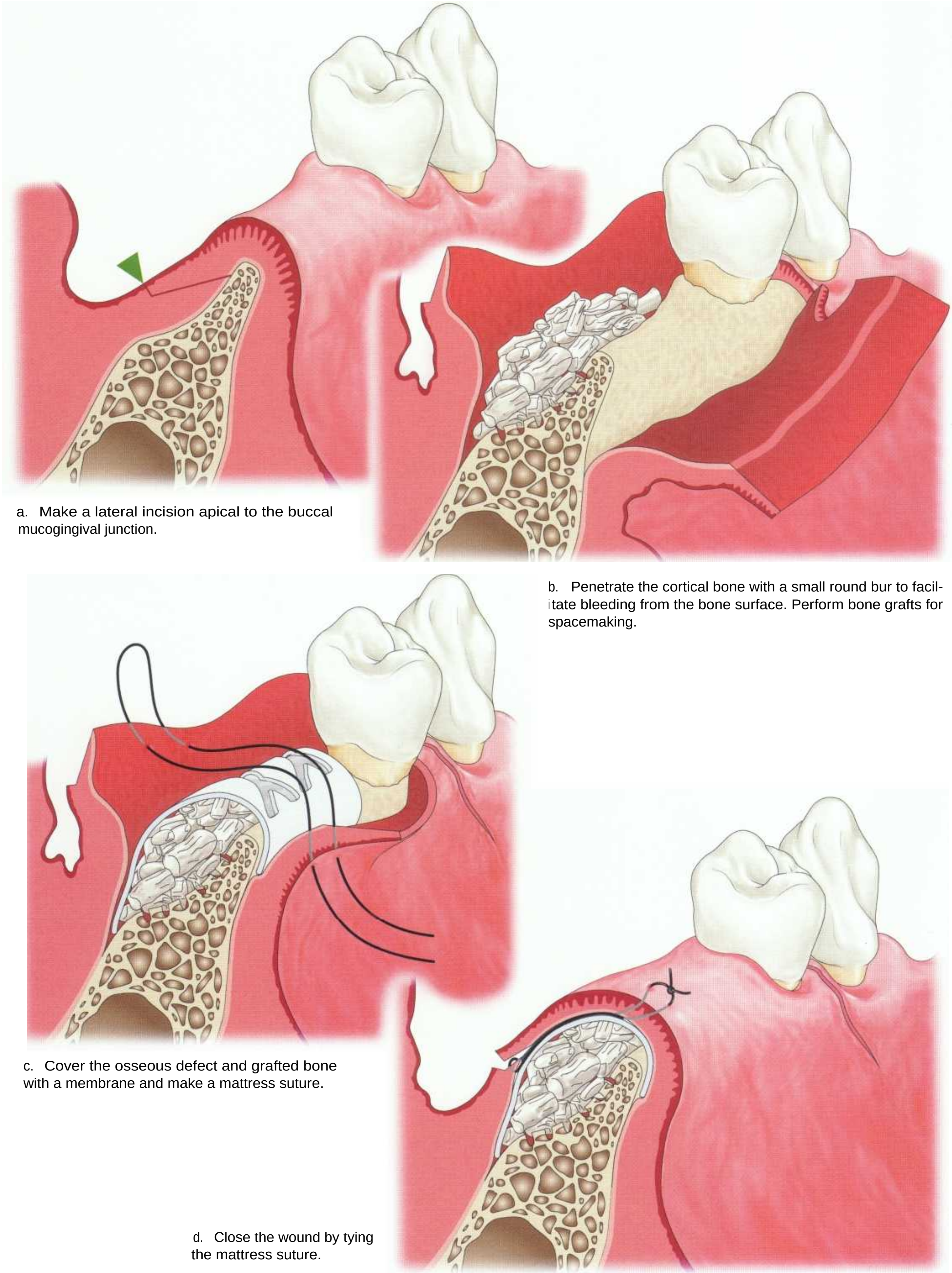




b. A no. 15 blade is used to make a shallow, partial-thickness horizontal incision on the alveolar mucosa about 3 mm apical to the mucogingival junction (left, lateral incision).

c. A combination partial- and full-thickness flap is reflected toward the lingual aspect (right).

Fig 5-14 GBR with a lateral incision and bone graft.



a. Make a lateral incision apical to the buccal mucogingival junction.

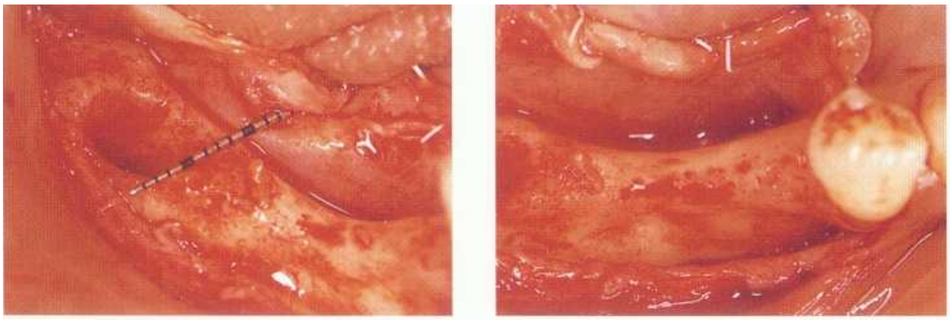
b. Penetrate the cortical bone with a small round bur to facilitate bleeding from the bone surface. Perform bone grafts for spacemaking.

c. Cover the osseous defect and grafted bone with a membrane and make a mattress suture.

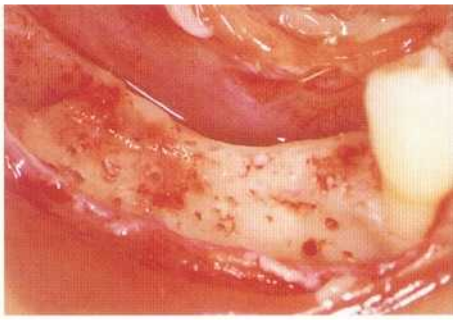
d. Close the wound by tying the mattress suture.

Bone graft and GBR

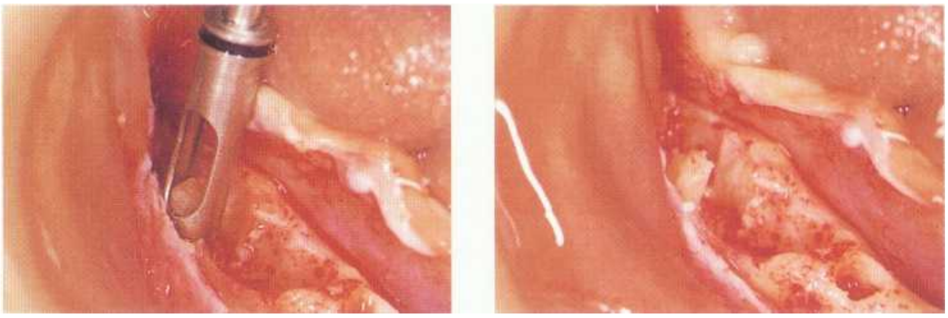
c7-4 Bone graft.



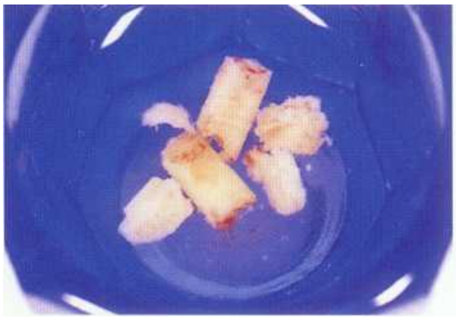
a. The ridge is narrow, about 3 mm on 30 and about 4 mm on 29. Note the marked collapse on the buccal aspect.



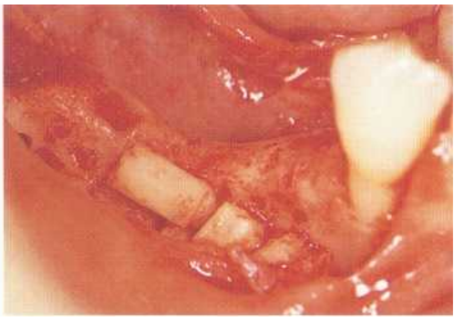
b. The cortical bone is penetrated with a small round bur.



c. With a trephine bur, the autografts are harvested from the retromolar ridge for spacemaking and stabilization of blood clot.

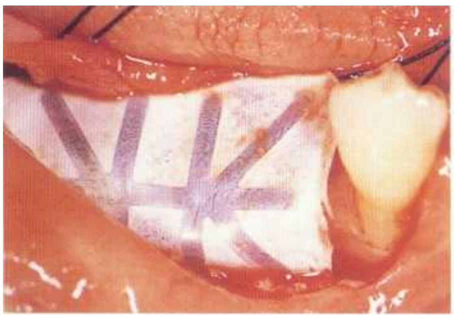


d. The harvested autografts are placed in physiologic saline solution.



e. The harvested autografts are transplanted.

c7-5 Membrane placement.



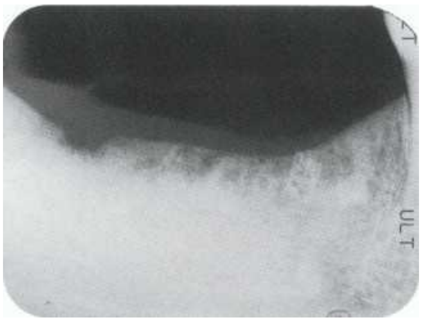
a. The titanium-reinforced membrane (TR9W, WL Gore) is adjusted.

b. The bone graft area is covered and the flap sutured.

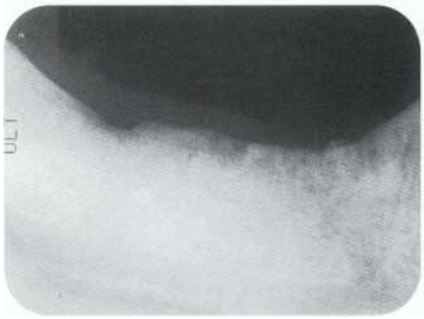
Prognosis

c7-6 **Bone fill.**

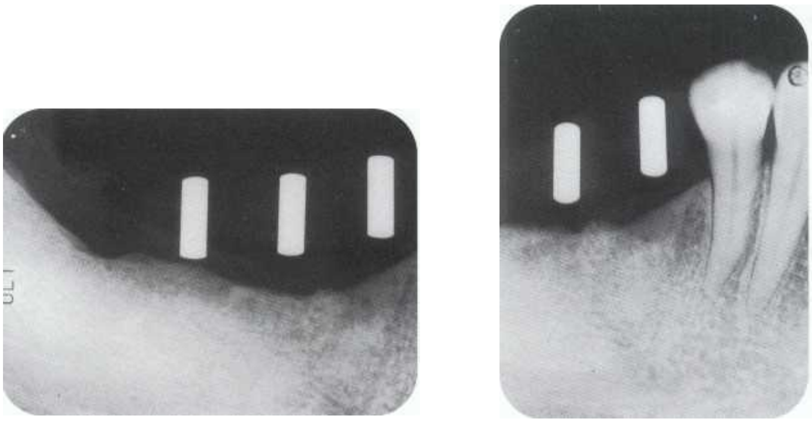
a. Before membrane removal 9 weeks after surgery.



b. Four months after surgery.



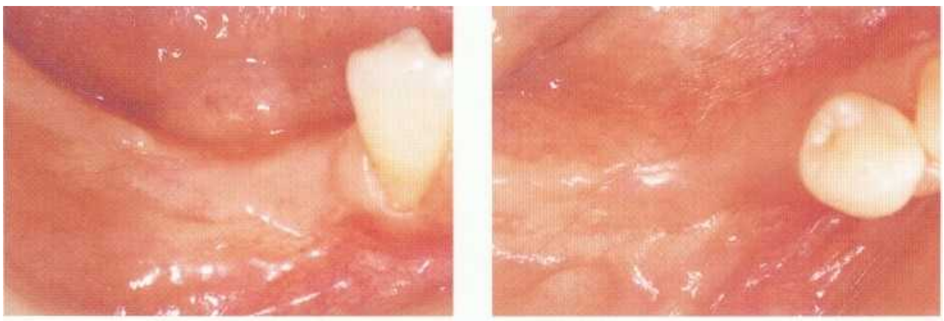
c. Seven months after surgery. Autografts are partially visible.



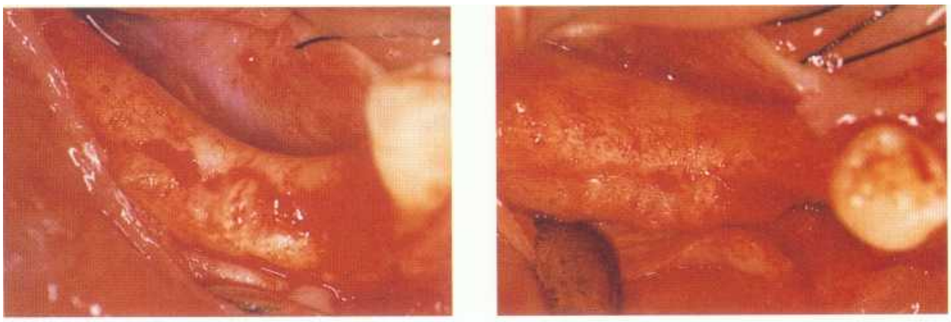
d. On re-entry 10 months after surgery. The autografts are no longer visible. Note the bone fill in the extraction socket of 31.

Fixture placement

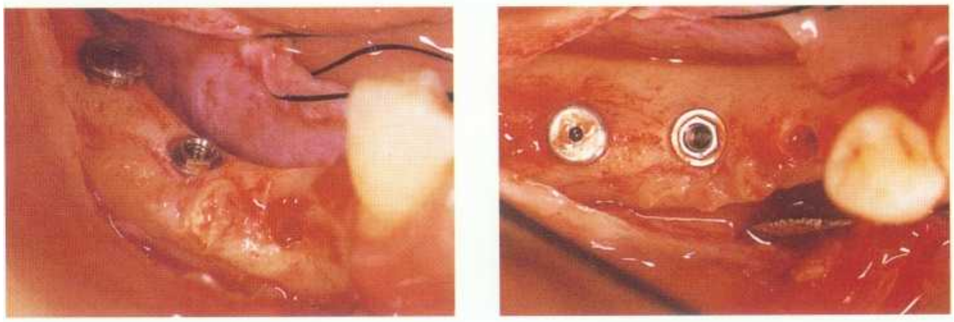
c7-7 **Fixture placement on 30 and** 31.



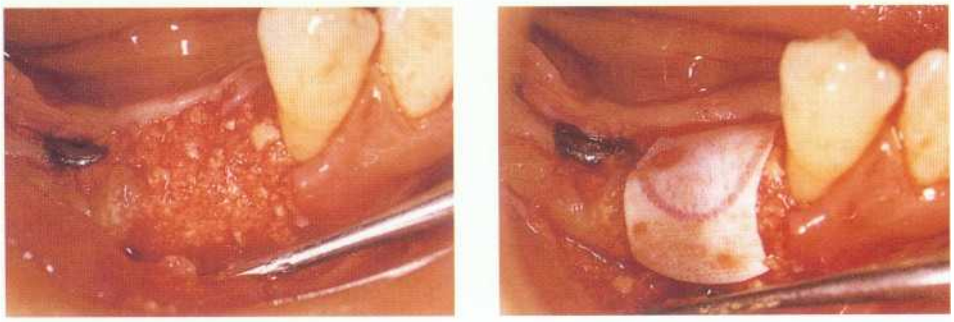
a. Before fixture placement.



b. Note the marked ridge augmentation (7-9 mm) in the area of 30 and 31. Due to membrane exposure, however, bone regeneration is not seen on 29.

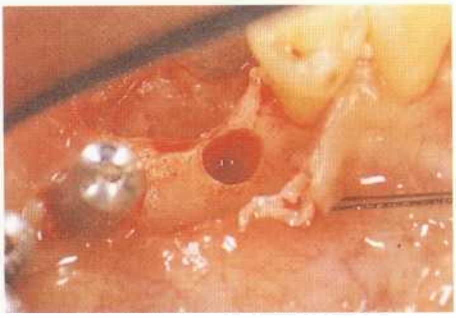


c. A fixture (10 x 3.75 mm) is placed on 30 and 31 (Nobel Biocare). GBR is again performed on 29.

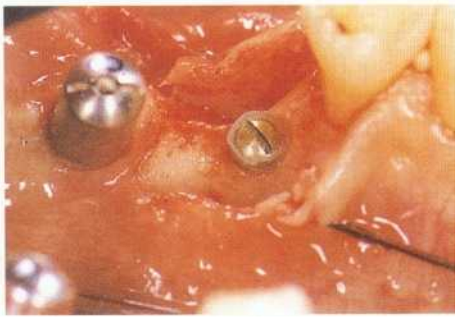


d. **Because the ridge** of 29 is inadequate for implant placement, a bone graft is performed with autografts harvested by the osseous coagulum trap during drilling. GBR is then performed again.

c7-8 Fixture placement on 29.

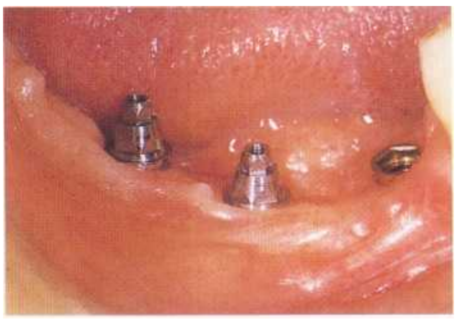


a. Preparation of the implant site on 29 10 months **after the second** GBR procedure.



b. Fixture placement (P01 three-piece-type implant, Kyocera).

c7-9 Placement of final restorations.



a. Esthetic Abutments (Hermans) placed on 30 and 31.

b. Screw-retained implant restorations are placed 4 months after the second surgery on 29.

Early Membrane Exposure and Its Management

Early Membrane Exposure

An important problem affecting the result of GBR is postoperative membrane exposure. Mellonig and Triplett" performed GBR during fixture placement in 66 sites (47 patients). The membrane had to be removed early in 35 sites (53%) due to membrane exposure or infection. Another study") reported that 20 of 49 sites treated with G BR during fixture placement had early membrane exposure resulting in membrane removal. There are many clinical studies on membrane exposure and amount of bone fill, and most reports suggest that early membrane removal occurs in 40%-55% of sites. GBR was applied prior to fixture placement for bone regeneration in an area with osseous dehiscence or fenestration due to insufficient ridge dimension. If vertical bone formation by GBR is sought during fixture placement because of lack of bone height, complete wound closure becomes more difficult, resulting in a greater probability of membrane exposure. In the author's clinical experiences of GBR for osseous dehiscences or fenestrations around fixtures, more than 50% of cases resulted in membrane exposure. The frequency of exposure may be higher in Asians than in Caucasians because Asians have thinner gingiva.

When performing GBR during fixture placement, it is usually desirable to remove the membrane on the second surgery (abutment connection). The period necessary for bone regeneration around the fixture is 6 months in the maxillary region and 3 months in the mandibular region, approximately.

Early membrane exposure is a common problem in GBR during fixture placement, but it does not mean treatment failure. Simion et al examined membrane exposure in GBR and found that 99.6% bone regeneration was ob tained in osseous defects around fixtures where membrane exposure did not occur for 6-8 months; 48.6% bone regeneration was found where membrane exposure occurred earlier. Membrane exposure reduces bone fill remarkably. Becker et al, Simion et al, and Gher et al'` reported that bone fill was profoundly reduced in areas where the membrane had to be removed due to early exposure (Fig 5-15).

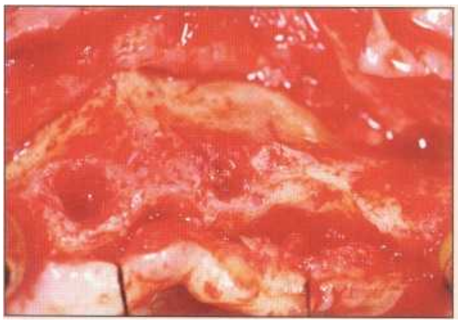
Early Exposure and GBR Outcome

There is no doubt that early membrane exposure affects GBR results. Complete primary closure is essential to prevent early exposure; however, some reports have shown that early membrane exposure may not affect the results of GBR depending on other conditions.

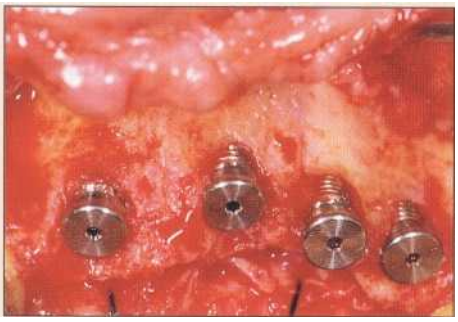
Mellonig and Triplett" reported that early membrane removal did not affect results despite early membrane removal in 53% of sites due to exposure during healing. However, frequent patient follow-up and thorough management of the exposed area is essential in early membrane exposure cases.

Dahlin et al'' also reported no difference in the amount of bone regeneration gained between those with early membrane exposure and those without. Rominger and Triplett reported that early membrane exposure and removal did not affect GBR results remarkably. Shanaman reported that membrane exposurewas not significant if postoperative oral hygiene management was adequate.

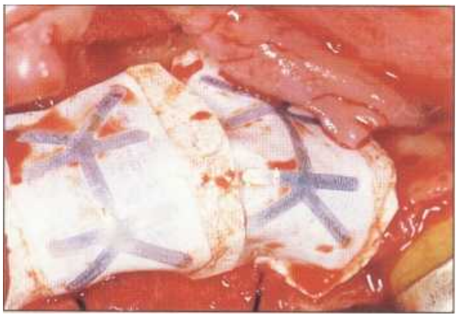
Fig 5-15 Membrane exposure.



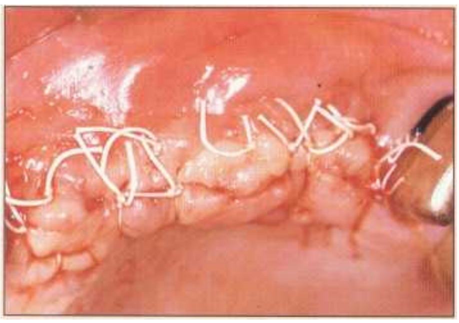
a. The osseous defect and alveolar process on flap reflection (maxillary anterior region).



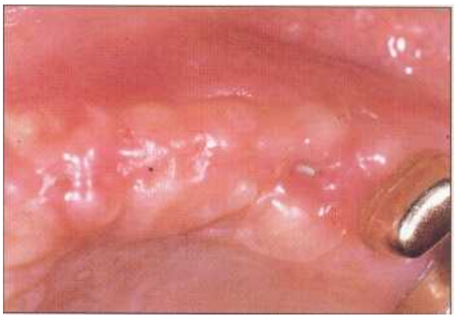
b. Fixture placement (Nobel Biocare). Note the marked dehiscence defect.



c. Two titanium-reinforced membranes (TR6Y, WL **Gore) are placed after bone grafting.**

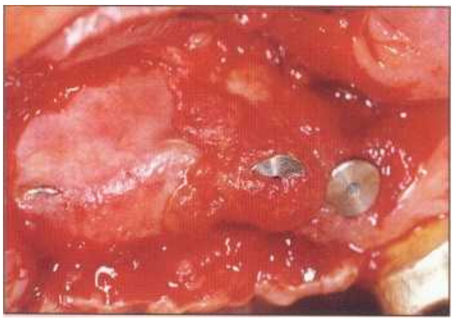


d. The **wound is closed with mattress and interrupted sutures.**

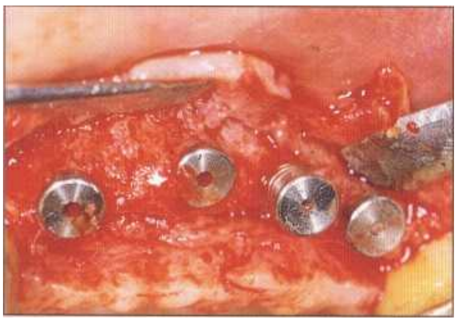


e. Thirty-two days after surgery. A small part of the membrane is exposed on 10.

f. Fifty-one days after surgery. The patient is examined weekly because the membrane area previously exposed is covered by gingiva.



g. Six and one half months after surgery. The membrane is removed because it is again exposed. In the area of 8 and 9 without membrane exposure, the area underneath the membrane is covered by soft tissue without bleeding. Note the red granular tissue on the exposed area of 10 and 11 under the membrane.



h. Second-stage surgery, 5 months after membrane removal and 11½ months after GBR. In the area of 8 and 9 with **no membrane exposure, the osseous dehiscence around the implants is completely covered by newly formed bone.** In the **area of 10 and 11 with membrane exposure, however,** there is only slight bone fill and a remaining osseous dehiscence. Bone regeneration around implants is usually hindered by membrane exposure due to soft tissue dehiscence during healing.

Thus membrane exposure due to a postoperative soft tissue dehiscence is disadvantageous, but thorough postoperative oral hygiene helps counter the problem because it reduces the likelihood of infection. A clinical study of immediate transmucosal implants (nonsubmerged implants) using GBR supported the importance of postoperative hygiene.

In the study of immediate implants using nonsubmerged fixtures,[11] although the neck portion of the fixture was exposed in the oral cavity, complete bone regeneration around the fixture was obtained in 20 of 21 fixtures with the aid of thorough plaque control. The plaque control program involved a mouthrinse with 0.1% chlorhexidine solution and the application of 1% chlorhexidine gel twice daily through the entire healing period. Only two sites of 21 had early membrane exposure. While this plaque control program is not practical for everyone, it is important to remember that infection control is a more important factor than primary closure. In this study,[12] membrane removal due to early exposure was required in no cases.

Good primary closure, however, makes postoperative management easier. In GBR with simultaneous fixture placement (simultaneous approach), complete primary closure should be achieved because infection due to membrane exposure could result in implant failure.

Suture recommendations in GBR to avoid membrane exposure

1. Remove granulation tissue and sulcular epithelium inside the flap covering the membrane.
2. Obtain complete primary closure using a combination of mattress suture and interrupted suture.
3. Achieve minimal tension to the flap by suture.
4. Start the suture from an area adjacent to the membrane.
5. Use nonabsorbable suture thread.

Management of Membrane Exposure

Ideally, the membrane should be completely covered by mucosa during the healing period. After a certain period (usually 6-9 months), the membrane is removed. However, membrane exposure due to a soft tissue dehiscence is not unusual.

Particularly in immediate ridge augmentation with an extensive osseous defect (staged approach) or immediate implants, membrane exposure frequently occurs due to a soft tissue dehiscence early in healing, even if primary closure of flap has been achieved. With the e-PTFE barrier membrane (GTAM, WL Gore), the inner portion of the membrane is protected against bacterial invasion. Therefore, if membrane exposure is limited to the center part, there may be no problem. If careful examination reveals that the marginal part of the membrane is not exposed, the membrane is removed 4-8 weeks after surgery with thorough plaque control of the exposed area.

One study[13] found that the inner portion of an e-PTFE membrane could delay bacterial invasion for about 4 weeks. Frequent application of bactericide to the exposed membrane surface is necessary because the antimicrobial characteristics are not permanent.

Bacterial contamination of the exposed membrane produces inflammation of the soft tissue dehiscence, consequently hindering bone regeneration. Continuous inflammation enlarges the dehiscence and results in exposure of the membrane margin. If infection spreads, inflammation reaches the circumferential tissue of fixture, possibly resulting in implant failure and severe infection. Therefore, in cases of membrane exposure, it is important to assess the condition of the membrane and degree of infection. If it is possible to maintain the membrane, thorough plaque control of the exposed area is essential. In Europe and America, chlorhexidine mouthrinse is usually applied.

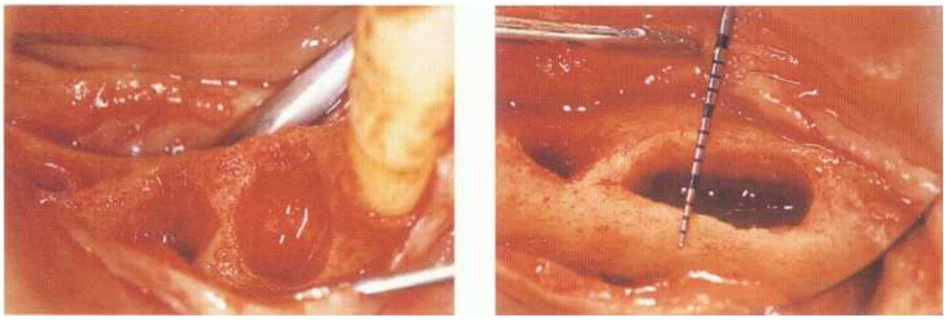
If the membrane margin is exposed, the membrane should be removed immediately. Pain or discharge following exposure are also indications for immediate membrane removal. In the absence of these problems, the membrane is removed 4-8 weeks later followed by thorough plaque control of the exposed area. But if membrane exposure progresses or a large amount of plaque builds up on the exposed membrane during management, the membrane should be removed 4 weeks after surgery. Otherwise, membrane removal is delayed as long as possible and the membrane removed 8 weeks after surgery. The patient should return at least once weekly (every 3 days if possible) so that the exposed area may be professionally cleaned. The patient should use a bactericidal mouthwash until membrane removal.

Caution is needed in the mechanical plaque removal of the exposed area to prevent damage of soft tissue dehiscence. Therefore, explicit instruction on the use of cleaning instruments is necessary. The author developed a toothbrush with a soft tuft (Ope-Go brush, Panadex) for use after periodontal surgery and recommends that patients use it (Case 5-8). This brush removes plaque deposited on the exposed membrane area but, because of its softness, it will not cause the soft tissue dehiscence to progress (and, unlike a standard toothbrush, it will not cause pain). The patient should use a soft toothbrush, brushing the exposed area with a bactericidal mouthrinse for most effectiveness. The patient should be instructed to use a bacteriostatic moutlirinsc at home.

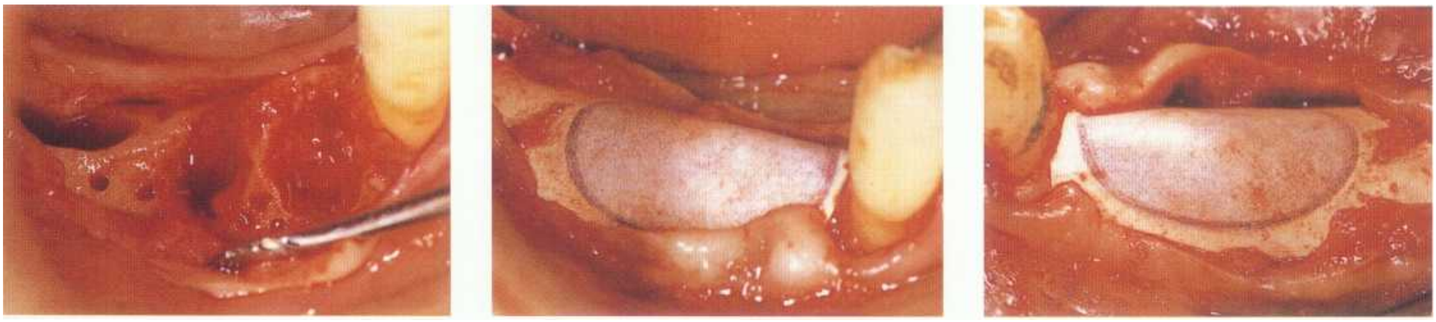
Case 5-8 Membrane exposure and its management in the staged approach

Root fracture of 28 and 29

c8-1 Osseous defect before surgery. Note the condition of the alveolar ridge after the removal of a single crystal aluminous implant on 31. Due to root fracture, the buccal walls of **the extraction sockets are destroyed (about** 8 mm on 28 and about 5 mm on 29).

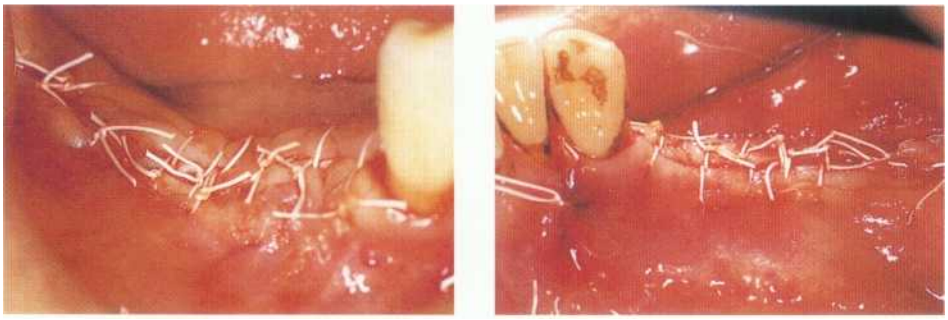


Membrane placement and suture



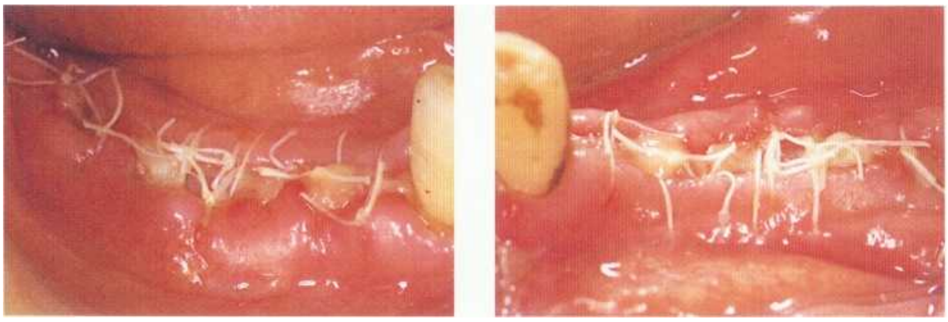
c8-2 Membrane placement. The cortical bone is penetrated with a small round bur. After bone grafting, the osseous defect area is covered by a GTAM (Oval 9, WL Gore).

c8-3 Suture. Because the mental foramen is close to the flap margin, a releasing incision of the periosteum cannot be made on the base of the flap, resulting in tension on the flap margin.



Management of membrane exposure

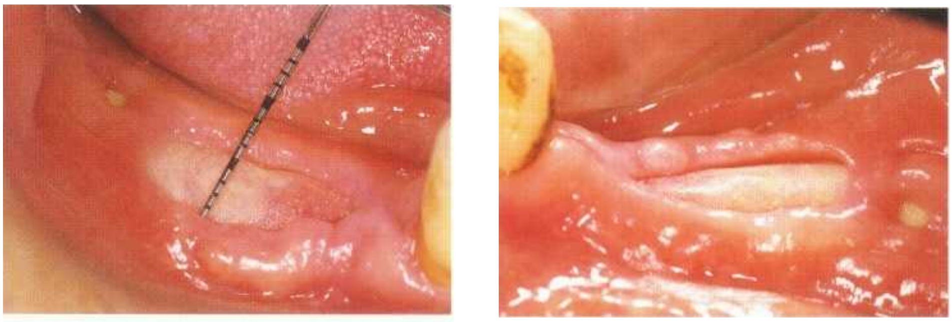
c8-4 Postoperative exposure.



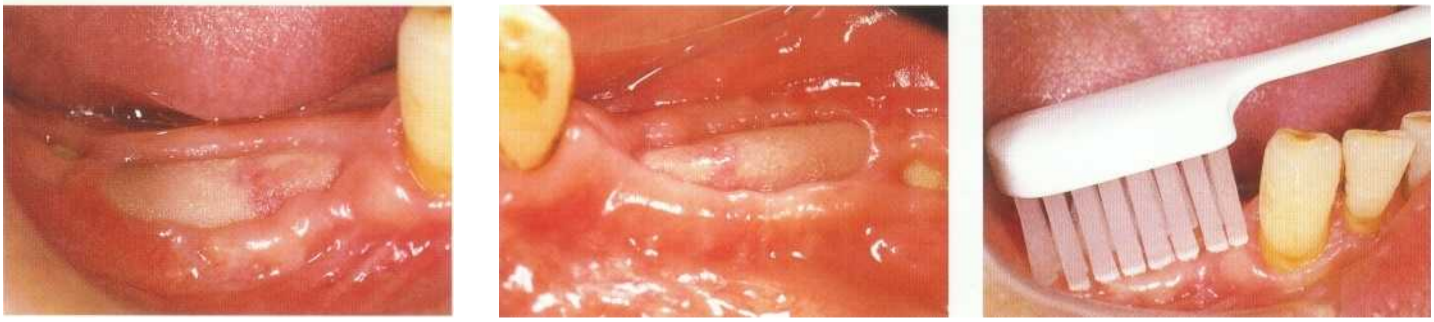
a. Note the soft tissue dehiscence and membrane exposure 6 days after surgery. Membrane exposure is limited to the inner portion.

b. The patient is instructed to **brush the membrane exposure area** with a soft brush immediately after suture removal and to return weekly for tooth cleaning and examination for signs of inflammation in the dehiscence area.

c8-5 Observation of membrane exposure.



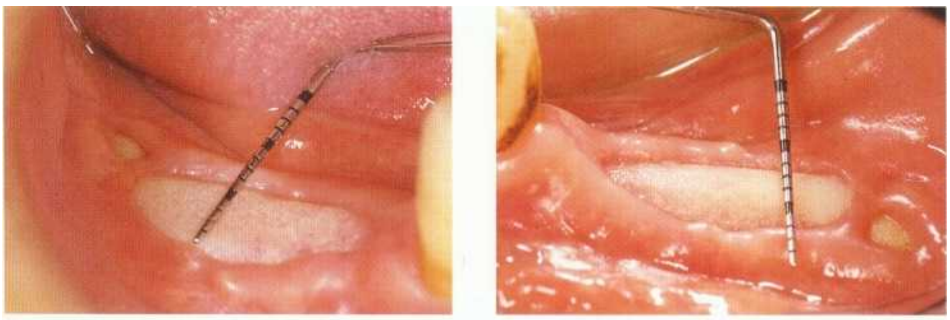
a. Note the membrane exposure (17 mm mesiodistally and 5.5 mm **buccolingually) 20 days after surgery.** The amount of exposure has increased slightly since 6 days after surgery.



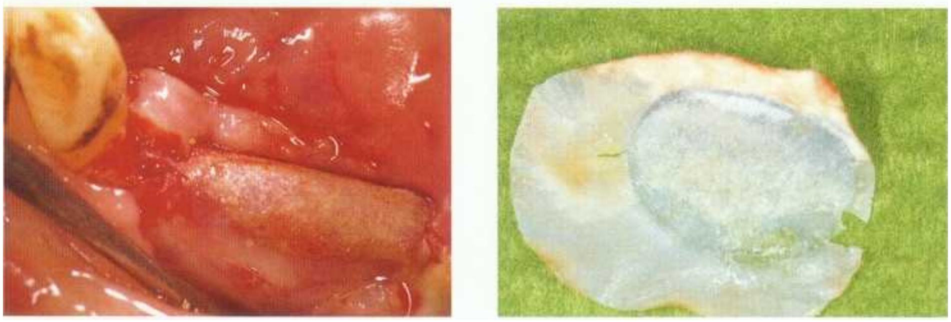
b. New red tissue is seen through the exposed membrane on the mesial aspect 4 weeks after surgery. The patient is instructed to use a soft brush with a short tuft.

Membrane removal and prognosis

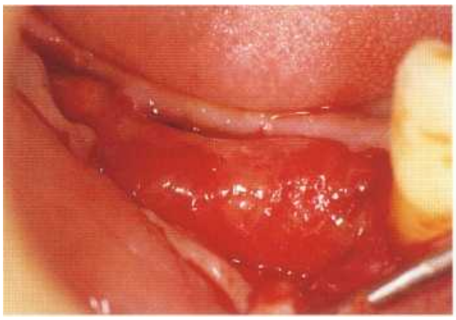
c8-6 Removal.

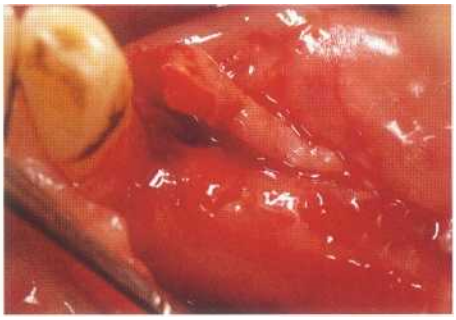


a. There is no gingival inflammation around the membrane 6 weeks after surgery. The amount of membrane exposure is the same as 20 days after surgery.



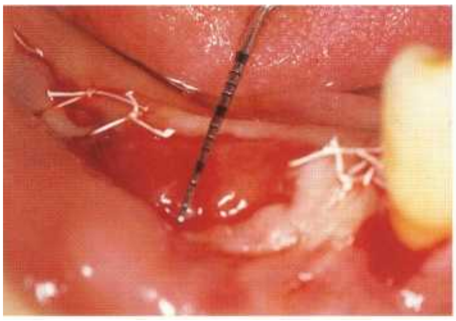
b. After a partial-thickness flap is prepared, the membrane is exposed and removed carefully.

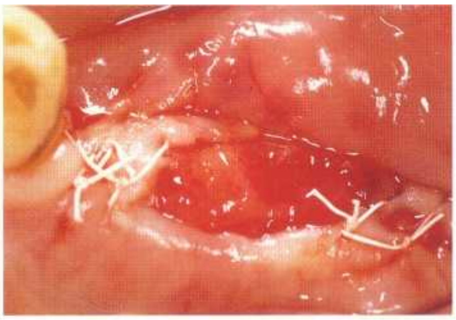




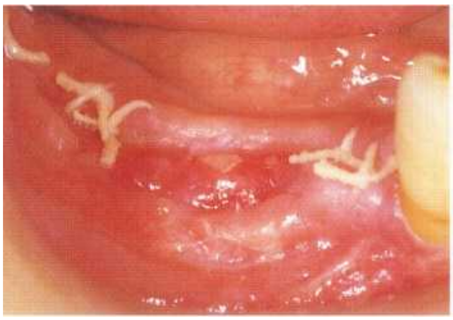
c. Note the new red tissue on membrane removal.

c8-7 **Suture.** The **amount** of exposed new tissue after suture is 15 mm mesiodistally and 8 mm buccolingually.





c8-8 **Prognosis.**



a. Nine days after membrane removal.

b. Fifteen days after membrane removal.

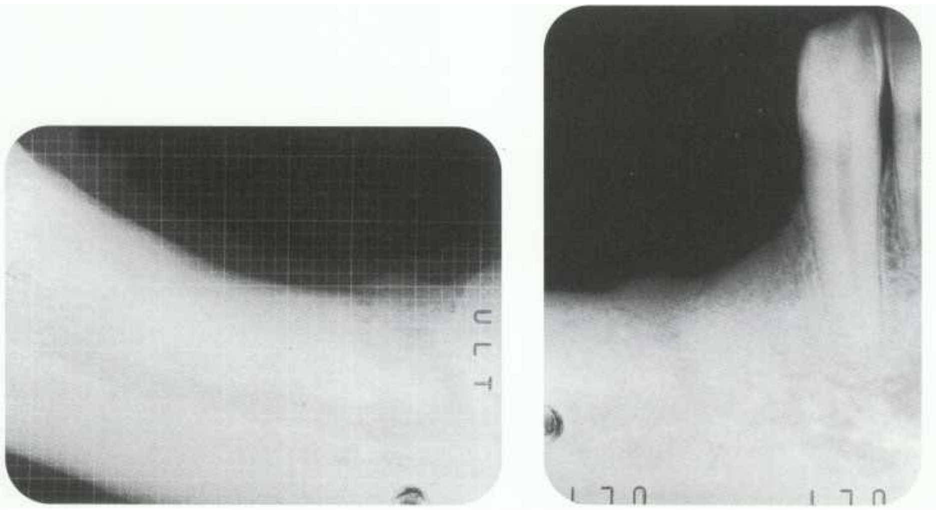
c. Twenty-three days after membrane removal.

d. The exposed new tissue is covered by epithelium 54 days after membrane removal.

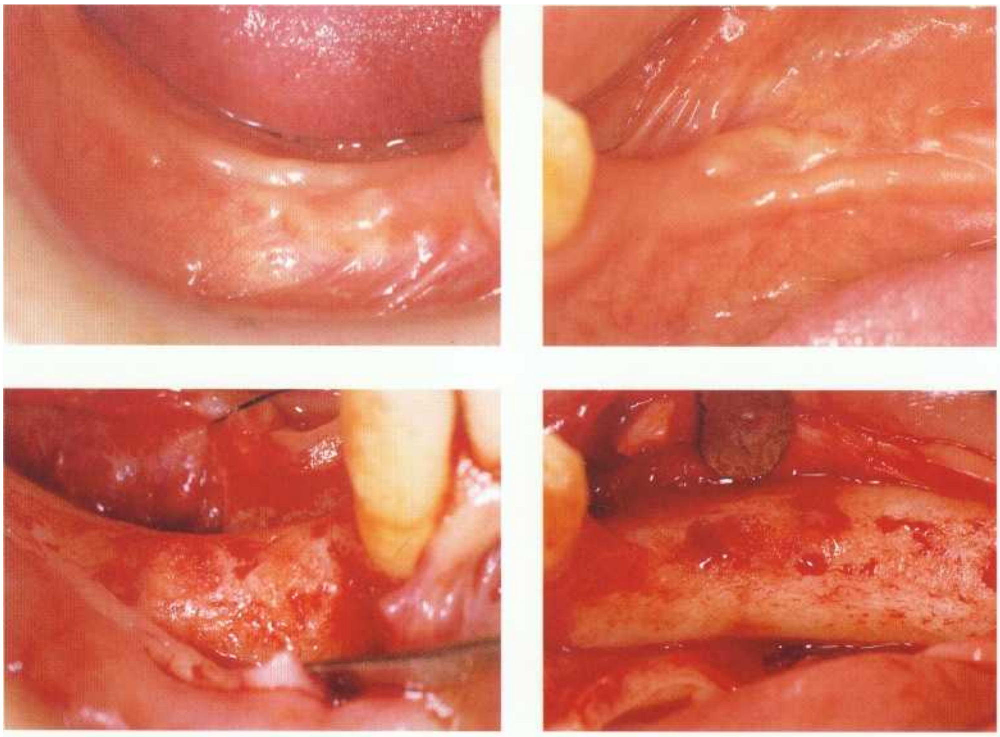
e. One hundred days after membrane removal.

Re-entry

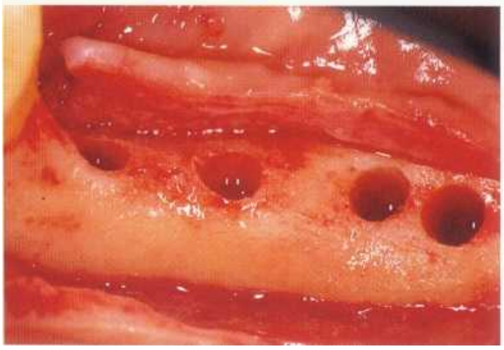
c8-9 Fixture placement.



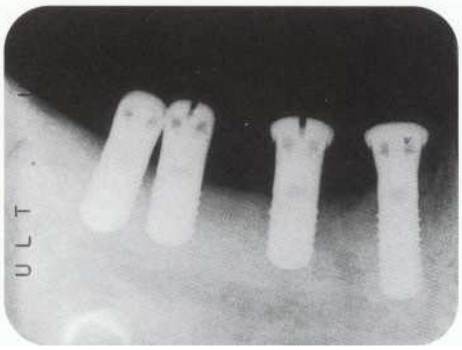
a. About 7 months after GBR. Note the marked bone fill. The distance of the crestal bone to the inferior alveolar canal is 7-8 mm.



b. Note the marked bone regeneration of the alveolar ridge despite early membrane exposure. The ridge dimension is about 7-8 mm.

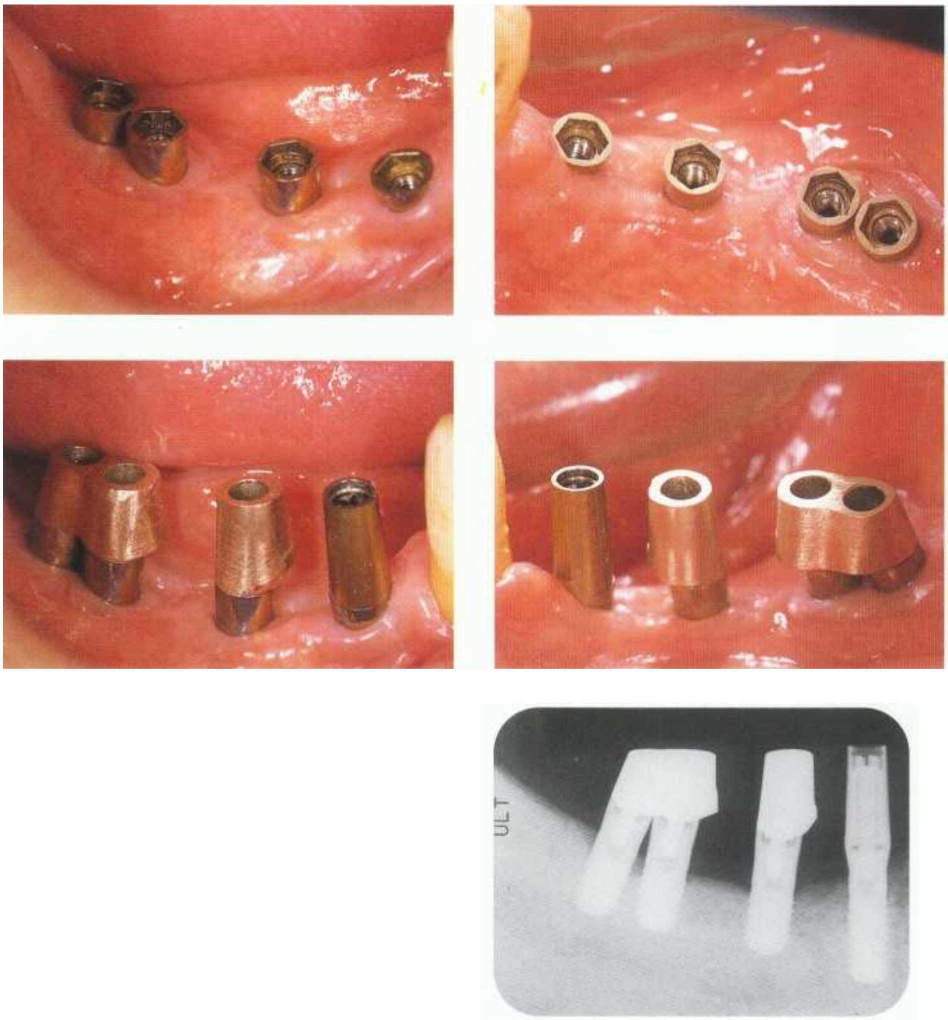


c. After preparation of the fixture placement site. Note that adequate bone wall has been gained circumferentially.

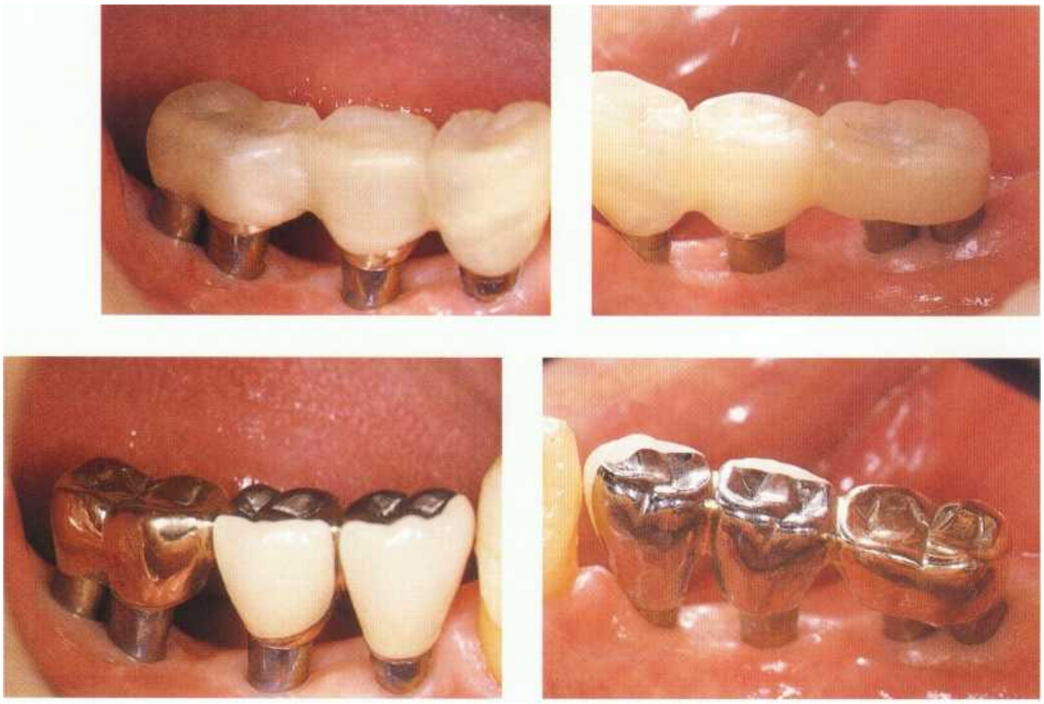


d. Fixture placement (10 x 3.70 mm on 28 and 8 x 4.2 mm on 29, 30, and 31 [POI two-piece-type; Finafix, Kyocera]).

Restorative procedure



c8-10 **Abutment connection.** Five months after implant placement. Abutments are connected and temporary restorations placed.



c8-11 **Final restorations.** About 1 year and 6 months after GBR. Final restorations are placed.

Immediate Implant Placement Using Guided Bone Regeneration

Concept of the Immediate Implant

Lazzara"' and Becker and Becker" introduced the surgical technique of fixture placement immediately after extraction using an e-PTFE barrier membrane. Lazzara placed the fixture in the extraction socket and covered the fixture and extraction socket with an e-PTFE barrier membrane. The top of the fixture was placed 2 mm deeper than the marginal crest of the extraction socket to allow for bone remodeling and osseous regeneration up to the cover screw. This permits tissue regeneration over the coronal aspect of the implant so that during the integration phase a soft tissue seal will develop over the implant. With this immediate implant technique, a barrier membrane not completely covered by the flap is removed about 1 month after placement. Becker and Becker" described a pedicle flap technique in which the barrier membrane was completely covered by the flap.

With the immediate implant technique, the barrier membrane isolates the wound (extraction socket) from the outside, facilitating the formation, maintenance, and stabilization of the blood clot and preserving and maintaining space for bone regeneration around the fixture. The barrier membrane is thought to prevent bacterial invasion and to hinder epithelial invagination into the apex, making bone regeneration of the extraction socket possible.

The technique of fixture placement in the extraction socket was developed from the principle of Branemark, in which the fixture is placed into sound bone tissue." Because 9-12 months is needed for the healing of an extraction socket, the fixture is placed 12 months after extraction in the Branemark technique.

However, marked bone resorption occurs in the marginal alveolar bone 6 months to 2 years after extraction. Especially in the presence of severe periodontal disease, functional and esthetic fixture placement may be restricted, or impossible, after healing of the extraction socket with bone resorption.

The immediate implant is designed to prevent bone resorption following extraction. With this method, the ridge dimension and height are maintained and a number ofsurgical procedures omitted, shortening the healing period. Preservation of the periodontal tissue of the adjacent teeth is another advantage. In maxillary molars, perforation of the maxillary sinus can be avoided, making a sinus lift procedure unnecessary.

Problems of the Immediate Implant

The immediate implant technique has problems, the first of which is that prediction of bone level after healing is difficult. An osseous defect around the fixture head may become apparent at second-stage surgery because prediction of bone resorption of the bone wall of the extraction socket is difficult. Also, because it is difficult to achieve primary stability due to the size and shape of the extraction socket, fixture position may be compromised. In the maxillary anterior region particularly, this may result in esthetic problems. Finally, there is the difficulty of complete flap closure of the fixture placement site because of the extraction socket.

The barrier membrane protects the extraction socket, but an osseous dehiscence or fenestration may occur ifsoft tissue enters the extraction socket before osseointegration occurs. Corona] migration of the flap is necessary for complete membrane coverage, but corona] migration moves the mucogingival junction coronally, resulting in an extremely narrow oral vestibule.

Prediction of the height of bone regeneration is difficult. At the same time, the final position of the mucosa is also difficult to predict, especially where membrane coverage by the flap is difficult to achieve or in cases of early membrane exposure. In the maxillary anterior region, prosthetic problems may result. Finally, osseointegration cannot be achieved without complete debridement of the extraction socket.

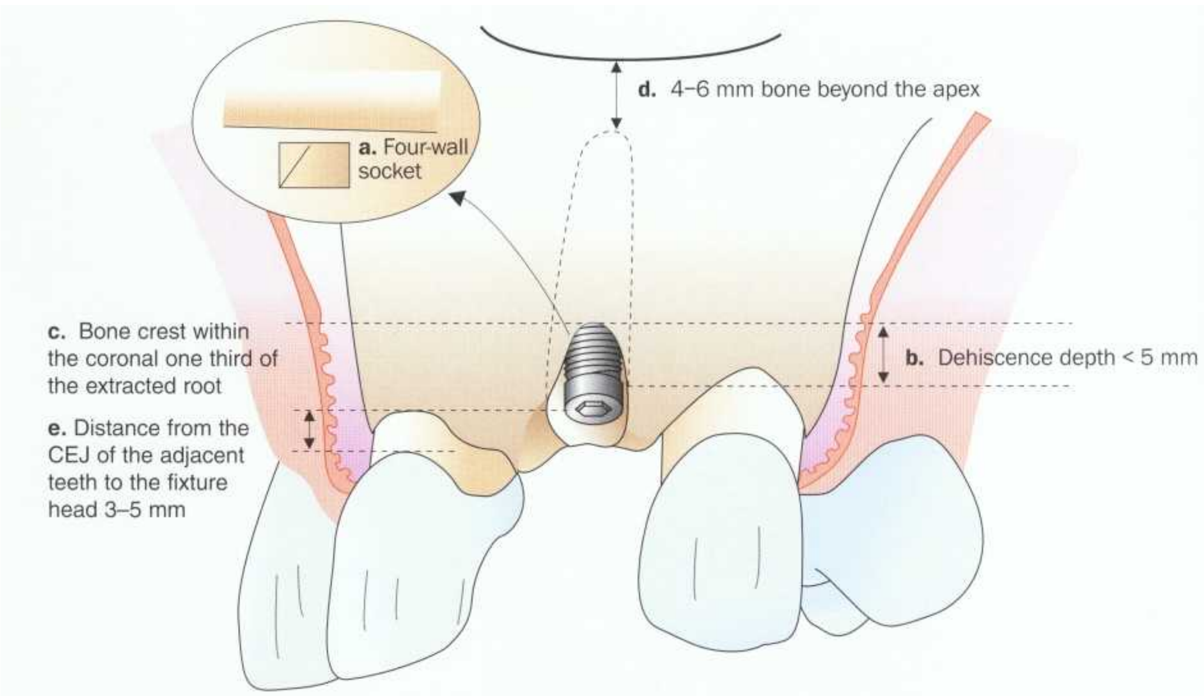
Indications and Contraindications of Immediate Implant Placement

From the vantage point of esthetic restrictions and achieving primary stability, the premolar area is the optimum position for the immediate implant. Sufficient bone around the extraction socket makes primary stability possible, enabling fixture placement immediately after extraction.

Severe destruction of circumferential tissue is a contraindication for immediate implant because of the absence of bone. When extraction is planned because of root fracture, crown fracture, endodontic failure, severe decay, or unfavorable crown-root ratio, the immediate implant is indicated. Root fracture is an indication for an immediate implant because sound bone tissue remains around the extraction socket.

According to Salama and Salama, extracted sites suited for an immediate implant are: (a) four-wall socket; (b) three-wall dehiscence-type defect (5 mm or less in the apicocoronal direction); (c) the osseous crest lies in the corona] one third of the root to be extracted; and (d) sufficient bone (4-6 mm) beyond the apex for primary stability of the implant.

Fig 5-16 Indication for immediate implant placement on extraction.[41]



Also, from the perspective of esthetics and hygiene, the osseous crestal topography should be harmonious, allowing an acceptable discrepancy between the top of the fixture, in the extraction socket, and the cervical area of adjacent teeth. To provide the proper emergence profile from fixture to superstructure, (e) the optimum distance between the CEJ of the adjacent teeth and the top of the fixture top is 3-5 mm. Sufficient buccal bone wall of the extraction socket is necessary for an esthetically favorable result (Fig 5-16).

Immediate implant placement is not indicated for cases that do not meet these conditions. In short, if sufficient depth for primary stability of the fixture is not possible due to proximity of the maxillary sinus or inferior alveolar canal and the bottom of the extraction socket, or the width of the extraction socket is less than 4-5 mm, or the site depth is not more than 10 mm, immediate implant is not indicated. This procedure is especially contraindicated in areas of periodontal disease with acute inflammation or where complete curettage of the extraction socket is not possible.

Also, the healing pattern of the bone around the fixture in the extraction socket is greatly affected by the thickness of remaining alveolar bone. If the fixture is close to thin, buccal bone, the buccal screw thread of the fixture may become exposed during second-stage surgery due to bone resorption.

Therefore, it is important to place the fixture adjacent to the thick alveolar bone, separated from thin bone or areas with fenestrations. The fixture is best placed on the palatal side of the extraction socket in the maxillary region. [,49]

Conditions of fixture placement for immediate implants

1. Within bone envelope: Place the entire fixture within the bone envelope of the extraction socket.
2. Infraversion placement: To prevent fixture exposure due to resorption of the extraction socket margin, place the fixture such that the fixture head is positioned apical (about 2 mm) to the alveolar crest.
3. Primary stability: Place the implant 3-5 mm beyond the bottom of the extraction socket for primary stability.
4. Slightly palatal placement: Place the fixture close to the thick alveolar bone wall, separated from the thin part of the bone wall. In the maxillary region, the placement site is usually slightly palatal.

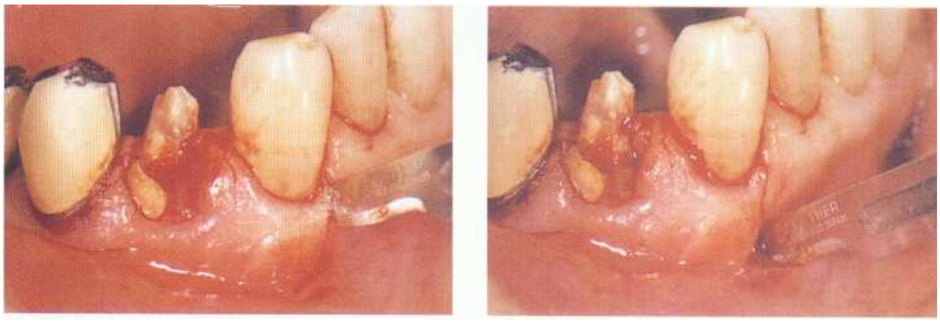
Where the extraction socket is remarkably larger than the fixture dimension, or where there is a wide crater-like osseous defect due to periodontal disease, the fixture should be placed deeply for alveoplasty. Deep placement, how ever, makes the implant crown-root ratio unfavorable because of the height of' the suprastructure. In such cases, the fixture is placed at the appropriate depth and a membrane used.

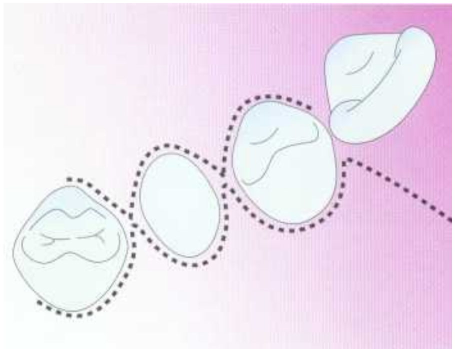
Case 5-9 Immediate implant placement using GBR

c9-1 Indication for immediate implant. Note the horizontal crown fracture of 28 extending subgingivally and the bone resorption on the mesial portion. The mesial periodontal pocket on 28 is 8 mm. A fixed partial denture is placed on 29, 30, and 31; 27 is a natural tooth. The root of 28 is thin and short, and more than 5 mm of bone exists on the apical aspect of 28. Immediate implant is indicated (61-year-old man).

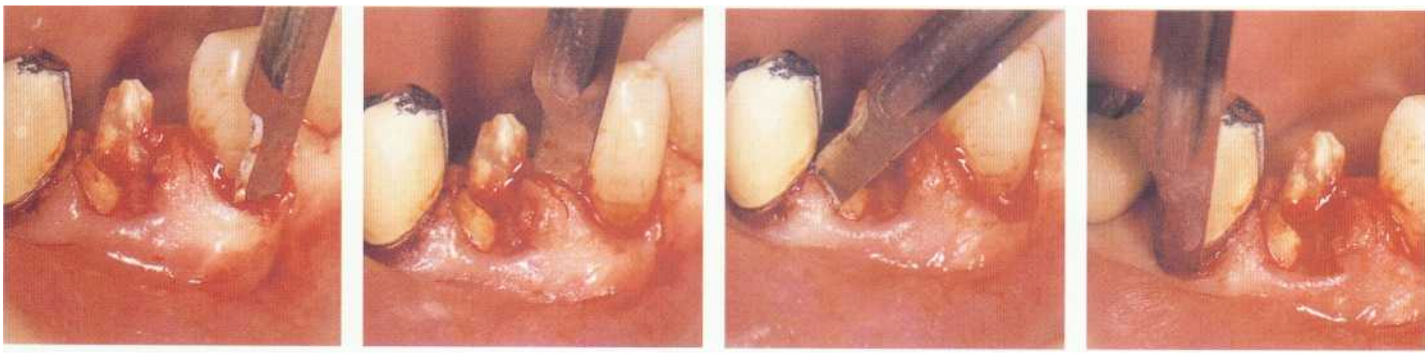
Flap design

c9-2 Flap preparation.





a. A no. 15 blade is used to make a vertical incision toward the alveolar mucosa on the mesiobuccal line angle of 27, which is the tooth adjacent to the tooth planned for extraction.

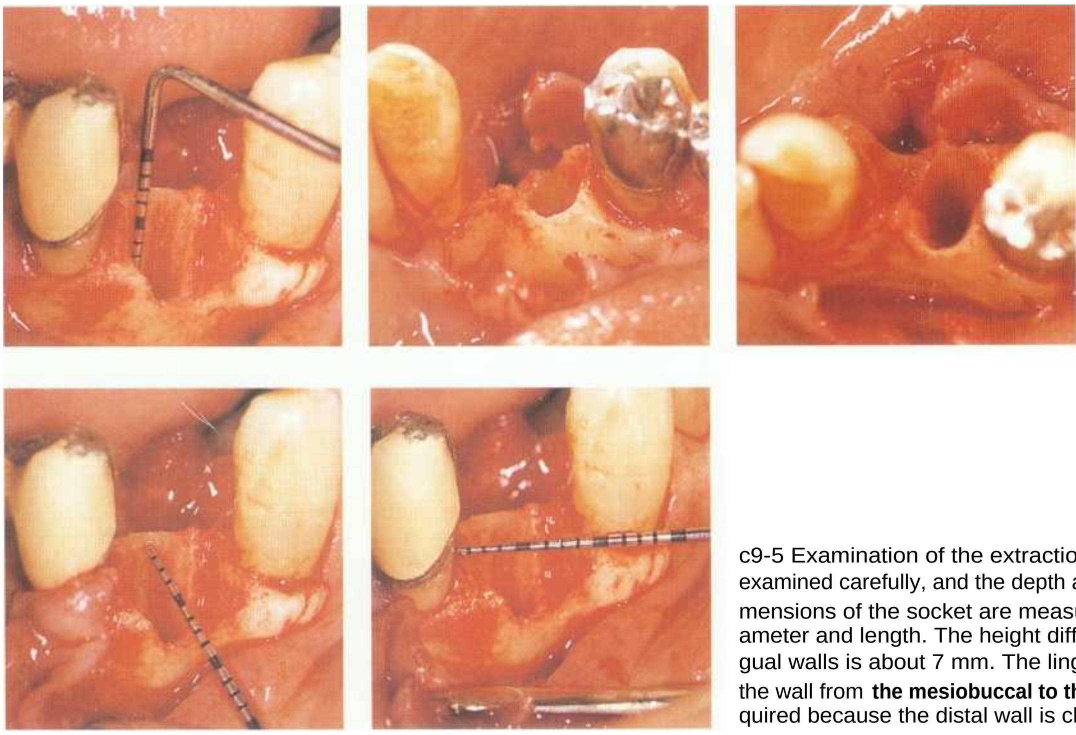


b. A sulcular incision is made extending to the bone from the mesiobuccal aspect of 27 to the circumference of the tooth planned for extraction and the distobuccal aspect of the distal adjacent tooth. A full-thickness flap (as thick as possible) is prepared on the buccal and lingual aspects. In the incision, it is important to include much keratinized tissue and to preserve the mesiodistal interdental papilla of the tooth planned for extraction.

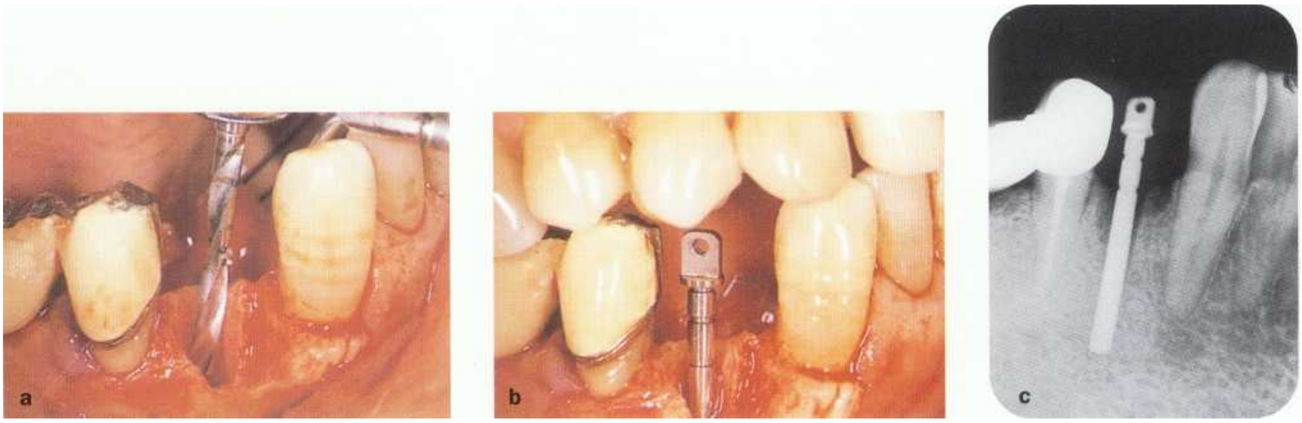
c9-3 Flap reflection. A partial-thickness flap is made apical to the mucogingival junction to facilitate coronal migration of the flap and distal migration of the pedicle flap and complete primary closure.

c9-4 Extracted tooth.

Extract the tooth carefully, avoiding damage to the buccal and lingual bone walls of the extraction socket. Luxate mesiodistally (not buccolingually) using a small elevator gently and slowly. Loosen the tootle by repeating this technique, and extract the tooth only after complete luxation. After extraction, remove the granulation tissue of the extraction socket thoroughly using a curette, file, or round bur.



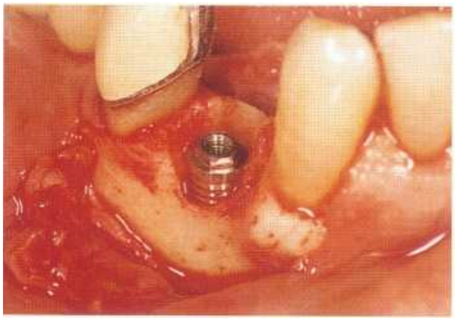
c9-5 Examination of the extraction socket. The extraction socket is examined carefully, and the depth and buccolingual and mesiodistal dimensions of the socket are measured for determination of fixture diameter and length. The height difference between the buccal and lingual walls is about 7 mm. The lingual wall of 28 is not damaged, but the wall from **the mesiobuccal to the buccal** is destroyed. Caution is required because the distal wall is close to the mesial of 29.

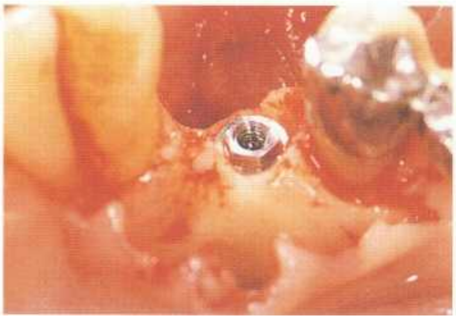


c9-6 Implant site preparation. A surgical stent is used as a guide to penetrate the bottom of the extraction socket for implant site preparation. Following the guide hole preparation with a twist drill (a), a depth gauge is inserted and the path of insertion, depth, and parallelism of the implant checked (b). The bone is drilled 5 mm from the bottom of the extraction socket. The placement site is enlarged and the occlusion checked (c).

Fixture placement

c9-7 Check of fixture placement site. The prepared placement site is checked and a Branemark implant (Nobel Biocare, 15 x 3.75 mm) placed. Note the osseous defect from the mesial to the buccal aspect and the dehiscence. **Three threads are exposed due to the dehiscence about 4 mm from the head of the fixture.**

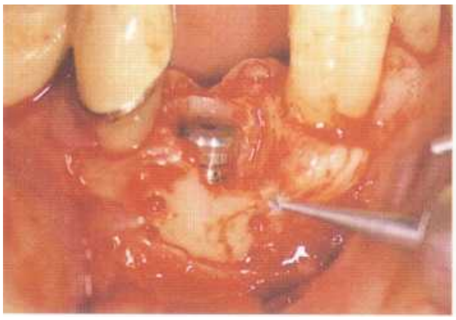
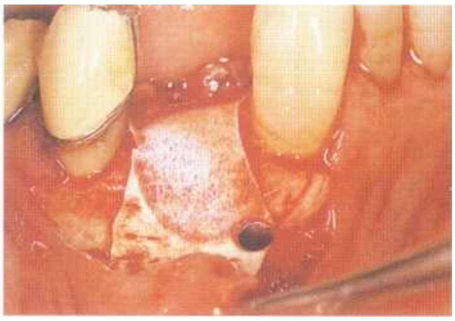

a. Buccal aspect.


b. Lingual aspect.


c. The distance between the implant head and the extraction socket wall is 2 mm on the lingual wall, 3 mm on the mesial wall, and 2.5 mm on the buccal wall.

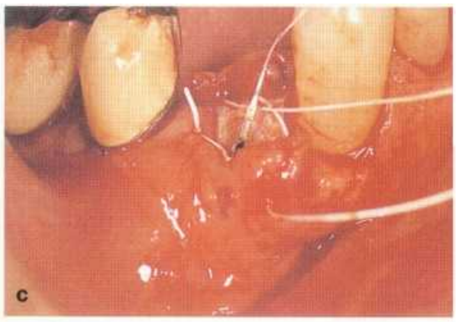

c9-8 Cover screw connection. The fixture is placed beyond the bottom of the extraction socket. Primary stability is obtained.

GBR



c9-9 Membrane placement and fixation. See Fig 5-8 for the fixation screw that is used in this case.

Suture

c9-10 Suture of pedicle flap. The pedicle flap prepared on the buccal aspect of 27 is displaced distally and placed on the membrane. If there is tension, a releasing incision of the periosteum is made on the bottom of the flap for free flap migration. A mattress suture is made.



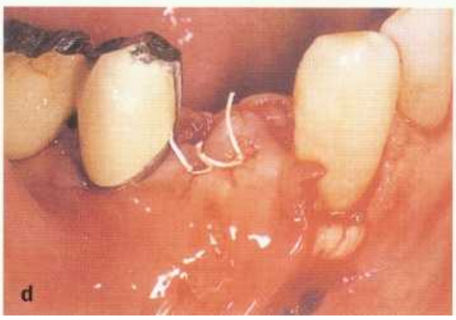
a. The needle is inserted from the outside of the buccal flap. Nonabsorbable thread is used (WL Gore).

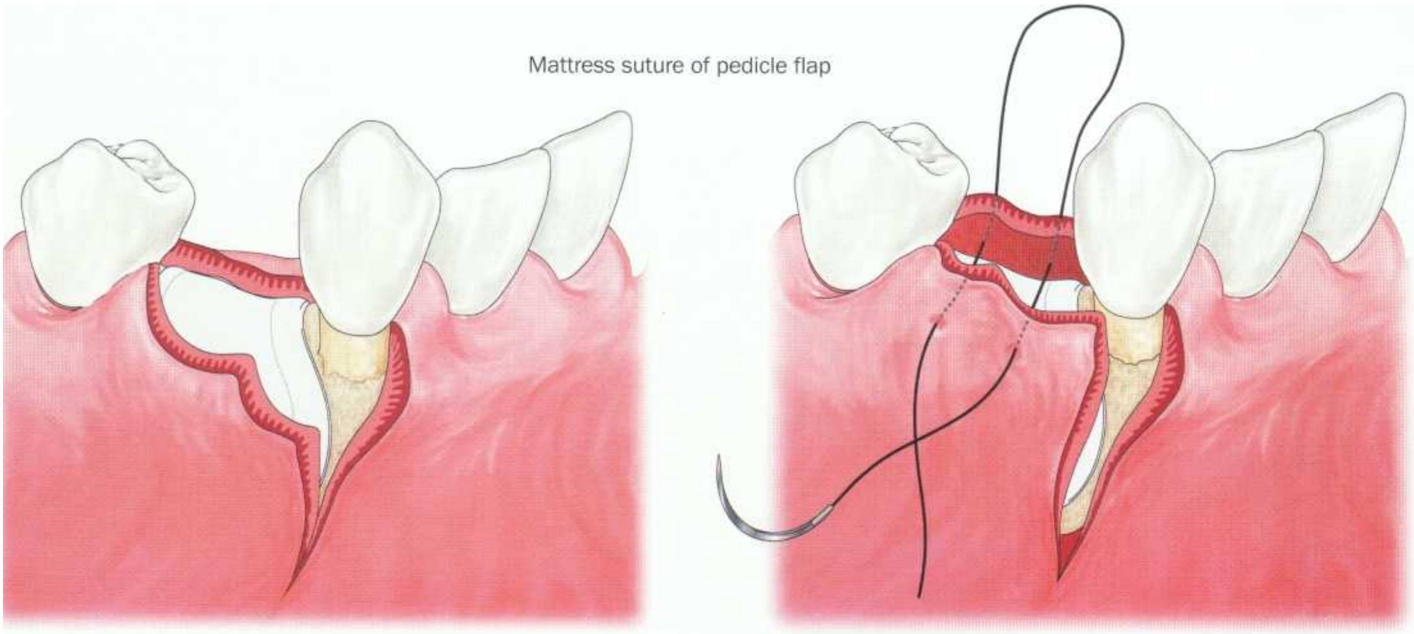
b. In the lingual flap, the needle is inserted from the inside and pushed, and then inserted from the outside of the same lingual flap.

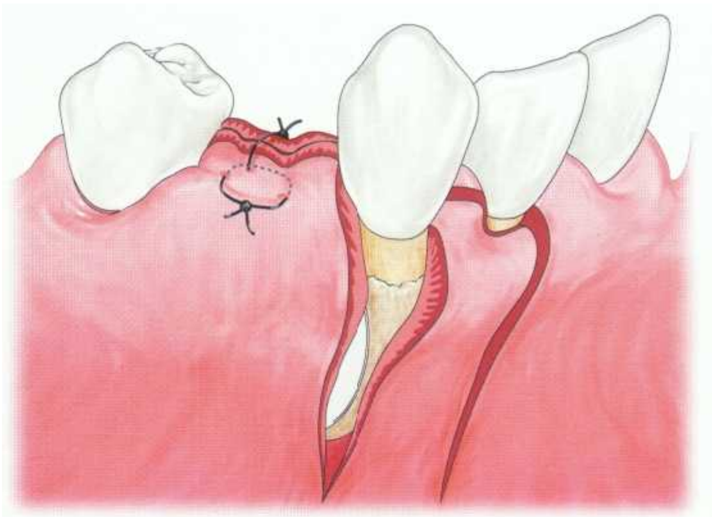
c. The needle is inserted from the inside of the buccal flap.

d. A ligature made on the buccal aspect.

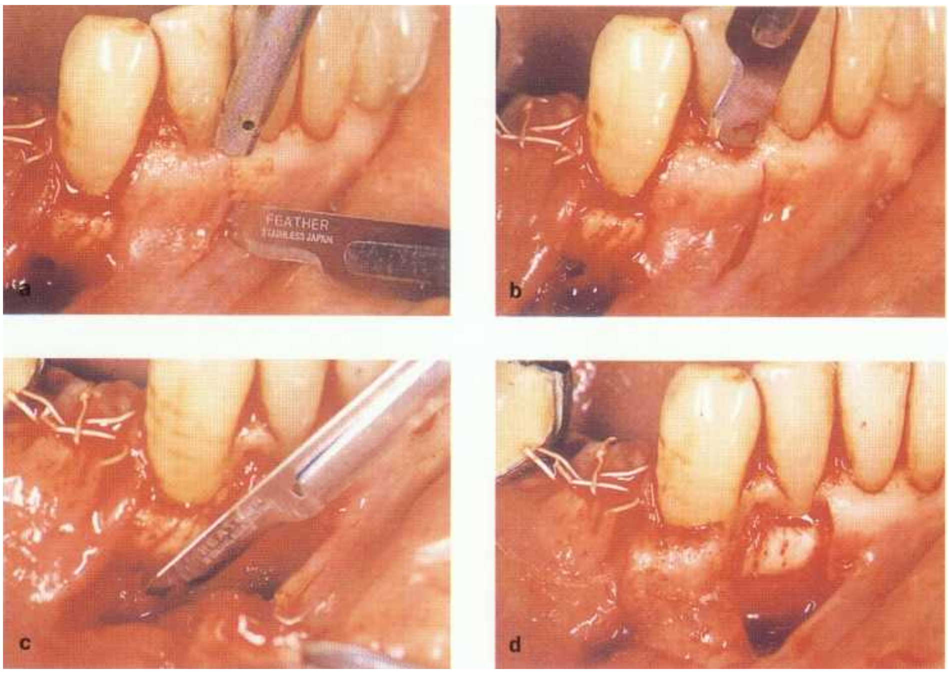
e. One interrupted suture is made.







Interrupted suture



c9-11 Wound closure of donor site.

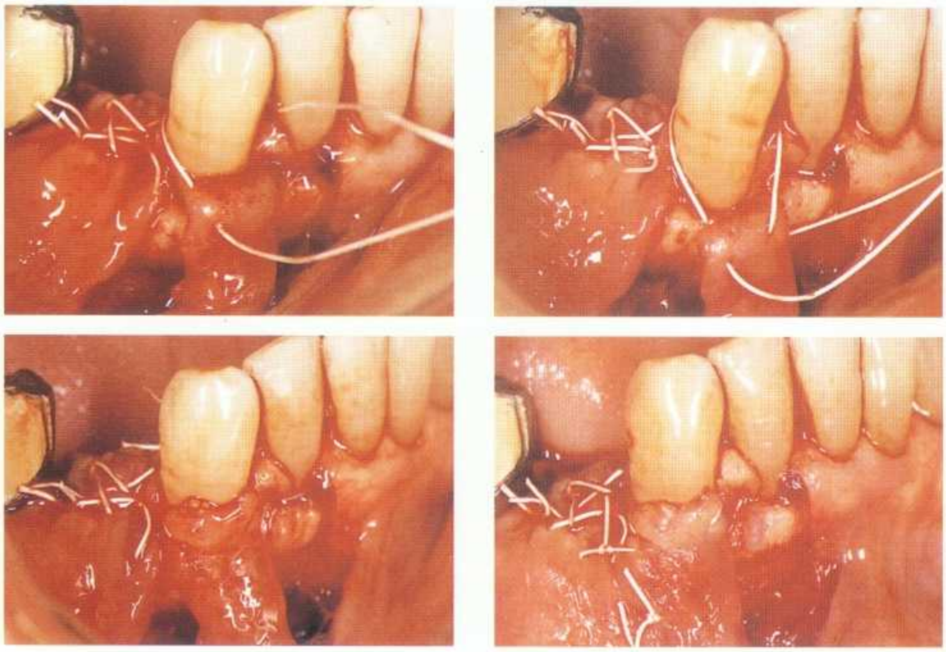
a. A pedicle flap is prepared on the buccal aspect of 26 for wound closure of the donor site. A vertical incision is made on the mesial line angle of 26 beyond the mucogingivaljunction.

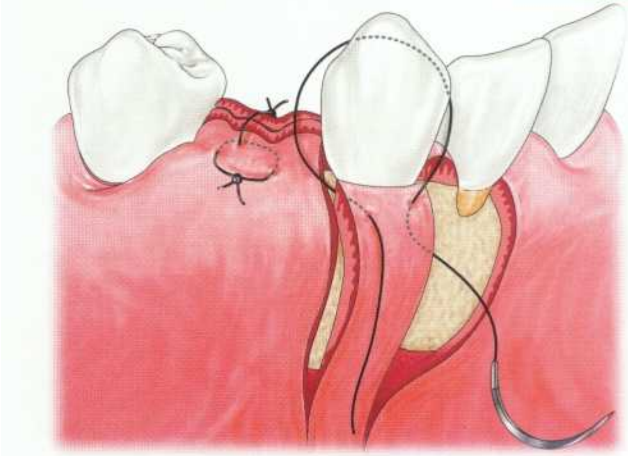
b. An internal bevel incision is made from the free gingival margin of 26 toward the bone crest.

c. A partial-thickness incision is made on the bottom of the pedicle flap for free flap migration.

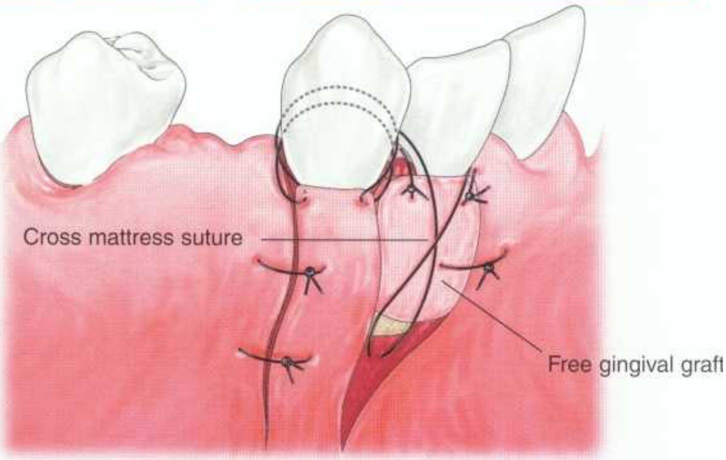
d. The pedicle flap is displaced distally to cover the buccal aspect of 27.

e. The pedicle flap is fixed firmly coronal to the CEJ of 27 with a sling suture.

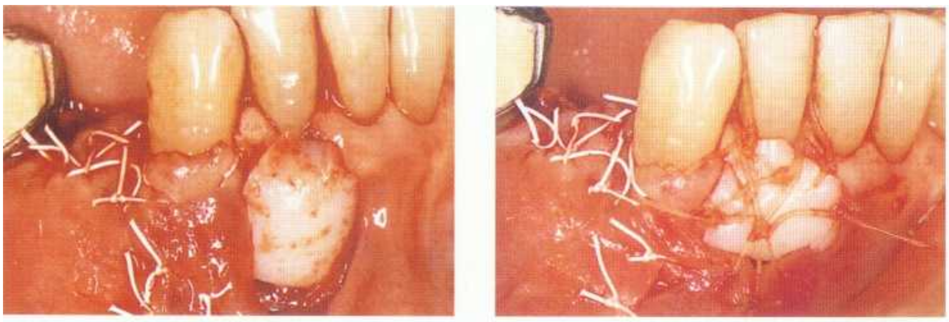


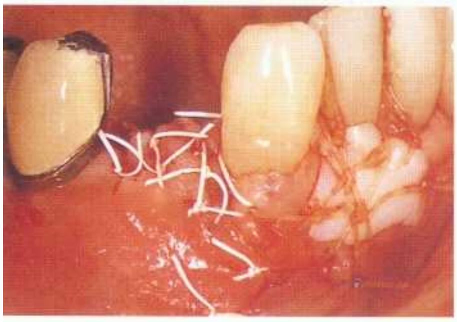


Fix the pedicle flap coronally with sling suture.



Place the free gingival graft on the pedicle flap donor site, pull the apical alveolar mucosa with a mattress suture, and adapt the graft by cross suture. Suture the coronal part of the graft to the interdental papilla.



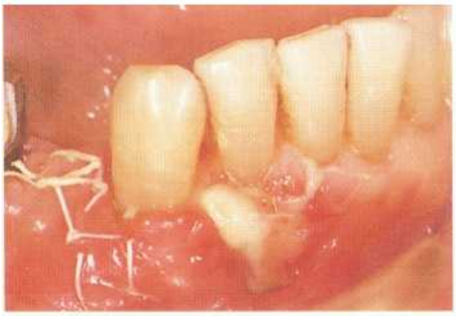


f. A free gingival graft 1.5 mm thick is harvested from the palate. It is placed on the exposed bone surface on the donor site of 26 and a suture made.

g. After GBR.

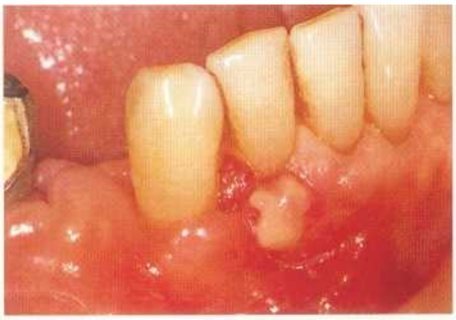
Prognosis

c9-12 Postoperative condition.



a. Seven days after surgery.

b. Ten days after surgery.



c. Sixteen days after surgery.

d. About 3 weeks after surgery.

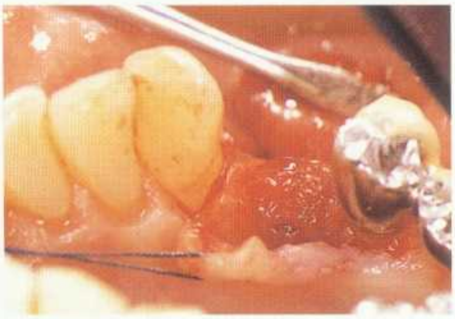
e. About 5 weeks after surgery.

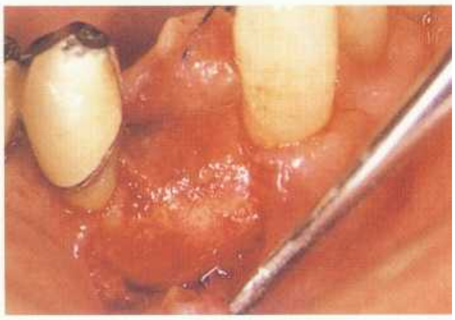
f. About 13 weeks after surgery. Note the slight membrane exposure on the mesiolingual aspect of 29.

c9-13 Membrane removal.

a. Note the slight membrane exposure on the mesiolingual aspect of 29, 3 months after surgery (left).

b. A horizontal partial-thickness incision is made on the alveolar crest and the membrane exposed (right).



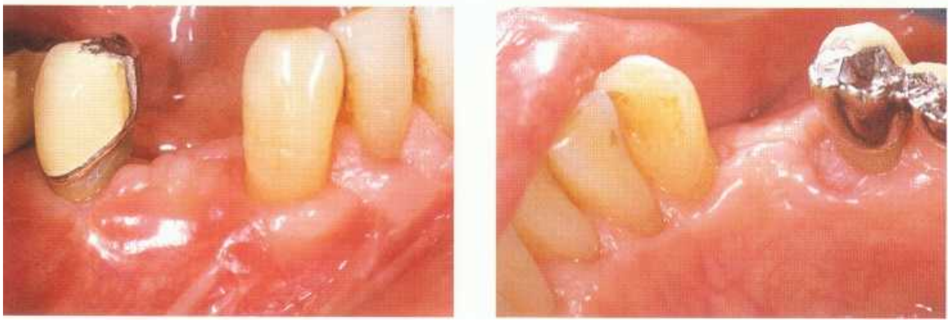


c. Membrane removal reveals new tissue on the coronal part of the implant.

d. The new tissue is covered completely by the flap and a suture made.

c9-14 After membrane removal.

a. Two weeks after membrane removal.

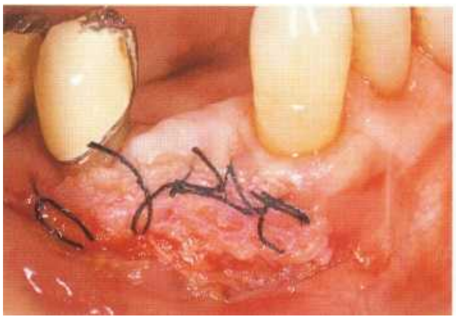


b. Twenty days after membrane removal.

Free connective tissue grafts for keratinized tissue augmentation

c9-15 Connective tissue grafts.

a. Connective tissue grafts to increase keratinized tissue are performed 6 months after implant placement.



b. Suturing of graft.

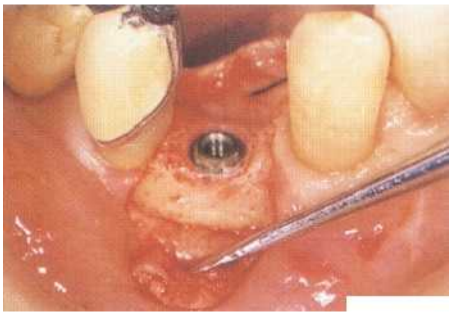
c. Six weeks after surgery.

Second-stage implant surgery

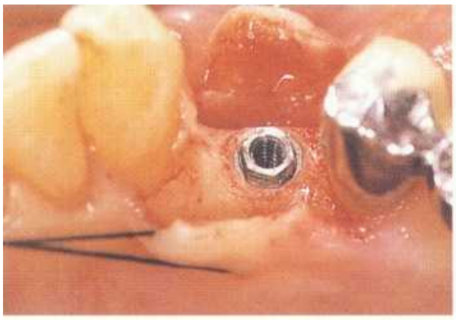
c9-16 Fixture exposure.

a. Eight months after immediate-implant placement. Bone regeneration around the implant is obvious on radiography. Sufficient keratinized tissue is gained on the area of 28.

b. A trapezoidal incision is made and a flap reflected.



c. Note the bone regeneration around the fixture.



d. A temporary healing abutment is placed.

c9-17 Papilla regeneration technique (see Case 6-17 for details).

a. Flap preparation.

b. Flap suture.

c. Ten weeks after surgery.

c9-18 Placement of final restorations. About 5 months after the second surgery (left) and 5 months after the placement of final restorations (right).

c9-19 After second-stage implant surgery.

a. About 11 months after immediate implant placement on delivery of the Esthetic Abutment connection (Hermans).

b. About 1 year and 1 month after immediate implant placement. Final restorations are placed.

c. Five months after the placement of final restorations.

Implants in Recent Extraction Sockets Using GBR

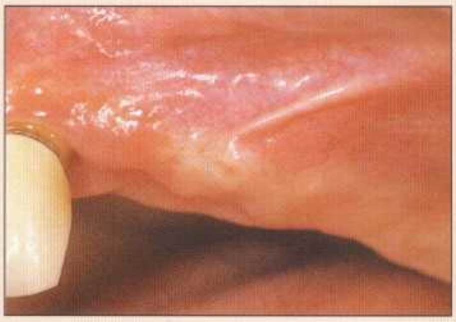
Healing of Extraction Wound and Timing of Implant Placement Surgery

The major problem of immediate implants is the difficulty of obtaining complete coverage of the extraction socket by soft tissue. Even if primary wound closure is achieved, membrane exposure frequently occurs by epithelial dehiscence early in the healing process. Early membrane exposure may cause membrane contamination and eventually may hinder bone regeneration around the fixture. The fixture head may project from the alveolar ridge on second-stage surgery in immediate implant procedures.

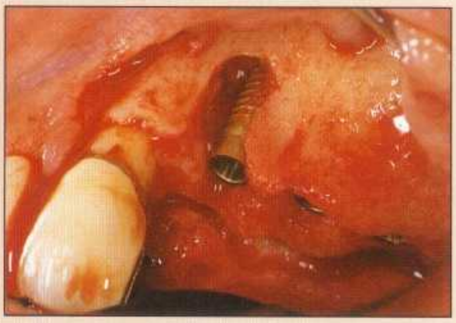
To avoid this problem with the immediate implant, the method of fixture placement following complete coverage of the wound by epithelium 6 to 8 weeks after extraction is proposed. Buser et al" advocated a simultaneous ap proach in which fixture placement and GBR are performed simultaneously 2-3 months after extraction. The membrane is removed on second-stage implant surgery 6 months later, then prosthetic treatment is begun.

Fig 5-17 Implant in recent extraction sockets using GBR after healing of extraction wound epithelium.

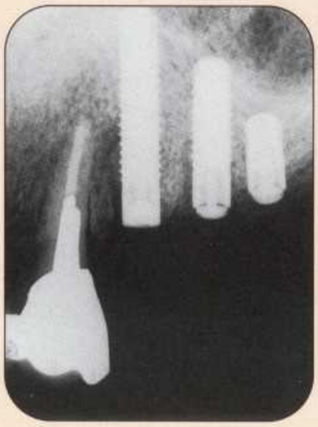
a. Note secondary caries on 13, an apical lesion on 12, and bone resorption on 13.

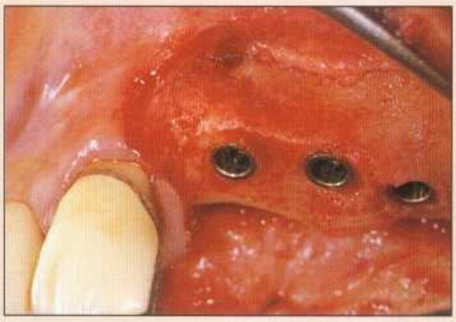


b. Two months after the extraction of 12 (3 months after the extraction of 13). Implant therapy will begin after the extraction socket is completely covered by soft tissue.



c. A POI three-piece-type implant (Kyocera) are placed (18 × 3.7 mm on 12, 13 × 3.7 mm on 13, and 7 × 3.7 mm on 14). The size of the dehiscence defect on 12 is 8 mm on the buccal aspect and 3 mm on the palatal aspect. Note the 3 mm osseous dehiscence on the palatal aspect of 13.





d. Second stage implant surgery 8 months after surgery. The dehiscence defect around the fixture is completely resolved.

Key point

When the fixture is placed after healing of the epithelium covering the extraction socket, the frequency of membrane exposure is markedly decreased because primary closure can be achieved with complete membrane coverage. This method, therefore, is the preferred approach for fixture placement in extraction sockets using GBR.

Currently, this method is probably the most basic approach for fixture placement using GBR in an extraction socket (Fig 5-17).

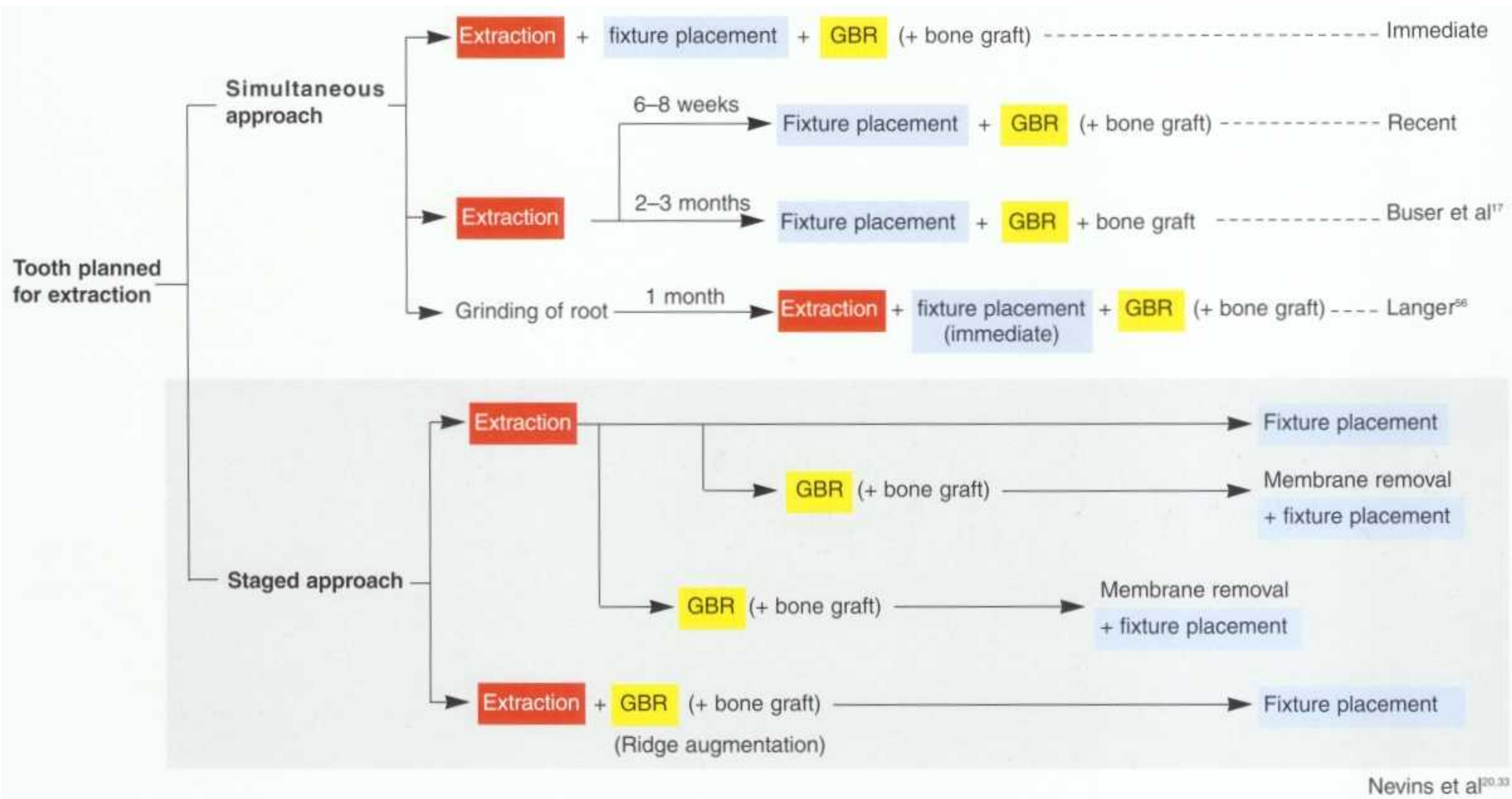
Wilson and Weber classified the timing of fixture placement into four categories:

1. Immediate: Fixture placement with simultaneous extraction
2. Recent: Fixture placement after healing of extraction wound epithelium (6-8 weeks)
3. Delayed: Ridge augmentation performed, then fixture placement after bone maturity
4. Mature: Fixture placement on completely healed area of extraction socket a few months to a few years after extraction

In cases of marked ridge resorption, GBR makes bone regeneration possible and increases the predictability of osseointegration. However, GBR extends the treatment period and requires advanced surgical technique. Also, thorough consideration of the timing of GBR in relation to extraction and fixture placement is necessary to make the best use of treatment time and to enhance the success of implant therapy.

With fixture placement after epithelial healing of the extraction socket, the frequency of membrane exposure is low compared to immediate implant therapy because primary closure is achieved Nvith complete coverage of the extrac tion socket and the membrane. Additionally, compared to the immediate implant, the chance of infected tissue remaining is reduced because debridelnent of the extraction socket is easy in this technique. With the immediate implant, the final height of the soft tissue after healing is hard to predict; however, with the delayed approach, the final position of the soft tissue does not change because primary closure and primary healing are achieved. Therefore, this method is suited for areas such as the maxillary anterior region, where esthetics is a concern.

Fig 5-18 Timing of extraction and fixture placement.



But this method lacks the advantages of the immediate implant such as fewer surgeries and relative brevity of the treatment period. Nevins and Mellonig described one disadvantage of implant placement in recent extrac tion sockets: immature bone (6 weeks after extraction) cannot support the fixture, and second surgery should not be done for any purpose except exposed membrane removal 3-6 weeks after extraction. Additionally, loss of part of the buccal bone plate may occur 1 month after extraction. When the condition of the alveolar ridge is poor and the position of fixture placement is restricted, they recommend a staged approach.[21] In this approach, ridge augmentation with bone grafts and a membrane is performed immediately after extraction and the fixture placed 6-10 months later. While this method is reliable, it has some shortcomings: 1) long treatment periods; 2) numerous surgeries; and 3) possibility of early membrane exposure as with the immediate implant.

Mensdorff-Pouilly et al" compared results of immediate implants and implants in recent extraction sockets. Their study revealed no difference in osseointegration or bone regeneration, but the immediate implant had unfavor able results in probing depth and membrane exposure. They recommended the immediate implant in the maxillary anterior region to avoid extreme bone resorption after extraction, and implants in recent extraction sockets in mandibular and maxillary molars where bone resorption is less rapid.

Immediate vs recent implant[57]

Implant type	Probing depth	Use of membrane	Membrane exposure
Immediate (n = 85)	Average 2.5 mm	32 sites	13 sites (15%)
Recent (n = 88) (6–8 weeks after extraction)	Average 1.9 mm	40 sites	5 sites (5%)

Jovanovic and Busee stated that with the immediate implant the following four conditions must be met:

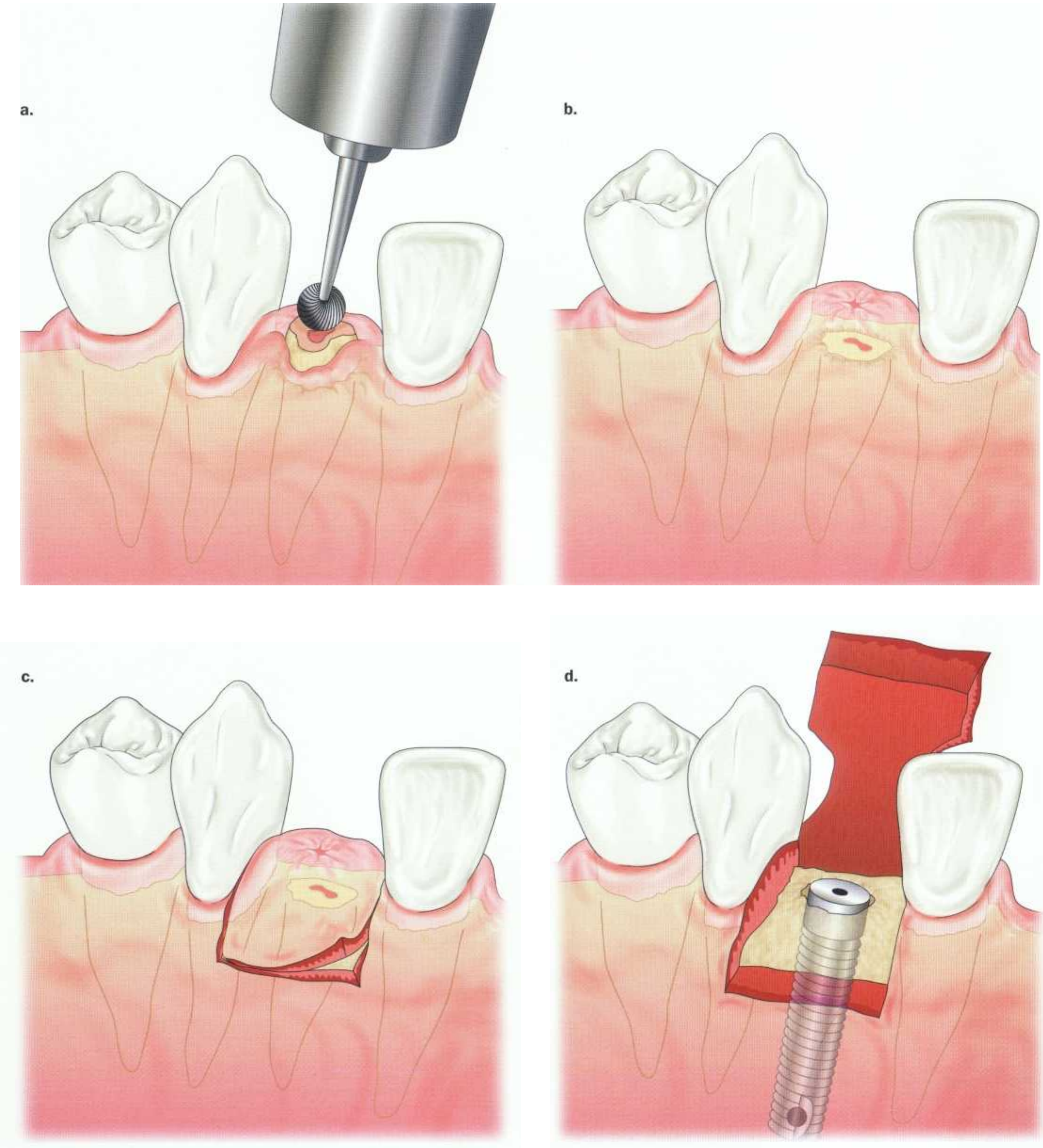
1. Sufficient bone wall exists around the extraction socket.
2. No lesion exists in the extraction socket.
3. Soft tissue exists for wound closure.
4. Sufficient sound bone exists apical to the bottom of the extraction socket for primary stability.

Utilization of the Gingiva of Remaining Roots

Langer advocated a technique in which the tooth planned for extraction is reduced such that it is like a residual root. The goal is to achieve proliferation of the gingival epithelium to cover the extraction socket where the implant fixture will be placed (Fig 5-19). This method uses the regenerative ability of the gingiva around the root of the extraction tooth. The procedures are as follows:

1. Reduce the extraction tooth subgingivally with an appropriate bur.
2. For subgingival grinding, use a small diamond bur carefully to avoid damage to the surrounding tissue.
3. Reduce the tooth almost to the level of the bone margin. If reduction is inadequate, sufficient gingival proliferation for coverage of the residual root will not occur.

Fig 5-19 Grinding of the extraction tooth for gingival proliferation .



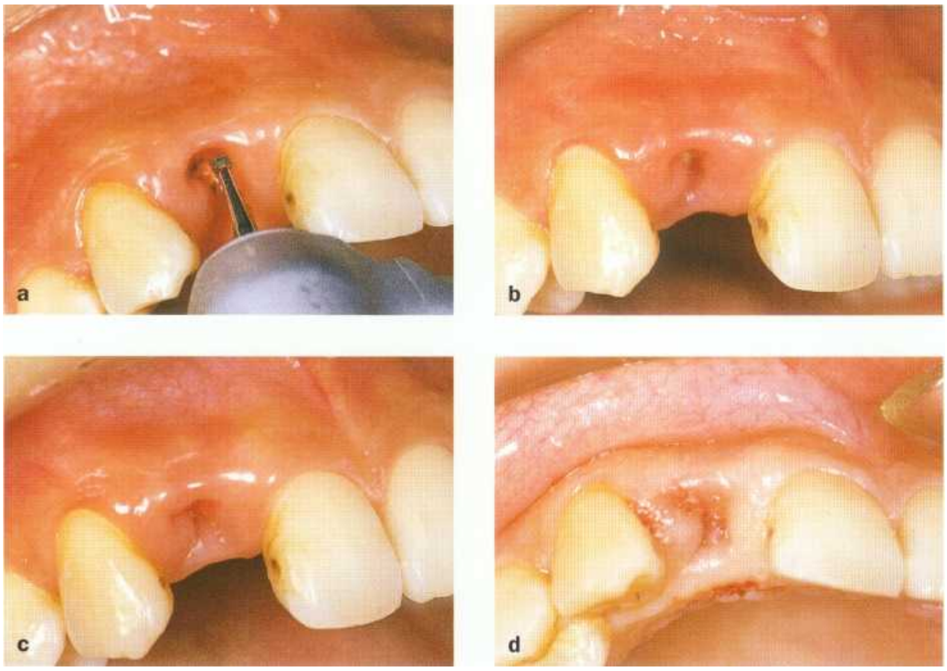
By grinding the tooth planned for extraction (a), coverage by gingiva will be achieved within 3 to 4 weeks (b). In this technique, the flap **design consists of two vertical incisions and a partial-thickness incision palatal to the alveolar crest (including a small dehiscence remaining on gingiva) (c).** A full-thickness flap is reflected from where the partial-thickness incision reaches bone and the fixture is placed in the extraction socket (d). Within an immediate implant, coronal migration of flap is usually necessary for primary closure of the extraction socket. However, in this method, the mucogingival junction is not displaced because coronal migration of the flap is unnecessary. Therefore, sufficient keratinized mucosa is preserved around the implant, which is one advantage of this method.

Case 5-10 Primary closure of extraction sockets using the gingiva of the remaining roots

c10-1 Coronal fracture of 7 due to severe caries. Because it is short and thin, the remaining root of 7 cannot be an abutment for restorative treatment. Teeth 6 and 8 are natural. Immediate implant placement is indicated because of the condition of the alveolar socket. Additionally, sufficient gingiva will be gained by Langer's technique before extraction; therefore, wound closure may be achieved after fixture placement (29-year-old woman).

Utilization of the gingiva of remaining roots

c10-2 Grinding of extraction site.



a. The tooth planned for extraction is ground to the level of the bone margin. Caution is required not to damage the surrounding tissue.

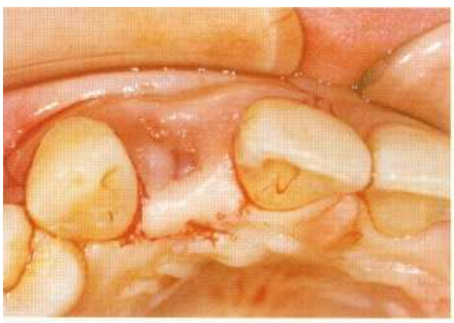
b. Three days after grinding.

c. Twelve days after grinding. Note the marked gingival proliferation on the remaining root.

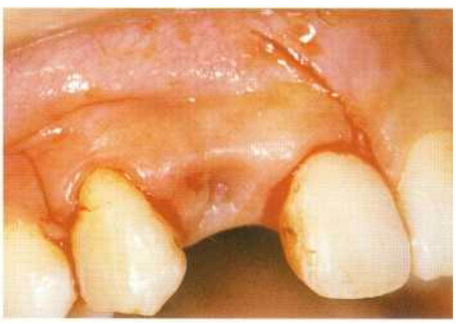
d. One month after grinding. Most of the remaining root was covered by gingiva within 3 to 4 weeks.

Flap design and fixture placement

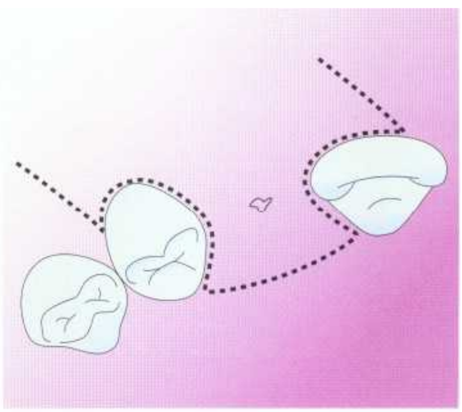
c10-3 Flap design.

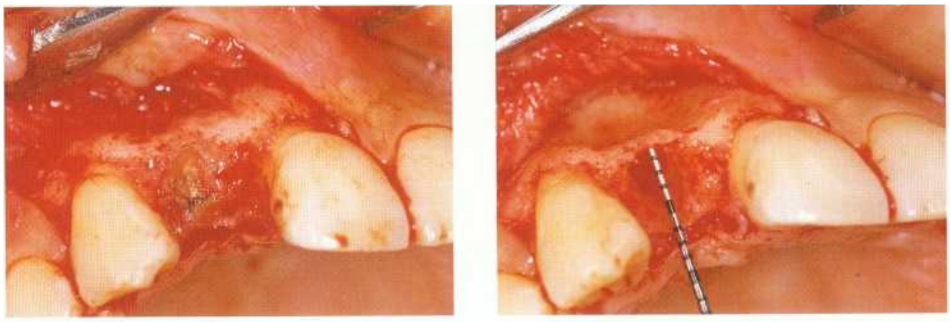


a. A partial-thickness incision is made on palatal to the alveolar crest (including a small remaining gingival dehiscence).



b. The sulcular incision on the distal of 8 and the mesial of 6 is extended to the buccal area. Two vertical incisions (releasing incision) are then made on the mesial aspect of 8 and the distal line angle of 6.

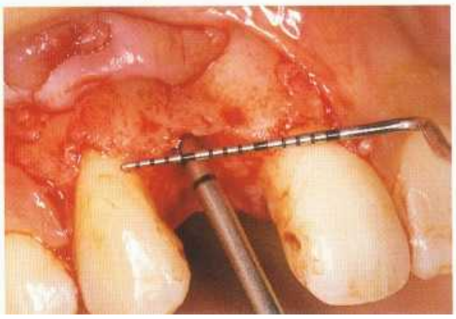




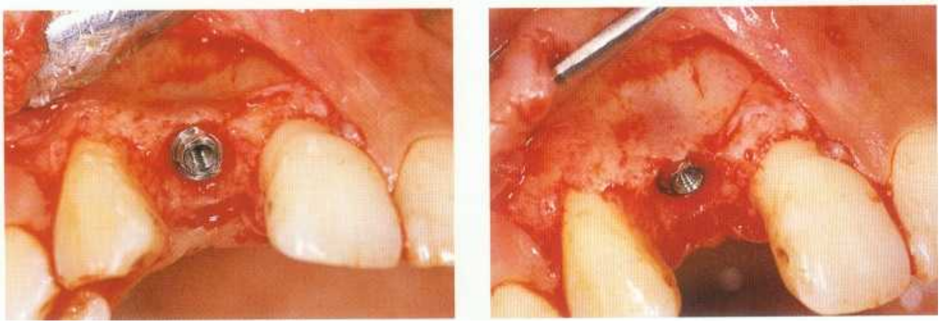
c. The prepared flap is reflected buccally and the remaining root exposed for extraction (left).

d. The remaining root is extracted carefully to avoid damage to the bone wall around the extraction socket. Note the four-wall osseous defect on the remaining bone wall around the extraction socket without destruction of the buccal bone plate (right).

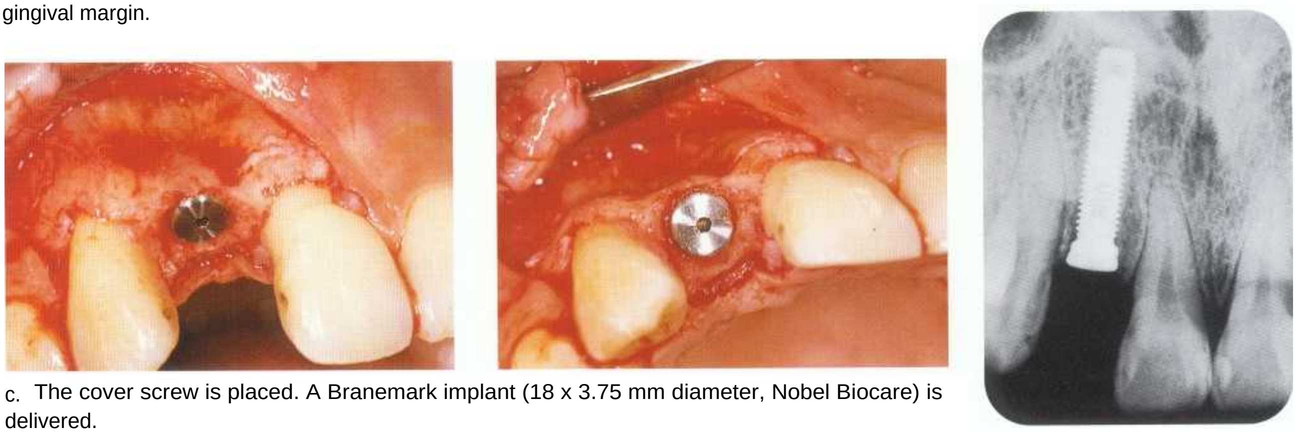
c10-4 Fixture placement.



a. For an immediate implant in the anterior region, the fixture head is placed about 2-3 mm apical to the CEJ of the adjacent teeth or gingival margin.

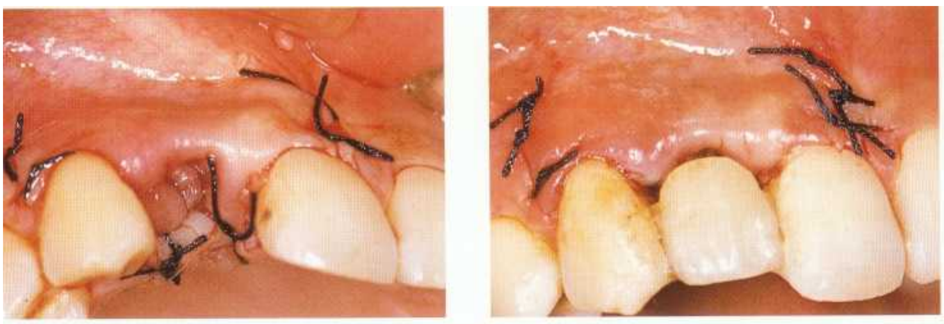


b. The fixture is placed into the circumferential bone as much as possible. The fixture head is slightly apical to the alveolar bone margin.



c. The cover screw is placed. A Branemark implant (18 x 3.75 mm diameter, Nobel Biocare) is delivered.

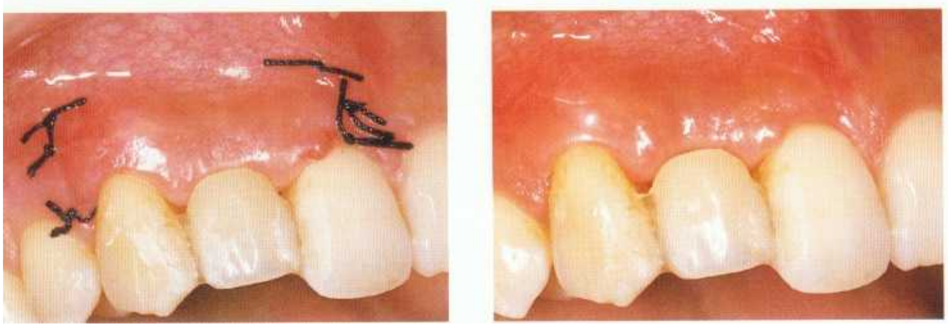
Flap suture and prognosis



c10-5 Suture.

a. Sufficient gingival proliferation before extraction makes coverage of the extraction socket possible without a releasing incision of the periosteum or coronal migration of flap for primary closure (left).

b. The temporary restoration must be placed so that its base will not overload the implant during healing (right).



c10-6 Postoperative observation.

a. Note the rapid tissue healing 5 days after surgery (left).

b. One month after surgery (right). Keratinized tissue is sufficiently preserved and esthetic with minimal gingival contraction. Neither bone graft nor membrane is used because the space between the implant and surrounding extraction socket wall is narrow and the circumference completely surrounded by bone walls.

Using Bone Grafting Only in Bone Defects Around Immediate Implants

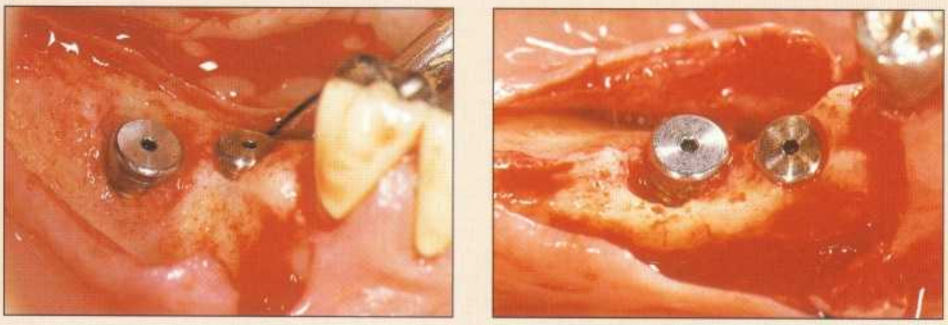
With immediate implants, use of a membrane should be minimized because of the possibility of infection due to membrane exposure. As the predictability of the immediate implant has been established, omitting the membrane has been attempted in cases with little space between the fixture and extraction socket wall or where the fixture is surrounded by thick bone wall. In their clinical study of autogenous bone grafting of small bone defects following immediate implant, Becker et al reported almost complete bone regeneration around fixtures within the alveolus. Also, they reported sufficient bone regeneration in extraction sockets with buccal dehiscence defects.

Gelb transplanted DFDBA (demineralized freeze-dried bone allograft) into circumferential defects surrounding fixtures and reported that the exposed thread was 100% covered by bone. Such reports suggest the possibility of achieving bone regeneration using bone grafts only if the fixture is completely covered by the bone wall of the extraction socket (Fig 5-20). Thus, the healing of osseous defects around fixtures is similar to the healing pattern of intrabony defects of periodontally diseased teeth. Because bone regeneration of intrabony defects occurs from the apical aspect, complete bone regeneration is most likely to occur in narrow osseous defects. The use of bone grafts alone bring good results in small and narrow defects. However, even in a small extraction socket with remaining bone wall, an immediate implant without a membrane has low predictability if the buccal bone wall is thin because of the likelihood of resorption (Fig 5-21). An immediate implant without a membrane is limited to molar extraction sockets surrounded by thick bone wall, or anterior extraction sockets in which lingual or palatal fixture placement is possible prosthetically.

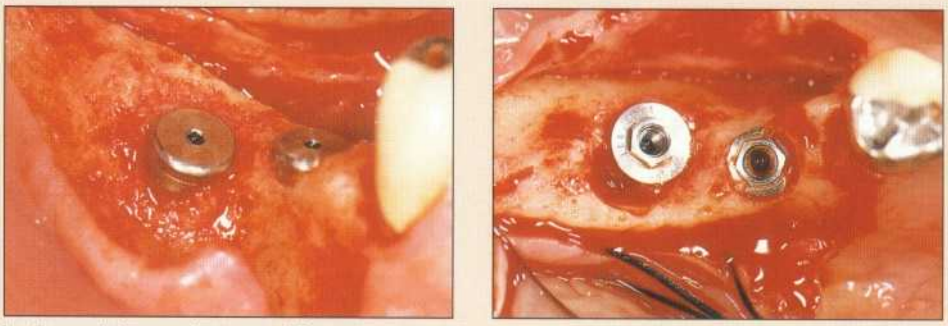
Table 5-5 Evaluation of the Immediate Implant Using Autogenous Bone Grafting Without a Membrane[59]

	Within alveolus (24 sites)		Within alveolus; buccal dehiscence (26 sites)	
	Prior to surgery	**Second-stage surgery**	**Prior to surgery**	**Second-stage surgery**
Depth of osseous defect (extraction socket) (bottom of defect to fixture head)	5.7 mm	0.3 mm	5.3 mm	0.6 mm
Width of osseous defect (buccal or lingual bone margin to cover-screw head)	3.8 mm	0.1 mm	3.7 mm	0.4 mm

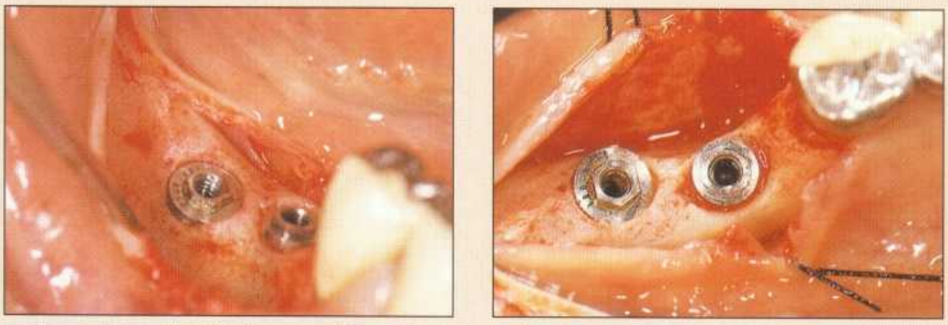
Fig 5-20 Bone regeneration around implants by bone grafting only.



a. After the placement of a wide-diameter, self-tapping threaded implant (3i, 10 × 5.0 mm diameter). Note the remaining osseous defect 3 mm wide and 4–5 mm deep between the fixture and extraction socket wall from the lingual to distal aspect. Note, too, the exposed part of the thread on the buccal and lingual aspects.

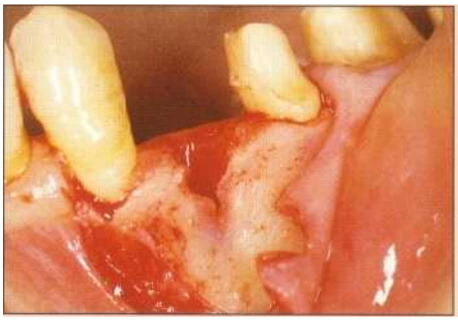


b. Bone chips are harvested from the circumference and transplanted to the osseous defect area (right, occlusal view before bone grafting).

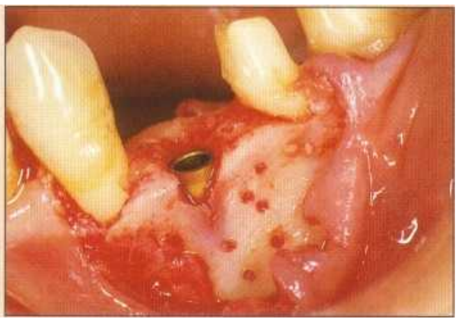


c. Second-stage implant surgery 6 months after primary surgery. The osseous defect area is completely covered by new bone (right, occlusal view).

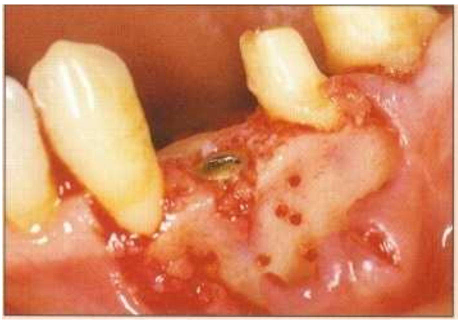
Fig 5-21 Implant failure due to thin-walled extraction socket.



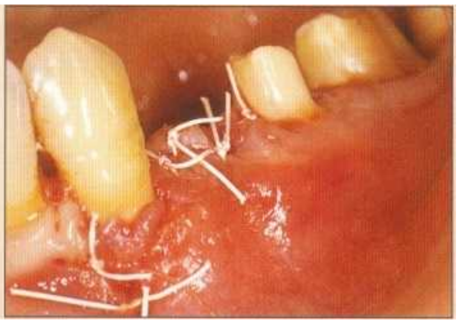
a. After extraction of 21. Note the slight dehiscence defect on the buccal aspect; however, most of the bone walls of the extraction socket remain.



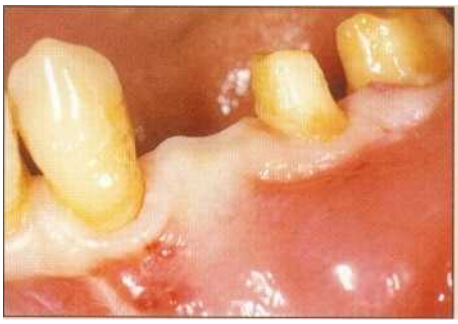
b. A P01 three-piece-type implant (15 x 3.7 mm, Kyocera) is placed immediately after extraction. The width of the extraction socket is the same as the fixture diameter; however, there is about a 3-mm dehiscence defect on the buccal aspect. Buccally, the remaining marginal bone is thin.



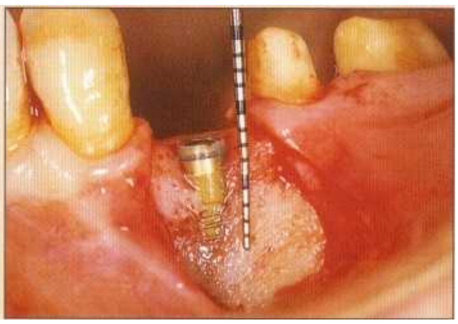
c. Small bone chips are harvested with a bone chisel and transplanted to the dehiscence area.



d. Complete primary wound closure.



e. Second-stage surgery is performed 7 months after primary surgery.

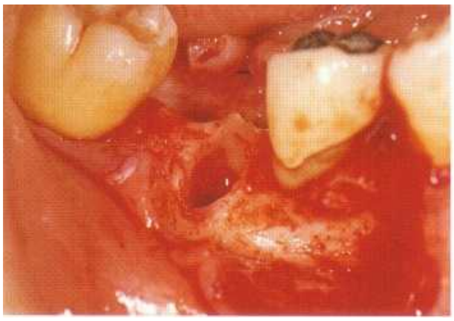


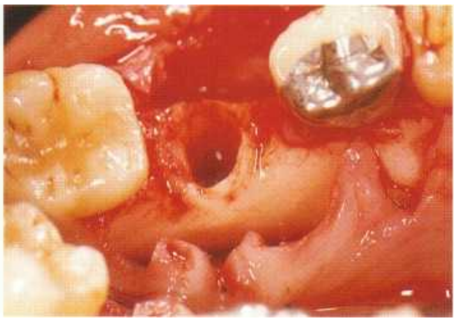
f. Note the 6 mm dehiscence defect on the buccal surface of the fixture. Implant placement adjacent to thin buccal bone may cause bone resorption.

Case 5-11 Immediate implant without a barrier membrane

c11-1 External root resorption of tooth with autogenous graft (26-year-old woman).

Extraction, fixture placement, and autogenous graft



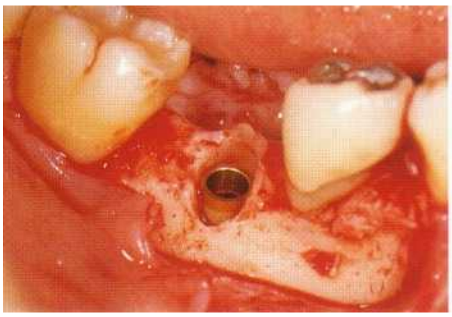


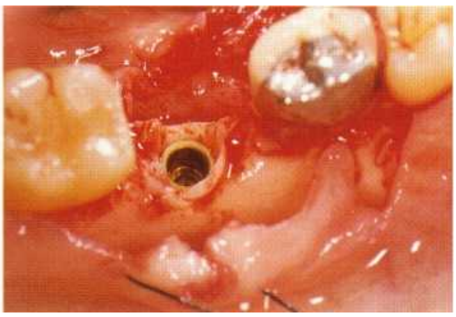
c11-2 Extraction. A sulcular incision around the tooth planned for extraction is made. The incision is extended to the mesial line angle of 29 and a vertical incision on the mesiobuccal line angle, extending to the alveolar mucosa, is made. The buccolingual width of the extraction socket is 8 mm, and the mesiolingual width is 5.5 mm. Part of the buccal wall has been lost.

Key points

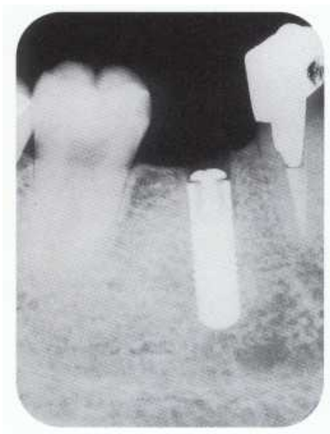
Conditions required for the placement of an immediate implant without barrier membrane:

1. More than 5 mm of'bone exists apical to the bottom of the extraction socket (for primary stability).
2. The size of the extraction socket is the same as the implant diameter.
3. Bone walls exist around the entire circumference of the extraction socket, making; fixture placement within the alveolus possible.

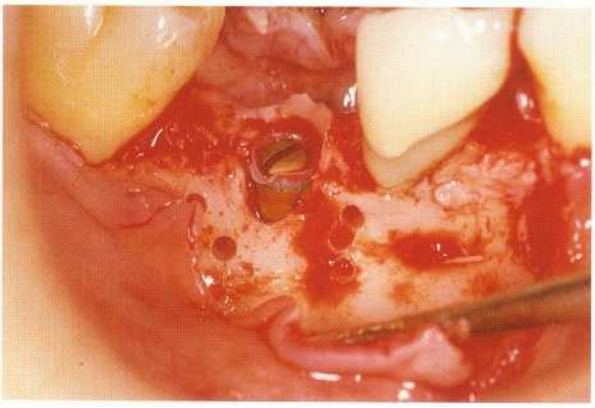




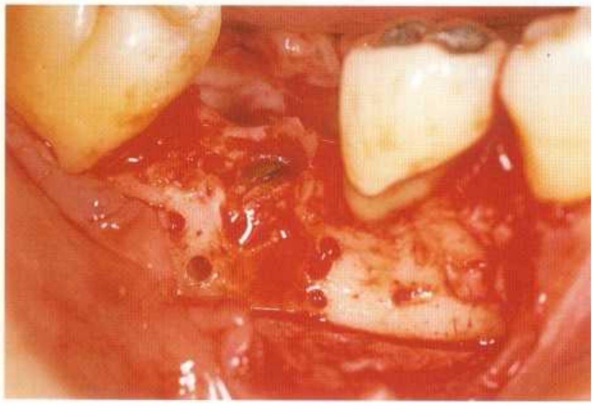
c113 Fixture placement. A P01 three-piece-type implant (13 x 4.2 mm, Finafix, Kyocera) is placed in the immediate extraction socket. Note, however, the dehiscence defect on the buccal aspect (4.2 mm wide and 2 mm deep).



c11-4 Bone grafts.

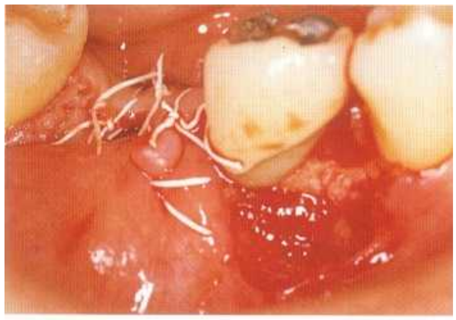


a. The cortical bone is penetrated with a small round bur.



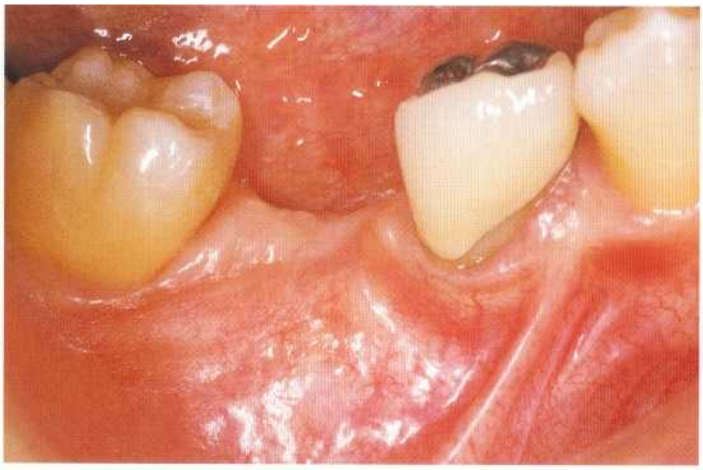
b. Because the osseous defect is small, bone chips are harvested from the surrounding bone and transplanted to the exposed implant surface.

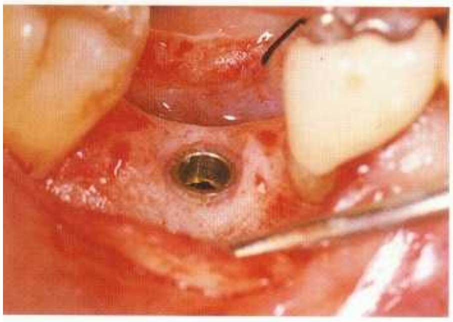
c11-5 Suture. The pedicle flap is displaced from the buccal aspect of 29 to the distal aspect, the extraction socket completely covered, and the flap sutured.

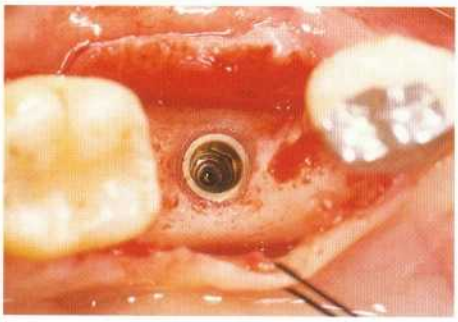


Re-entry

c11-6 ***Eight* months after surgery.**







c11-7 Bone regeneration. Flap reflection reveals complete coverage of the dehiscence area with new bone.

c11-8 After abutment connection.

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6

Periodontal Plastic Surgery

Periodontal Plastic Surgery

As described in Chapter l, the objective of periodontal surgery is not only the elimination of inflammatory factors but the creation of an easily maintained periodontal environment to prevent disease recurrence. Additionally, there are procedures to improve esthetics that come under the category of periodontal plastic surgery' In periodontal surgery, mucogingival surgery is a therapy to create a better periodontal environment and improve esthetics. Among specialists, however, there is no consensus on the indications and effectiveness of these procedures.

While the focus here is on attachment gain and increasing keratinized mucosa around implants in mucogingival surgery, there are other procedures in mucogingival surgery, such as vestibuloplasty and frenectomy. There are also procedures to create interdental papillalike form around edentulous areas adjacent to abutments or implants, and procedures to improve gingival morphology around restorations. These procedures are periodontal plastic surgical procedures, the primary objective of which is esthetics. Improving the periodontal environment and improving esthetics, however, are not always compatible. There is the possibility of forming a pseudopocket (or false pocket) that compromises cleaning. The periodontal environment may be sacrificed for esthetic improvement. Increasing gingiva and alveolar mucosa without an increase in attachment is especially associated with maintenance difficulty.

Attachment gain by GTR is one way to improve both esthetics and the periodontal environment. Periodontal plastic surgery with its objective of esthetic improvement, has also been greatly changed.

Conventional resective procedures have been refined to eliminate periodontal pockets, to gain attachment, and to improve esthetics. An important factor in surgical crown lengthening, for example, is esthetic harmony of the gingival line and smile line. In this procedure, the postoperative gingival contour should be planned during the provisional restoration phase (Figs 6-1 and 6-2). Also, in the treatment of an edentulous ridge, not only alveolar ridge aug-

Table 6-1 Periodontal Plastic Surgery

Objectives	Methods	Procedures	
Improvement of gingival contour and crown lengthening	Surgical elongation Root coverage	Crown lengthening Soft tissue grafts	Resective surgery Regenerative procedures
Reduction of gingival recession	Root coverage	Soft tissue grafts GTR	Regenerative procedures
Alveolar ridge preservation and reconstruction of edentulous ridge	Ridge augmentation	Soft tissue grafts GBR Bone grafts	Augmentation of alveolar mucosa Regenerative procedures
Gain of interdental papilla	Papilla reconstruction	Soft tissue grafts	Augmentation of gingiva and alveolar mucosa
Esthetic improvement around implants	Bone and/or soft tissue augmentation	Soft tissue grafts GBR Bone grafts	Augmentation of alveolar mucosa

Various periodontal plastic surgery procedures

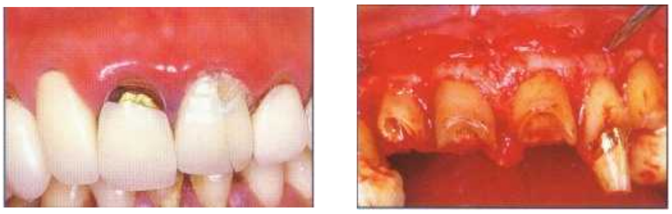
Fig 6-1 Treatment of disharmony of the gingival margin.

a. Esthetic restorations cannot be placed due to the disharmony of the gingival line.

b. Surgical crown lengthening of 10.

c. Postoperative provisional restorations.

Fig 6-2 Improvement of gingival appearance with crown lengthening.



a. Note the problems in the cervical area and the imbalance of the gingival line.

b. A crown lengthening procedure provides preservation of sound tooth structure and improvement of the gingival morphology.

c. Three years and 6 months after the placement of final restorations.

Fig 6-3 Alveolar ridge surgery (alveolectomy).

a. Thick soft tissue interferes with the placement of an esthetic pontic.

b. An alveolectomy of the edentulous area is performed. The labial part of the alveolar ridge is reduced to the level of the top of the alveolar ridge at the palatal one third.

c. Four years after the placement of restorations.

Fig 6-4 Ridge augmentation.

a. Alveolar ridge depression after extraction.

b. Ridge augmentation using connective tissue grafts.

c. Six years and 4 months after the placement of final restorations.

mentation but resective correction of alveolar mucosa morphology may be desirable (Figs 6-3 and 6-4). Because the objectives of most periodontal surgeries are to eliminate inflammatory factors and to improve the periodontal environment and esthetics, there is no absolute distinction between periodontal surgery and periodontal plastic surgery.

Periodontal plastic surgery may be a resective procedure, increasing the gingiva or alveolar mucosa, or a regenerative procedure leading to attachment gain (Table 6-1). In this book, procedures to improve the periodontal environment are the focus.

Surgical Root Coverage

What Is Root Exposure?

In health, root cementum, which is derived from mesenchyme, gingival fibers, the periodontal membrane, and alveolar bone compose the periodontal tissue. Gingival recession causes root exposure, which results in the fragmentation and ulceration of the epithelium. An exposed root surface, however, does not manifest inflammatory symptoms like a common ulcer. Therefore, root exposure is often understood as a morphologic change rather than a pathologic condition. However, dental hypersensitivity, caused by the exposure of dentinal tubules communicating with the dental pulp, often follows root exposure. This inflammatory symptom is understood to be caused by root exposure. However, in dental hypersensitivity, odontoblasts which were stimulated from the outside (exposed root) create irregular dentin on dental pulp as a response mechanism. The hypersensitivity will resolve due to calcification of the dentinal tubules.

Therefore, generally, root exposure is understood as neither a disease nor impediment but an esthetic problem. It is important to determine if pathologic symptoms are present as a result of the root exposure.

Root exposure may be caused by tooth extrusion or gingival recession. In any case, root exposure does not occur without loss of attachment of gingival fibers under the CEJ. Attachment loss may be caused by marginal periodontitis, labial migration of teeth, an osseous dehiscence due to trauma, and obstruction of circulation in the long epithelial attachment area due to trauma or other causes. In the absence of inflammation, gingival morphology follows the shape of the bone. Therefore, if there is an osseous defect or dehiscence in the labiobuccal bone, gingival recession will occur because of loss of long epithelial attachment.

If attachment loss and the osseous dehiscence are progressive, the first choice is to eliminate the problem. However, even with treatment and with nonprogressive cases, various problems, including esthetic problems, will remain. Hypersensitivity of the root surface may create discomfort or pain on brushing, hindering brushing effectiveness and increasing the risk of gingival inflammation. In patients with a high risk of decay, the risk of root caries will increase.

If gingival recession is followed by pathologic migration of the tooth or tooth malalignment, attachment recovery by orthodontic therapy should be considered first. However, in these cases, there may be problems such as time limitations or patient nonacceptance. Surgical methods are an important option for improving esthetics relatively quickly.

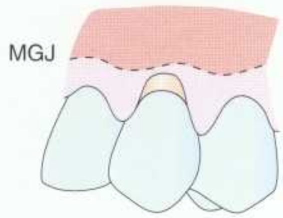
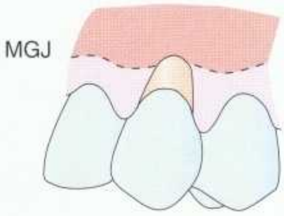
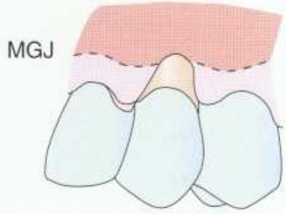
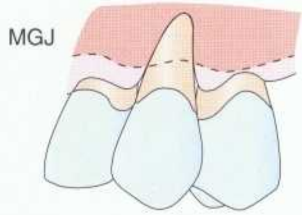
Indications for Root Coverage by Surgery

The indications of root coverage by surgery are mainly esthetic. If gingival recession is progressive, diagnosis and elimination of the cause are the first priority. After resolution of the inflammation or the elimination of trauma, the clinician may determine whether root coverage is indicated.

The predictability of coverage of the exposed root surface is influenced by many factors, including whether the gingival margin is apical to the mucogingival junction (MGJ), whether there is loss of interalveolar septa or interdental gingiva, and the extent of tooth malposition' (Table 6-2).

If there is no loss of interalveolar septa and interdental soft tissue, coverage of exposed root surface is attainable. With the loss of these tissues, root coverage is possible to some degree if the tissue remains coronal to the marginal tis sue. Root coverage cannot be achieved if the interdental tissue level is apical to the receded marginal tissue.

Table 6-2 Classification of Gingival Recession[2]

Gingival recession	Level of receded marginal tissue	Interalveolar septa and interdental gingiva	Prospect of root coverage
Class I 	Coronal to the MGJ 	No loss 	Excellent 
Class II 	Extends to or beyond the MGJ 	No loss	Excellent 
Class III 	At the MGJ or apical to the MGJ 	Loss or tooth malposition 	Good–Fair 
Class IV 	At the MGJ or apical to the MGJ	Extreme loss or extreme tooth malposition	Cannot be anticipated

Conditions Necessary for Successful Surgical Root Coverage

Root coverage, 100% or partial, is possible in Class I-III gingival recession. The factor most influencing the result is blood supply to the grafted tissue (Tables 6-3 and 6-4).

Table 6-3 Conditions Necessary for Successful Root Coverage
1. Appropriate case selection.
• No loss of interdental papilla and interdental alveolar bone adjacent to gingival recession area.
• Sufficient interdental papilla adjacent to gingival recession area.
2. Sufficient blood supply ensured to donor tissue.
3. Root surface covered with thick donor tissue (flap and graft).
4. Donor tissue adapted closely to the recipient site and sutured. Dead space between the donor tissue and recipient site will interfere with circulation.
5. No severe decay or abrasion on exposed root.

Table 6-4 Criteria of Successful Root Coverage[3]
1. The gingival margin is on the CEJ in Class I, Class II gingival recession.
2. The depth of gingival sulcus is within 2 mm.
3. There is no bleeding on probing.
4. There is no hypersensitivity.
5. Color match with adjacent tissue is esthetically harmonious.

Surgical Procedures and Their Selection

Surgical root coverage may be achieved by a number of techniques, including pedicle gingival grafts, free autogenous gingival grafts, and connective tissue grafts. Guided tissue regeneration may also be used. In selecting a surgical procedure, it is necessary to evaluate the amount of coverage required for the exposed root and other factors (Table 6-5). The methods and indications of the various surgical techniques are shown in Table 6-6.

Connective tissue grafts and GTR are applicable to wide and deep gingival recessions and offer esthetically pleasing results. Case 6-13 (p. 408) shows the esthetic results of these procedures, and the results are comparable. If the procedure is selected according to indication, optimal results can be achieved (Fig 6-5 and Table 6-7).

Table 6-5 Key Factors in the Selection of Surgical Procedures

Recipient site	Donor site
1. Whether gingival recession is limited to one tooth or extends to multiple teeth 2. Degree of gingival recession (width and depth) 3. The amount and thickness of existing keratinized gingiva in the area of recession 4. The relation between the height of adjacent interdental papilla and gingival recession 5. Whether the area of recession protrudes labially from the dental arch 6. The relation between the gingival recession area and the smile line 7. Whether restorative/prosthodontic treatment after root coverage is necessary	1. Whether area adjacent to gingival recession can be used as a donor site • Amount of keratinized gingiva • Thickness of keratinized gingiva • Size of adjacent interdental papilla • Thickness of the alveolar bone covering the donor tissue 2. Thickness of palatal soft tissue used as donor tissue

Table 6-6 Methods and Indications of Root Coverage

Surgical methods for root coverage	Number of teeth for which root coverage is necessary		Amount and thickness of keratinized gingiva in recession area		Degree of gingival recession		Postoperative color harmony	Labial protrusion of gingival recession area
	Single tooth	Multiple teeth	Sufficient	Insufficient	Wide and deep	Narrow and shallow		
1. Pedicle gingival grafts a. Laterally positioned flaps b. Double papilla flaps c. Transpositional flaps d. Coronally positioned flaps	•		•			•	•	
2. Free autogenous gingival grafts	•	•		•		•		
3. Connective tissue grafts or subepithelial connective tissue grafts	•	•		•	•	•	•	•
4. GTR	•		•		•		•	•
5. Semilunar coronally positioned flaps	•	•	•			•	•	

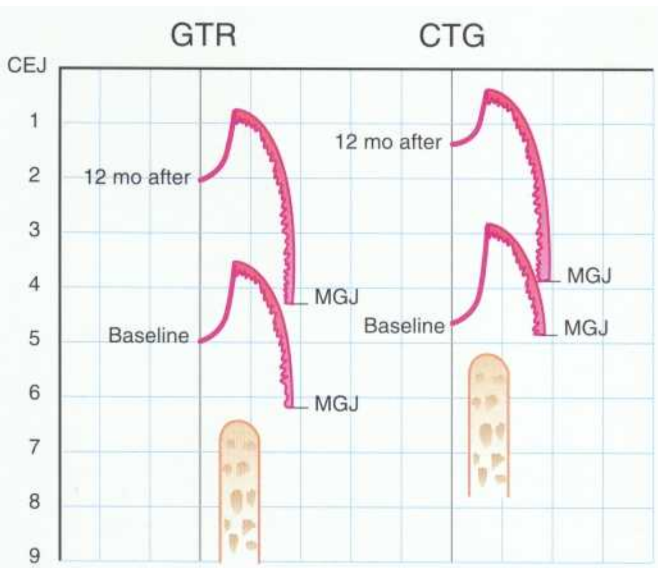


Fig 6-5 Comparison of GTR and connective tissue grafts (CTG) for the treatment of exposed root surfaces.

Table 6-7 Comparison of GTR and Connective Tissue Grafts for the Treatment of Exposed Root Surfaces (mm)

	GTR (14 patients, 22 teeth)		CTG (14 patients, 28 teeth)	
	Baseline	12 months later	Baseline	12 months later
Gingival recession	3.5	0.8	2.9	0.4
Probing depth	1.5	1.1	1.6	0.9
Attachment level	5	2	4.6	1.4
Keratinized tissue width	2.8	3.6	2	3.4
Bone defect	6.5		5.1	
Recession reduction		2.7		2.5
Probing depth reduction		0.4		0.7
Attachment level gain		3		3.2
Keratinized tissue width increase		0.8		1.4

Pedicle Gingival Grafts

Table 6-8 Pedicle Gingival Grafts
Advantages
1. One surgical area (no donor site).
2. Blood supply of the pedicle flap covering the root surface is preserved.
3. Postoperative color is in harmony with the surrounding tissue.
Disadvantages
1. Applicable for relatively minor gingival recession (narrow and shallow) or for recession limited to one tooth.
2. The success rate is not high.

Pedicle gingival grafts are classified according to the direction of' flap migration.

1. Rotational flap- flap rotated or displaced laterally (Fig 6-6)
   - Laterally positioned flap (Case 6-1)
   - Transpositional flap (Case 6-2)
   - Double papilla flap (Case 6-3)
2. Advanced flap-flap placed without rotation or lateral migration (Fig 6-7)
   - Coronally positioned flap

Fig 6-6 Coverage of the exposed root by a rotational flap.

Fig 6-7 Coverage of the exposed root by an advanced flap.

Pedicle gingival grafts require no donor site and offer excellent blood supply (Table 6-8).

Laterally Positioned Flaps

Laterally positioned flaps have been widely used since Grupe and Warren' introduced this method for the treatment of localized gingival recession. In this procedure, the adjacent keratinized gingiva is positioned laterally, and the exposed root surface in the localized gingival recession is covered (Fig 6-8). The disadvantages of this method are possible bone loss and gingival recession on the donor site. Guinard and Caffesse" reported an average of 1 mm of postoperative gingival recession on the adjacent donor site.

Table 6-9 Coverage of the Exposed Root Surface Using Laterally Positioned Flaps

Indications

1. Sufficient width, length, and thickness of keratinized tissue exist adjacent to the area of gingival recession.
2. Coverage of the exposed root is limited to one to two teeth.
3. This method is most suitable for root coverage in gingival recession with narrow mesiodistal dimension (eg, mandibular anterior area).

Contraindications

1. Insufficient width and thickness of keratinized tissue in the adjacent donor site.
2. Extremely thin bone in the donor site or an osseous defect such as a dehiscence or fenestration.
3. Gingival recession area extremely protrusive.
4. Deep periodontal pocket and remarkable loss of interdental alveolar bone in the adjacent area.
5. Narrow oral vestibule.
6. Multiple teeth involved.

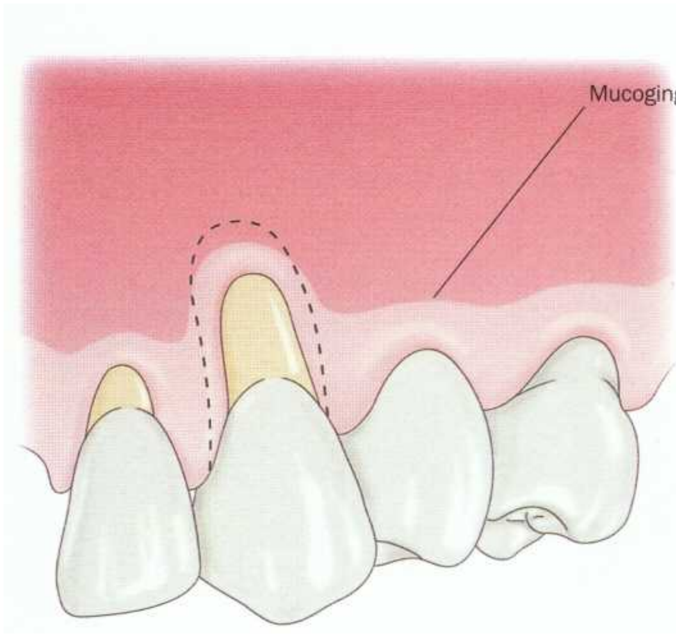
This method is therefore contraindicated where the width, height, and thickness of the adjacent keratinized gingiva of the donor tissue is inadequate or where an osseous dehiscence or fenestration exists.

Many modified methods of Grupe and Warren have been developed to avoid gingival recession on the donor site. Staffileno advocated the use of a partial-thickness flap to avoid recession on the donor site. Grupe[3] reported a modified technique to preserve the marginal gingiva by making a submarginal incision on the donor site. However, laterally positioned full-thickness flaps have the best prognosis for exposed root surface coverage.

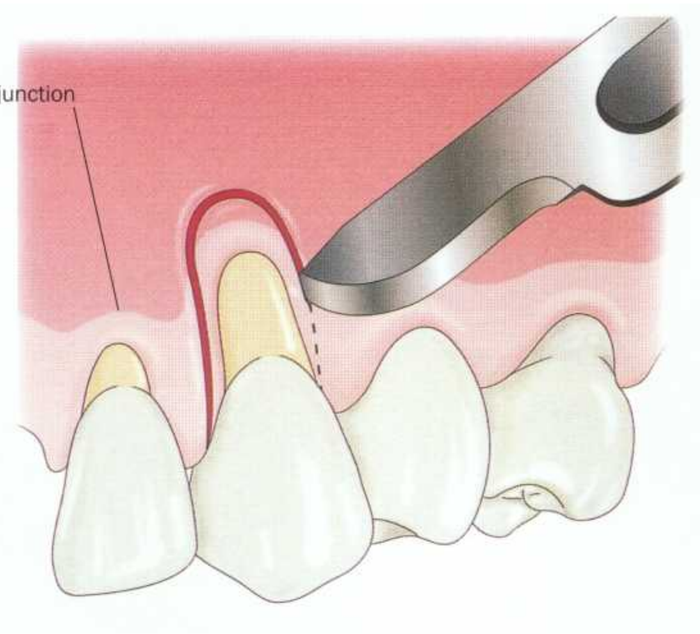
Pfeifer and Heller reported that reattachment on the exposed root surface is more likely to occur with full-thickness laterally positioned flaps than with partial-thickness flaps. Therefore, full-thickness flaps are appropriate for root coverage, and partial-thickness laterally positioned flaps are suitable for increasing the width of the attached gingiva.

Ruben et al demonstrated the method of the partial- and full-thickness pedicle flap; a full-thickness flap is prepared to cover the exposed root and a partial-thickness flap is prepared near the donor site to protect the exposed root site and to prevent bone loss by preserving periosteum. Knowles and Ramfjord used a free autogenous gingival graft to cover the donor site. Espinel and Caffesse[12] compared these two procedures and found minimal gingival recession on the donor site with the free autogenous gingival graft. They found that if the free gingival autogenous graft was used, there was no reduction of the width of keratinized gingiva on the donor site. If, however, the free gingival autogenous graft was not used, more than 1 mm of keratinized tissue on the donor site was lost. Therefore, laterally positioned flaps with free autogenous gingival grafts on the donor site is the clinical method most favored currently (Case 6-1). Studies on clinical root coverage by the laterally positioned flap report about a 70% success rate.

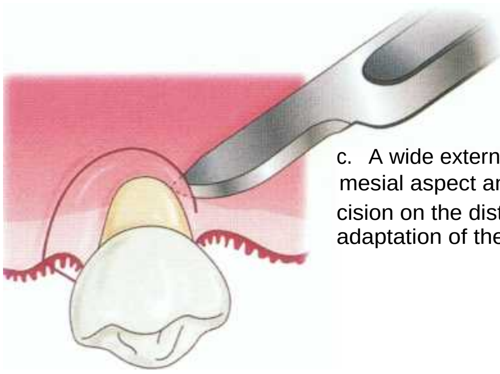
Fig 6-8 Root coverage using laterally positioned flaps.



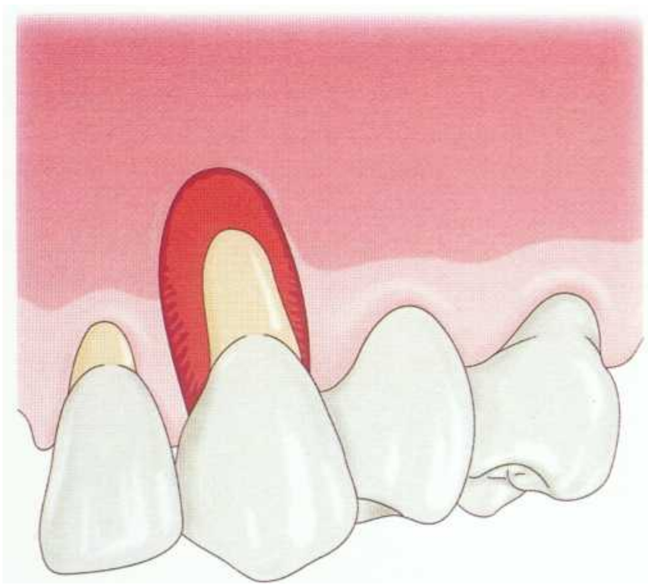
a. Pedicle flap design.



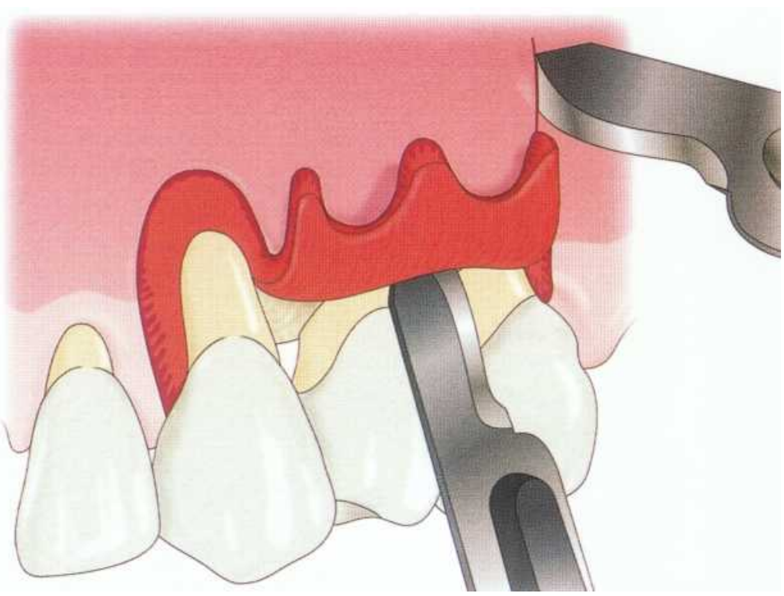
b. Make a V-shaped incision in the peripheral gingiva in the gingival recession area while preserving sufficient interdental papilla on the distal aspect of 10.



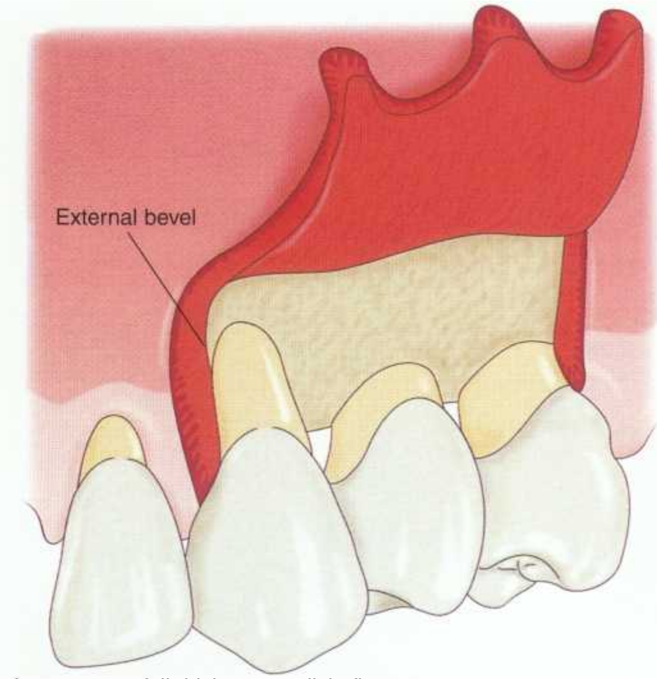
c. A wide external bevel incision on the mesial aspect and an internal bevel incision on the distal aspect create close adaptation of the flap.



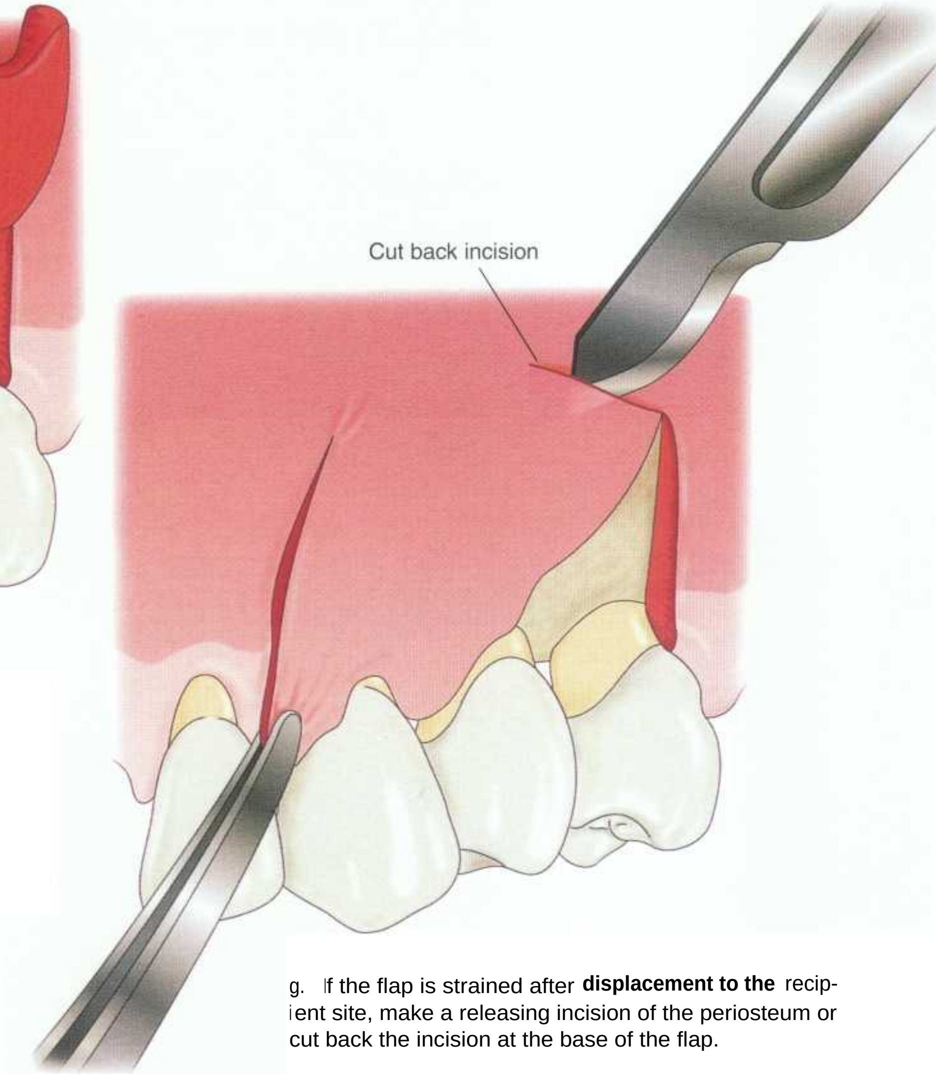
d. Remove the V-shaped gingiva and make a bevel for flap adaptation.



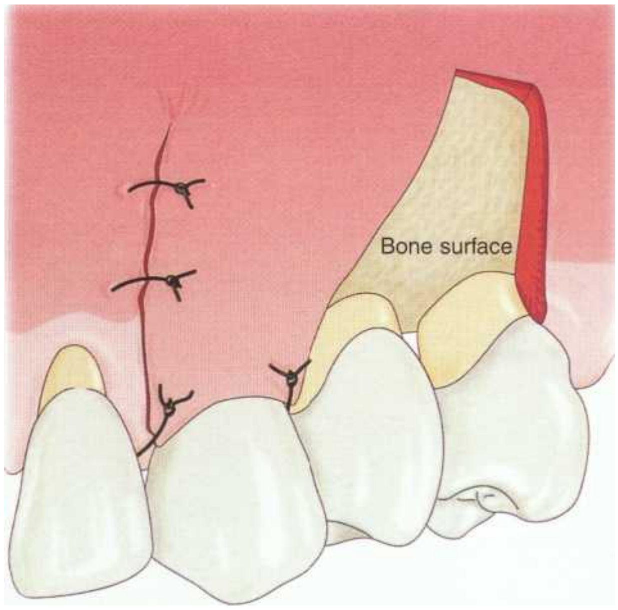
e. Make an internal bevel incision toward the alveolar bone crest from the free gingival margin of the donor site. Prepare a vertical incision one and one-half teeth from the recipient site.



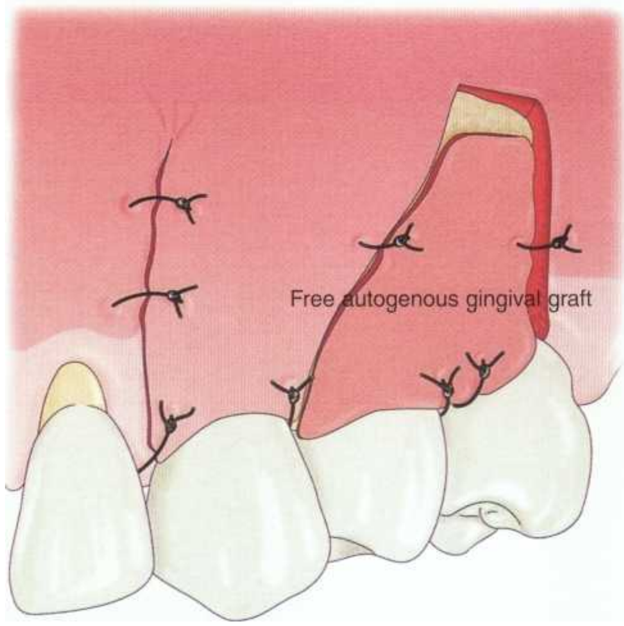
f. Prepare a full-thickness pedicle flap.



g. If the flap is strained after **displacement to the** recipient site, make a releasing incision of the periosteum or cut back the incision at the base of the flap.

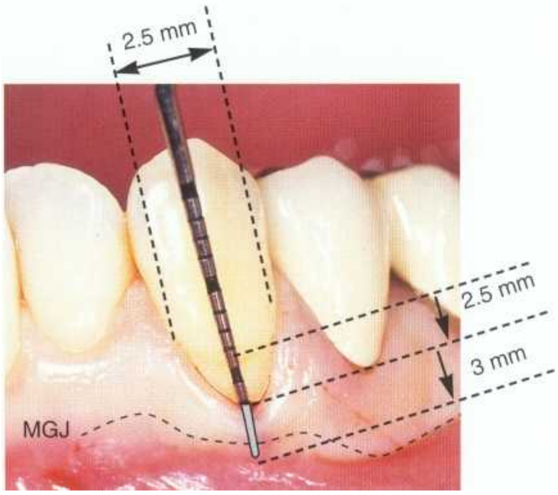


h. Cover the exposed root surface completely with the peck cle flap and suture the flap coronal to the CEJ.



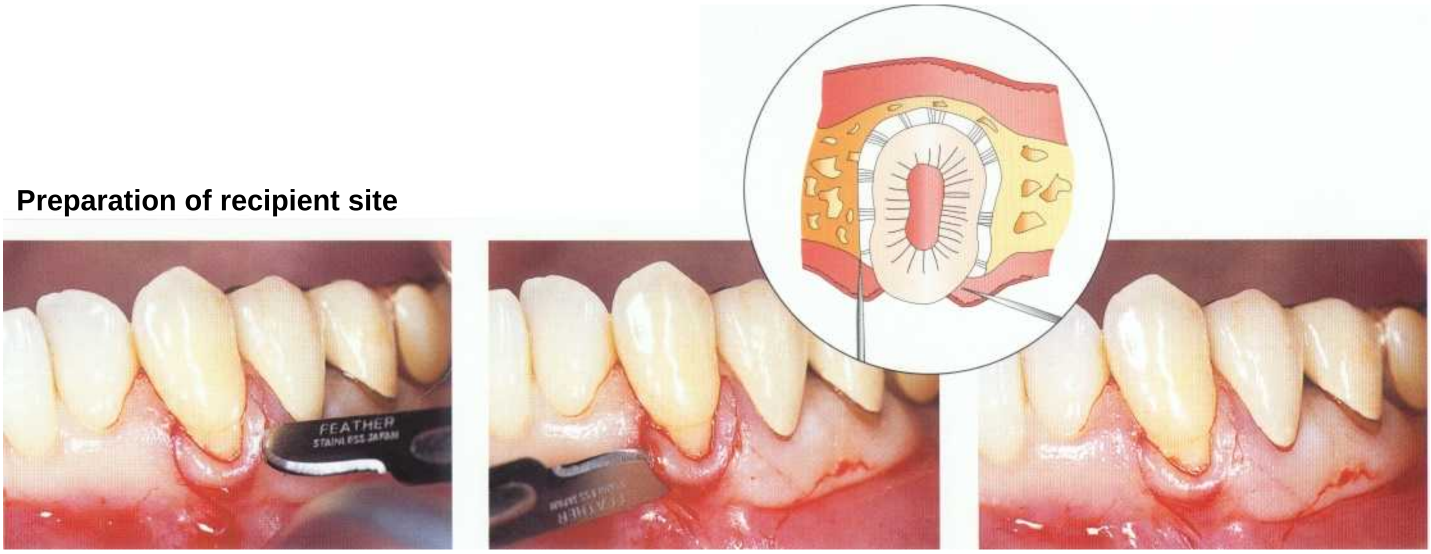
i. To minimize postoperative gingival recession at the donor site, place a free autogenous gingival graft.

Case 6-1 Root coverage using laterally positioned flaps[11,12]



Class II gingival recession. Note the gingival recession 2.5 mm apical to the CEJ on 22. The adjacent tissue is healthy, and there is sufficient keratinized gingiva and sufficient interdental bone height for use as donor site. The oral vestibule is deep (45-year-old woman).

Preparation of recipient site



c1-1 **Incision of free gingiva in the gingival recession area.** A no. 15 blade is used to make a V-shaped incision that crosses the apical area around the area of gingival recession. An external bevel is provided obliquely on the distal aspect of 22, to which the pedicle flap will be displaced, to overlap the connective tissue of the recipient site.

c1-2 Pedicle flap preparation.

a. An internal bevel incision is made toward the bone from the free gingival margin on the donor site. An internal bevel incision is made apical to the gingival margin to protect the mesial interdental papilla of 22.

b, c. A vertical incision is prepared at the distal line angle area at least 1 1/2 teeth away from recipient site.

Key point

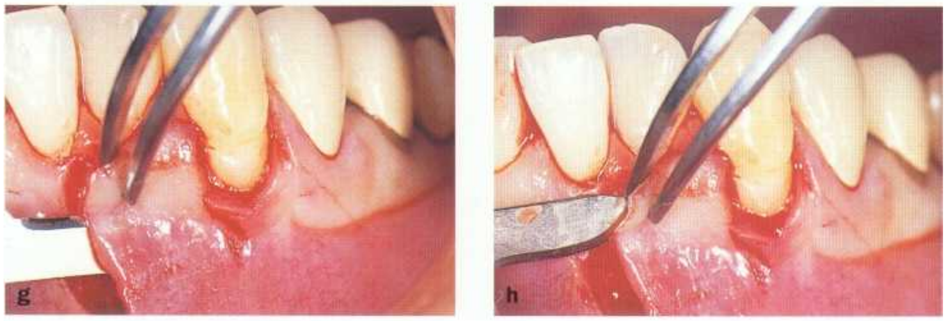
Pedicle flap preparation with a 1:4 width-to-length ratio reduces flap necrosis. Extend a vertical incision to the alveolar mucosa to provide proper flap mobility, if necessary.

d. The **V-shaped free gingiva is removed** with a curette. Note the wide bevel made on the marginal gingiva on the recipient site (distal aspect of 22).

e. The pedicle flap has a width 1½ times the area of gingival recession, and blood supply is sufficient.

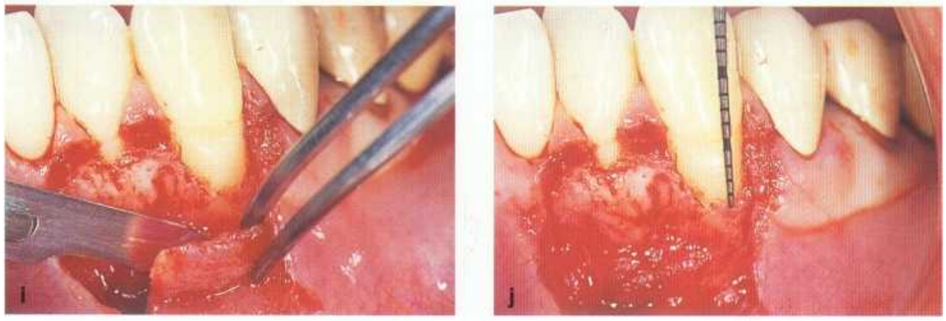
f. In the marginal area of the pedicle flap, an internal bevel is made to correspond to the external bevel of the recipient site for optimal adaptation.

g, h. A no. 15 blade is inserted into the area apical to the mucogingival junction. **Small tissue pliers are used to lift the flap margin.** The blade is placed coronal to the apex and the flaps reflected.



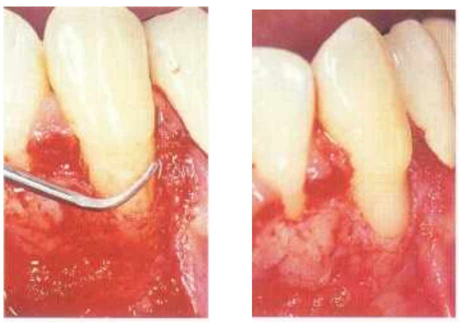
i. The pedicle flap is reflected sufficiently to enable displacement without tension. If the flap is stretched and tensed, the incision should be extended to the alveolar mucosa.

j. A **full-thickness flap is prepared in the gingival area and a partial-thickness flap pre**pared in the alveolar mucosa area. Note the 5.5-mm osseous dehiscence apical to the CEJ.



Root preparation and suture

c1-3 Root planing and root preparation.

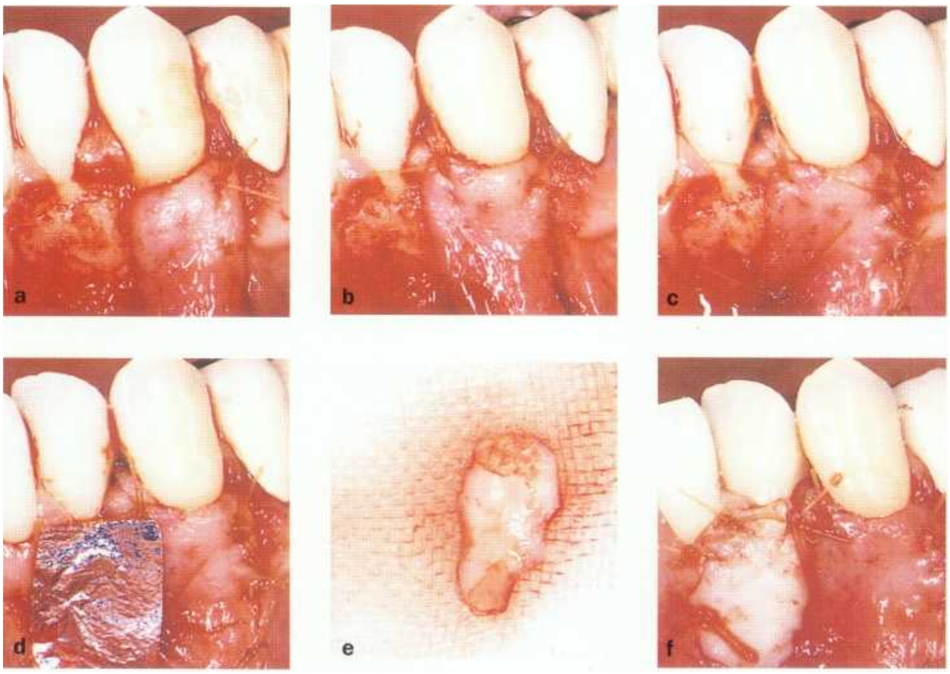


a. Root planing of the exposed root surface is performed in the osseous dehiscence area near the CEJ with a curette. At the same time, the convexity of the root is reduced.

b. After root planing.

c. After root planing, the root is treated with tetracycline solution (125 mg/mL) for 3 minutes.

d. The root surface is slightly white after preparation.



cl-4 Suture of pedicle flap.

a. The pedicle flap is sutured 1-2 mm coronal to the CEJ. A 4.0 bioabsorbable material is used to make an interrupted suture between the pedicle flap (with an internal bevel) and the interdental papilla recipient site (with an external bevel), or the distal aspect of 22.

b. The mesial interdental papilla is sutured.

c. The pedicle flap is positioned and sutured.

d-f. A free autogenous gingival graft is harvested from the palate and sutured on the donor site where the bone surface is exposed. Gauze soaked in physiologic saline solution is pressed on the site for 3-5 minutes. A periodontal dressing is placed.

Key point

It, at displacement to the recipient site, pedicle flap tension occurs due to movement of the lips and buccal rimcosa, make a releasing incision to the periosteum at the base of the flap and reflect the flap. The pedicle (lap Must cover the root surface without tension.

Prognosis

cl-5 Prognosis.

a. Suture thread is removed 10 days after surgery.

b. Seventeen days after surgery.

c. Twenty-seven days after surgery.

d. Thirty-seven days after surgery.

Forty-three days after surgery.

f. Fifty-seven days after surgery.

g. Eighty-two days after surgery.

h. One hundred forty-three days after surgery.

Transpositional Flaps

Bahat et al'' modified the oblique rotated flap introduced by Pennel et al.'s This is called the transpositional flap (Fig 6-9).

Table 6-10 Root Coverage Using Transpositional Flaps

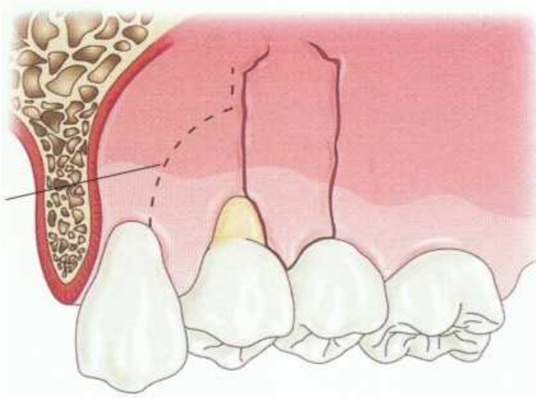
Advantages

1. Predictability in areas of narrow root exposure
2. Possible to avoid gingival recession at the donor site

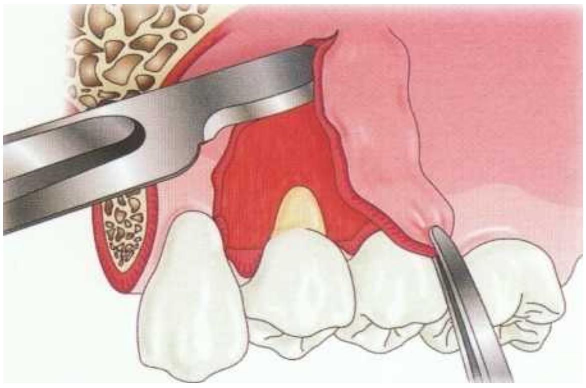
Disadvantages

1. Sufficient length and width of the interdental papilla adjacent to the gingival recession area necessary
2. Not suitable for multiple tooth root coverage

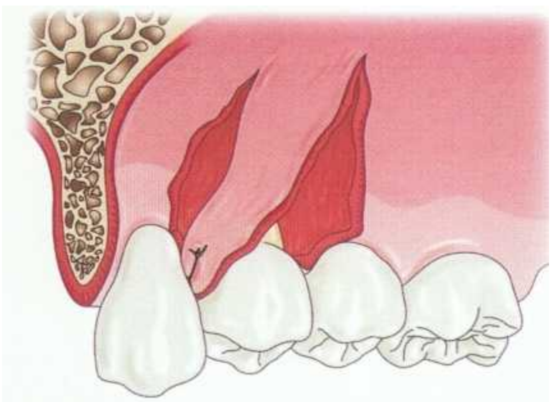
Fig 6-9 Transpositional flap design.



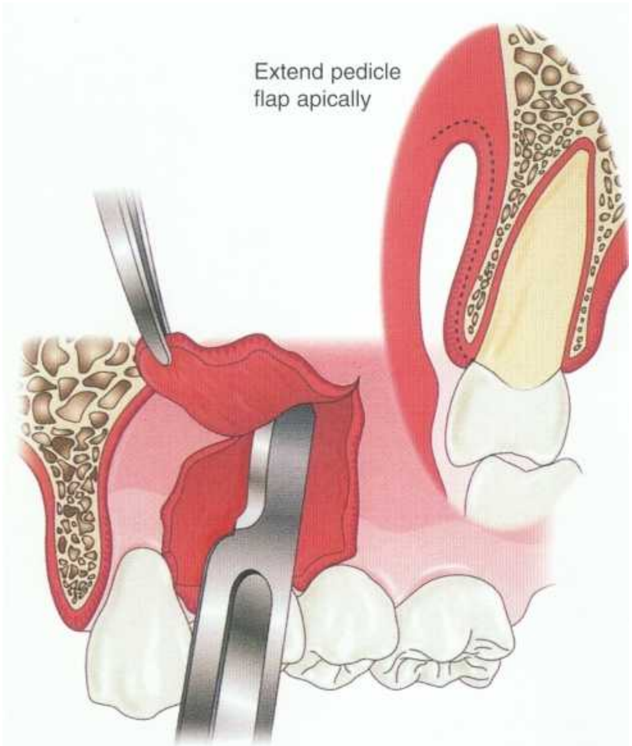
a. Make two vertical incisions including sufficient interdental papilla.



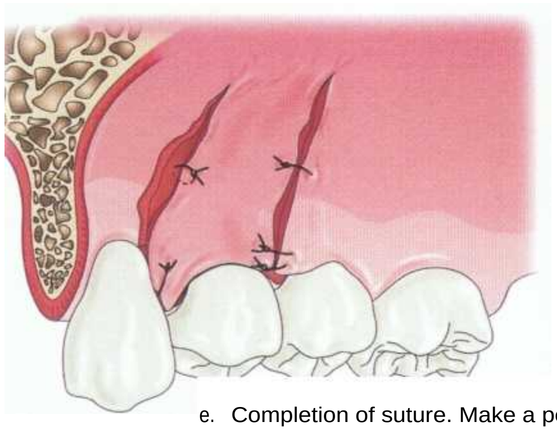
b. Prepare the pedicle flap using a partial-thickness incision. Resect the epithelium of the mesial interdental papilla and prepare the recipient site.



c. Suture the pedicle flap on the mesial interdental papilla area of the recipient site.

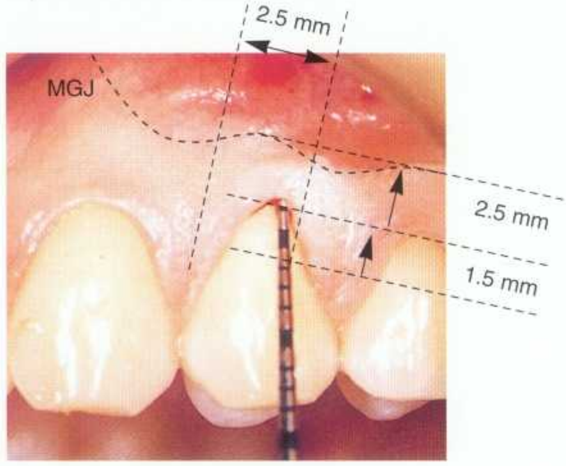


d. Using partial thickness, extend the pedicle flap preparation apically beyond the MGJ so that it may be displaced to the exposed root surface.



e. Completion of suture. Make a periosteal suture on the mesial aspect.

Case 6-2 Root coverage using transpositional flaps"

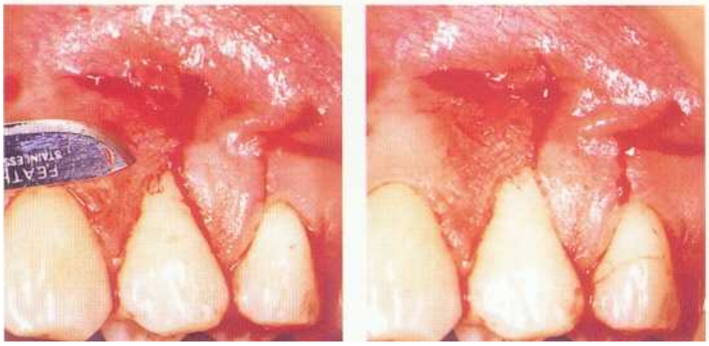


Class II recession.

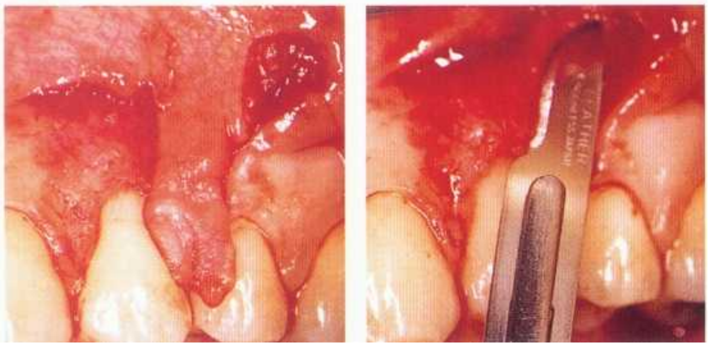
Note the relatively shallow gingival recession 1.5 mm from the CEJ with 2.5 mm width on 12. The patient reports localized pain on 12 on brushing. The adjacent interdental papilla is large and suitable as a donor site (22-year-old woman).

Flap design

c2-1 Preparation of partial-thickness flap. A no. 15 blade is used to make two vertical incisions, including sufficient distal interdental papilla of 12, and to prepare a partial-thickness flap. In this vertical incision, a flap with sufficient length is necessary for displacement onto the exposed root surface.



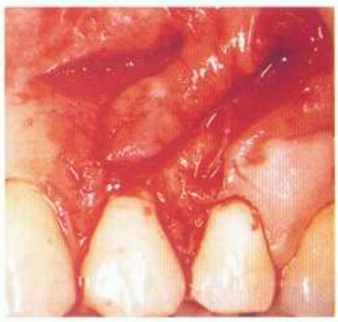
c2-2 Preparation of recipient site. The epithelium of the mesial interdental papilla adjacent to the defect slightly coronal to the CEJ is removed and the recipient site prepared.

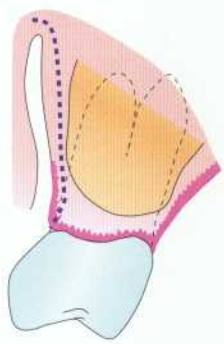


c2-3 Flap reflection. A no. 15 blade is placed toward the gingival margin. The side of the blade is held parallel to the gingiva to prepare a partial-thickness incision and reflect a pedicle flap.

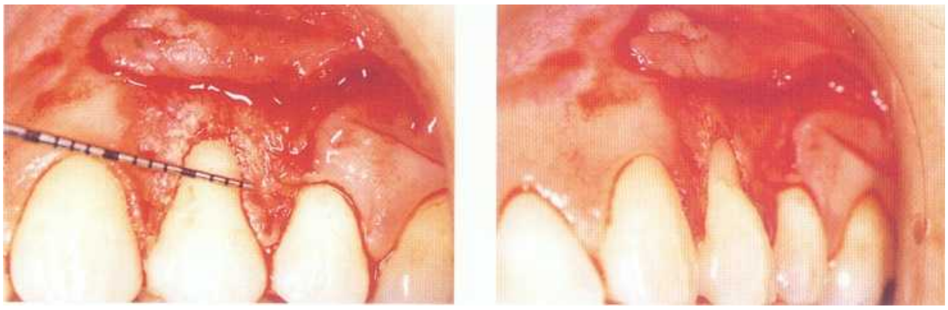
Key point

The pedicle flap must be displaced without tension. If there is tension, extend two vertical incisions and make a releasing inci-sion of the periosteum at the base. In this releasing incision, it is necessary to maintain 1.5-2.0-min thickness for **flap** blood supply. Make a releasing incision of the periosteum on the distoapical aspect of the flap. If necessary, make one on the mesioapical aspect of the flap for mobility.





c2-4 Root planing and odontoplasty. Root planing is performed and the convex part of the root surface is recontoured with a curette. Tetracycline solution is applied for 3 minutes for root preparation (see c1-3 of Case 6-1). Note the 4-mm osseous dehiscence from the CEJ to the bone crest.

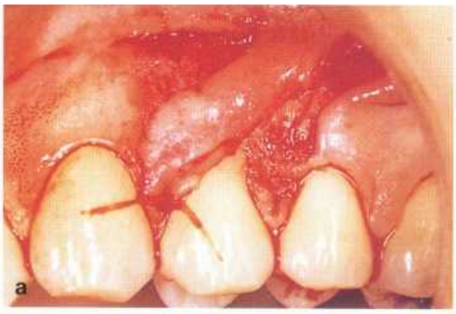


Suture of pedicle flap

c2-5 Suture.

a. With 4.0 absorbable thread, the mesial end of the flap is sutured to the mesial interdental papilla from which the epithelium was removed. The flap edge is sutured to the interdental papilla at least 2 mm mesial from the edentulous area to prevent the formation of a gingival dehiscence due to atrophy after healing.

b. The distal edge of the flap is placed onto the cervical area and sutured to the distal interdental papilla of 12. The flap is positioned coronal to the CEJ.



c. Suture of the remainder of the flap.

d. Gauze soaked in physiologic saline solution is pressed to the site for 10-12 minutes to prevent bleeding on hematoma and to avoid dead space.

e. A periodontal dressing is placed.

Prognosis

c2-6 Prognosis.

a. One week after surgery. The periodontal dressing and suture thread are removed.

b. Four months after surgery.

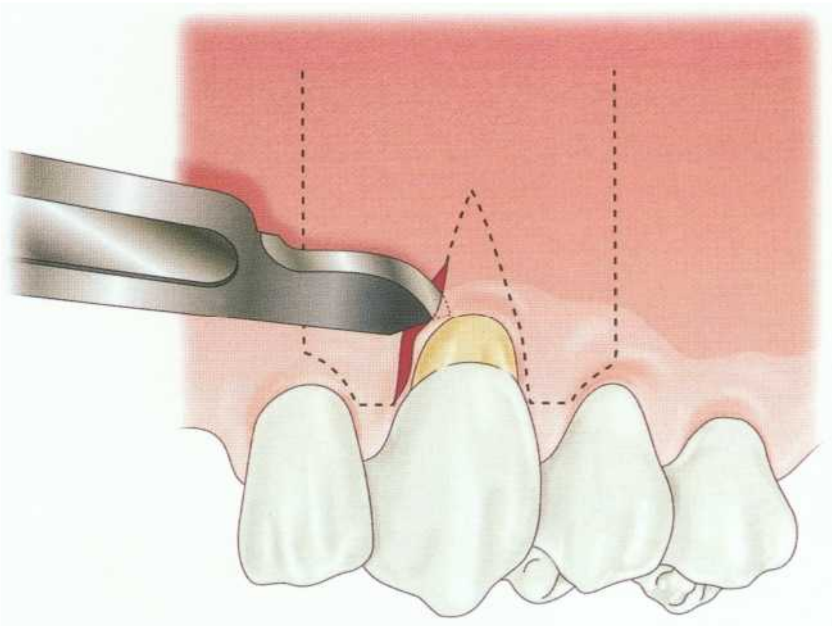
c. Ten months after surgery.

d. Sixteen months after surgery. Complete root coverage is achieved.

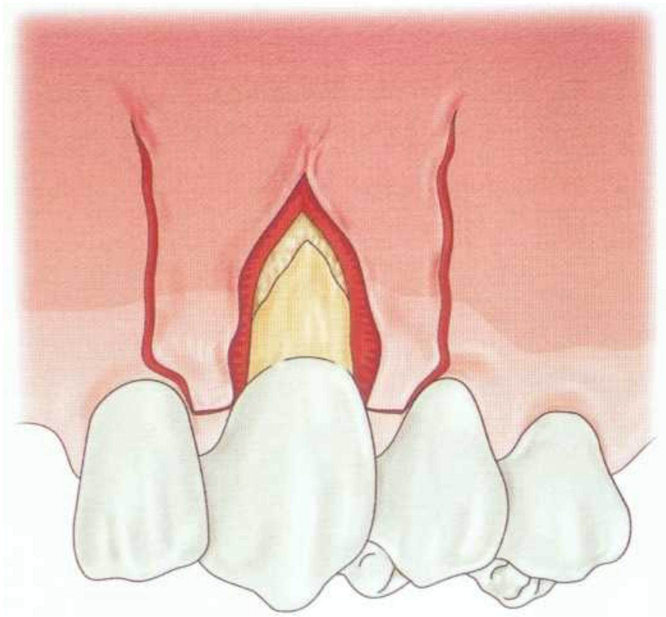
Double Papilla Flaps

Cohen and Ross" introduced the method in which bilateral interdental papilla is used as donor tissue for localized root coverage. In this technique, there is less chance of flap necrosis and suture is easy because interdental papilla is thicker and wider than labial gingiva on the root surface. Therefore, double papilla flaps are useful in cases where there is no gingiva on sites adjacent to areas of gingival recession or where there are periodontal pockets on the labial surfaces of the adjacent tooth. Laterally positioned flap surgery is not indicated in these cases (Fig 6-10).

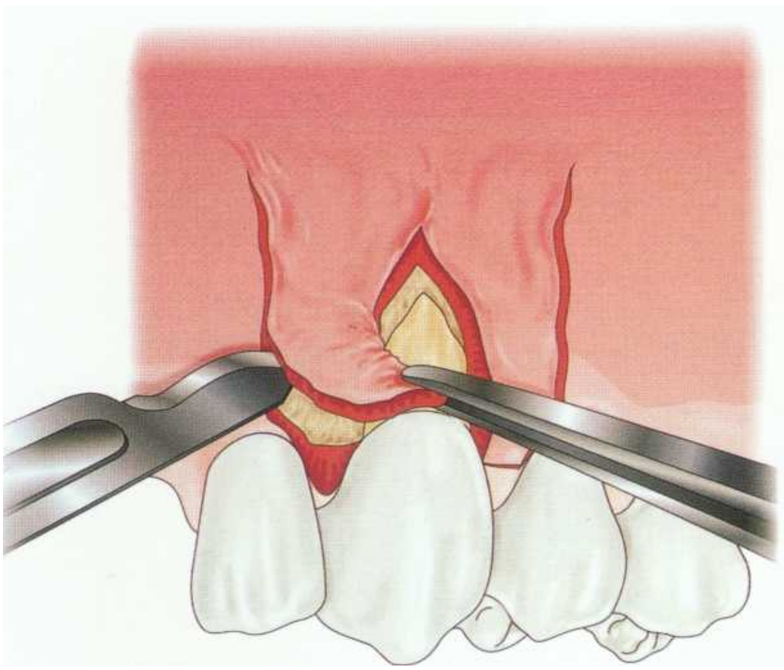
Fig 6-10 Root coverage using double papilla flaps.



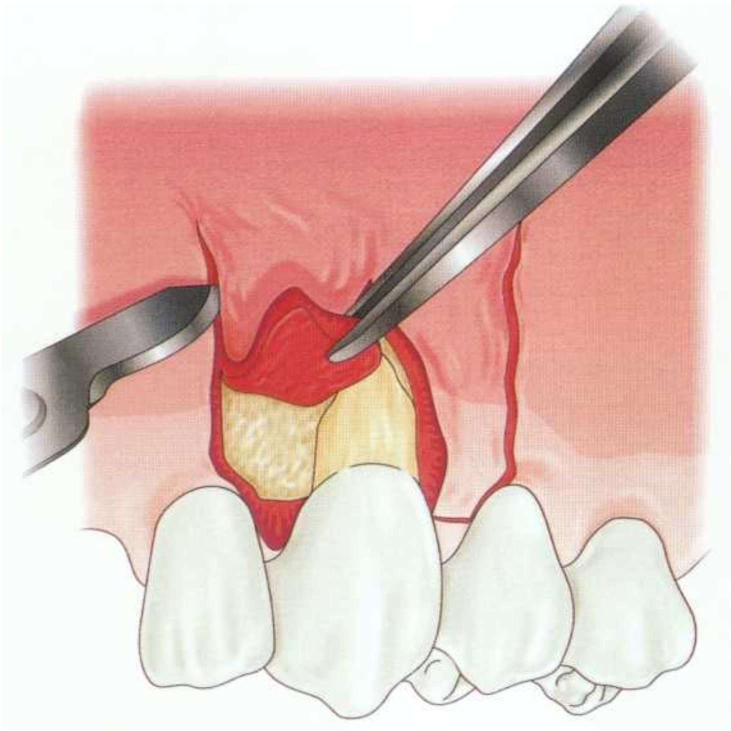
a. Make a V-shaped incision with a bevel on the mesial interdental papilla surface.



b. Remove the V-shaped tissue. The flap design includes a hori zontal incision to the mesiodistal interdental papilla on the coronal side and two vertical incisions.



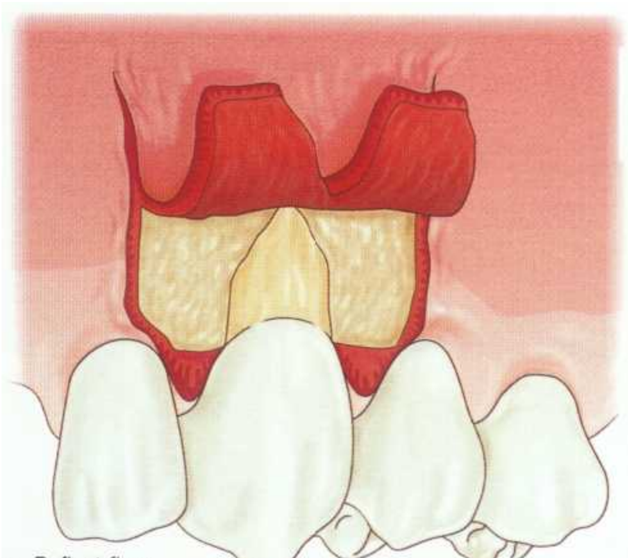
c. Prepare a full-thickness pedicle flap including sufficient interden-tal papilla on the mesial and distal sides.



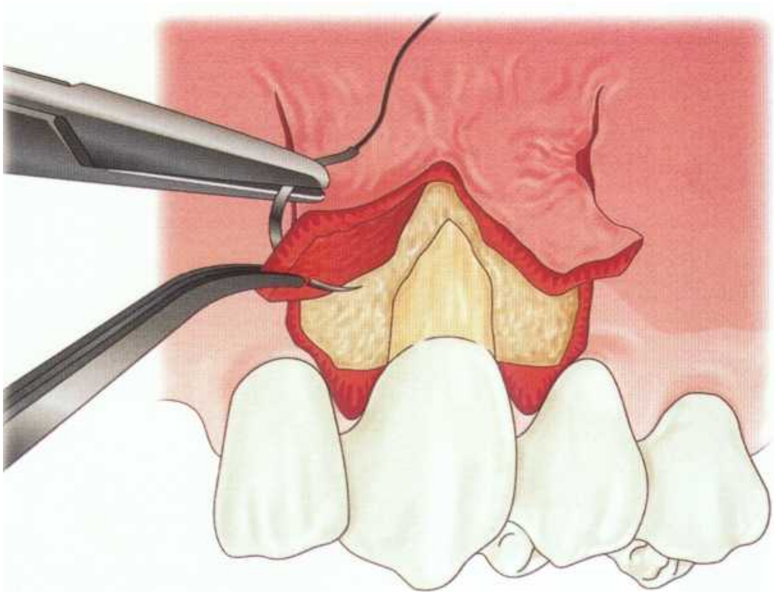
d. Make a partial-thickness flap on the apical part of the flap for easy flap migration.

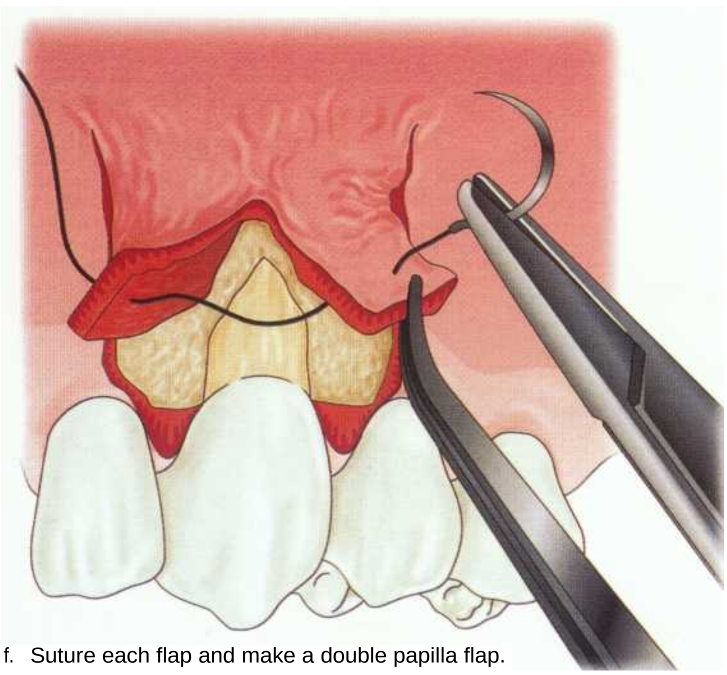
Table 6-11 Root Coverage Using Double Papilla Flaps

Indication
1. Sufficient width and length of the interdental papilla on both sides of the area of gingival recession.
Advantages
1. The amount of donor tissue is small because interdental papilla adjacent to the gingival recession area is displaced. Therefore, the procedure can be achieved with less tension to the pedicle flap.
2. While interdental bone is exposed if a full-thickness pedicle flap including interdental papilla is used, there is little damage to the alveolar bone because interdental alveolar bone is thick.
Disadvantages
1. Technically demanding.
2. Limited application. The technique is generally used for multiple interdental papilla grafting, not for root coverage. The objective is to increase the width of the attached gingiva.

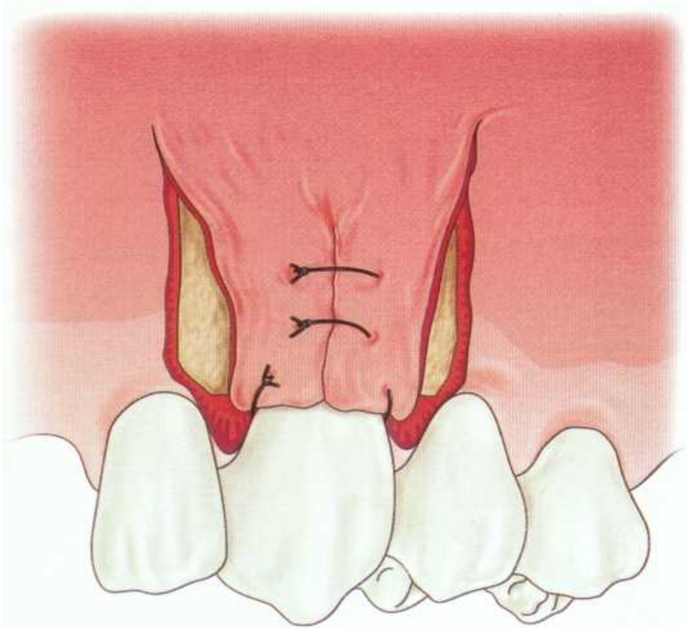


e. Reflect flaps.



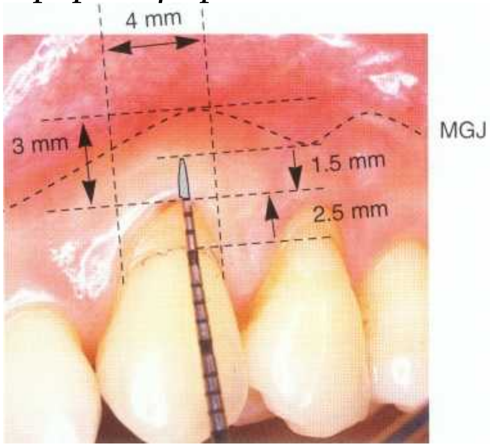


f. Suture each flap and make a double papilla flap.



g. Cover the exposed root with the double papilla flap. Stabilize the flap coronal to the CEJ with a sling suture.

Case 6-3 Root coverage using double papilla flaps"

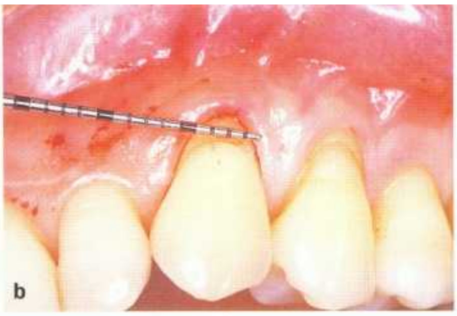


Class I recession.

Note the gingival recession on 11 and 12 (45-year-old woman).

Preparation of recipient site

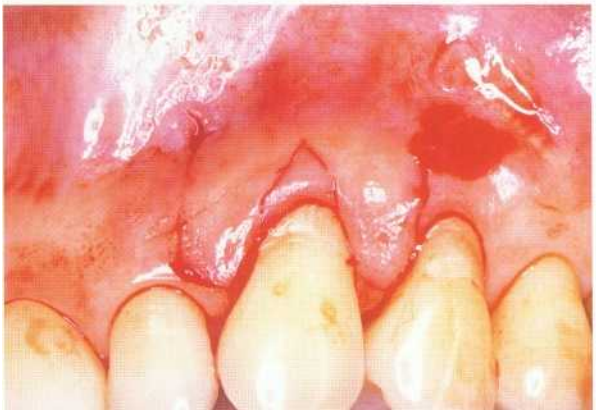
c3-1 Root planing and reshaping of the root surface.



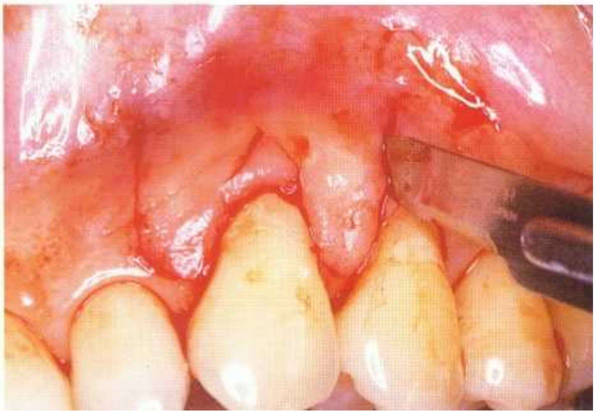
a. A curette is used for root planing. A root planing bur is used to reshape the root for better flap adaptation.

b. After root planing.

c3-2 Incision for pedicle flap.

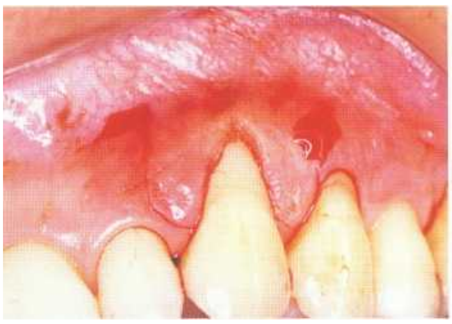


a. A no. 15 blade is used to make a V-shaped incision on the recipient site. An oblique incision is made on the mesial interdental papilla surface and a bevel provided to expose the connective tissue. This is done to enable close adaptation of the distal papilla and connective tissue.

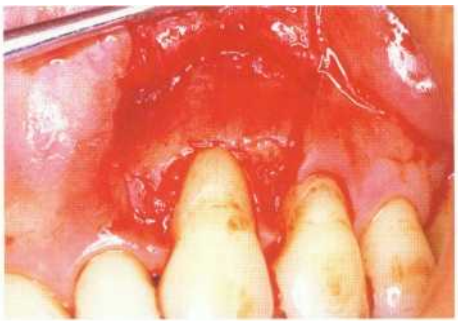


b. A horizontal incision is made on the mesial and distal interdental papilla coronally. Two vertical incisions reaching the alveolar mucosa are made on the line angle area of the adjacent teeth. A full-thickness pedicle flap that includes sufficient interdental papilla bilaterally is prepared.

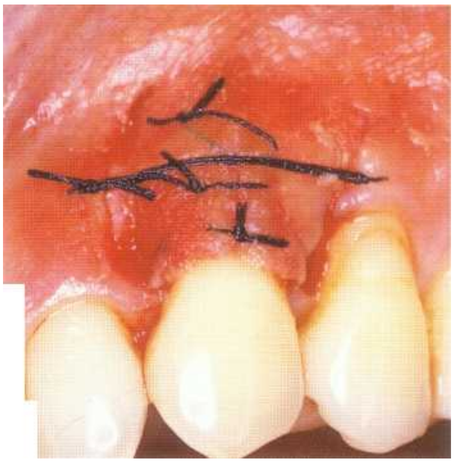
c3-3 Flap preparation.



a. After removal of the marginal tissue, citric acid is applied to the exposed root surface for about 5 minutes.



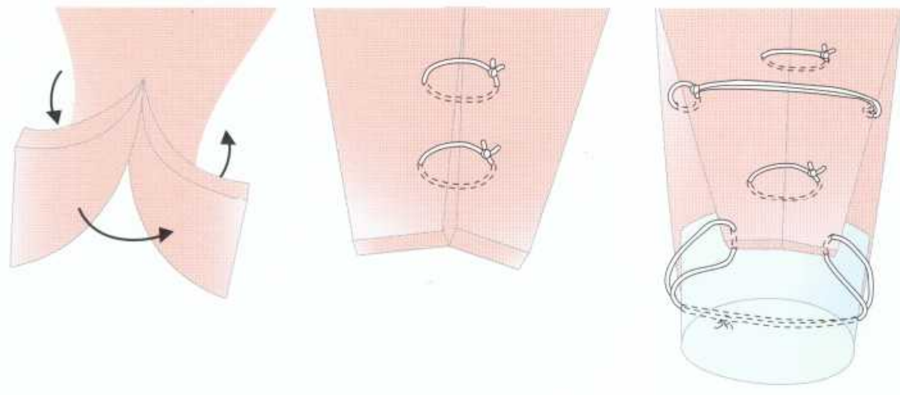
b. A full-thickness flap (about 3 mm) is reflected from the crest of the osseous dehiscence area. A partial-thickness flap is prepared in the apical alveolar mucosa area for easy flap migration.



c3-4 **Suture.** After an interrupted suture of the mesial and distal papilla flap is made, a sling suture is prepared. Hemostasis is achieved by applying pressure for 5 minutes. A periodontal dressing is placed.

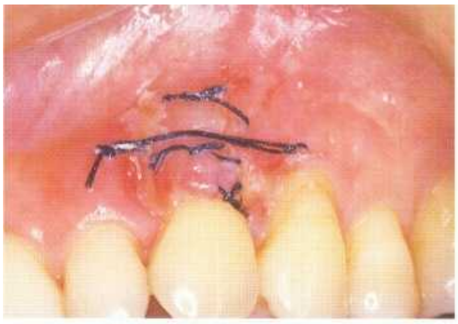
Key point

Insert the needle from outside of the distal aspect of the papilla flap and then insert the needle from the inside of the mescal aspect of the papilla flap. Join the distal aspect of the papilla flap and the bevel of the mescal papilla flap. Make an interrupted suture to overlap each connective tissue surface. If the flap edge is not straight after suture of the bilateral papilla, make a releasing incision of the periosteum to relieve flap tension. Place the flap edge on the enamel coronal to the CEJ and stabilize the overlapped bilateral papilla with a sling suture. Next, make a horizontal suture onto the flap mesiodistally for close adaptation of the flap to the root surface.



Prognosis

c3-5 **Prognosis.**



a. Ten days after surgery.

b. Two weeks after surgery.

c. Ten weeks after surgery.

d. Nine months after surgery.

e. One year and 3 months after surgery.

f. Two years and 3 months after surgery. The depth of the gingival sulcus is 1 mm, and the width of the keratinized gingiva is 5 mm.

Free Autogenous Gingival Grafts

At one time, free autogenous gingival grafts were used only to increase the width of keratinized gingiva, not to cover exposed root surface. Possible root coverage was limited to 3-mm width and 3-mm depth with free autogenous gingival grafts. This method was not indicated for root coverage of deep and wide gingival recession areas because of insufficient blood supply to graft. However, a series of procedures modified by Miller=' and Holbrook and Ochsenbein demonstrated successful root coverage using free autogenous gingival grafts. The common techniques are:

1. Thorough planing of the root surface to reduce the thickness of cementum, thereby reducing the mesiodistal dimension of the root surface. This improves the adaptation of graft and root surface.
2. Creating close adaptation of the coronal margin of the recipient site and the graft with a butt joint.
3. Using a graft of 1.5-2.0-mm thickness.
4. Stretching the graft to regenerate vascularity.

Furthermore, Holbrook and Ochsenbein introduced a unique suture technique to reduce dead space, which interferes with blood supply. In this technique, the graft is adapted closely to the recipient bed and root to keep the graft on a denuded root surface (Fig 6-12).

Table 6-12 Root Coverage Using Free Autogenous Gingival Grafts

Indications

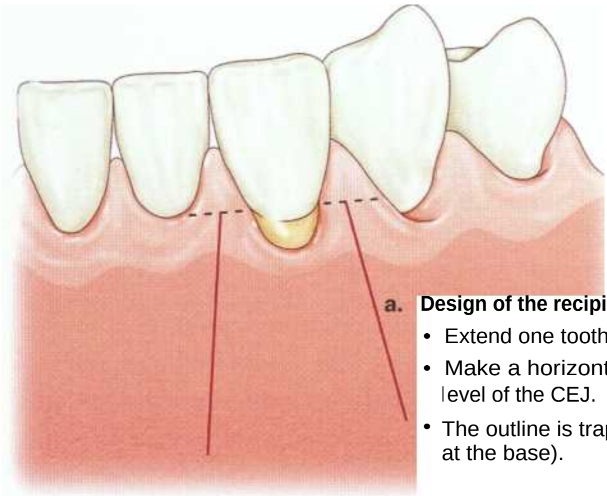
All cases where root coverage is necessary except where a graft of sufficient thickness (1.5-2.0 mm) cannot be harvested (palatal tissue).

However, in areas of extensive gingival recession, there is the problem of blood supply to the graft. In such cases, connective tissue grafts are suitable. Because a disharmonious result at the recipient site is possible, the author limits root coverage using free autogenous gingival grafts to the mandibular anterior teeth and premolars.

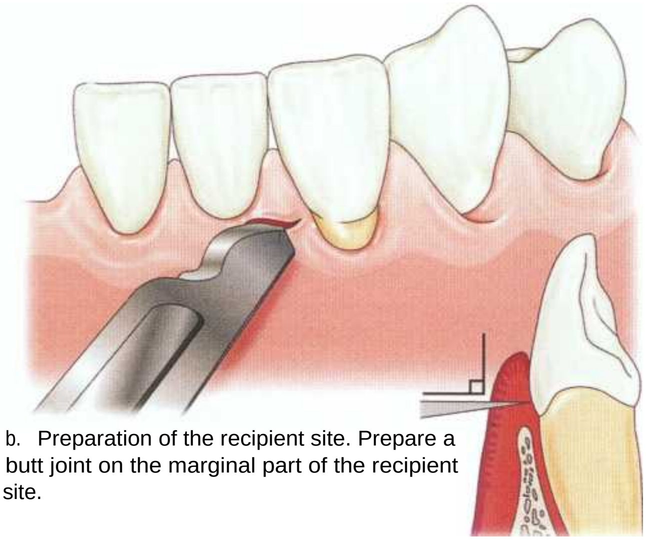
Disadvantages

1. Method with poorest ability to provide blood supply to the graft for root coverage.
2. Because a large and thick graft is necessary, a deep and large wound is exposed on the palatal mucosa (donor tissue). Various problems may occur, such as difficulty achieving hemostasis and patient pain and discomfort due to slow healing (healing by secondary intention).
3. Scarring occurs with wound healing, therefore, esthetic results may be inferior to other methods.
4. Surgery is required in two areas.

Fig 6-11 Root coverage using free autogenous gingival grafts.

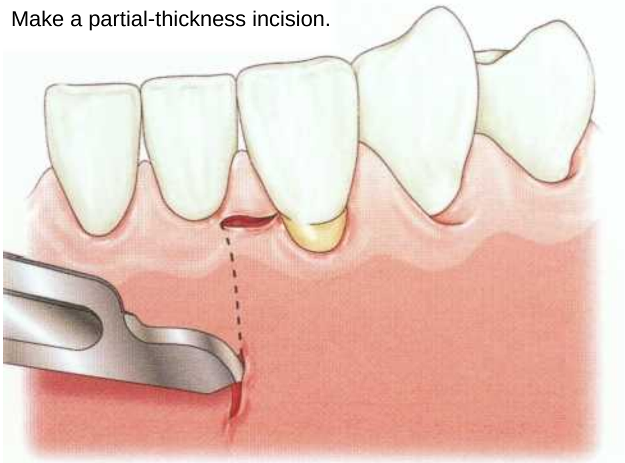


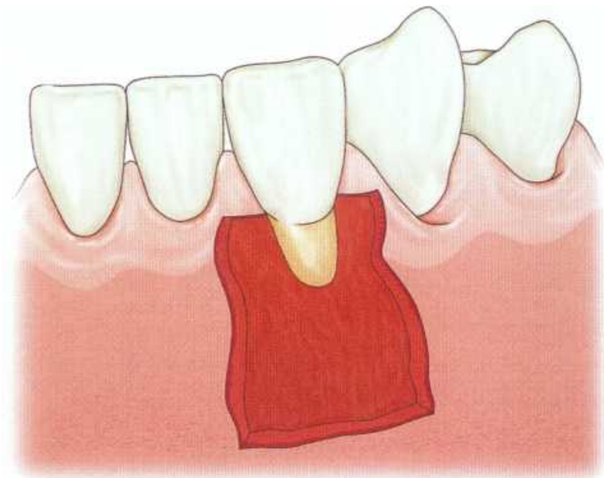
a. Design of the recipient site.
- Extend one tooth bilaterally.
- Make a horizontal incision at the level of the CEJ.
- The outline is trapezoidal (broader at the base).



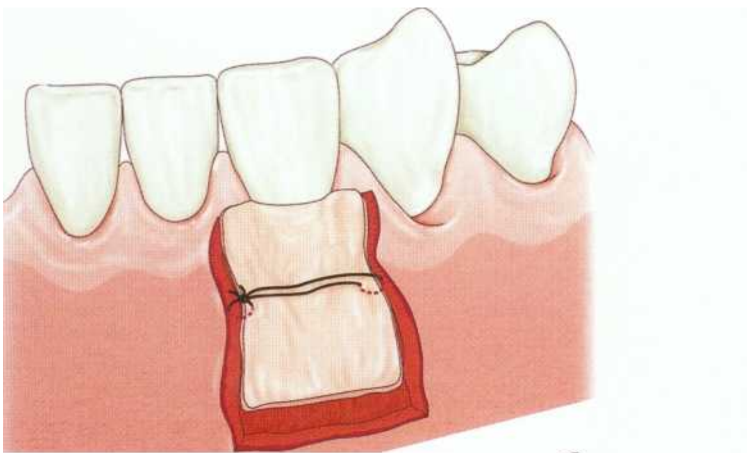
b. Preparation of the recipient site. Prepare a butt joint on the marginal part of the recipient site.

c. Make a partial-thickness incision.



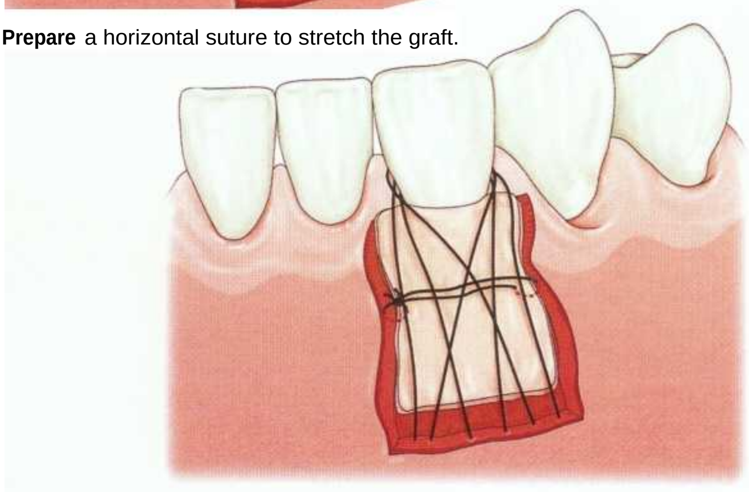


d. Complete recipient site preparation.
- Nonmobile periosteum-connective tissue site.
- Prepare recipient site 3-5 mm or more apical to the most apical part of the exposed root.



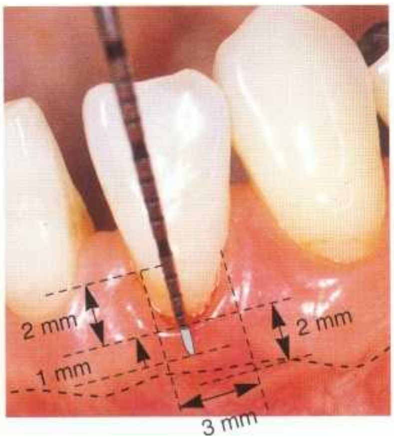
e. Prepare a horizontal suture to stretch the graft.

f. Make a circumferential suture.



g. Make an interdental concavity suture. The ligature of the suture is made on the lingual aspect.

Case 6-4 Root coverage using free autogenous gingival grafts 23



Class I gingival recession.

Note the gingival recession 2 mm apical to the CEJ on 23. Marked root exposure was not observed 7 and 8 years ago (8 years ago, left; 7 years ago, right).

36-year-old woman.

Reshaping of the root surface and preparation of the recipient site

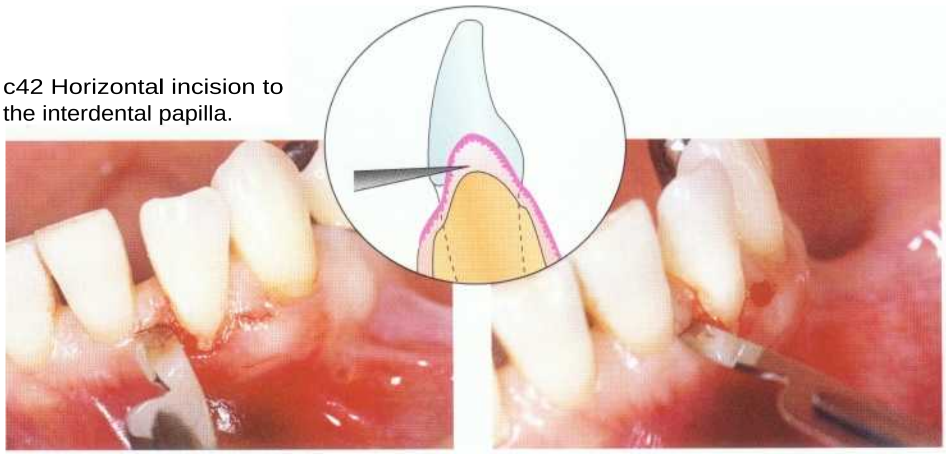
c4-1 Root planing.

a. A curette and bur are used for thorough root planing.

b. The convex curvature of the root is corrected and the root surface recontoured.

c. After root planing.

c42 Horizontal incision to the interdental papilla.



a. It is necessary to prepare the recipient site such that sufficient blood supply is preserved. A no. 15 blade is used to make a horizontal incision to the interdental papilla at the level of the CEJ. (If root coverage to the CEJ is impossible, the horizontal incision is made at the level where the root coverage is expected.) The horizontal incision is extended at least 3 mm to the line angle of the adjacent teeth bilaterally.

b. A vertical incision is made mesiodistally so that the outline of the recipient site is trapezoidal.

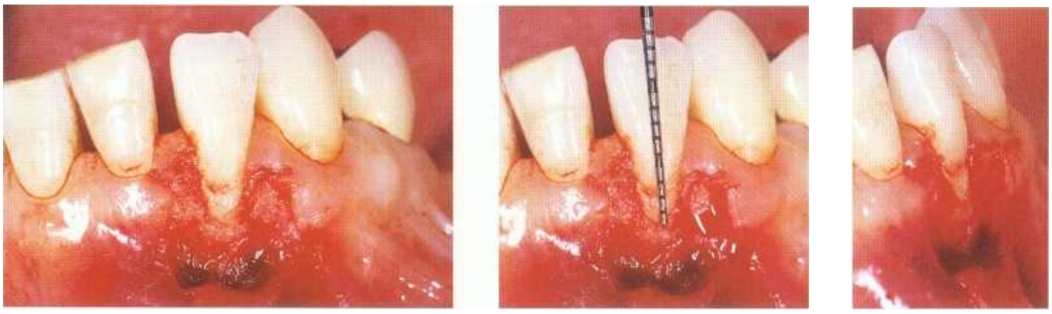
c43 Partial-thickness incision.

a. A vertical incision is made to make a butt joint at the recipient site margin of the coronal side. It is extended about 5 mm apical to the gingival margin of the exposed root.

b. The recipient site, which consists of non-mobile periosteum-connective tissue, is gently prepared and a partial-thickness incision made.

Key point

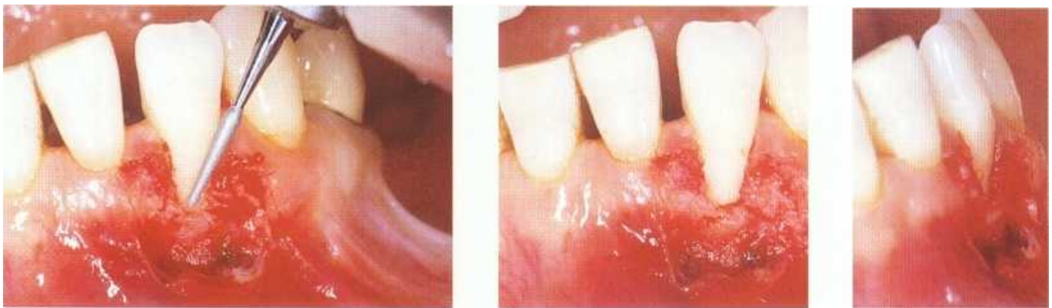
Prepare the recipient site 3-5 mm or more apical to the most apical part of the bone of the exposed root. This ensures sufficient keratinized gingiva apical to the recessive area for root coverage.



c. Scissors and a blade are used for preparation of the recipient site. The reflected partial-thickness flap is removed. Note the 3.5-mm osseous dehiscence apical to the CEJ.

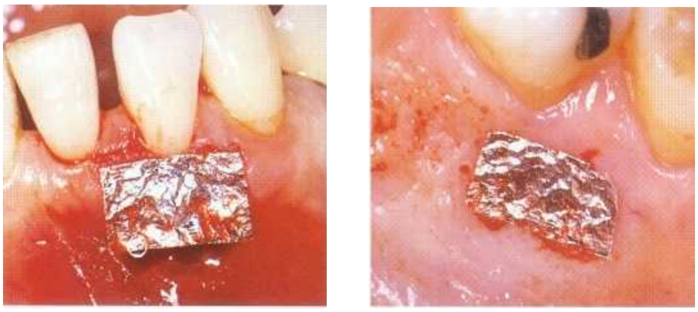
Key point

Providing a butt joint at the marginal area of the recipient site and contouring the root surface facilitate graft adaptation and suture. Consequently, sufficient blood supply to the graft is obtained.

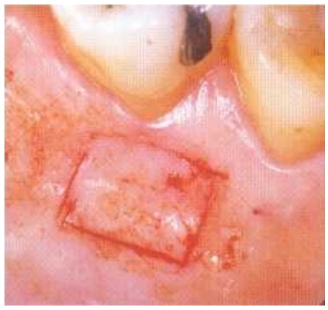


d. .A root planing bur is used to restore the root surface so that it is at the same level as the adjacent alveolar b one (from the CEJ to the bone crest).

c44 Harvesting of the graft.



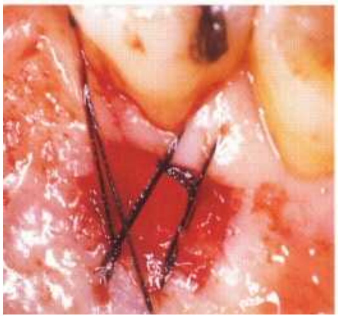
***a.* Tinfoil is placed over the recipient site to determine the size.** The tin-**foil** is then **placed over the palatal area.**



b. An incision is made to the palatal tissue with a depth of about 2 mm. The incision should be about 1 mm l**arger than the outline of the tinfoil to accommodate graft shrinkage.**

c. Small tissue pliers are used to lift the graft's edge. The graft is separated along the outline and a uniform-thickness graft (about 2 mm) is harvested.

Key point
Optimally, the graft has a uniform thickness of about 2 mm. The graft edge should be perpendicular to the recipient site with the butt joint. The graft edge should never be incised obliquely.



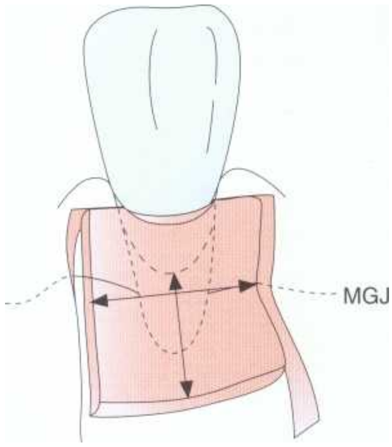
d. After harvest, the donor site is immediately sutured and an absorbable hemostat gauze is placed.

e. The harvested graft is placed onto a gauze soaked with physiologic saline solution. The thickness of the adipose tissue and glandular tissue is checked.

f. The graft thickness necessary for root coverage is 1.5-2.5 mm.

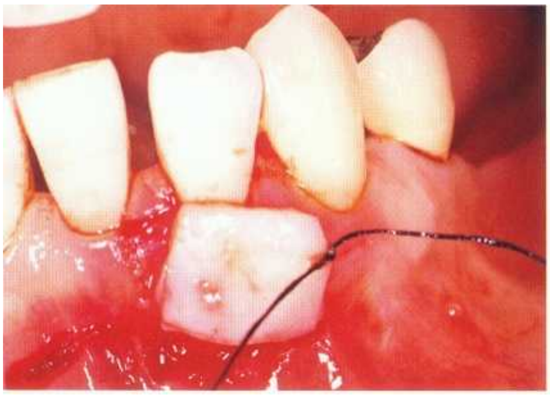
c4-5 Graft tried to the recipient site.

Key point
The graft should extend 3-5 nun apical to the margin of the exposed root.

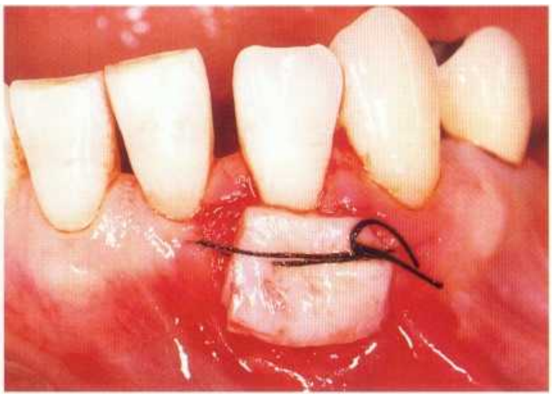


Suture of graft

c4-6 Horizontal suture.



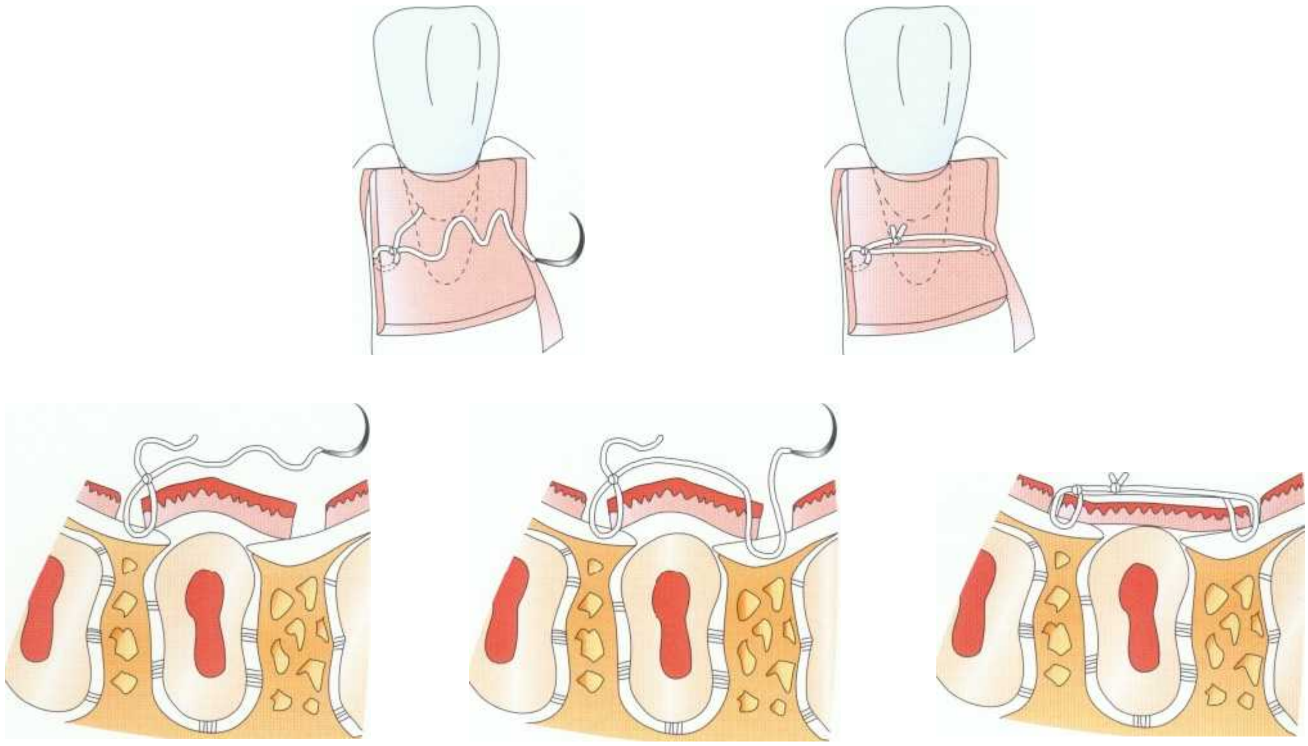
a. A periosteal suture is made with 5.0 suture thread on the distal edge of the recipient site flap.



b. The thread is brought across the graft to the mesial aspect without cutting. A periosteal suture is made through the periosteal bed, mesial to the margin of the graft. The graft is stretched and the mesial edge sutured. The graft is thus extended 2-3 mm.

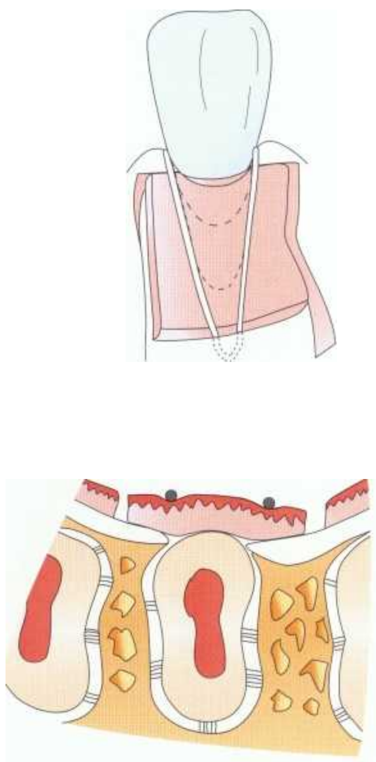
Key point
It is difficult to properly adapt a thick graft (1.5-2.5 mm) to a recipient site for root coverage, especially where there is interdental collapse or remarkable curvature mesiodistally. Using the suture technique of Holbrook and Ochsenbein :' makes graft adaptation to the exposed root more reliable.

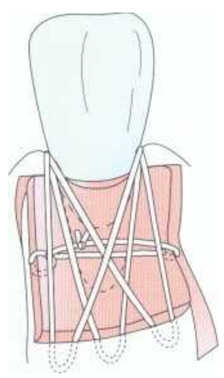
Fig 6-12 Suture technique of Holbrook and Ochsenbein.



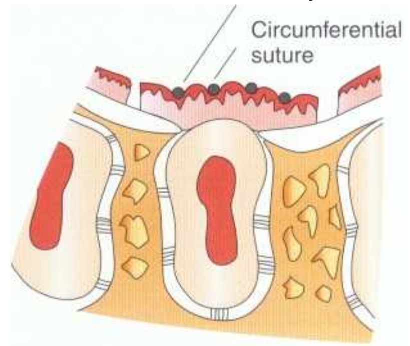
Horizontal suture

After making the ligature, pass the needle through the body of the graft and pull it out from the bottom without cutting the thread. Engage the periosteum 2-3 mm from the mesial edge of the flap. Leave a slack in the suture. Last, make a ligature and stretch to eliminate the sag. Stretching prevents primary shrinkage of the graft (primary contraction) and regenerates graft vascularity.





Interdental concavity suture

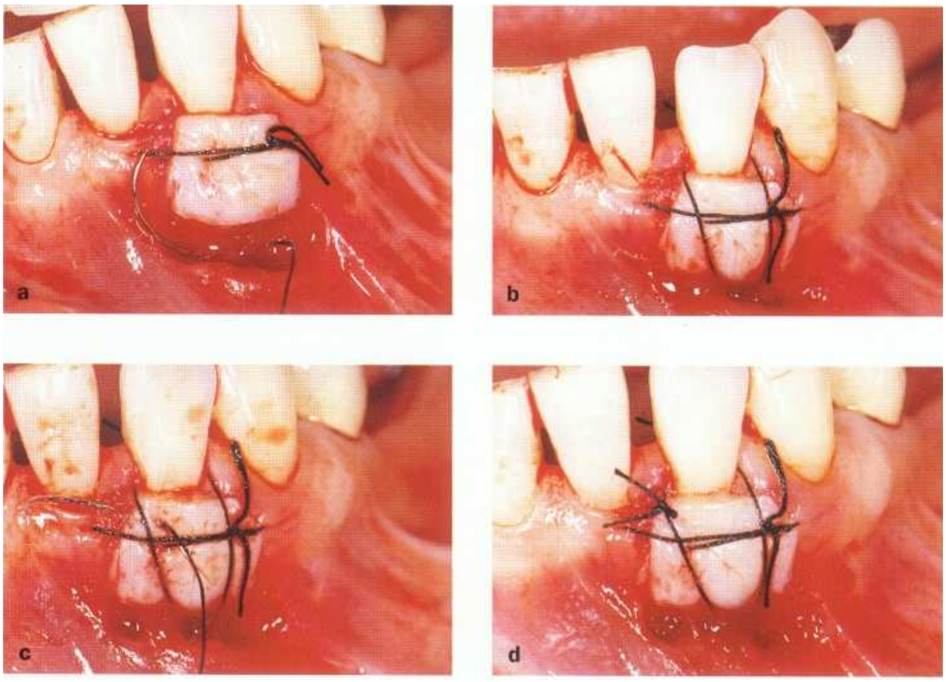


Circumferential suture

Insertthe needle in the periosteum of the recipient site slightly apical to the bottom edge of the graft. Carry the suture around the cervical area and tie it to the tail on the lingual aspect. The thread presses the graft at the border of the exposed root (dotted line).

Interdental concavity suture

Insert the needle in the periosteum at the bottom of the interdental concavity area. Circle the needle around the tooth, suture the graft diagonally, make a sling, and make a ligature on the lingual aspect. Perform the same procedure in the other Interdental area.

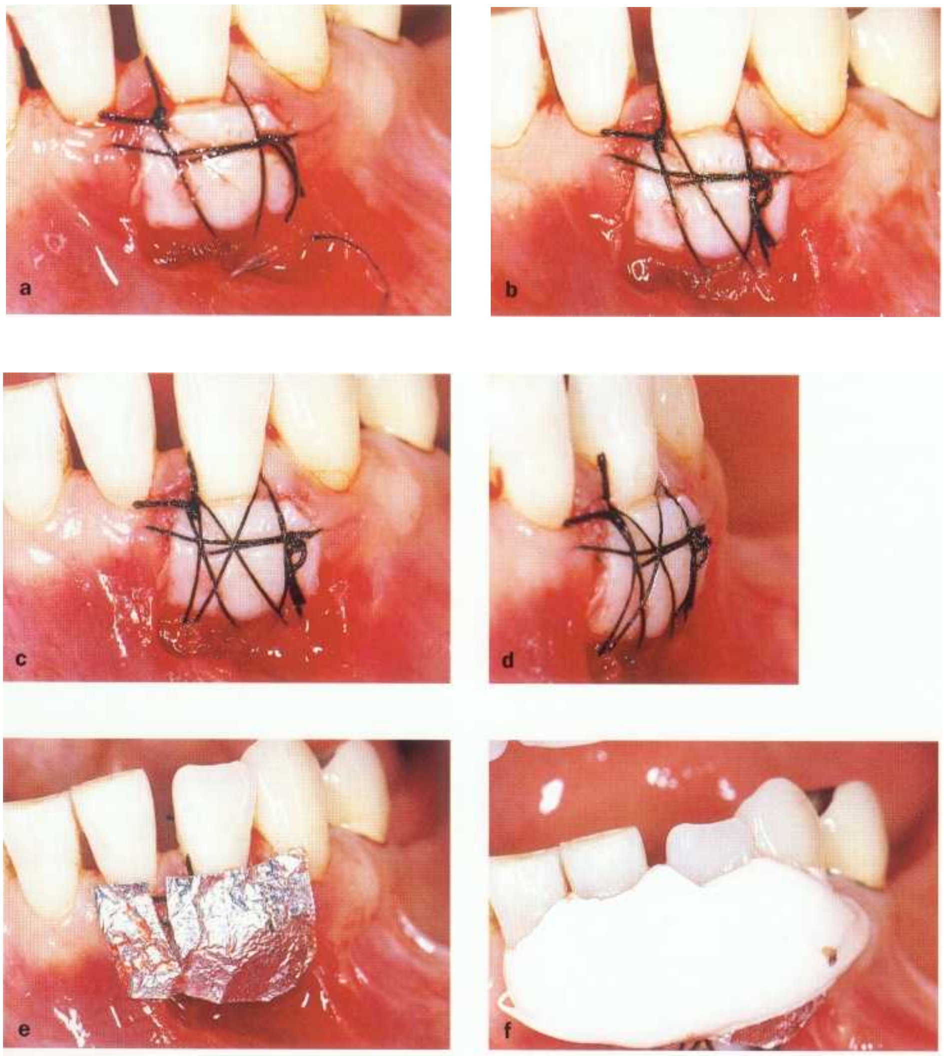


c47 Circumferential suture. A circumferential mattress suture is **made to avoid dead space in the marginal area of the** exposed tooth. This enables the graft to make contact with the root surface and periodontal membrane.

a. A horizontal suture is made through the apical periosteum from the bottom edge of the graft.

b. The cervical area is surrounded and a sling made. A ligature is then made on the lingual aspect.

c, d. In this case, an interrupted suture is added on the mesiocoronal part of the graft for better adaptation of the graft on the coronal side.



c48 Interdentat concavity suture.

a. A horizontal suture is made on the recipient site in the mesial interdental concavity area under the graft. This is done to prevent dead space in the interdental concavity area and for better adaptation of the graft to this area.

b. The cervical area is surrounded and a sling made. A ligature is then made on the lingual aspect. The same suture is made on the distal aspect.

c. Note the close adaptation of the graft to the root surface and recipient site.

d. In the interdental papilla area, the graft is in close contact with the butt **joint.**

e, f. Gauze soaked in physiologic saline solution is pressed on the site for about 5 minutes. Tinfoil is placed over the graft to prevent the thread from entering the periodontal dressing before the periodontal dressing is placed.

Prognosis

c49 **Prognosis.**

a. The periodontal dressing and suture thread are removed 13 days after surgery, and the patient is instructed to gargle. Subsequently, the patient may brush gently with an ultrasoft brush using the rolling method.

b. Three weeks after surgery.

c. Five weeks after surgery.

d. Eight weeks after surgery.

e. Nine months after surgery.

Connective Tissue Grafts

Langer and Langer introduced the use of subepithelial connective tissue grafts for root coverage. Root coverage was thought to be difficult to achieve in wide and deep gingival recession areas or in an adjacent gingival recession area with multiple teeth, but results were satisfactory with this technique.

Table 6-13 Results of Studies on Root Coverage Using Connective Tissue Grafts

	Procedure	Number of teeth	Months of observation	Preoperative gingival recession (mm)	Postoperative gingival recession (mm)	Average root coverage (%)
Raetzke[25]	Envelope flap and connective tissue grafts	10 patients 12 teeth	2–8	3.29 mm (2–5.0) mm	0.67 mm (0.0–2.0) mm	80% 5 teeth, 100% 7 teeth, 60–80%
Nelson[26]	Subpedicle connective tissue grafts	14 patients 29 teeth	6–42	6 teeth Slight (1–3 mm) 3 teeth Moderate (4–6 mm) 20 teeth Advanced (7–10 mm)		100% 92% 88% Average 91% Complete root coverage 50% of advanced group 60% of moderate group
Levine[27]	Langer and Langer technique[24]	10 patients 21 teeth	3–30	3.86 mm		97.04% Complete root coverage 18 teeth
Harris[28]	Partial-thickness double pedicle grafts, connective tissue grafts, and tetracycline root conditioning	20 patients 30 teeth	3	3.6 mm (2–7 mm)	0.1 mm (0–1.5 mm)	97.4% Complete root coverage 24 teeth, 80%
Jahnke et al[29]	Thick free gingival grafts, connective tissue grafts, and citric acid root conditioning	9 patients 9 teeth	6	2.8 mm (2.0–3.5 mm)	0.6 mm (0–1.5 mm)	80% Complete root coverage 5 teeth
Allen[30]	Supraperiosteal envelope flap and connective tissue grafts	12 patients 23 teeth	6–48	12 teeth Slight (1–3 mm) 10 teeth Moderate (4–6 mm) 1 tooth Deep (7–10 mm)		95% 73% 75% Average 84%
Harris[31]	Partial-thickness double pedicle grafts, connective tissue grafts, and tetracycline root conditioning	74 patients 100 teeth		3.3 mm (2–7 mm)	0.1 mm (0–1.5 mm)	97.7% Complete root coverage 89 teeth
Bouchard et al[32]	Langer and Langer technique 1. With citric acid root conditioning, without epithelial collar connective tissue grafts (CR group)	15 patients 15 teeth	6	4.20 mm	1.27 mm	70%
	2. Without root conditioning, with epithelial collar connective tissue grafts (CTG group)	15 patients 15 teeth	6	4.53 mm	1.60 mm	65% Average 69.2% Complete root coverage CR group, 3 teeth CTG group, 5 teeth
Borghetti and Louise[33]	Subpedicle connective tissue grafts	15 patients 15 teeth	12	3.66 mm	1.09 mm	70.93% 6 teeth, 75%–100% 9 teeth, 50%–75%

Raetzke=' performed connective tissue grafting with the envelope flap and achieved, on average, 80% root coverage. Nelson" reported an average of 88% root coverage (height) in areas of extreme gingival recession using subepithelial connective tissue grafts. Harris[=fl,3'] examined Nelson's technique and confirmed the results (Table 6-13).

jahnke et al compared the use of gingival grafts and connective tissue grafts in the same patient and found that the amount of coverage and rate of complete coverage was better with the use of connective tissue grafts.

Root coverage using connective tissue grafts has a high success rate and is therefore frequently used (Case 6-5).

Table 6-14 Root Coverage Using Connective Tissue Grafts

Advantages

1. High predictability.
2. The graft receives abundant blood supply from both the inside of the flap and the periosteum-connective tissue.
3. Wound closed at palatal donor site after harvest of connective tissue graft. Therefore, hemostasis is easy and healing is rapid. There is also less discomfort and pain during healing.
4. The graft fits the surrounding tissue on the recipient site, therefore, results are esthetically pleasing.
5. Applicable for gingival recession on multiple teeth.

Disadvantages

1. Technically demanding.
2. Because a thick graft is used, the grafted tissue is thick. Gingivoplasty may be necessary postoperatively to obtain better morphology.

Indications

Root coverage necessary in the gingival recession area.

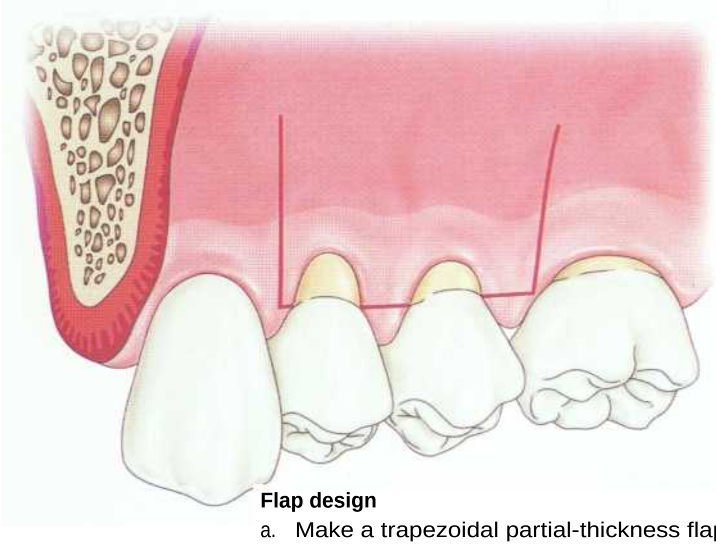
Contraindications

Inadequate thickness of donor tissue. The necessary thickness of the connective tissue graft for root coverage is 1.5-2.0 mm, and the thickness of the palatal flap should be 1.5-2.0 mm after graft harvest to prevent necrosis. Therefore, at least 3-mm thickness is necessary in the palatal soft tissue of the donor site.

Table 6-15 Causes of Failure of Connective Tissue Grafts[34]

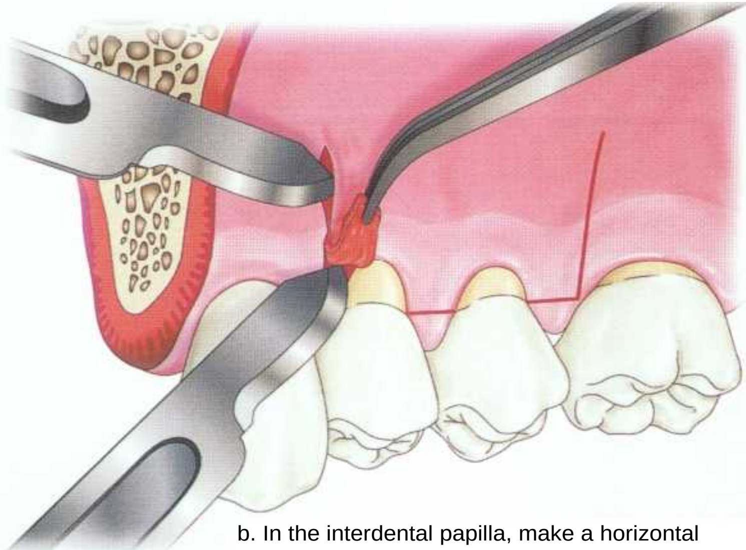
1. Insufficient height of interdental bone and soft tissue.
2. Horizontal incision placed apical to the CEJ.
3. Reflection of all interdental papilla.
4. Flap penetration.
5. Inadequate root planing.
6. Insufficient blood supply from surrounding tissue due to inadequate recipient site preparation.
7. Connective tissue graft too small.
8. Connective tissue graft too thick.
9. Connective tissue graft inadequate for root coverage and coronal placement.
10. Insufficient coronal migration of flap covering the graft.

Fig 6-13 Root coverage using subepithelial connective tissue grafts.

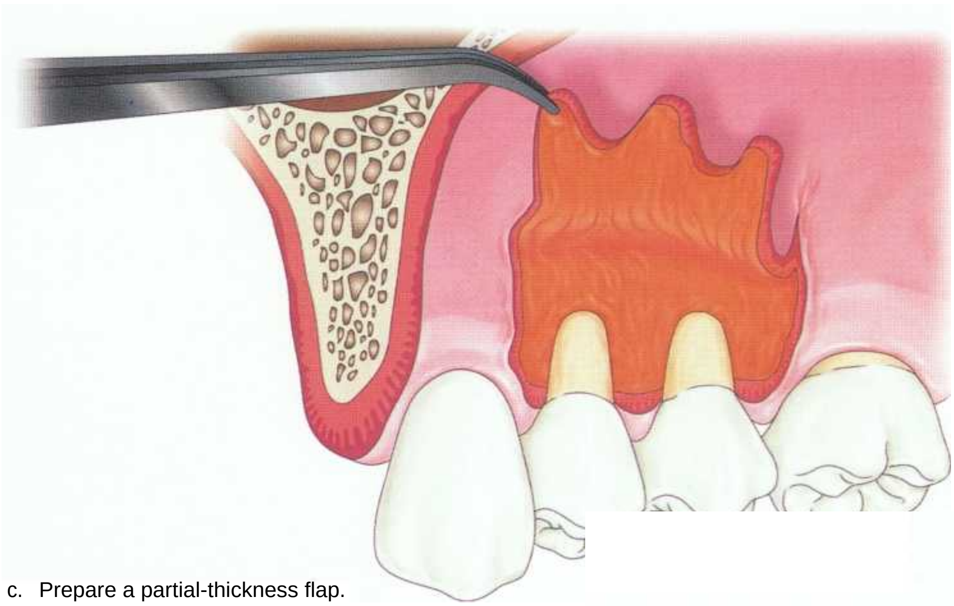


Flap design

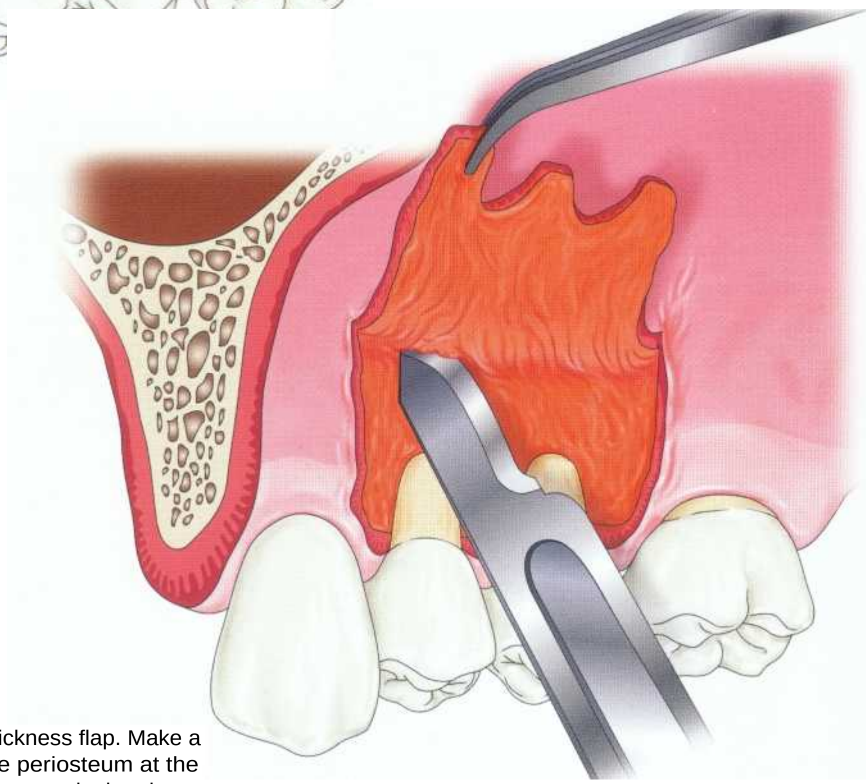
a. Make a trapezoidal partial-thickness flap with two vertical incisions mesiodistally. Vertical incisions should be at least 0.5 mm from the gingival margin of the adjacent teeth.



b. In the interdental papilla, make a horizontal incision at the CEJ or slightly coronal to it.



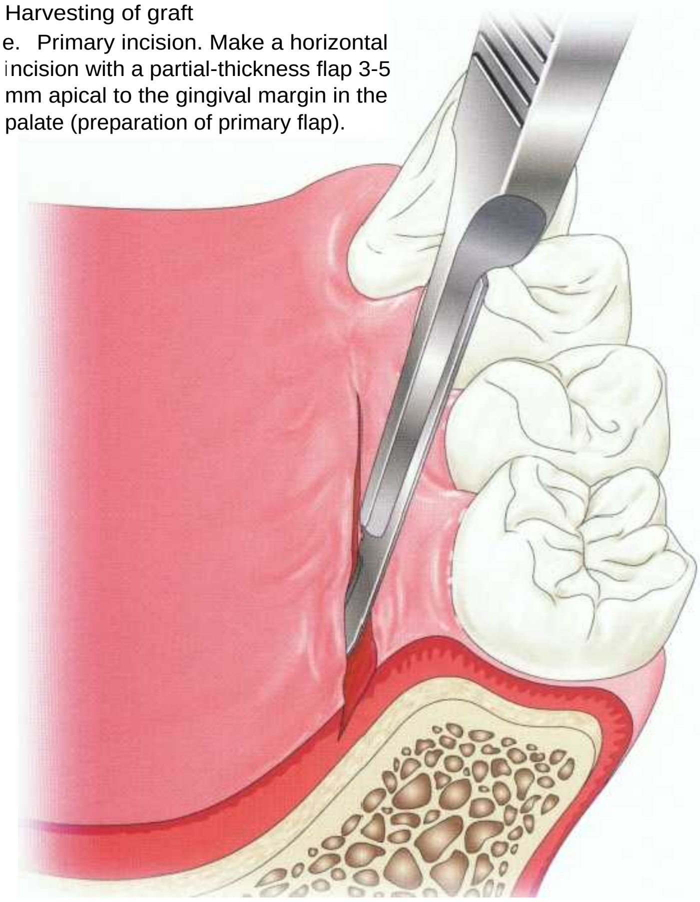
c. Prepare a partial-thickness flap.



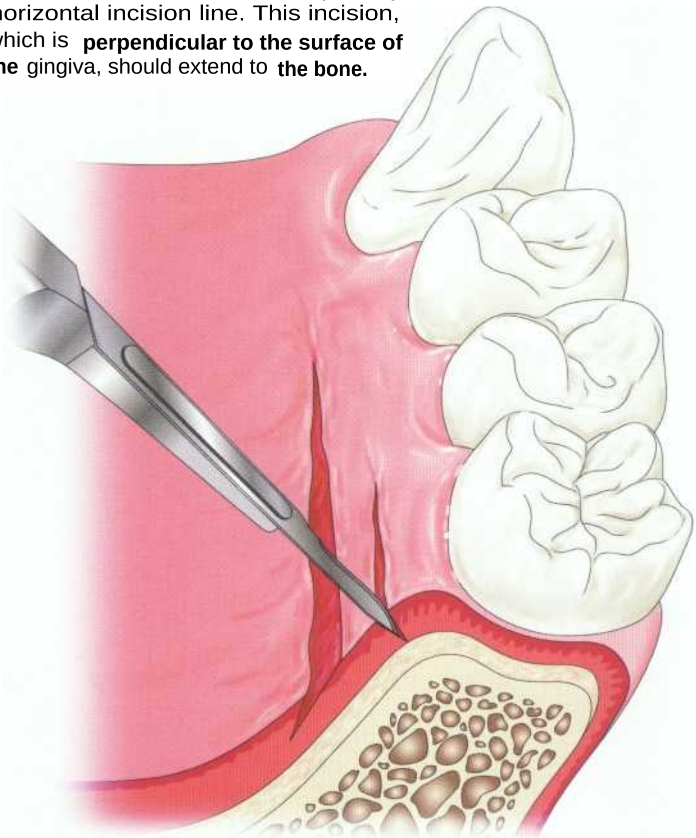
d. Reflect the partial-thickness flap. Make a releasing incision of the periosteum at the base of the flap for easy coronal migration.

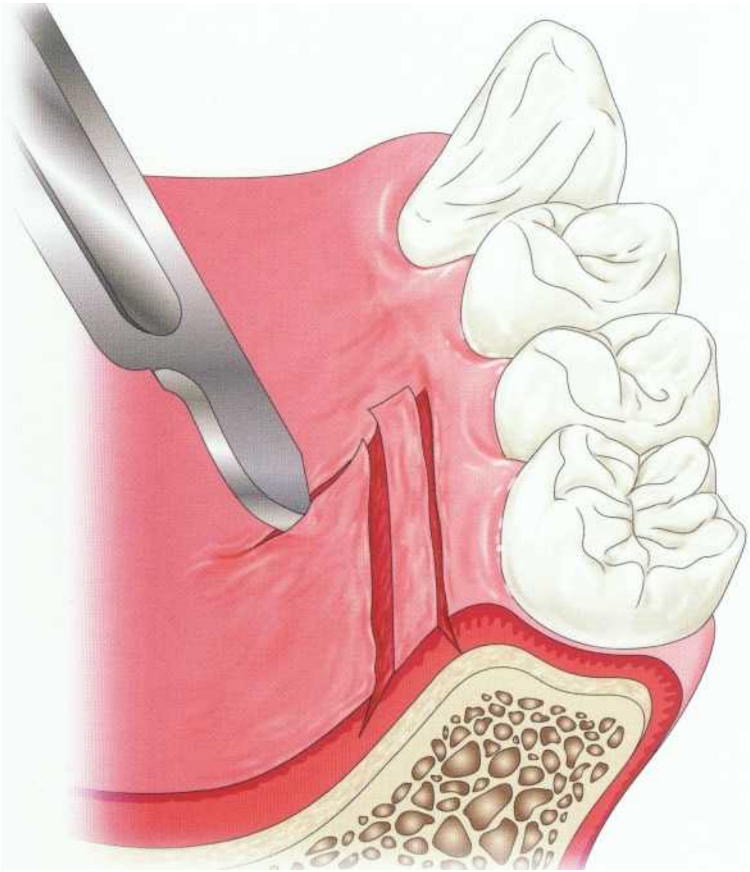
Harvesting of graft

e. Primary incision. Make a horizontal incision with a partial-thickness flap 3-5 mm apical to the gingival margin in the palate (preparation of primary flap).

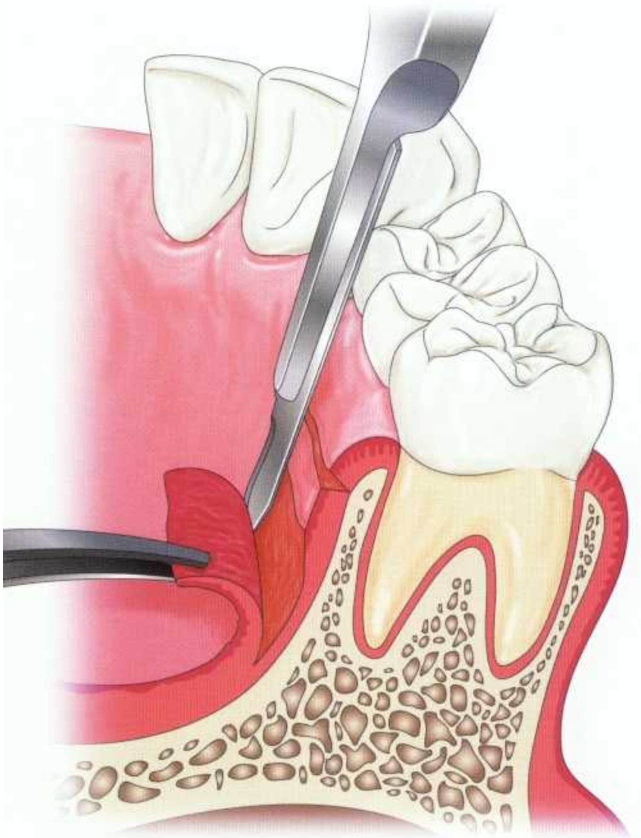


f. Secondary incision. Make a secondary incision 1-2 mm coronal to the primary horizontal incision line. This incision, which is **perpendicular to the surface of the** gingiva, should extend to **the bone.**



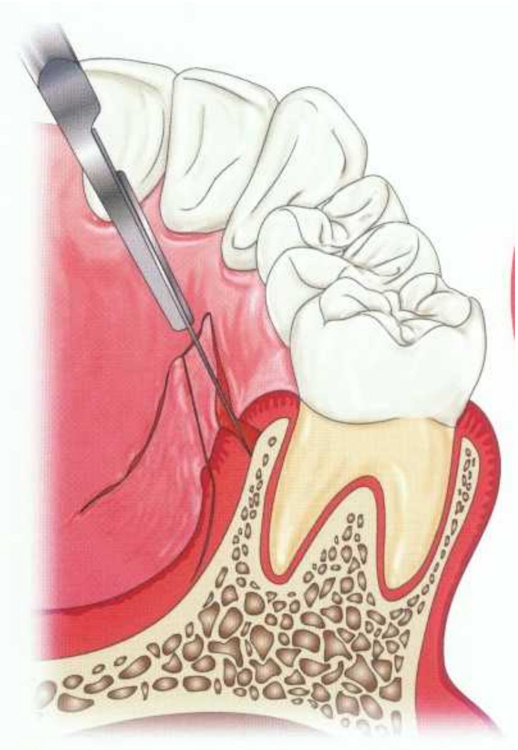


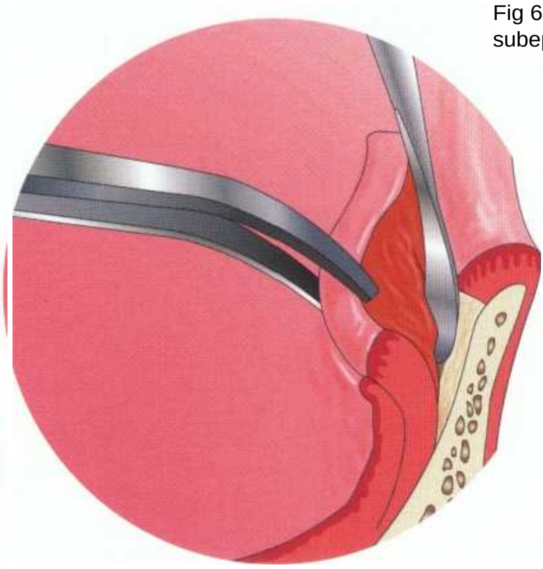
g. Make a vertical incision mesiodistally approximating the width and length of the necessary graft.



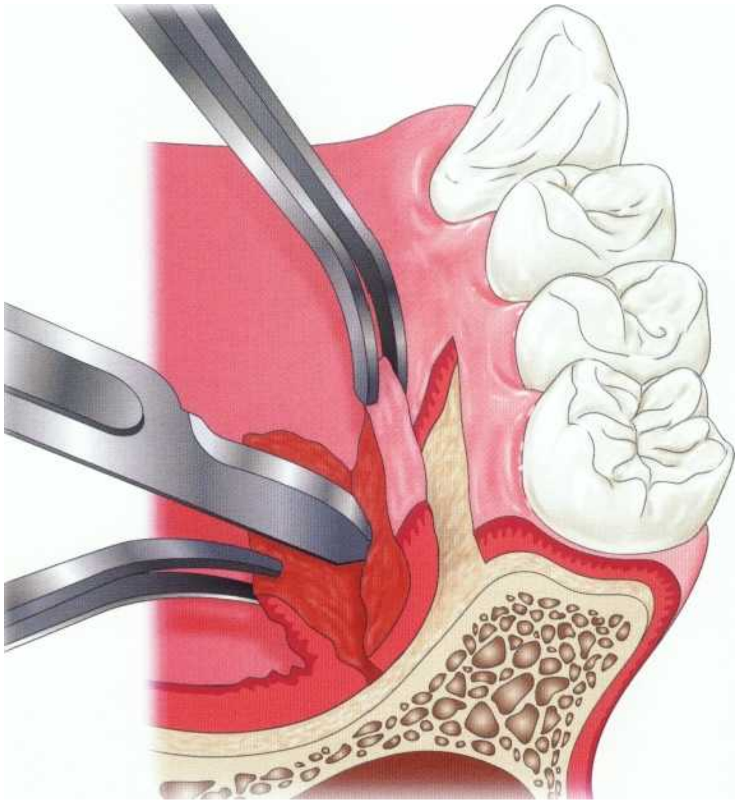
h. Prepare a primary partial-thickness flap (1.5-mm thick) toward the center of the palate, parallel to the palatal gingiva. Expose the underlying connective tissue.

Fig 6-13 **(continued) Root coverage using** subepithelial connective tissue grafts.

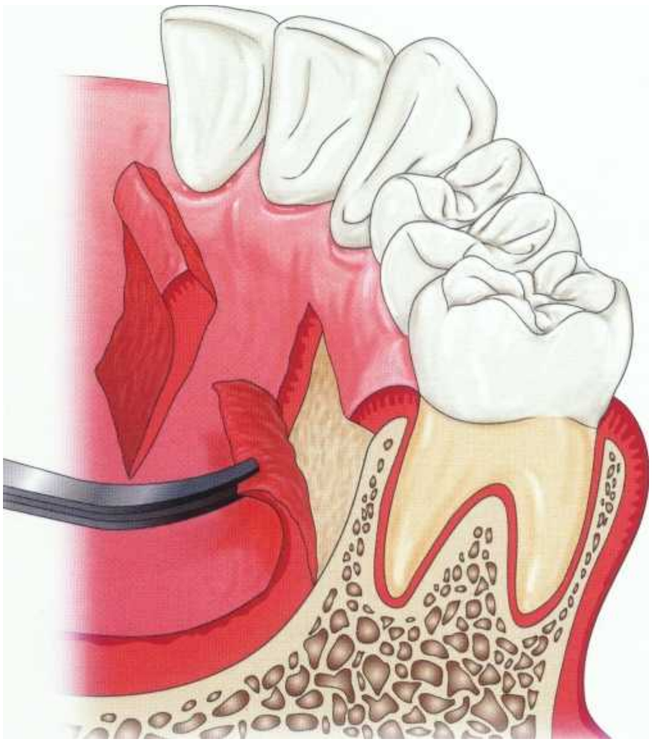


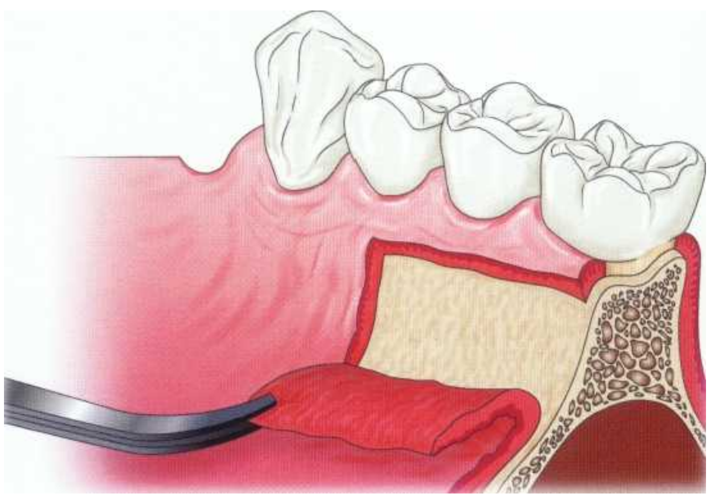


i. For the secondary incision, the blade contacts the bone. Use a small periosteal elevator or Kirkland $^{15}/_{16}$ knife to reflect the connective tissue graft, bringing it toward the center of the palate.

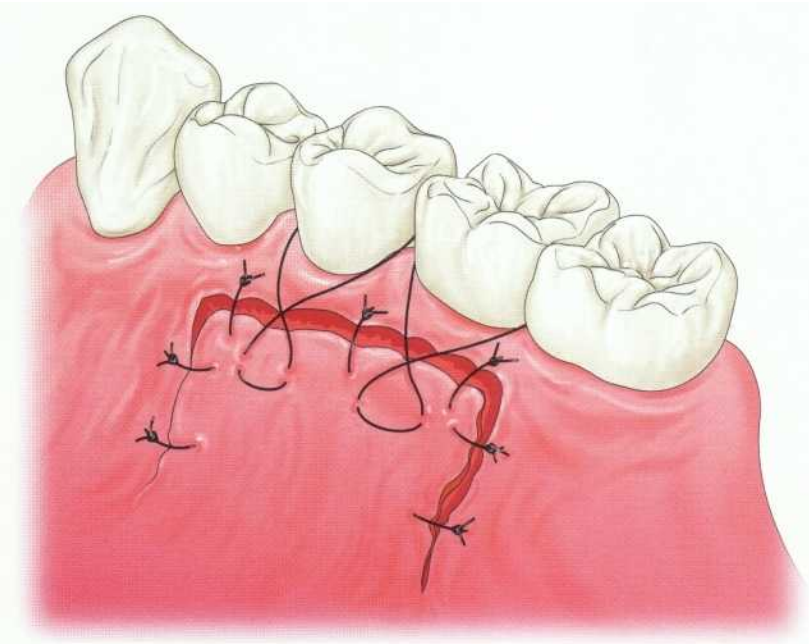


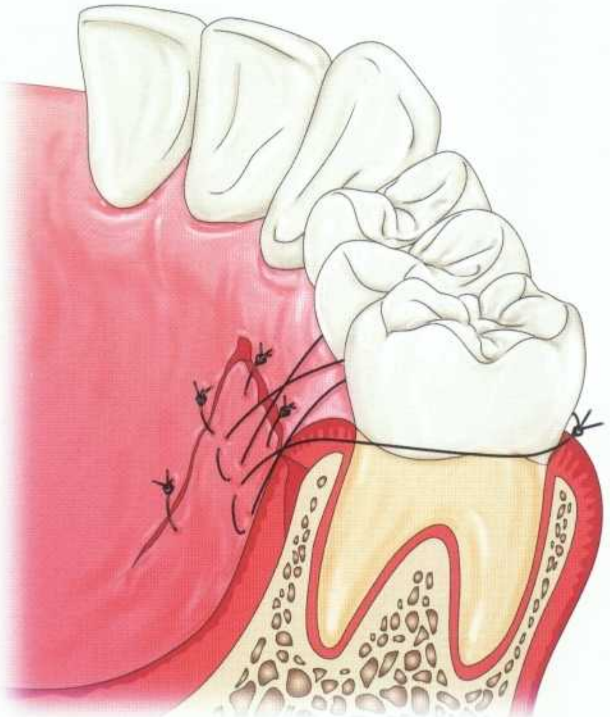
j. Extend the base of the primary incision to the bone. Separate the connective tissue graft from the bone.



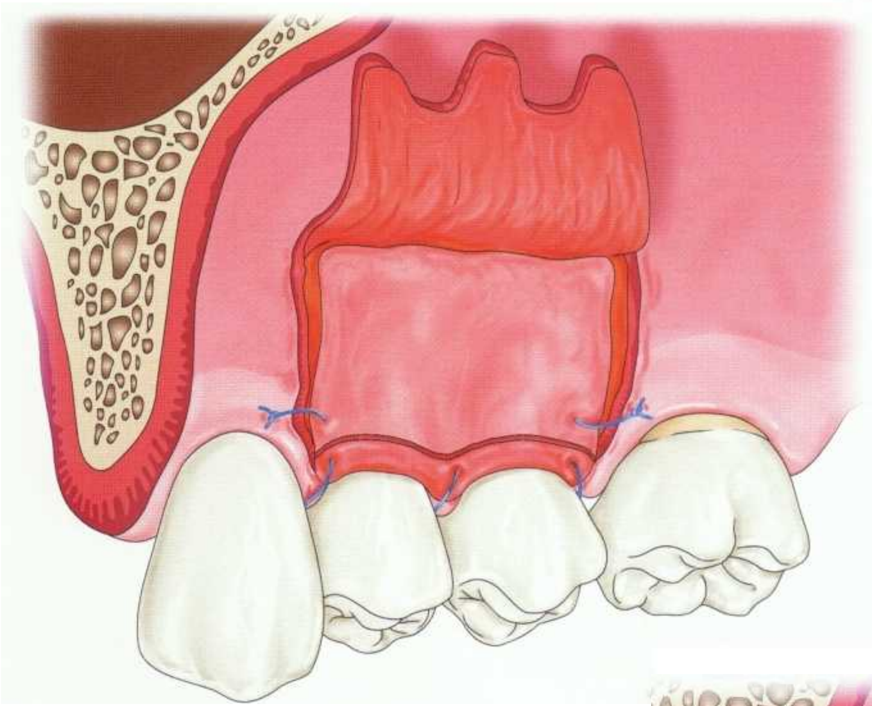


k. After harvesting of the connective tissue graft, the bone surface is exposed.

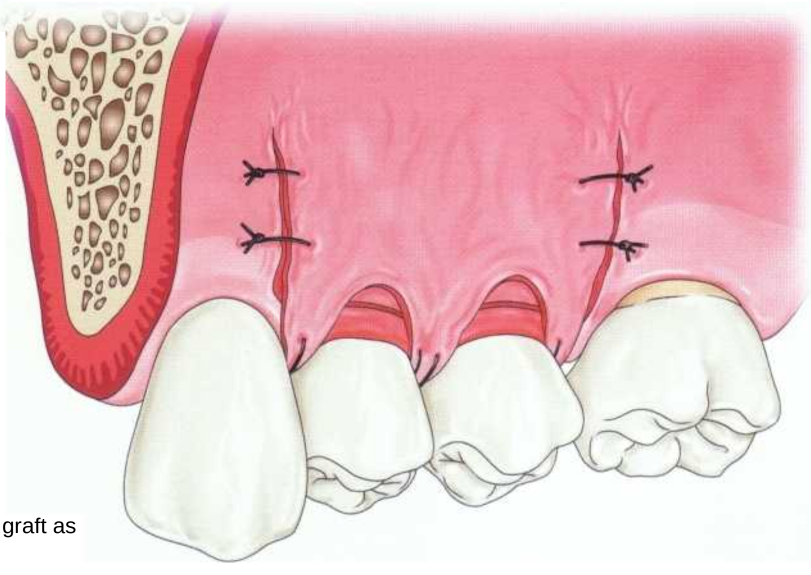




l. Suture the primary flap. Close the wound with an interrupted suture and a cross horizontal sling suture.

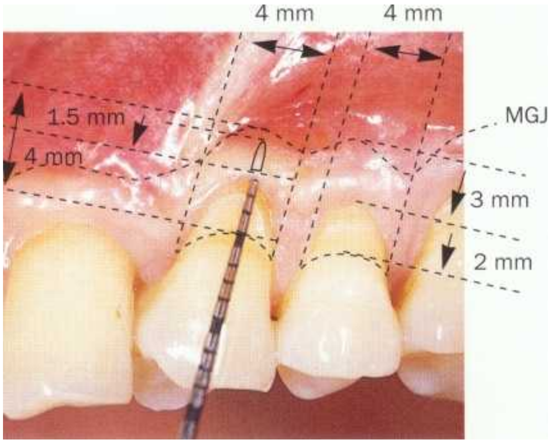


m. In subepithelial connective tissue grafts, place the thin border of the epithelium, left on the marginal area of graft, coronal to the CEJ. Make an interrupted suture in the interdental papilla with resorbable suture material and then stabilize the graft.



n. Displace the flap coronally, covering the graft as much as possible, and suture.

Case 6-5 Root coverage using subepithelial connective tissue grafts"

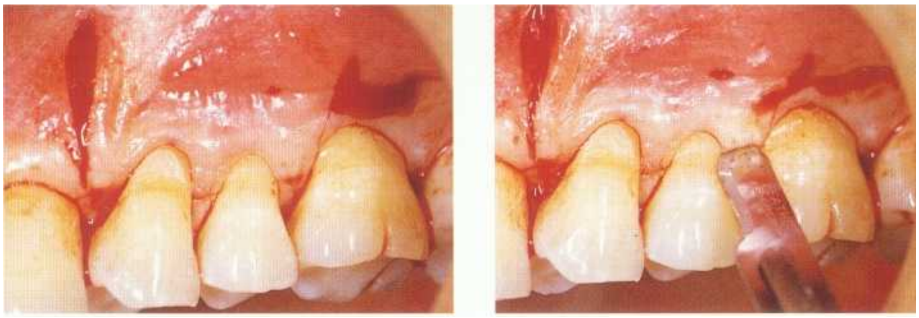


Class I gingival recession.

Note the gingival recession on 12 (4 mm) and 13 (2 mm). The patient reported hypersensitivity to cold water and on toothbrush ing (56-year-old man).

Preparation of recipient site

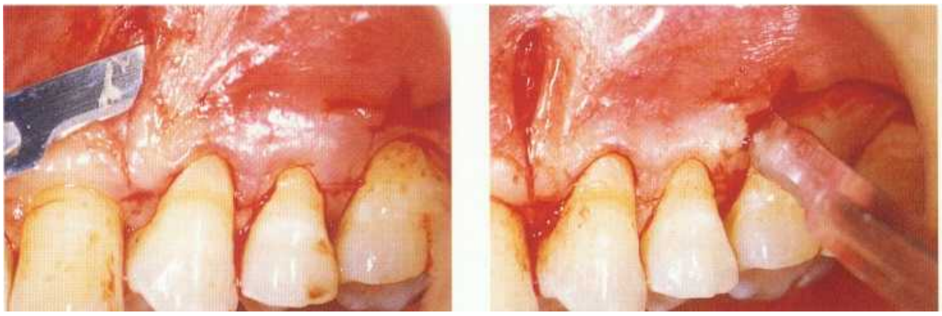
c5-1 Preparation of trapezoidal partial-thickness flap.



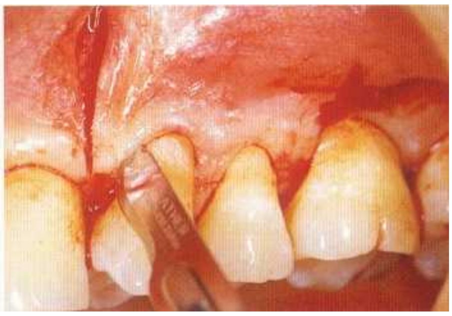
a. The tip of a no. 15 blade is used to make a partial-thickness horizontal incision in the interdental papilla area. The desirable position is on the CEJ or slightly coronally.

Key point

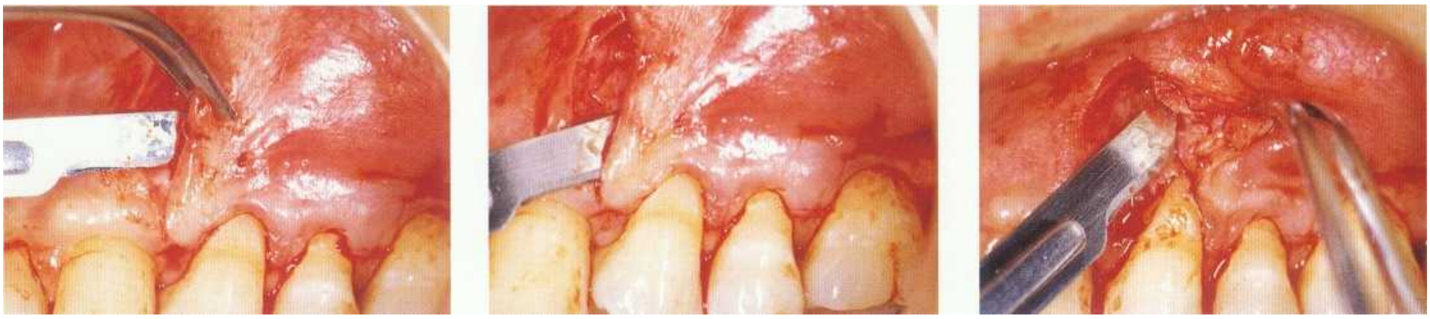
Do not make a horizontal incision apical to the CEJ because the position of the horizontal incision determines the position of the root coverage. While manipulating the incision, preserve the interdental papillary epithelium completely without damage. Where the mesial and distal interdental papilla is narrow, use a no. 15 C or no. 12 B instead of a no. 15 blade for a narrower tip.



b. Two vertical incisions are made mesiodistally 3 mm from the gingival recession area. The vertical incisions should be extended apical to the mucogingival junction and the incision outline broader at the base (trapezoidal).

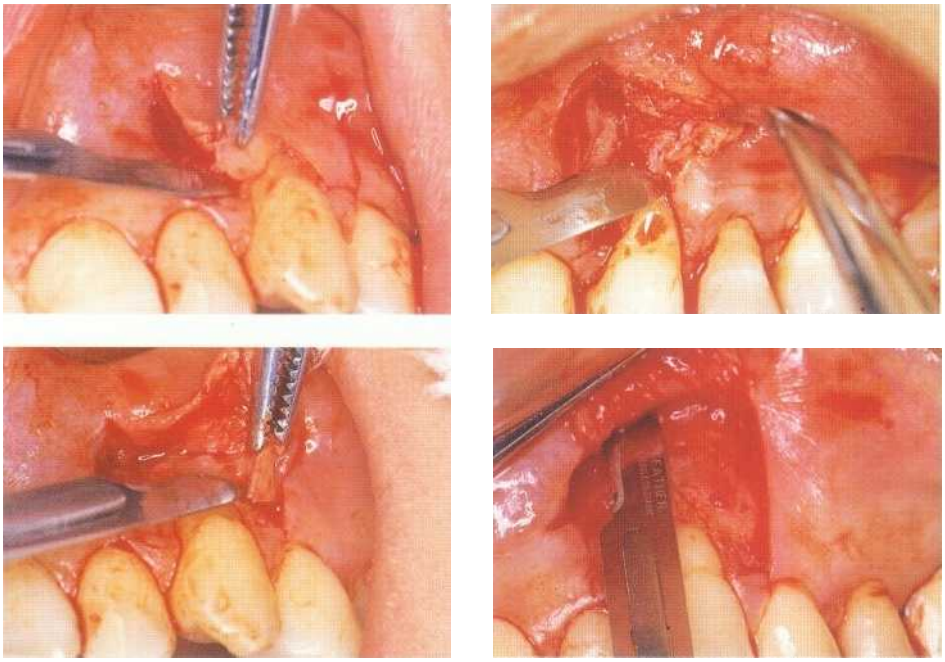


c. A sulcular incision is made in the gingival recession area and connected to the vertical incisions and horizontal incision.



d. A no. 15 blade tip is inserted coronally. The flap's edge is held and pulled with small tissue pliers to prepare a partial-thickness flap while the blade tip is gently moved coronally. In the incision, the side of the blade is used to make contact with the bone to prevent flap penetration.

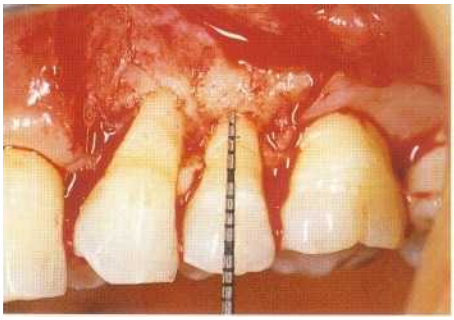
c5-2 Preparation of partial-thickness flap (different patient). After the partial-thickness incision to the coronal margin is completed, tissue pliers are used to liftthe coronal margin of the flap. The blade tip is turned apically while tension is applied to the flap to make a partial-thickness incision apically and slowly. The flap is then reflected gently. A partial-thickness incision is prepared beyond the mucogingival junction.



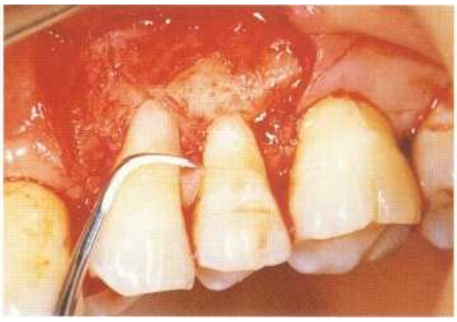
Key point

If there is a risk of flap penetration due to flap thinness, prepare a full-thickness flap and then a partial-thickness flap apical to the mucogingival junction. Extend the releasing incision of the periosteum to the alveolar mucosa for free coronal migration of the flap without tension. The partial-thickness flap should move freely apically Also, it is important to make the flap of uniform thickness.

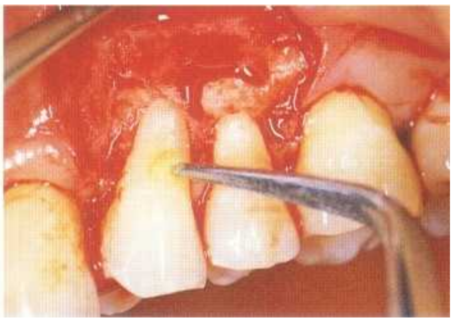
c5-3 Root planing.



a. Note the osseous dehiscence (6 mm on 12 and 3 mm on 13) from the CEJ to the bone crest on flap reflection.



b. Root planing.



c. The cotton pledget is changed every 30 seconds and 50 mg/mL of tetracycline is applied for 3 minutes.

Harvesting of graft

c5-4 Donor site selection.

a. Tinfoil is placed on the recipient site for measurement of the connective tissue graft.

b. Due to its characteristics, the palatal tissue from the canine to the mesial aspect of the first molar is suitable for the donor tissue because the connective tissue is thick and the vascularity abundant.

Key point

Always measure the thickness of the soft tissue at the donor site before harvest. The required graft thickness is 1.5-2.0 mm to prevent necrosis of the palatal flap left after harvest of the connective tissue. Therefore, a thickness of'3-4 mm is necessary in palatal soft tissue. If there is insufficient thickness, select another donor site or consider other methods, such as pedicle gingival grafts or GTR.

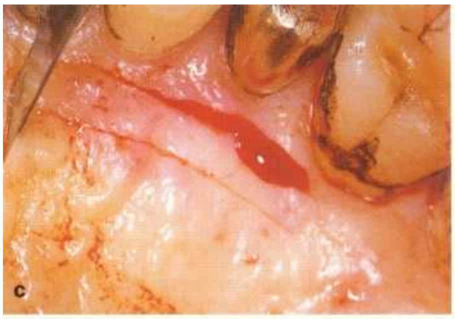
c5-5 Harvesting connective tissue graft procedures (note figures b, c, e, i-1, and n are a different patient).

a. Primary incision. A no. 15 blade is used to make a straight partial-thickness horizontal incision mesiodistally. Sufficient length for the graft is ensured with 3-5 mm separation from the gingival margin.

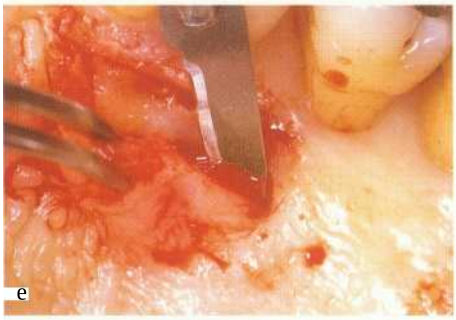
b. A secondary incision to the bone is prepared. This incision is made 1-2 mm coronal to the primary horizontal incision and perpendicular to the surface of the gingiva. A no. 15 blade is used first, then a Kirkland 15/16 blade is used to cut to the bone surface.

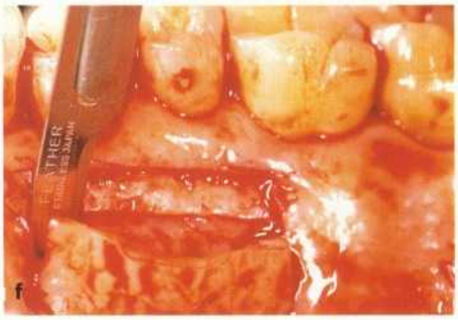
Key point

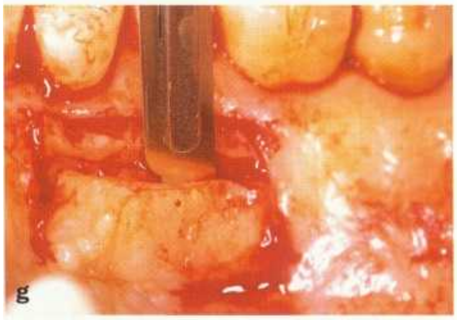
The horizontal incision is important because it becomes the starting point for the undermining partial-thickness palatal flap. Use a no. 15 blade tip to make a 2 mm incision depth. The thickness of the prepared primary flap should not be less than 1.5 mm.

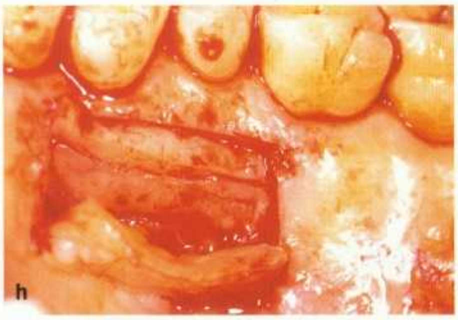


c, d. A vertical incision is made mesiodistally The position and length of the vertical incision are determined by the length and the width required for the graft.

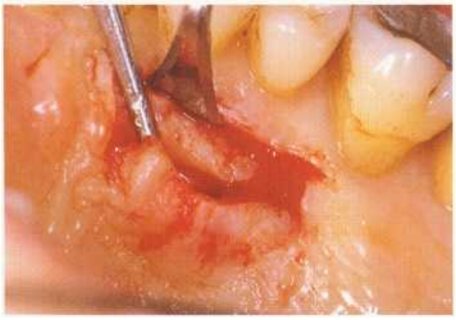


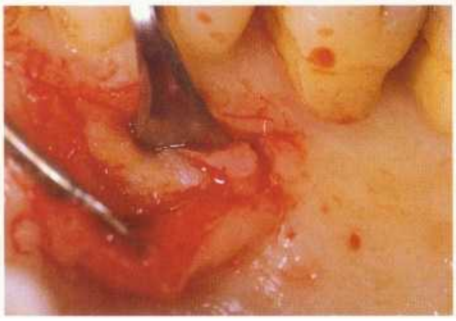






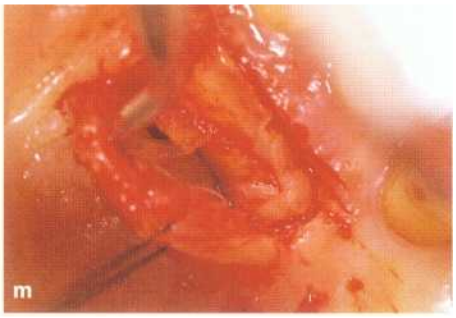
e-h. The edge of the primary flap is held with tissue pliers to expose the palatal connective tissue layer. The blade is advanced toward the center of the palate parallel to the palatal soft tissue. Care must be taken to avoid flap penetration. A partial-thickness flap is prepared with 1.5-2 mm thickness.



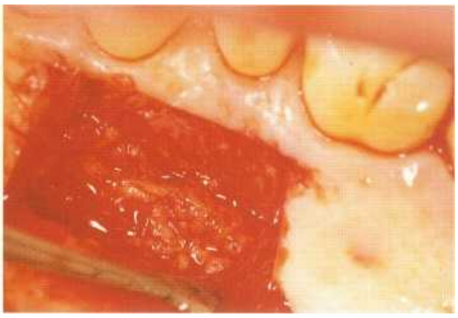


i, j. A small periosteal elevator (Molt bone curette z/ or wax spatula no. 7A are useful) or Kirkland 15/16 knife is inserted into the secondary incision area. A full-thickness periosteal connective tissue (donor connective tissue) is reflected from the bone gently. Care is taken to avoid damaging the graft.

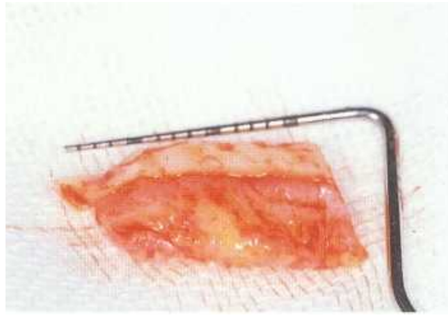
k. The edge of the reflected connective tissue is lifted gently with tissue pliers. A Kirkland 15/16 knife is used to reflect the tissue toward the center of the palate.



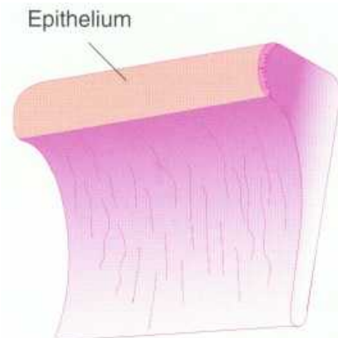
l, m. A no. 15 blade or Kirkland 15/16 knife is used to extend the base of the primary incision to the bone. The connective tissue graft is separated from the bone surface.



n, o. The graft is harvested from the bone surface.



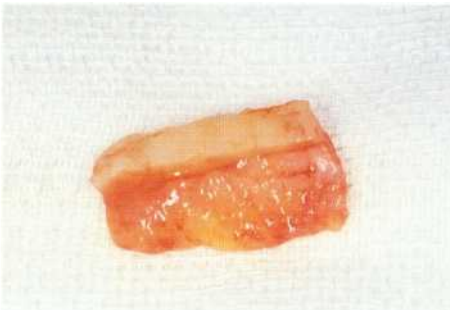
p. Epithelium (a few millimeters in width) is left on the edge of connective tissue graft to facilitate suture manipulation of the graft to the recipient site.

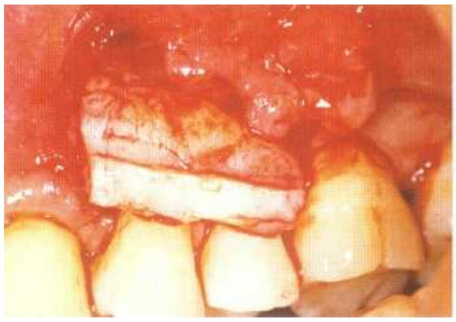


c5-6 Suture of donor site. The harvested graft is placed in physiologic saline solution and the palatal flap brought back, sutured, and the wound closed.

Graft suture

c5-7 Suture of donor tissue. The shape of the connective tissue graft is corrected according to the shape of the recipient site and adapted to the site.





Key point

Place the epithelium of the graft coronal to the CEJ to increase the amount of root coverage and to enhance esthetics.

c5-8 Flap suture.

a. An interrupted suture is made on the graft epithelium and interdental papilla with absorbable suture thread.

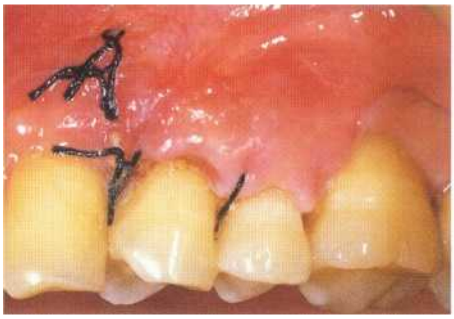
b. A suture is made to cover the graft with the flap as completely as possible.

Key point

There must be no flap tension when covering the graft. If there is tension, make a releasing incision of the periosteum to the base of the flap and place a periodontal dressing.

Prognosis

c5-9 After surgery. The periodontal dressing and suture material are removed 1 week after surgery. The patient may gargle and use an ultrasoft toothbrush in the surgical area for 6 weeks after surgery. Professional tooth cleaning is planned every week for 2 months, after which the patient may brush as usual.



a. Ten days after surgery.

b. Two weeks after surgery.

c. About 3 months after surgery.

d. Nine months after surgery.

e. One year and 4 months after surgery.

Modified Technique of Langer and Langer

The most important factor in flap preparation is maintaining its blood supply. Blood supply to the gingiva comes from the apical area, the interalveolar septum, and the external periosteum. Most of its nutritional supply depends on the blood supply via the external periosteum, which runs along the periosteum of the labiobuccal and linguopalatal gingiva and the external periosteum under the oral mucosa. Supply to the flap after reflection depends primarily on the bilateral surrounding gingival tissue (laterally) and oral mucosa (apically) in the surgical area, because the blood supply from the interalveolar septum and periodontal membrane is terminated.

The Langer and Langer technique requires a vertical incision to the flap, therefore reducing blood supply markedly. The envelope flap (modified flap), which is reflected without the vertical incision, is superior to the full flap with a vertical incision in this respect. Bruno modified the Langer and Langer technique to include a horizontal partial-thickness incision extending mesiodistally to the recipient site. Blood supply to the graft is increased because the grafted connective tissue is covered by this flap. Also, the lack of a vertical incision alleviates postoperative discomfort and facilitates healing, and no scar will develop in the vertical incision area, an esthetic advantage (Table 6-16). The horizontal incision aids close adaptation of the interdental papilla area and graft with a butt-joint effect. The blood supply from the interdental papilla area is enhanced by this close adaptation.

Table 6-16 Modifications of Langer and Langer"

1. Do not use a vertical incision when preparing a recipient site to:
   - Ensure excellent blood supply to flap.
   - Alleviate postoperative discomfort.
   - Avoid scarring.
2. Make a partial-thickness horizontal incision perpendicular to the interdental papilla of the recipient site.

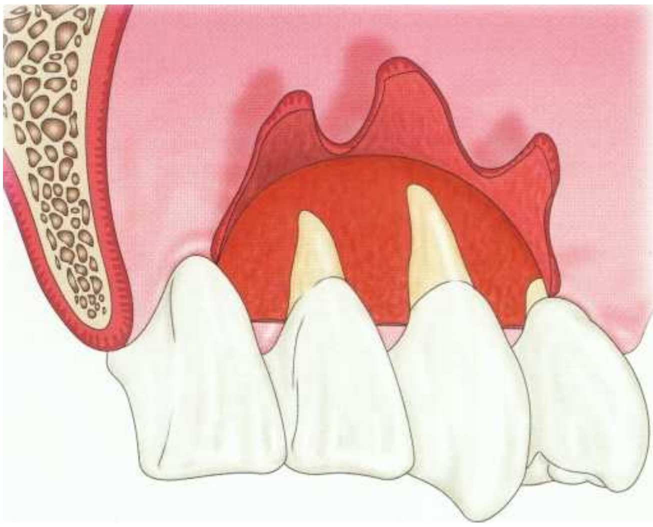
   Close adaptation to donor tissue is obtained with a butt joint.

Fig 6-14 The modified Langer and Langer technique.

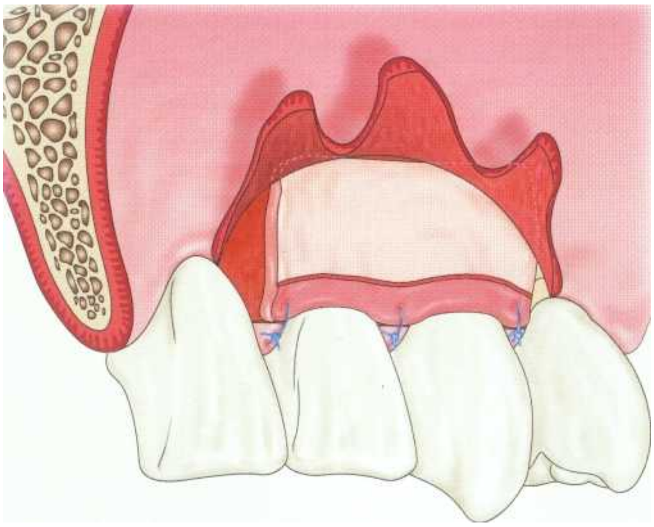
a. Make a partial-thickness horizontal incision on the CEJ or slightly coronally and perpendicular to the interdental papilla.

b. Connect each horizontal incision with a sulcular incision. Extend the incision mesiodistally and prepare a large flap for proper access.

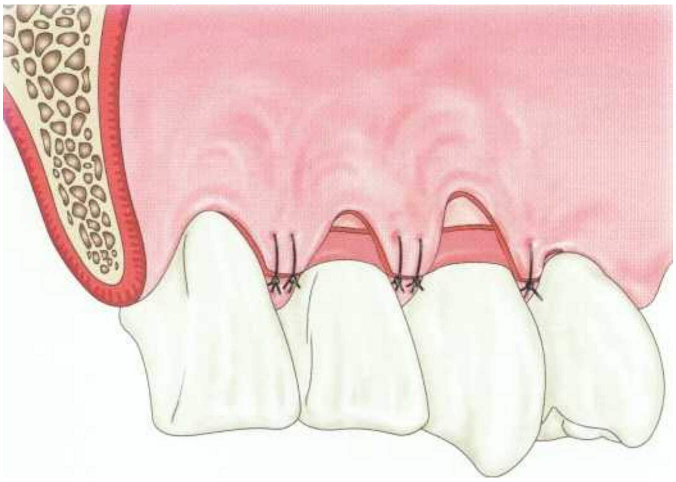
Fig 6-14 **(continued)** The modified Langer and Langer technique.



c. After reflecting a partial-thickness flap, prepare a periosteum-connective tissue recipient site. Extend the partial-thickness incision apically for coronal migration of the flap.

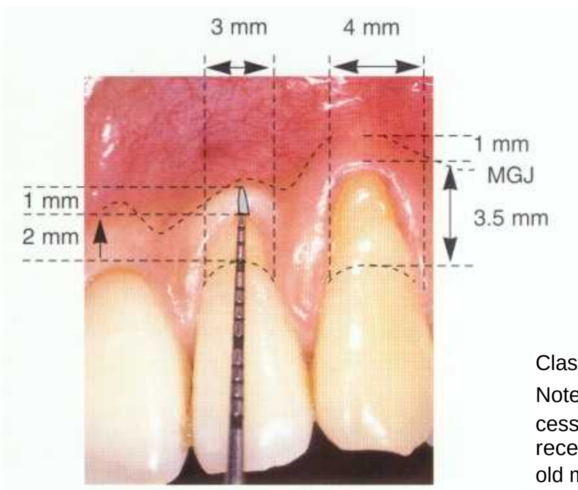


d. Cover the exposed root with a connective tissue graft and suture.



e. Cover the graft completely with the flap and suture.

Case 6-6 Root coverage using the modified Langer and Langer procedure"



Class II gingival recession. Note the 2 mm gingival recession on 10 and 3.5 mm recession on 11 (33-year-old man).

Preparation of recipient site

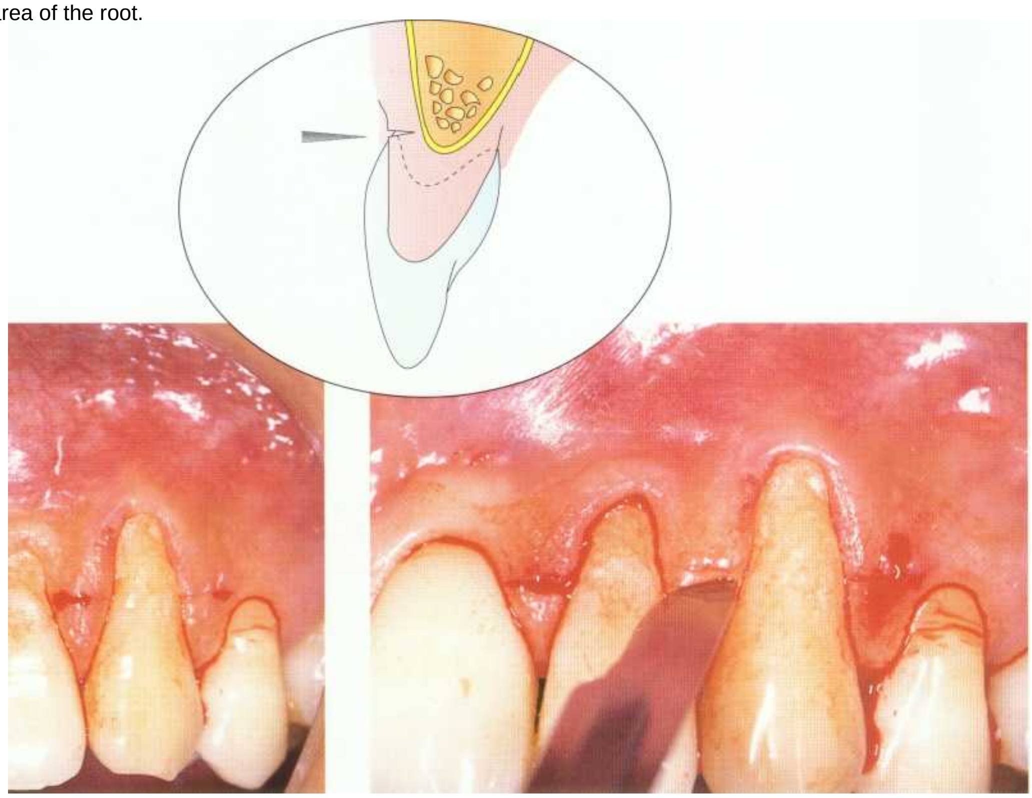
c6-1 Debridement and recontouring of root surface.

a. A curette is used to perform root planing of the exposed root and to recontour the convex area of the root.

b. Tetracycline solution (125 mg/mL) is applied to the root surface for 3 minutes.

c. The root surface is whitened after root conditioning.

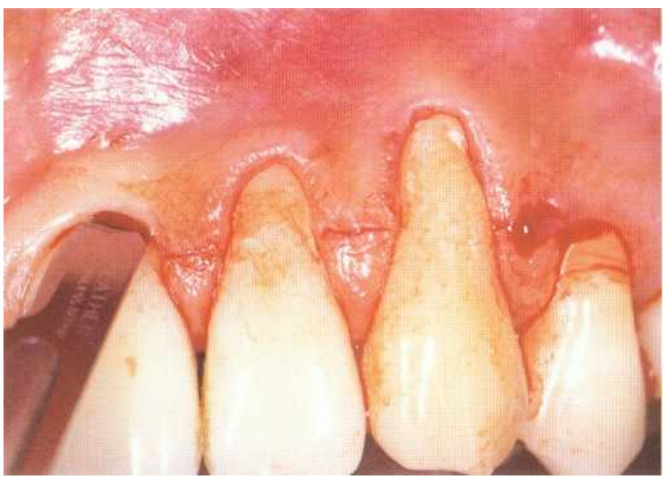
c6-2 Flap design of recipient **site.**
(Design different from the Langer and Langer technique).



a. A no. 15 blade is used to make a partial-thickness horizontal incision perpendicular to the interdental papilla on the CEJ or slightly coronally.

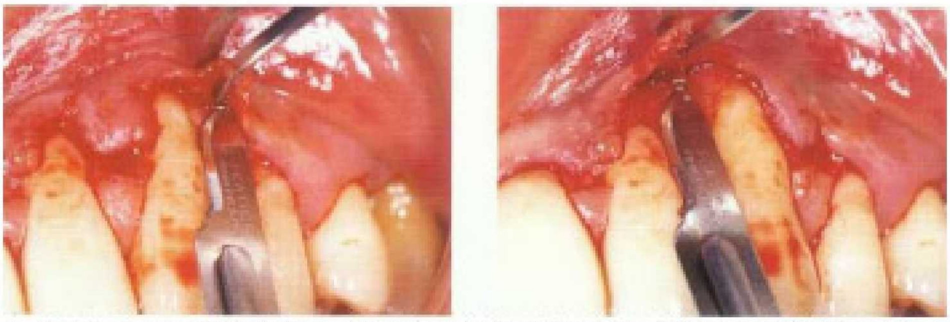
Key point

The flap is designed without a vertical incision. It is necessan, to prepare a large flap for easy access to the exposed root. Therefore, it is important to extend the incision mesiodistally with care to avoid damage to the interdeutal papilla.



b. The horizontal incisions are connected with sulcular incisions.

c6-3 Flap reflection in the recipient site.



a. The tip of a no. 15 blade is used to make a horizontal incision. A 2 mm partial-thickness flap is made from the coronal side. The blade tip is used to lift the flap and small tissue pliers are used to hold the reflected edge. A partial-thickness flap is prepared apically while the edge is pulled slowly, with care taken to avoid penetrating the flap. A partial-thickness incision is extended sufficiently beyond the mucogingival junction for access to the root surface and coronal displacement of the flap.

b. After flap reflection, a recipient site is prepared with a butt joint (periosteum and connective tissue on coronal edge).

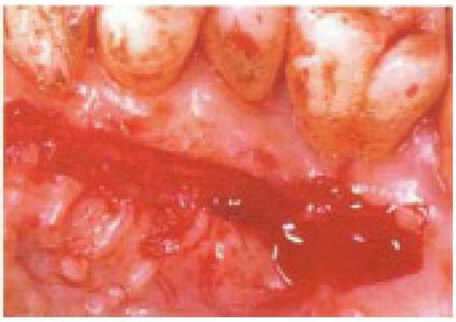
c. Note the osseous dehiscence extending about 5 mm from the CEJ on 10 and 11.

d. A curette is used for root planing of the subgingival root surface.

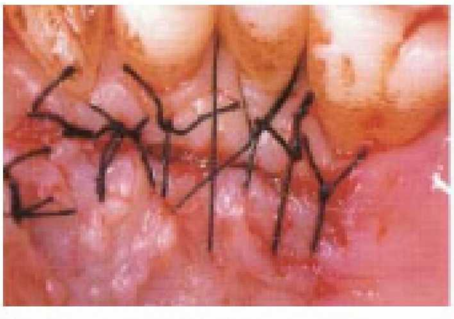
Harvesting of donor tissue and grafts

c6-4 Harvesting of donor tissue.

a. Two parallel horizontal incisions are made from the canine to the first molar.



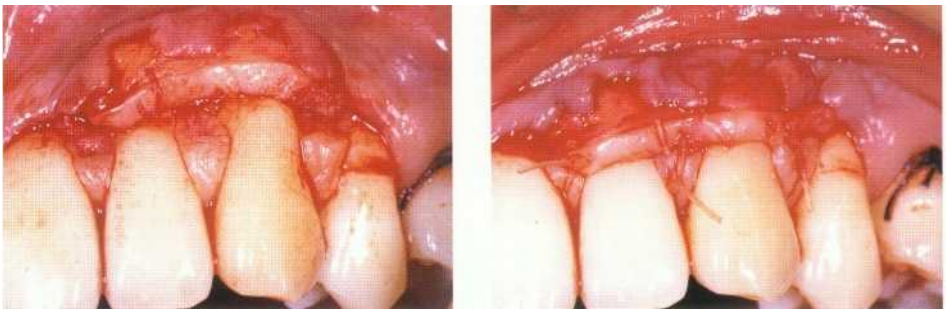
b. After graft harvest.



c. Suture of donor site. A horizontal mattress suture is made to close the wound and stop the bleeding.

d. An absorbable hemostat or oxidized regenerated cellulose is placed after suture.

c6-5 Suture and stabilization of graft.



a. A connective tissue graft is placed on the exposed root and 4.0 resorbable suture thread used for suture of the graft and interdental papilla.

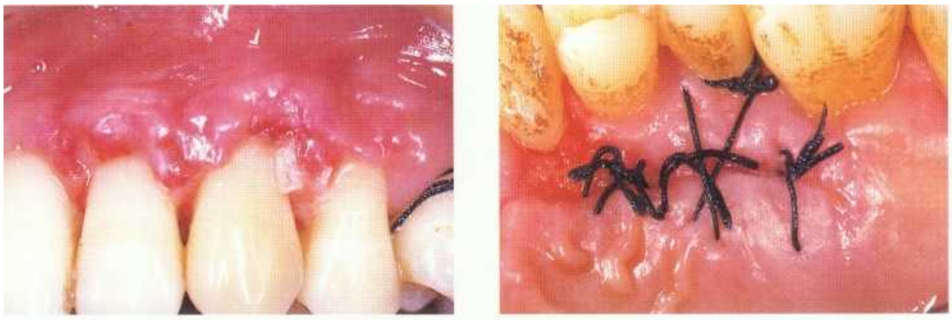
b. An interrupted suture with a resorbable thread is made coronally to cover the graft with the flap.

Key point

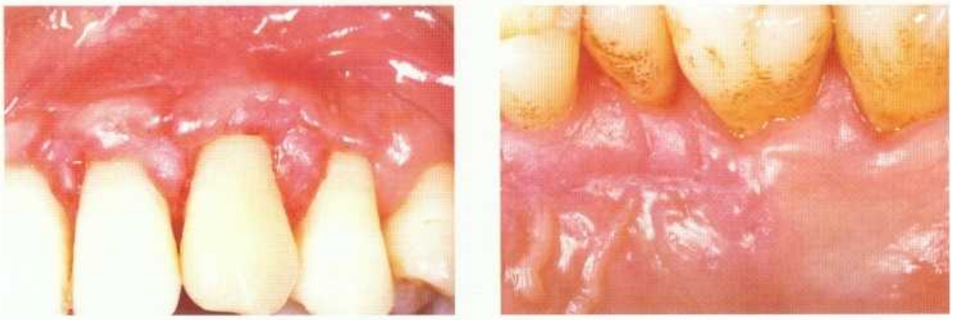
Note that the graft epithelium is positioned coronal to the CEJ and is closely adapted to the horizontal incision area in the recipient site and graft with a butt joint. Note the slight epithelium of the graft on 10 and 11 after suture; it is unnecessary, however, to cover the graft completely.

Prognosis

c6-6 Prognosis.



a. Ten days after surgery.



b. Seventeen days after surgery.

c. Twenty-three days after surgery.

d. Thirty days after surgery.

e. Forty-two days after surgery.

f. Fifty-eight days after surgery.

g. Three months after surgery.

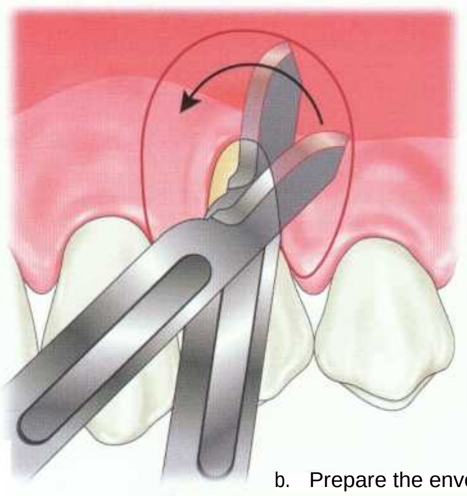
h. Nine months after surgery.

Connective Tissue Graft Using an Envelope Flap

Raetzke introduced a connective tissue graft using an envelope technique. A partial-thickness envelope flap is prepared on the soft tissue adjacent to the gingival recession area from the gingival sulcus. No horizontal or vertical incision is made. The connective tissue graft harvested from the palate is inserted into the envelope flap and held (or bonded) with cyanoacrylate rather than sutured. The advantages of this technique are: simplicity, minimal surgical invasiveness, and good esthetics because the interdental papilla is preserved.

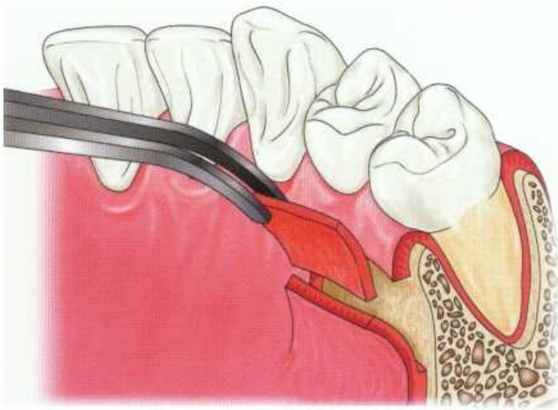
One limitation of the envelope flap is that it cannot be displaced coronally. The envelope flap is also not applicable in areas of extensive gingival recession because there is a limit to the size of the graft that can be placed in the enve lope flap. Therefore, the technique is used only with localized gingival recession limited to one to two teeth. Allen"' modified this procedure to include areas of gingival recession on multiple teeth.

a. Perform root planing of the exposed root and use a finishing bur to recontour it.

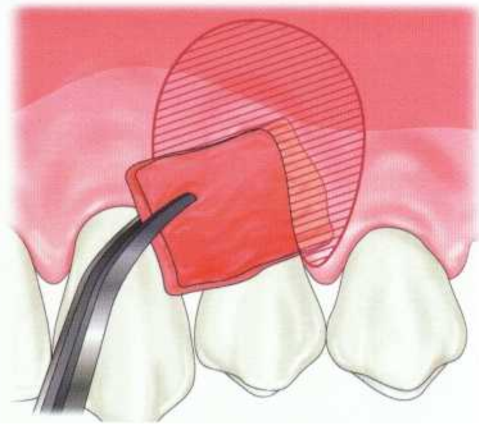


b. Prepare the envelope flap.

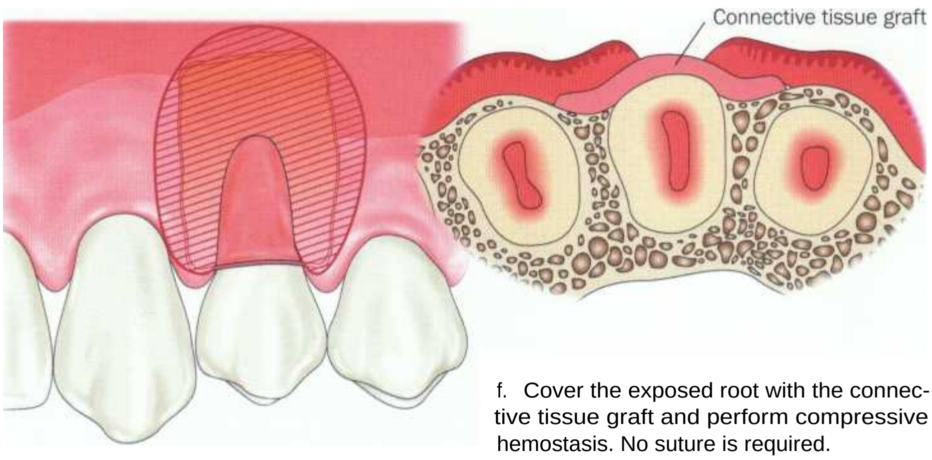
c. Prepare a partial-thickness flap at the donor site and reflect it. Expose the underlying connective tissue.



d. Reflect the connective tissue graft from the bone with full thickness and harvest it. Because the connective tissue graft does not include the epithelium on the edge, this is a modification of the Langer and Langer procedure.



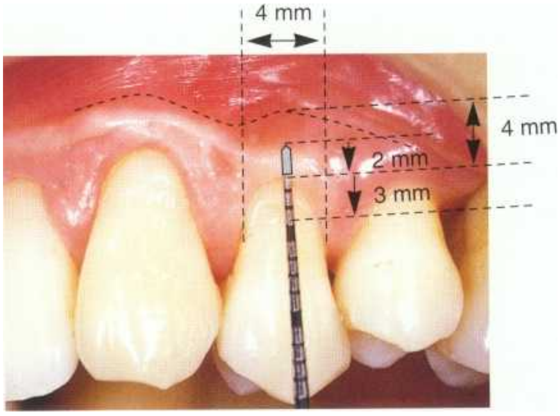
e. Gently guide the connective tissue graft into the envelope flap.



f. Cover the exposed root with the connective tissue graft and perform compressive hemostasis. No suture is required.

Fig 6-15 Root coverage using the envelope flap.

Case 6-7 Connective tissue grafts using an envelope flap for root coverage"



Class II gingival recession.

Note the gingival recession 3 mm from the CEJ on 12. (Root coverage on 10 and 11 was done with the technique described in Case 6-6, 33-year-old man.)

Conditioning of exposed root and preparation of envelope flap

c7-1 Root planing and root conditioning.

a. A curette is used to perform root planing of the exposed root.

b. A finishing bur is used to recontour the convexity of the root.

c. A cotton pledget soaked in tetracycline solution is applied for 3 minutes. After root conditioning, the root surface is whitened.

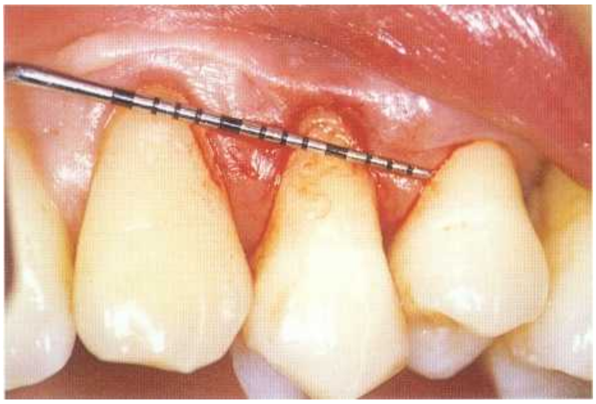
c7-2 Preparation of envelope flap of recipient site.

a. A no. 15 C blade is inserted into the gingival sulcus of the gingival recession area and a sulcular incision of undermining partial -thickness made from the distal toward the mesial aspect. The envelope flap is prepared from the surrounding tissue of the exposed root.

Key point

Contact the bottom of the blade tip with the root surface for stability. Raise the blade tip 2-3 mm and make the incision as if slicing off the inside of the gingival sulcus. If there is a possibility of penetrating the partial-thickness flap due to gingival thinness, carefully prepare a full-thickness envelope flap.

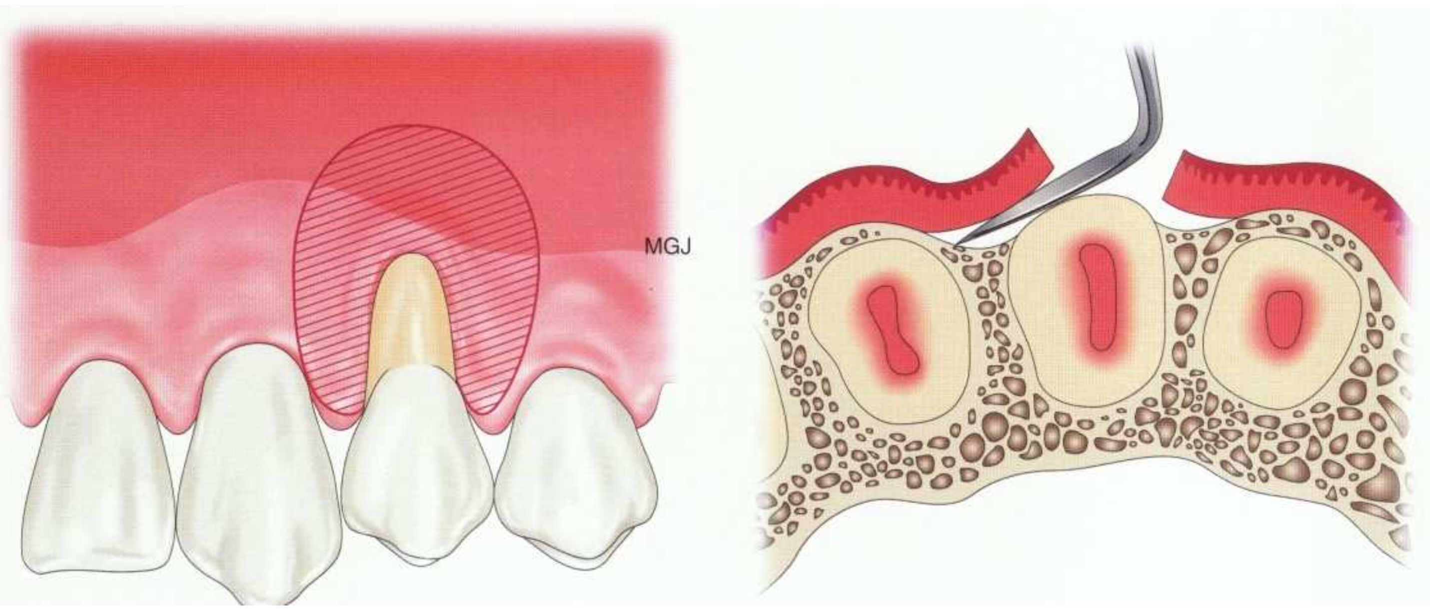
b. An Orban interdental knife 1/2 is placed to extend more than 3-5 mm laterally and apically from the recession area, and an undermining partial-thickness incision is made. The adjacent interdental papilla is undermined to slightly coronal to the CEJ.



c. The required size of the graft is measured.

Key point

Range for preparation of envelope flap: Extend the incision slightly coronally from the CEJ and more than 3-5 mm laterally and apically from the area of recession.



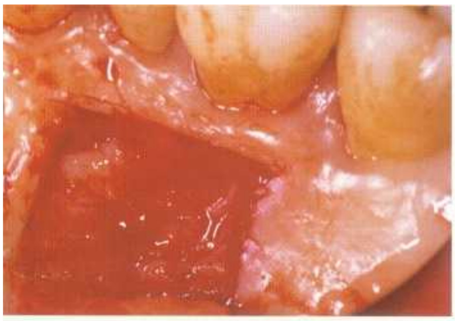
Harvesting of connective tissue graft

c7-3 Exposure of connective tissue.

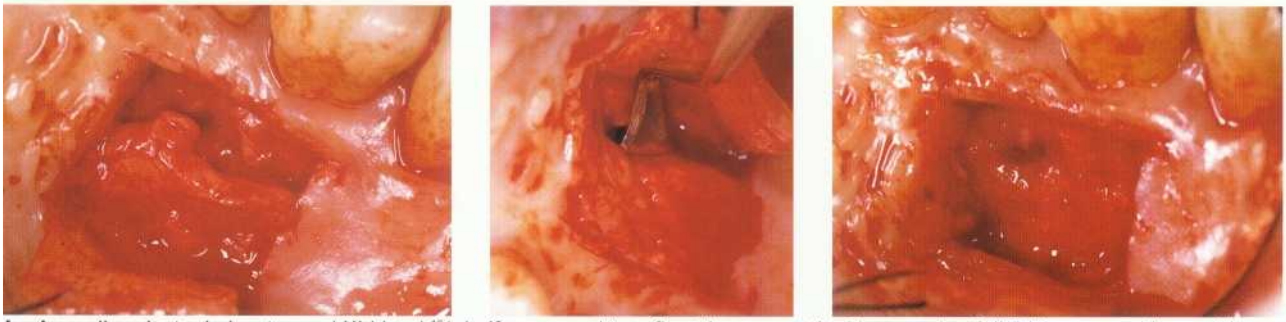
a. The harvesting of the connective tissue graft is performed in the palate, following a "trap door" flap design. A no. 15 blade is used to make a partial-thickness horizontal incision with a bevel about 3 mm apical to the gingival margin of the first premolar extending toward the first molar. Two vertical incisions are made mesiodistally.

b. Tissue forceps are used to lift the prepared palatal flap edge. It is reflected toward the center of the palate and the underlying connective tissue exposed,

c7-4 Harvesting of connective tissue using full-thickness.



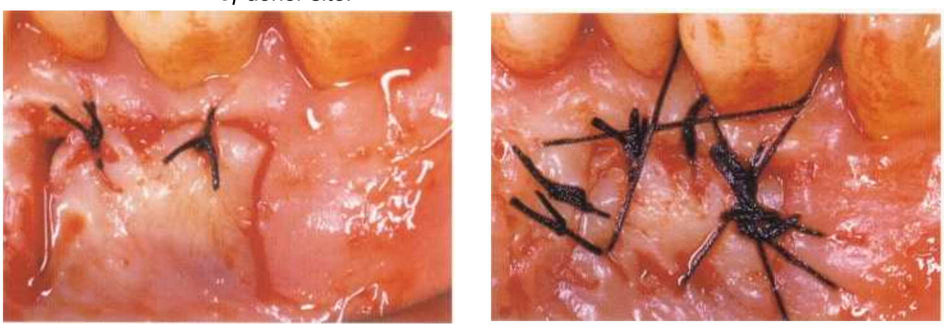
a. An incision perpendicular to the bone is made around the edge of the connective tissue, facilitating connective tissue reflection from the bone.



b. A small periosteal elevator and Kirkland 15/16 knife are used to reflect the connective tissue using full-thickness and harvest it.

c. Note that the connective tissue graft has no epithelium on the edge.

c7-5 Wound closure of donor site.



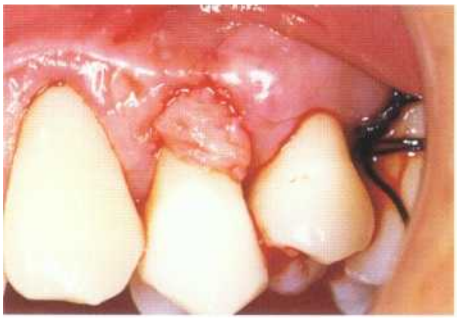
a. Interrupted and horizontal mattress sutures are made to close the wound.

b. An absorbable hemostat is placed to stop the bleeding.

c7-6 Placement and stabilization of graft.

The size of the graft is adjusted and the graft is guided gently into the prepared envelope flap. Then the exposed root is covered completely.

Gauze soaked in physiologic saline solution is placed on the site for 5 minutes to facilitate hemostasis to minimize the thickness of the blood clot. After hemostasis, stabilization is achieved with cyanoacrylate, and a periodontal dressing is placed.

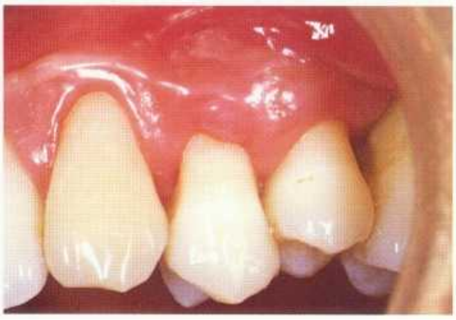


Prognosis

c7-7 Prognosis.

a. Twenty days after surgery.

b. Twenty-seven days after surgery.



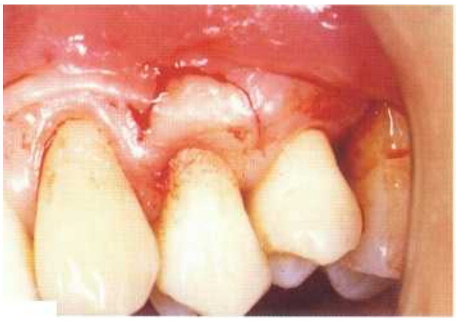
c. Forty-two days after surgery.

d. Fifty-six days after surgery.

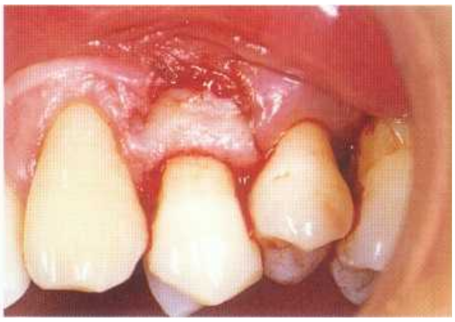
e. Eighty-six days after surgery.

Additional treatment using a semilunar flap

c7-8 Preparation of semilunar flap. The remaining exposed root is covered with a semilunar flap as a secondary surgery.



a. A semilunar partial-thickness incision.



b. The semilunar flap is displaced coronally.

c7-9 Prognosis.

a. Three days after surgery.

b. One month after surgery.

c. Two months after surgery.

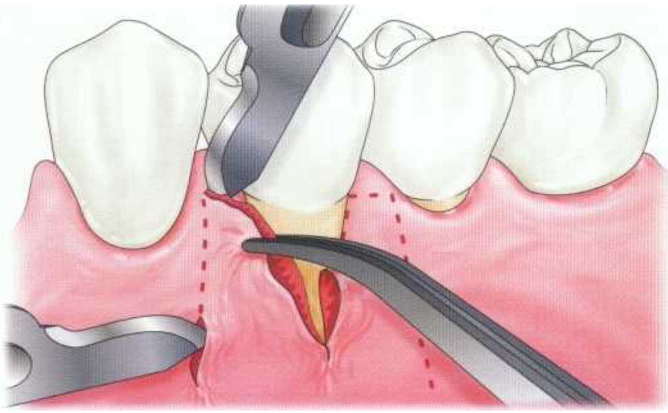
Subpedicie Connective Tissue Grafts

Connective tissue grafts may be used with a pedicle flap (double papilla or laterally positioned flap). Nelson=' and Borghetti and Louise described the full-thickness pedicle flap, and Harris described the partial-thickness pedicle flap.

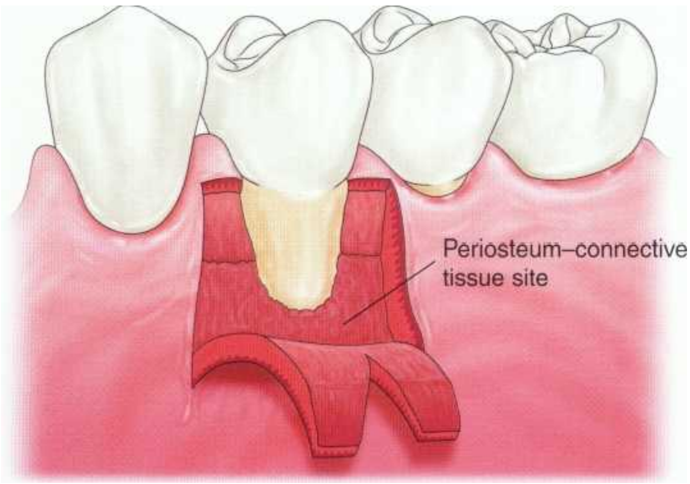
The greatest advantage of this technique is that a pedicle flap can cover connective tissue grafts on root surfaces lacking a vascular supply. In addition to root coverage, the width of the keratinized gingiva can be increased. Therefore, the technique may be used in areas of gingival recession with narrow keratinized gingiva. This use, however, is more technically demanding.

Fig 6-16 Root coverage using subpedicle connective tissue grafts.

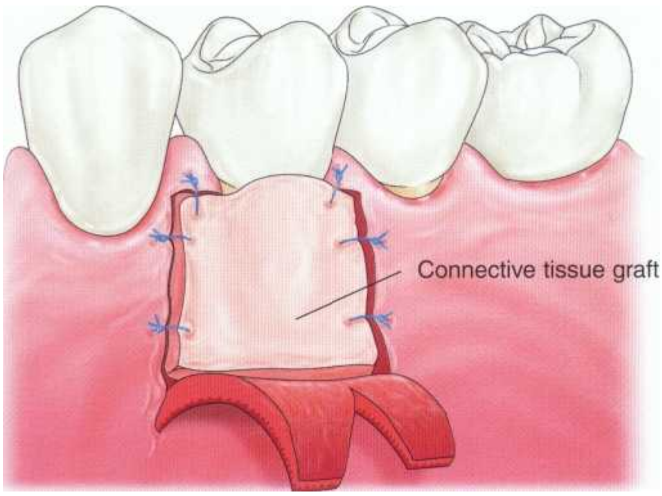
a. Double papilla flap design in recipient site.



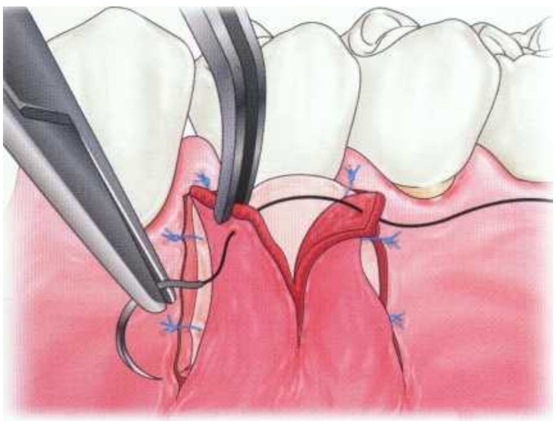
b. Prepare the partial-thickness pedicle flap, which includes mesiodistal interdental papilla.



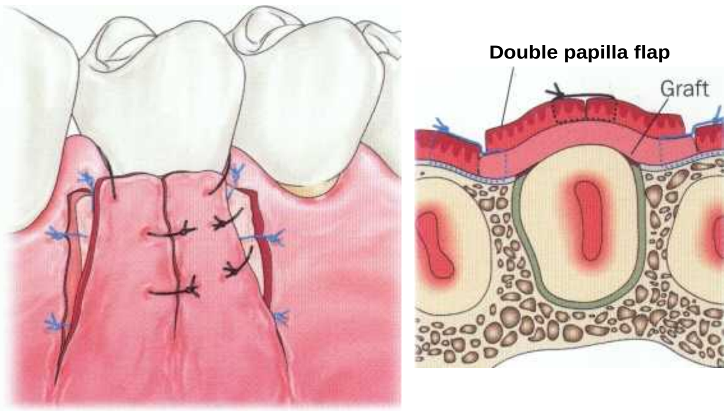
c. Prepare the recipient site, which consists of periosteum-connective tissue.



d. Suture and stabilize the connective tissue graft.



e. Connect each papilla flap to make a double papilla flap.



f. Cover the connective tissue graft on the root surface with the double papilla flap. Make a sling suture.

Case 6-8 Root coverage using subpedicle connective tissue grafts

Class II gingival recession.

Note the cervical caries on 21 and gingival recession about 3 mm apical to the CEJ (55-year-old man).

Conditioning of the exposed root and preparation of the pedicie flap

c8-1 Conditioning of the exposed root. The decay is removed from the tooth and a curette used to thoroughly contour the exposed root.

c8-2 Pedicle flap design of recipient site.

a. A no. 15 blade is used to make a horizontal partial-thickness incision. The incision is made perpendicular to the surface of the interdental papilla on the CEJ or slightly coronally.

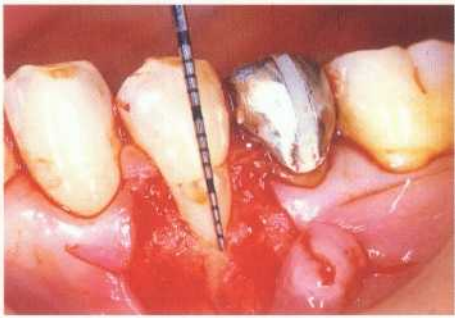
b. A vertical partial-thickness incision is made perpendicular to the mesiodistal edge of the horizontal incision.

c. A vertical incision is extended sufficiently beyond the mucogingival junction. A double papilla flap, which is broader at the base, is prepared.

c8-3 Flap reflection.

a. The blade is turned coronally and tissue pliers used to hold the outside of the flap. With the side of the blade, the bone is contacted to avoid penetration. The flap is reflected with partial-thickness.

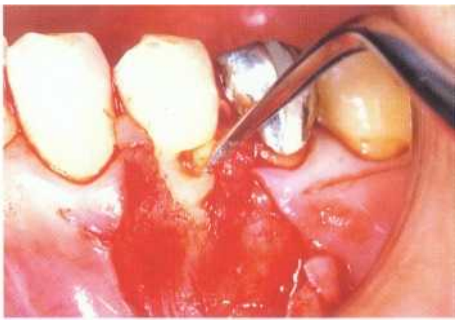
b. The flap is reflected to the level that would permit free movement of the mesial and distal pedicle flaps. The flap is sufficiently reflected and the recipient site is prepared with a butt joint, which consists of the periosteum-connective tissue on the coronal edge.



c. Note the osseous dehiscence extending 5.5 mm from the CEJ.

c8-4 Root conditioning.

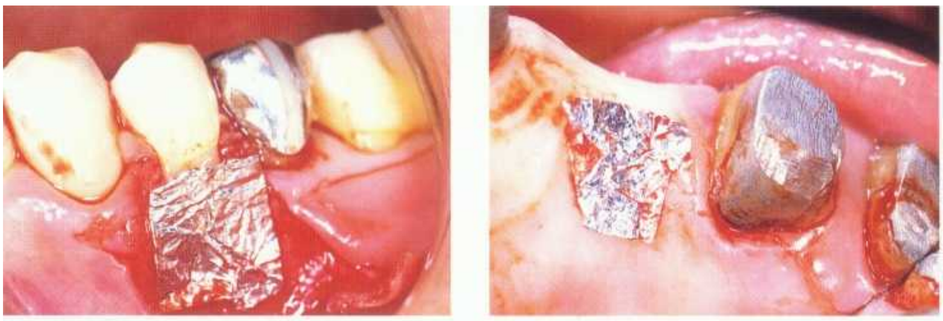
a. A curette and finishing bur are used to contour the root.



b. Tetracycline (125 mg/mL) is applied for 3 minutes.

c. The root convexity is flattened to the level of the alveolar bone.

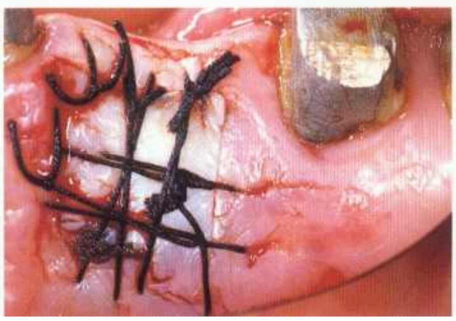
Harvesting of connective tissue graft and suture



c8-5 Harvesting of graft.

a. The size of the graft is determined and the incision planned on the donor site.

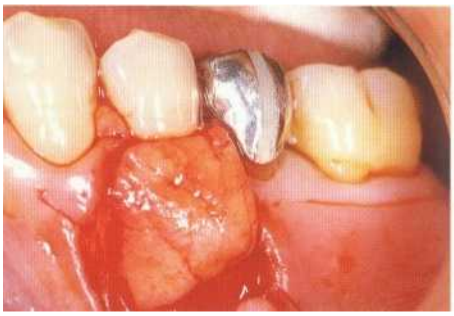
b. A "trap-door" partial-thickness flap to expose the connective tissue is prepared and reflected.



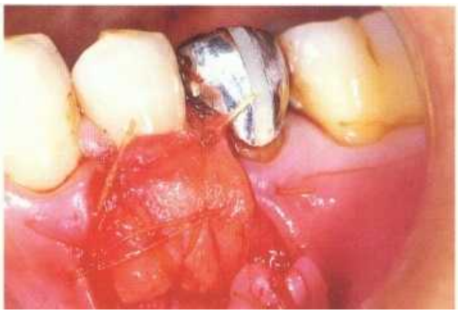
c8-6 Suture of partial-thickness palatal flap.

Transplant of connective tissue graft

c8-7 Suture of the graft.



a. The graft is placed on the recipient site.



b. Absorbable thread is used to make an interrupted suture on the interdental papilla at the level of the CEJ. Note that the graft extends more than 3 mm apically from the base of the area of recession.

c8-8 Coverage by double papilla flap.

The mesial and distal pedicle flaps are sutured together with a resorbable material, and coverage of the graft is provided. The flap is stabilized with a sling suture.

Prognosis

c8-9 Prognosis.

a. One week after surgery.

b. Fifteen days after surgery.

c. Three weeks after surgery.

d. Twenty-eight days after surgery.

e. Forty-six days after surgery.

f. About 1 year after surgery.

Guided Tissue Regeneration for Gingival Recession

While GTR was developed to recover attachment loss due to periodontal disease, it may also be used in cases of gingival recession. In one study,[36] suture thread was used to bend the membrane to create more regeneration space. The membrane was placed on the gingival recession area, and a semilunar flap was prepared and displaced coronally to cover the membrane. Tinti et a1 }` described an odontoplasty procedure in which the root was made concave to ensure regeneration space, a procedure that has since been improved. In this procedure, a thick and large trapezoidal flap, rather than a semilunar flap, is made to cover the membrane. This flap is simply displaced coronally, covers the membrane easily, and receives better blood supply (Fig 6-18).

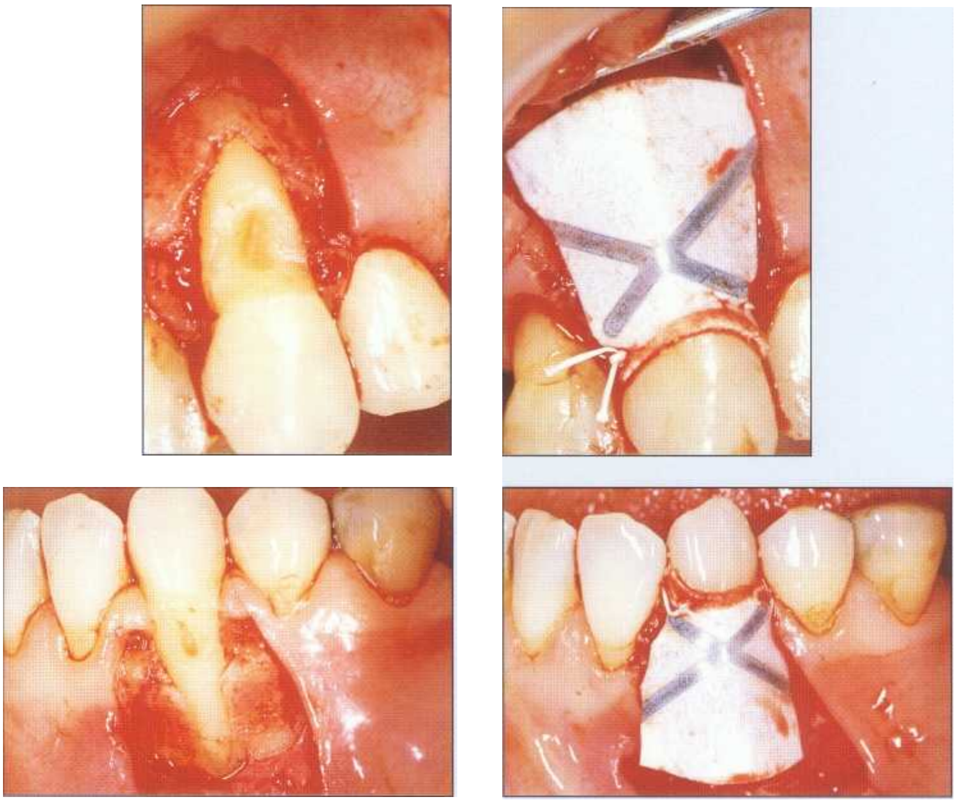
Pini Prato et al conducted a comparative study of GTR in gingival recession using the trapezoidal flap and the coronally positioned flap. Mucogingival surgery was performed with a coronally positioned flap after the placement of free autogenous gingival grafts and the results compared with the results of GTR. Results revealed no clinical difference in the average amount of root coverage, but greater attachment gain and pocket reduction were observed with GTR. Also, in areas with more than 5 mm of gingival recession, there was more root coverage observed with GTR than with mucogingival surgery.

The major problem of using GTR for root coverage is that spacemaking, which is necessary for GTR, is difficult. With the technique of Tinti et al (odontoplasty and membrane bent with suture thread), it is difficult to main tain the space created during healing. Now the titanium reinforced (TR) expanded polytetrafluoroethylene (e-PTFE) membrane may be used (Fig 6-17).

Table 6-17 Results of Root Coverage Using GTR

	Procedure	Number of treated teeth	Months of observation	Preoperative gingival recession	Postoperative gingival recession	Average root coverage
Pini Prato et al[38]	e-PTFE membrane	25	18	5.5 mm	1.4 mm	72.7%
Trombelli et al[39]	Tetracycline root conditioning, fibrinfibronectin, and e-PTFE membrane	15	6	4.7 mm	1.1 mm	77.4%
Tinti and Vincenzi[40]	Titanium-reinforced e-PTFE membrane	12	15	5.3 mm	1.4 mm	73.5%
Trombelli et al[41]	Tetracycline root conditioning, fibrinfibronectin, and e-PTFE membrane	8 (16)	6	4.5 mm	1.5 mm	67%
	e-PTFE membrane alone	8		4.4 mm	1.7 mm	60%
Roccuzzo et al[42]	e-PTFE membrane	12	6	4.75 mm	0.75 mm	83.2%
	Absorbable membrane	12	6	4.75 mm	0.83 mm	82.4%
Roccuzzo and Buser[43]	e-PTFE membrane and mini screws	12	9	5.2 mm	0.8 mm	84%

Fig 6-17 Spacemaking using a titanium-reinforced membrane.



Tinti and Vincenzi reported clinical results with the TR membrane, with its advantages of spacemaking and maintaining space. Clinical studies were also conducted by Pini Prato et al and Roccuzzo et al using bioresorbable membranes for gingival recession. As described, GTR should be performed on areas of limited gingival recession.

Table 6-18 Root Coverage Using GTR

Advantages

1. Gain of new attachment.
2. Donor site not necessary.
3. Root coverage highly predictable in deep and wide, but limited, gingival recession area.
4. Esthetic results because of good color harmony with surrounding tissue.

Disadvantages

1. Technically demanding.
2. Secondary surgery necessary for membrane removal.
3. Costly due to materials required.

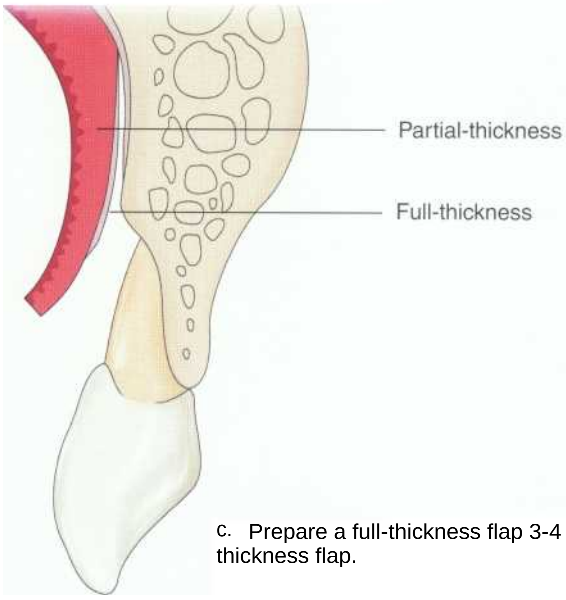
Indications

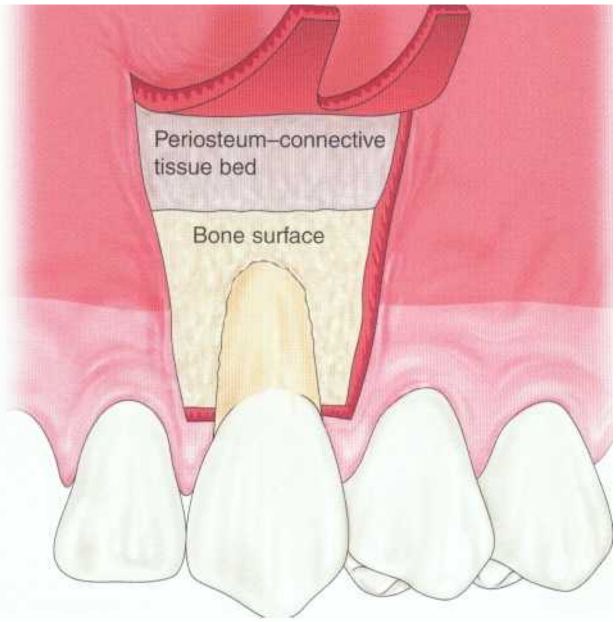
Deep and wide, one-tooth gingival recession with more than 5 mm attachment loss, particularly on the maxillary canine. For deep and wide gingival recession, the first choice of treatment is connective tissue grafts. However, most patients with gingival recession have thin, scalloped gingiva. A thick graft is difficult to obtain because the palatal soft tissue on the donor site is thin. GTR is applicable in these cases.

Fig 6-18 GTR for root coverage.

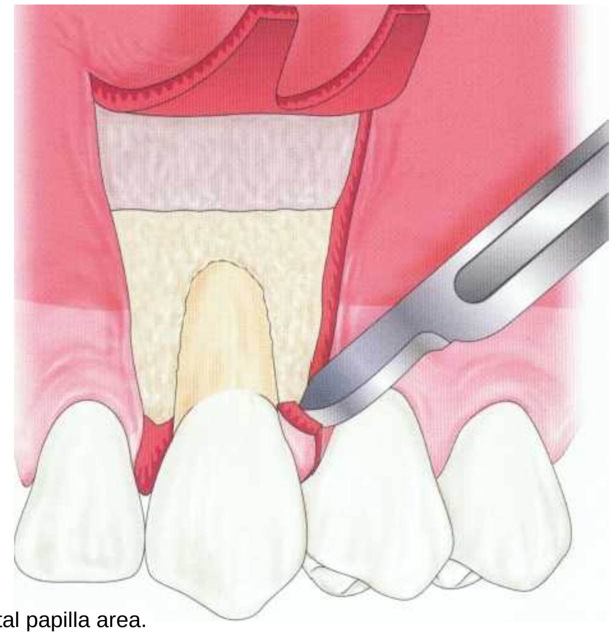
a. Prepare a full-thickness trapezoidal flap.
- Horizontal incision to the mesiodistal interdental papilla at the level of the CEJ.
- Two vertical incisions.

b. Connect the horizontal and vertical incisions with a sulcular incision.

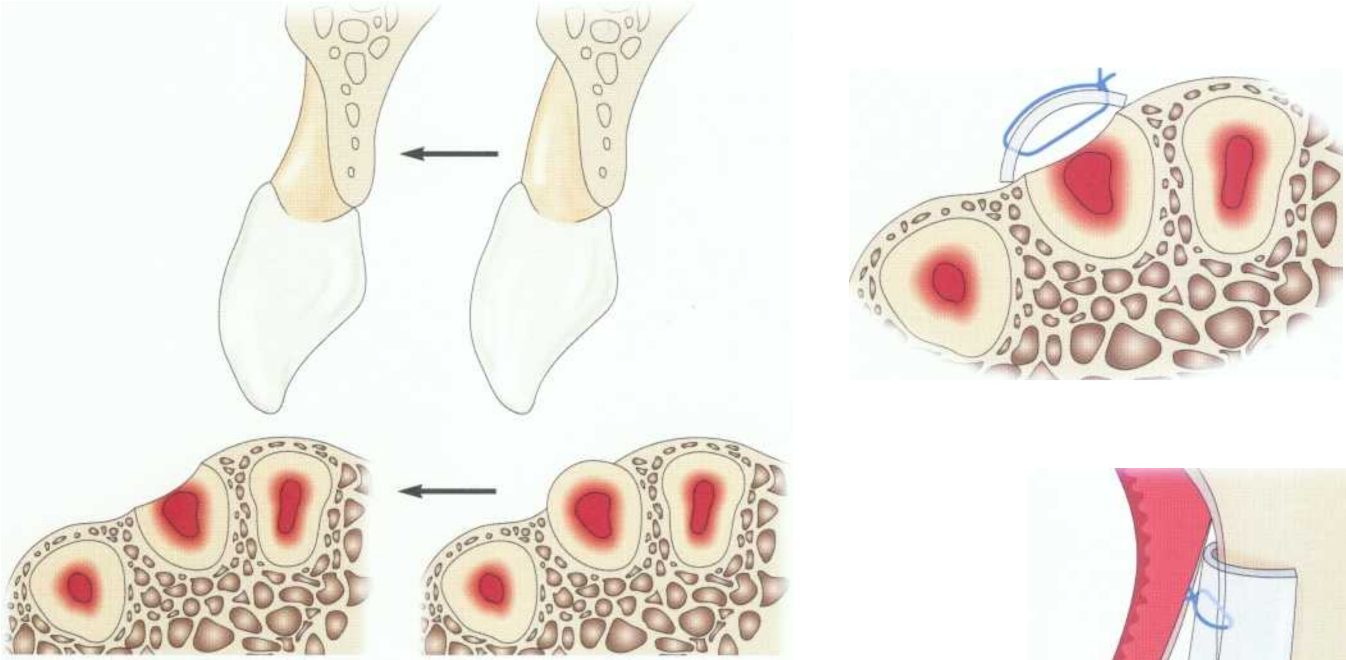




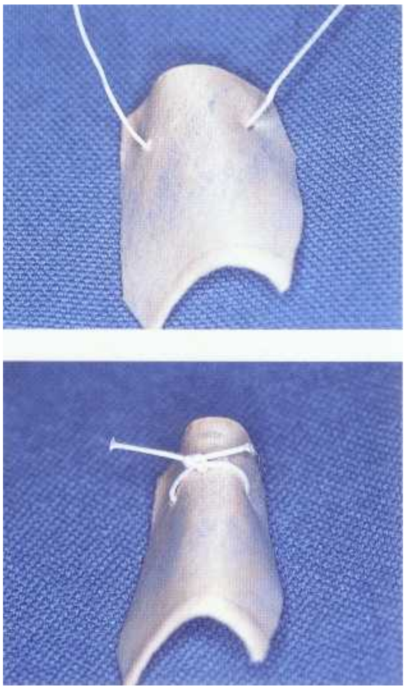
c. Prepare a full-thickness flap 3-4 mm apical to the crest of the osseous dehiscence. Apically, prepare a partial-thickness flap.



d. Remove the epithelial tissue in the interdental papilla area.

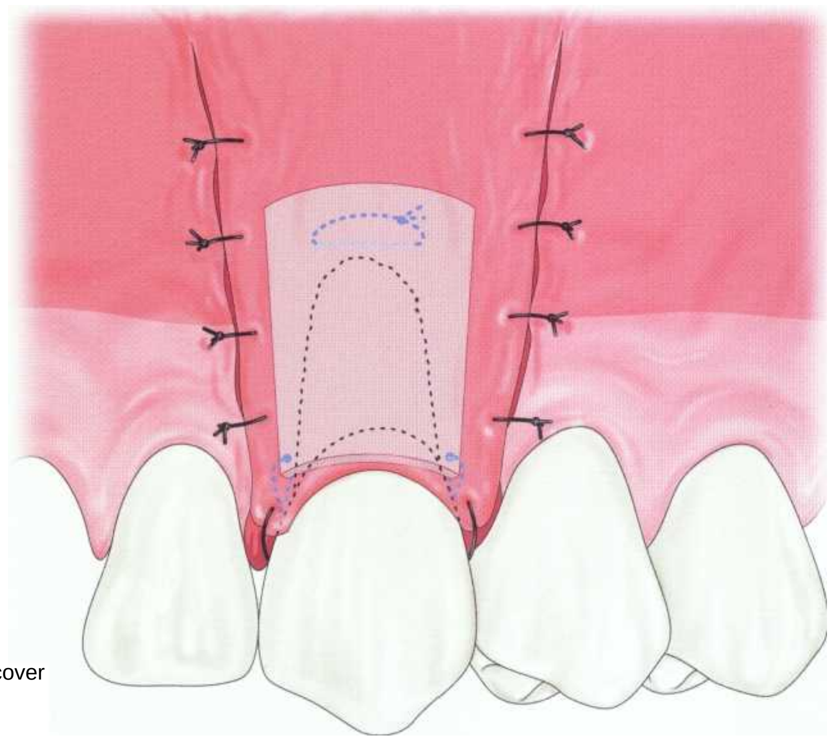


e. Perform root planing and preparation of root concavity.



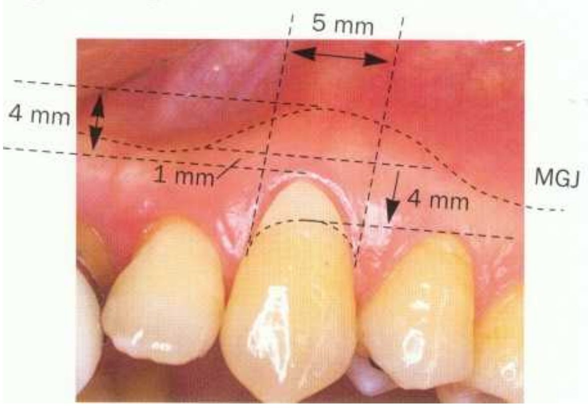
f. Bend the membrane in a tentlike fashion with suture thread.

g. Stabilize the membrane with a sling suture.



h. Displace the flap coronally and cover the membrane completely.

Case 6-9 Root coverage using GTR[38]



Class I gingival recession.

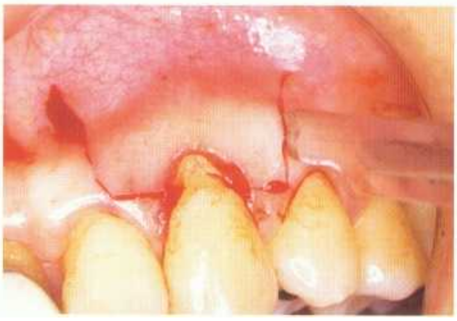
The patient complained of limited hypersensitivity on 11, which had a class V composite resin restoration cervically. The distance from the coronal margin of the restoration to the gingival margin is 3 mm (44-year-old woman).

Flap preparation

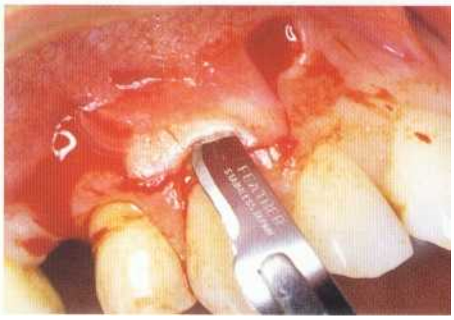
c9-1 Removal of restoration. A round bur is used to remove the restoration after the application of local anesthesia.

c9-2 Trapezoidal flap incision.

a. A no. 15 blade is used to prepare a horizontal right-angle incision at the level of the CEJ in the mesiodistal interdental papilla of the recession area.

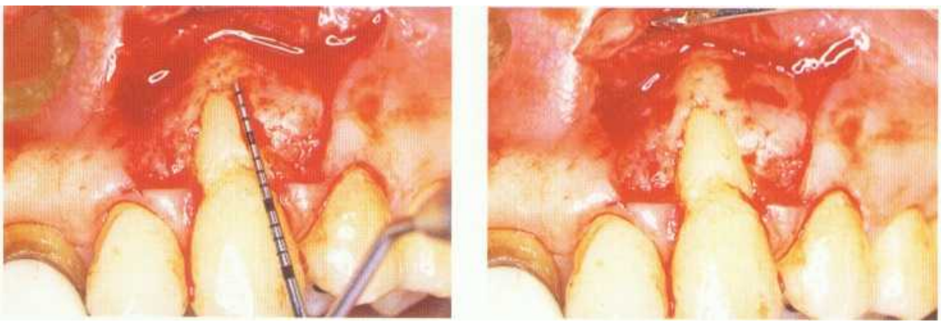


b. Two vertical incisions extending sufficiently beyond the mucogingival junction mesiodistally are made.

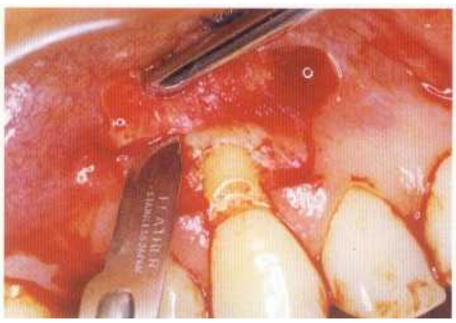


c. A sulcular incision is made to the buccal gingival recession area to connect the horizontal and vertical incisions. (Different patient.)

c9-3 Reflection of trapezoidal flap.



a. Note the 7.5-mm osseous dehiscence from the CEJ to the bone crest on full thickness flap reflection.



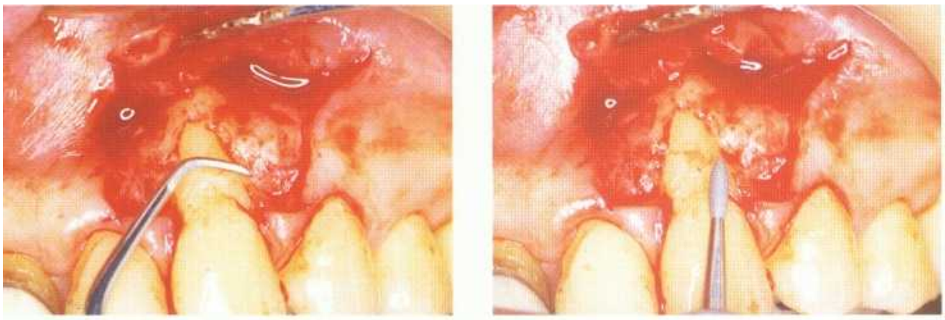
b. With a partial-thickness flap preparation, care must be taken to avoid penetrating the flap or making it too thin. (Different patient.)

Key point

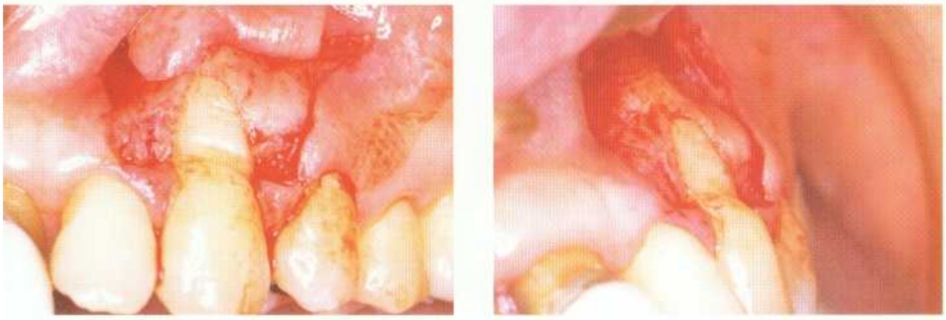
Prepare a full-thickness flap within 3 mm apical of the crest of the osseous dehiscence. Apically, prepare a partial-thickness flap to facilitate coronal migration of the flap and to cover the membrane.

Spacemaking and membrane placement

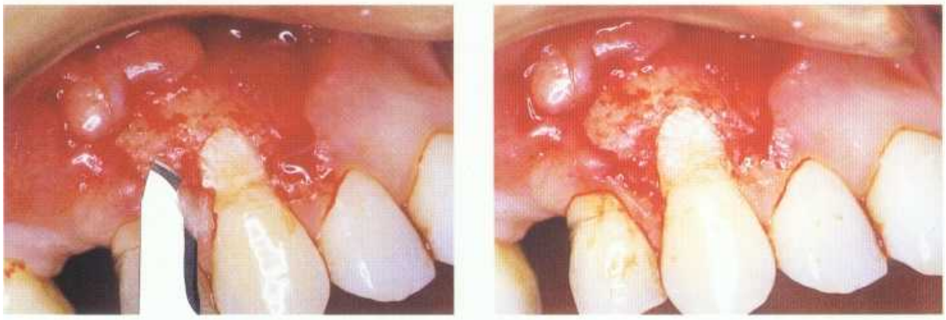
c9-4 Root planing and preparation of root concavity.



a. A sharp curette is used to thoroughly recontour the root surface toward the bone crest. The sharp edges of the CEJ are also removed. The root planing bur is used to correct the root morphology to create a smooth, concave form.

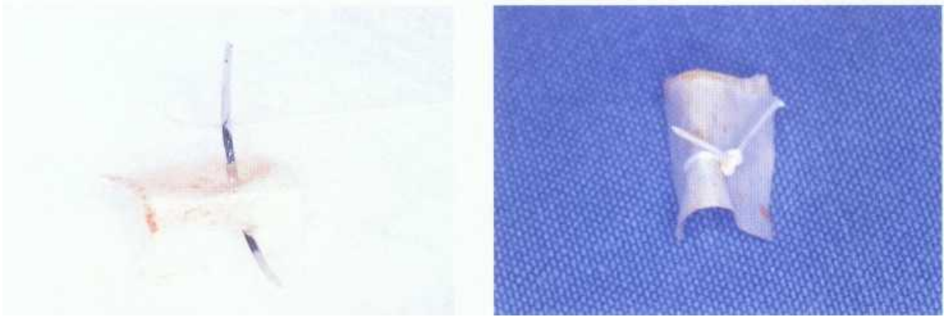


b. A root with a smooth, concave form is necessary to facilitate membrane adaptation and to obtain sufficient space for regeneration.



c9-5 Removal of interdental papillary epithelium. The remaining interdental papillary epithelium on the coronal side is resected. At this time, only the epithelial tissue is removed (the connective tissue is left). Care is taken to avoid reducing the height of the interdental papilla. (Different patient.)

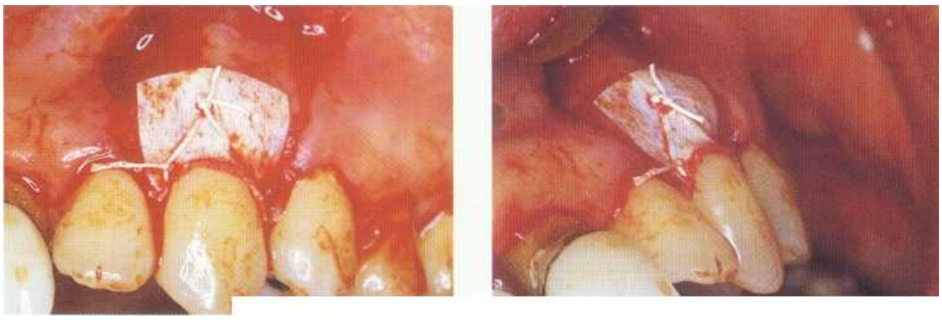
c9-6 Suture of membrane.



a. Suture material is used to bend the nonabsorbable membrane (WL Gore).

Key point

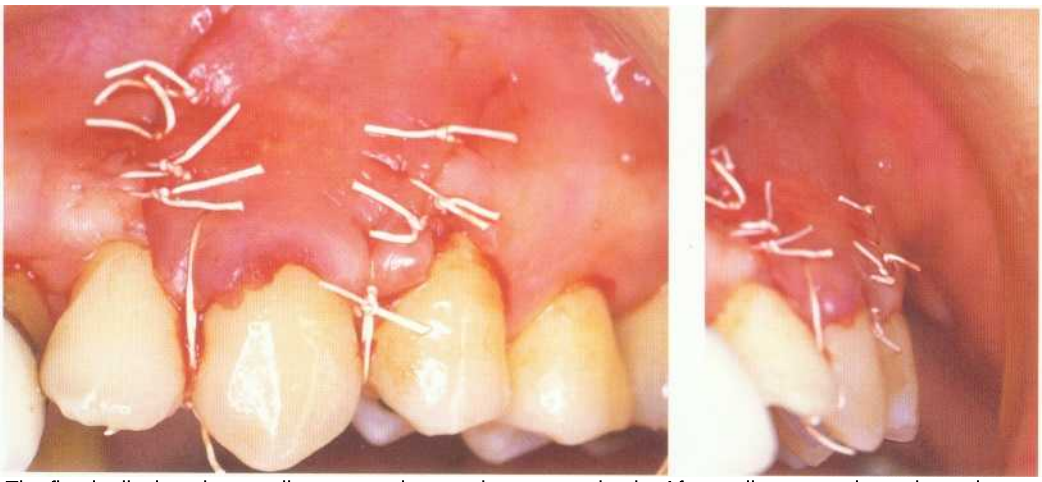
The formability of the membrane and the root concavity enable sufficient space for regenerated tissue. Use a membrane of appropriate size to cover the exposed root sufficiently. Place the collar part of the coronal side (open microstructure) 1 mm coronal to the CEJ. Place the lower margin about 2-3 mm apical to the crest of the osseous dehscencc.



b. The bent membrane is adjusted to adapt to the root morphology. Teflon suture thread (WL Gore) is used to make a sling suture, with caution taken to maintain the shape of the bent membrane.

Membrane coverage by flap

c9-7 Suture.



The flap is displaced coronally to cover the membrane completely. After a sling suture is made, an interrupted suture in the vertical incision area is prepared. In this case, the thread is passed over the contact point and the flap lifted for suture and ligation. No periodontal dressing is used.

Key point

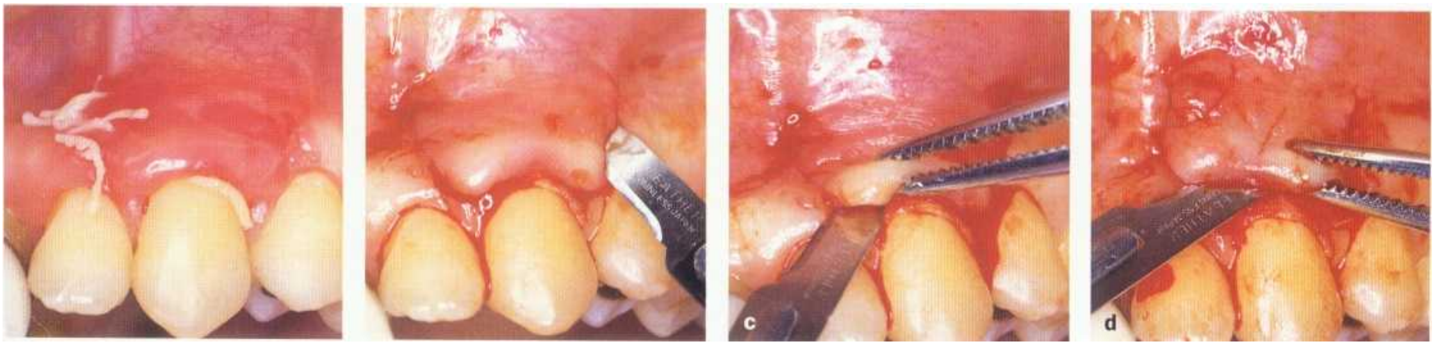
If the flap is not covered adequately, make a releasing incision of periosteum (partial-thickness) apical to the flap to release tension and to facilitate coronal migration. Be careful not to press the bent membrane Nvhile suturing. Suture from the interdental area adjacent to the membrane, then close the vertical incision area.

Prognosis and postoperative management

c9-8 Management until membrane removal.

a. Nine days after surgery the patient was instructed to rinse frequently with a mouthwash and, starting the day after surgery, to brush with an ultrasoft brush. Until the membrane is removed, weekly professional tooth cleaning in the surgical area is required.
b. Fifteen days after surgery. The collar of the distal interdental papilla is slightly exposed.
c. A loose thread in the interdental papilla is removed.

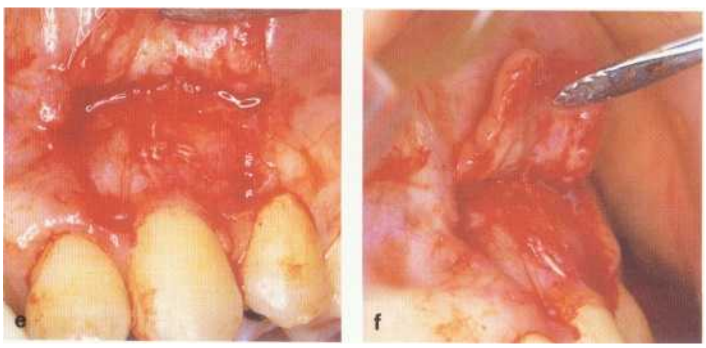
c9-9 Secondary surgery.



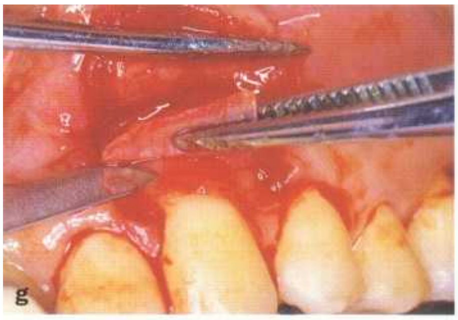
a. Four weeks after surgery.

b. An incision is made along the primary incision line and the tissue reflected to expose the membrane.

c, d. A no. 15 blade is used to refect and reflect the flap gently. The flap margin is held with tissue pliers to reflect the epithelium from the membrane without membrane fragmentation. The flap should never be reflected with one stroke of a periosteal elevator.



e, f. After flap reflection, the membrane's bent shape is maintained.

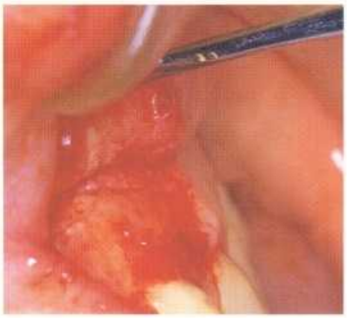


g. Small tissue pliers are used to hold the membrane for removal. A no. 15 blade is used to separate and remove the membrane from the new tissue, with caution taken to avoid damage to the new tissues.

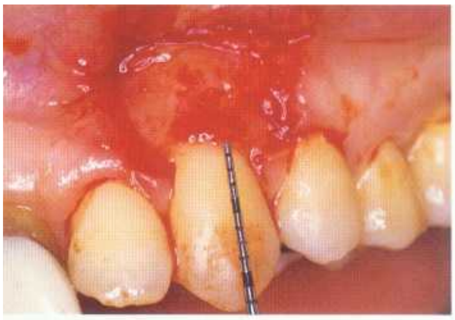
h. Removed membrane.

Key point

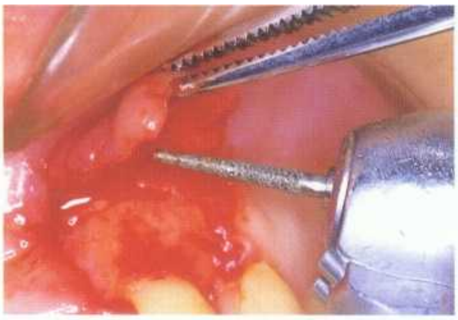
If the new tissue is not covered by the flap completely, loss of regenerated tissue will occur. In such cases, make a releasing incision of the periosteum apical to the flap. In a secondary surgery, place the flap to the level of the CEJ and suture.



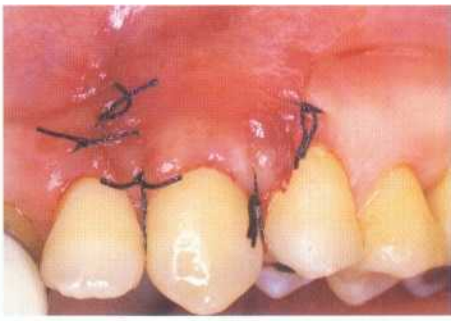
i, j. Note the red, solid new tissue completely covering the previously exposed root to the level of the CEJ.



k. The new tissue is solid and resistant to probing pressure. The attachment gain measured by probing is 7 mm.



l. A diamond bur is used to remove the epithelium covering the inside of the flap. Contact of the fresh connective tissue and regenerated tissue should be made.



m. The new tissue is completely covered by the flap. The suture is made with a 4.0 silk thread. The periodontal dressing remains in place for 1 week.

Prognosis

c9-10

a. The patient may brush with an ultrasoft brush. At suture removal 1 week after surgery.

b. Two weeks after surgery.

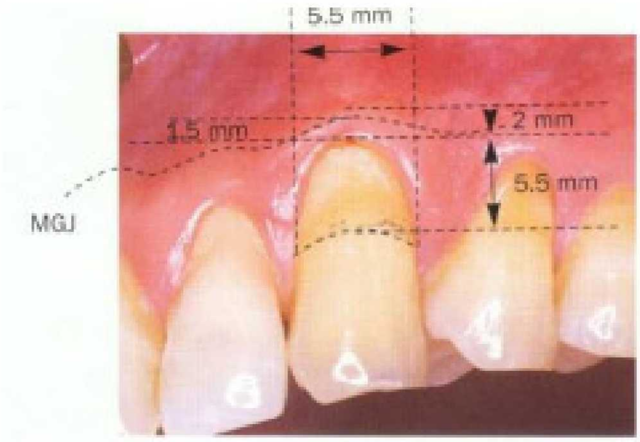
c. Four weeks after surgery.

d. About 5 months after surgery.

e. About 8 months after surgery.

f. About 20 months after surgery.

Case 6-10 Treatment of wide and deep gingival recession using GTR



Class II gingival recession.

Note the deep and wide gingival recession on 11. The mesiodistal dimension of the interdental papilla between 10 and 11 is very narrow, making incision difficult (56-year-old man).

c10-1 Preparation of trapezoidal flap. Note the 8 mm osseous dehiscence from the CEJ to the bone crest on flap reflection.

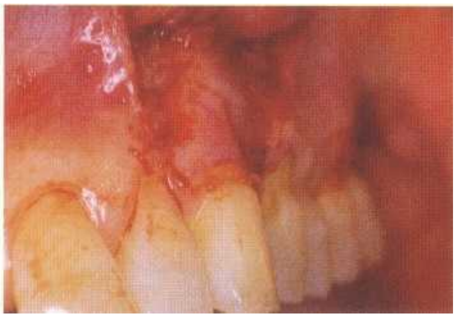
c10-2 Root preparation. A curette and root planing bur are used to reshape the root surface and to prepare the exposed root concavity.

c10-3 Membrane suture. A suture of the bent nonabsorbable membrane is made with Teflon at the CEJ and stabilized.

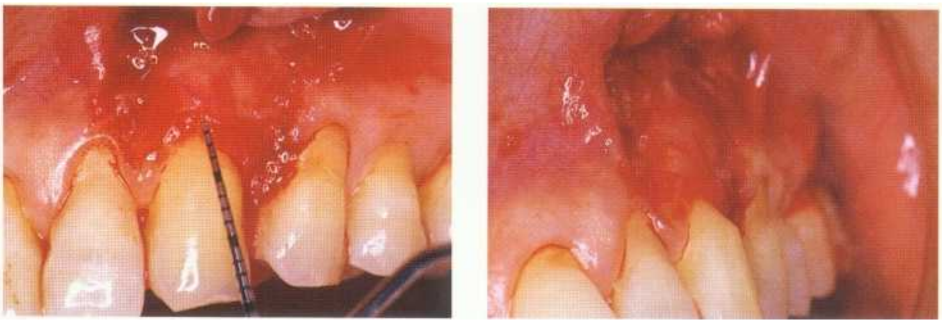
c10-4 Flap suture. The flap is displaced coronally for complete membrane coverage.

c10-5 Secondary surgery.

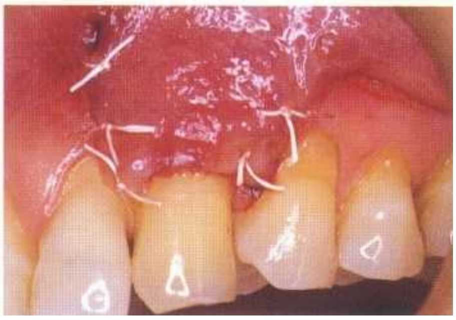
a. One month later, the collar portion of the membrane is exposed.



b. The membrane maintains its bent condition on flap reflection.



c. Note the red, solid new tissue covering the CEJ after membrane removal.



d. The regenerated tissue is completely covered with the flap and sutured coronally.

Prognosis

c10-6 Prognosis.

a. Three months after secondary surgery.

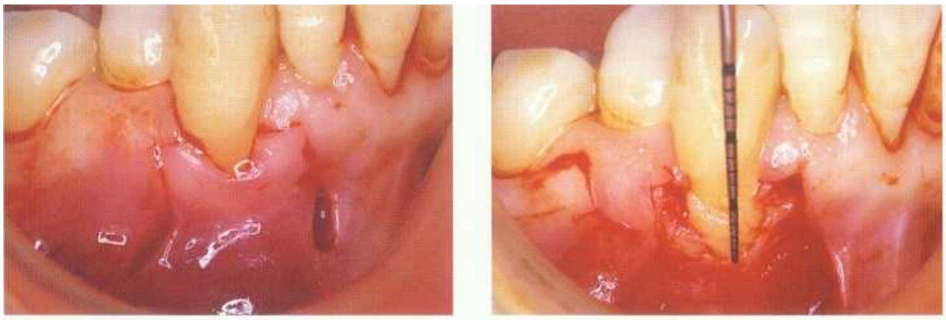
b. Twenty months after secondary surgery.

Case 6-11 GTR for gingival recession on a buccally malpositioned canine

Class II gingival recession.

The patient, a 44-year-old woman, complained of hypersensitivity limited to 27, which is buccally malpositioned and has 3.5 mm gingival recession. The height of the interdental papilla is coronal to the CEJ. There is no interdental bone loss (Miller Class II). Because 27 is severely buccally malpositioned, root coverage is difficult with conventional methods.

GTR

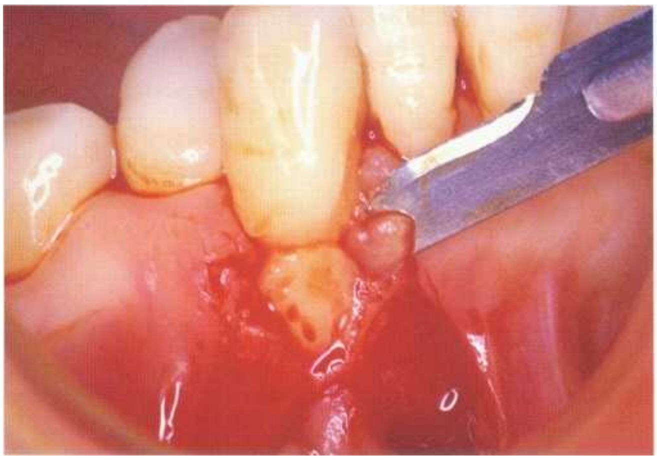


c11-1 Preparation of trapezoidal flap. Note the 7 mm osseous dehiscence from the CEJ to the bone crest.

c11-2 Root planing and preparation of concavity.

a. A curette and root planing bur are used for root planing from the CEJ to the bone crest.

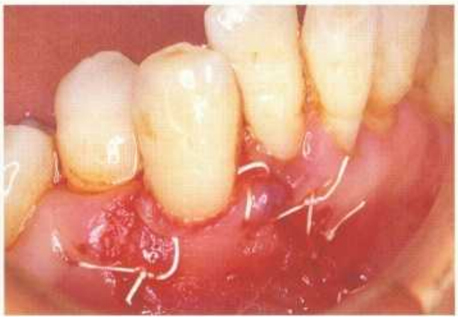
b. Because 27 is malpositioned buccally, more space under the membrane is required for regeneration. A marked concavity is created on the root and the root surface shaped to be lower than the level of the adjacent bone margin.



c11-3 Removal of interdental papillary epithelium. The interdental papillary epithelium is removed and tetracycline (125 mg/mL) applied for 3 minutes for root preparation.

Key point

When the osseous dehiscence is completely covered, use Teflon suture material for a sling suture. The Teflon thread used to bend the membrane should rest on the bone (apical to the recession) and not on the tooth. This thread is used to bend the membrane. This technique preserves space and avoids damage to the new tisstue on membrane removal.



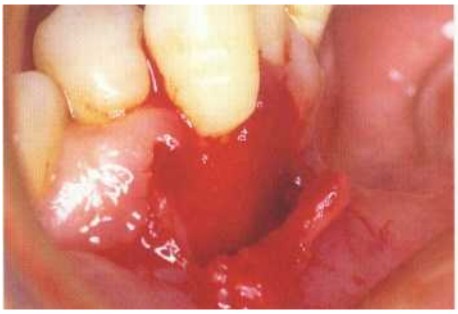
c11-4 Suture of membrane and flap. The nonresorbable membrane (WL Gore) bent by the suture thread is placed on the root surface. The membrane collar is positioned more than 1 mm coronal to the CEJ.

c11-5 Flap penetration. Twenty-three days after surgery. Note the exposure of the membrane collar and flap penetration on the mesial aspect.

ell-6 Secondary surgery.

a. Twenty-nine days after surgery. Note the flap penetration on the mesial and distal aspects.

b. An incision is made from the mesial aspect to the incision line of the initial surgery to avoid flap penetration.



c. After membrane removal. Note the new red tissue covering the root surface to the level of the CEJ on which root planing was performed. The new tissue is thicker than usual because of the concavity provided on the root **and** the bent membrane.

d. The regenerated tissue is completely covered by the flap.

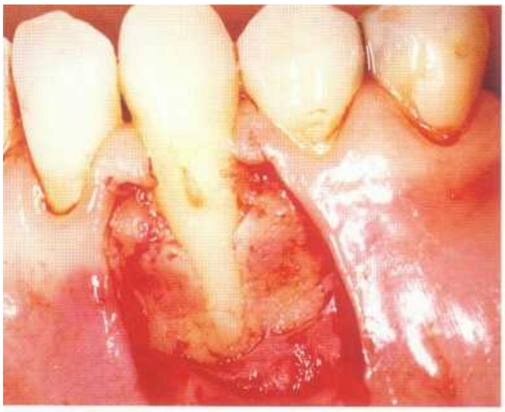
Prognosis

c11-7 Prognosis.

a. Two weeks after surgery.

b. Fifteen months after surgery.

Case 6-12 Bone regeneration on the labial surface using GTR



Before GTR. Note the marked osseous dehiscence on the buccal aspect.

About 14 months after GTR. Note the 6-6.5-mm bone fill on re-entry.

c12-1 Bone regeneration using GTR.

Preoperative.

Postoperative.

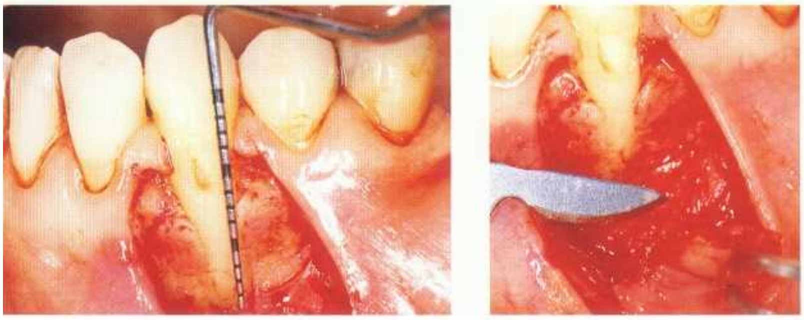
c12-2 Root coverage. Note the wedge-shaped defect on the cervical area and the root caries limited to 22 (48-year-old woman).

Flap preparation for GTR

c12-3 Preparation of trapezoidal flap. After root preparation following the usual method (see Case 6-9), a trapezoidal flap is prepared. A sulcular incision and a horizontal incision are made to connect the vertical incisions.

Key point

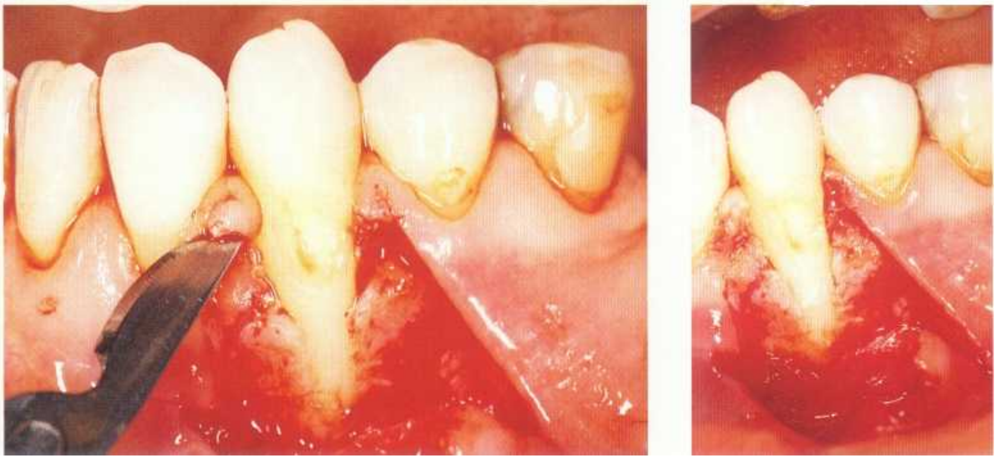
Make the vertical incision more than 0.5 mm from the gingival margin of the adjacent tooth to prevent damage to it.



c12-4 Apical releasing incision of the periosteum. On full-thickness flap reflection, the 12 mm osseous dehiscence from the CEJ to the bone crest is noted. A full-thickness flap is prepared apically and laterally 2-3 mm from the osseous dehiscence. A partial-thickness flap is then prepared apically.

Key point

Coronal migration of the flap to cover the membrane is more difficult in the mandible than in the maxilla. Prepare a releasing incision of the periosteum apically to avoid flap tension during suture.



c12-5 Removal of interdental papillary epithelium. The bilateral interdental papillary epithelium remaining coronal to the horizontal incision is removed. Care is taken to avoid reducing the height of the interdental papilla. Note the exposed connective tissue and the preparation of the recipient site when displacing the flap coronally.

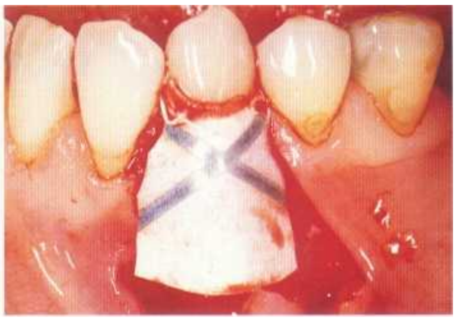
Trimming of membrane and suture

c12-6 Trimming of TR membrane.

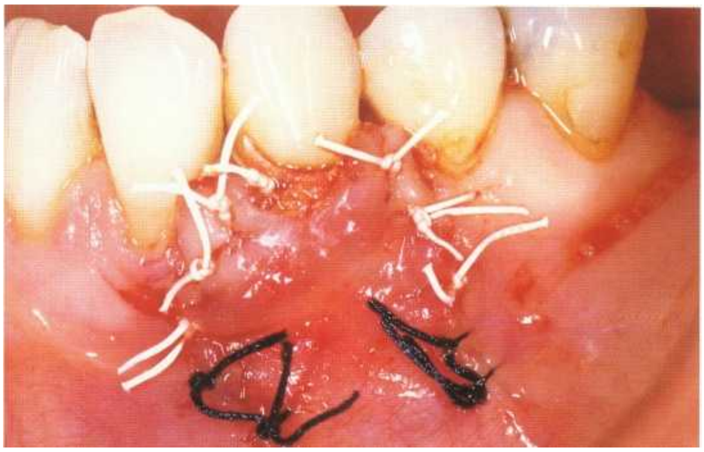
a. The TR membrane possesses formability.

b. When suturing the membrane, placing it too coronal makes it difficult to cover the flap. The membrane should be large enough to cover 2-3 mm of the buccal bone margin. The membrane may require trimming.

c. The titanium frame is bent to create space under the membrane.



d. The suture thread pierces the collar part of the membrane to position the coronal margin of the membrane on the enamel. It is stabilized with a sling suture.



c12-7 Suture. The flap is displaced coronally to cover the membrane without tension, and an interrupted suture is made with Teflon. After flap suture, a part of the membrane collar is exposed. It is difficult to cover the membrane completely with the flap in the mandible.

Prognosis

c12-8 Prognosis.

a. One week after surgery.

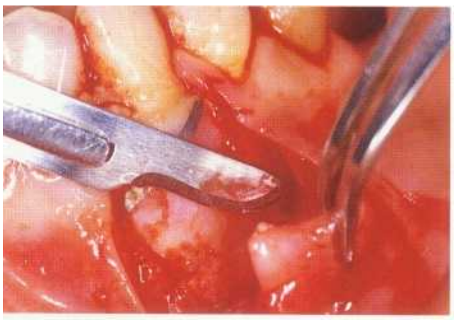
b. Thirteen days after surgery. All suture material is removed.

c. Four weeks after surgery. Membrane exposure is increasing.

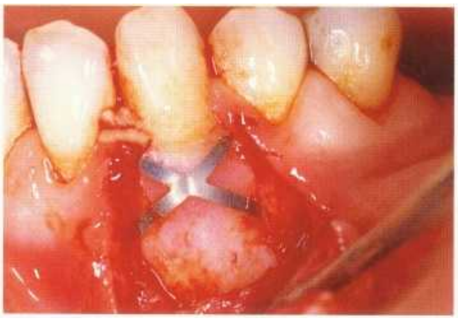
d. Five weeks after surgery before membrane removal. Membrane exposure on the membrane margin is 2-2.5 mm.

Membrane removal

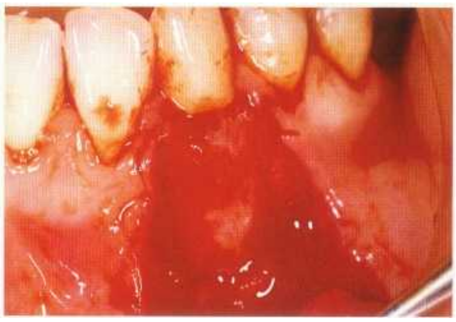
c12-9 Membrane removal.



a. A trapezoidal partial-thickness flap is prepared. Tissue pliers are used to raise the flap margin, and a no. 15 blade is used to reflect the flap from the membrane.

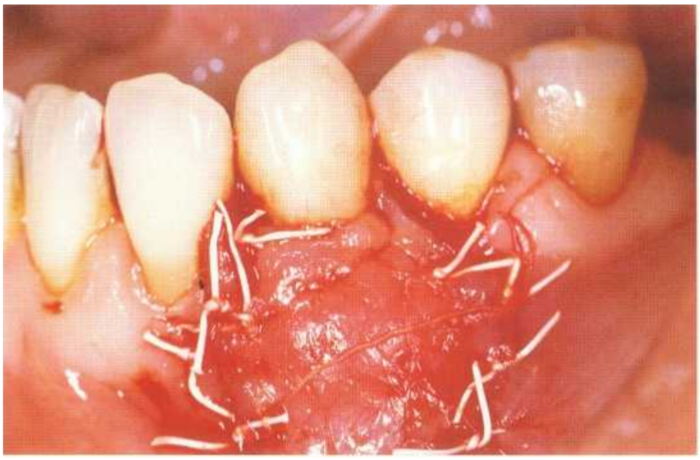


b. The TR membrane has maintained its condition (without collapse).



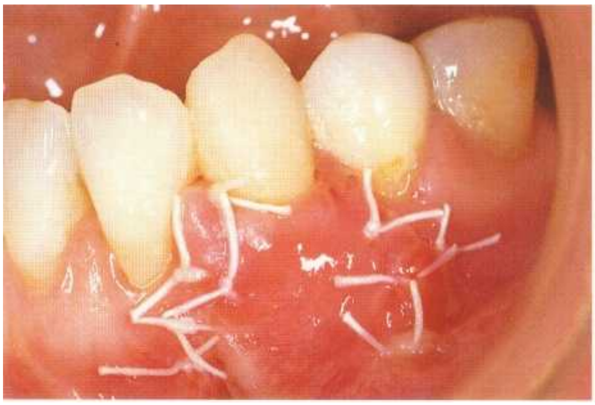
c. The membrane is removed gently without damage to the underlying new tissue. The exposed root surface is completely covered with new tissue at the CEJ. There is an attachment gain of about 12 mm. The new tissue is red on the coronal side of the exposed membrane but white apically.

c12-10 Suture. Postoperative exposure of the new tissue brings a recurrence of gingival recession. The flap therefore is displaced coronally to completely cover the new tissue with care to avoid tension. The flap is positioned at the CEJ and sutured.



Prognosis

c12-11 **Prognosis.**



a. Six days after membrane removal.

b. Three weeks after membrane removal.

c. About 7 months after membrane removal.

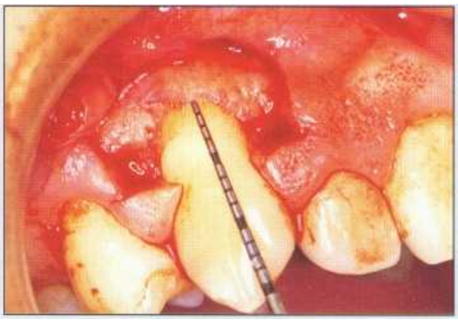
Achieving Optimal Esthetic Results in the Treatment of Gingival Recession

Comparison of GTR and Connective Tissue Grafts

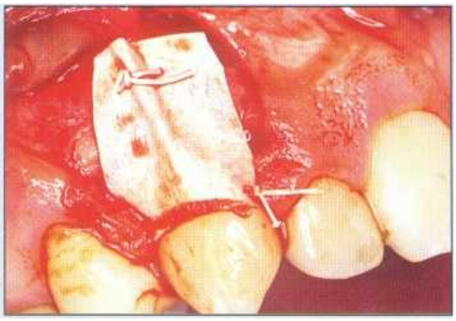
in deep and wide gingival recession or where the gingival recession area is protrusive, either GTR or connective tissue graft may be the choice of treatment. There is no difference in postoperative esthetics, and both procedures require a similar level of surgical skill.

Fig 6-19 GTR and connective tissue grafts.

a. A 27-year-old man with Class I, wide gingival recession. GTR is the treatment of choice for root coverage because the width of the keratinized gingiva is 4 mm.



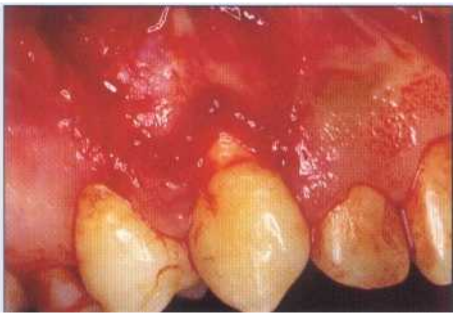
b. After trapezoidal full-thickness flap reflection. The distance from the CEJ to the bone crest is 6 mm.



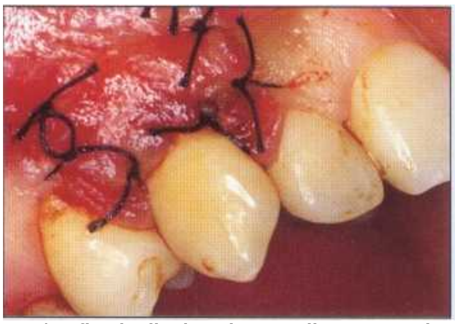
c. A single, narrow, X-large membrane is placed and stabilized,

d. The flap is displaced coronally and sutured.

e. One month after surgery, before membrane removal. A part of the membrane is exposed coronally.

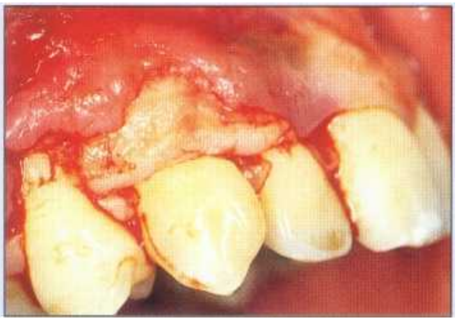


f. New tissue is evident on membrane removal. The distance from the CEJ to the new tissue is 2 mm.



g. The flap is displaced coronally to cover the new tissue.

h. One week after surgery. Root coverage is unsuccessful.



i. Six months after GTR. Subepithelial connective tissue grafts are placed.

j. Six months after the placement of subepithelial connective tissue grafts.

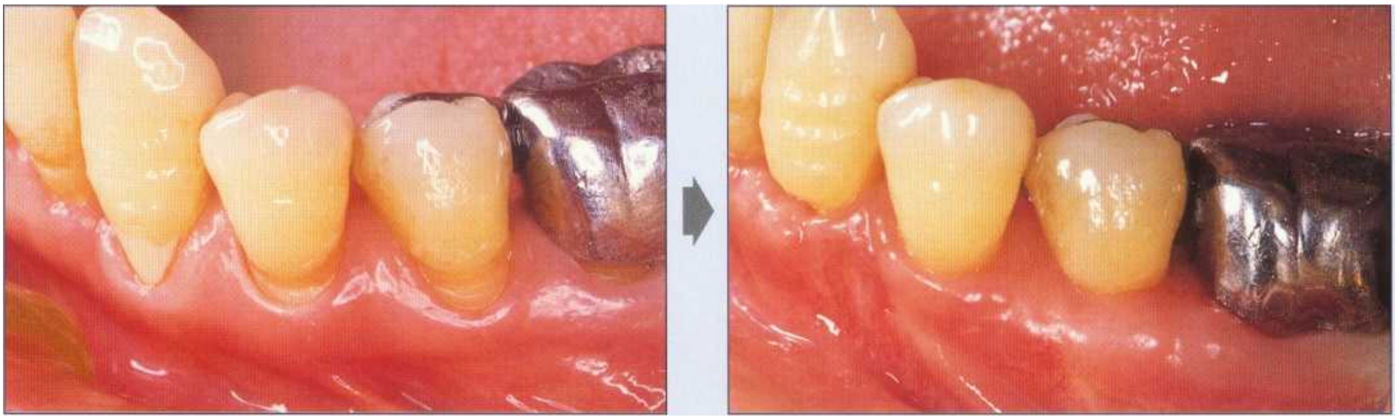
Connective tissue grafts may be used in cases of gingival recession on multiple teeth. However, it is impossible to treat gingival recession on multiple teeth at once in GTR. Also, GTR should not be performed if there is insufficient keratinized gingiva because adequate keratinized gingiva is necessary in GTR. With GTR, a donor site is unnecessary, but a secondary surgery is necessary. The regeneration of tissue in areas of gingival recession should be the goal of therapy. The technique of GTR for this purpose has been established. However, there are challenges in regard to this technique, such as spacemaking ability. It is also difficult to maintain and to completely cover the membrane and new tissue with the flap after membrane removal.

As Fig 6-19 shows, membrane exposure may occur when the membrane is not completely covered with the flap. In this case, there was also tension when the new tissue was covered after membrane removal and the patient smoked.

Hence, new attachment or bone regeneration (Case 6-12) may be achieved with GTR, but the results are not certain and results may depend on the area. Therefore, it may be necessary to perform connective tissue grafts or other complementary procedures (Fig 6-20).

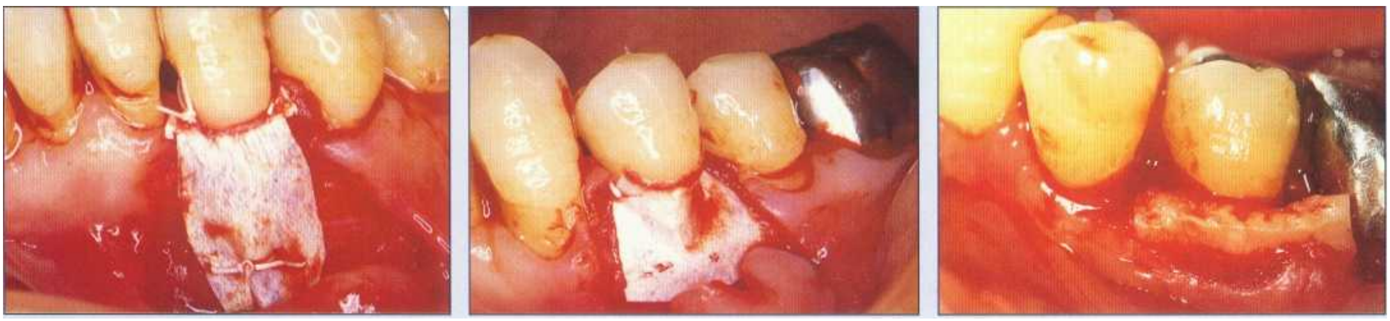
In Case 6-13, the postoperative esthetics of GTR and connective tissue grafts, for the treatment of gingival recession and an osseous defect in the same patient, are compared.

Fig 6-20 GTR and connective tissue grafts.



a. Note the gingival recession on 20, 21, and 22 (44-year-old woman).

b. Fifteen weeks after surgery on 22, about 1 year after surgery on 21, and 10 weeks after surgery on 20.



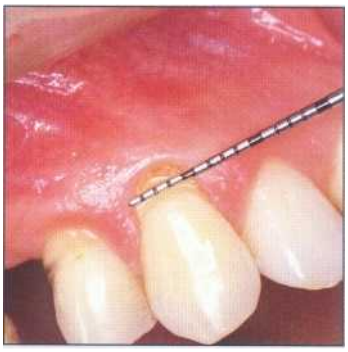
c. The membrane is bent with suture thread. Right, buccal aspect of 22 and 21.

d. Subepithelial connective tissue graft (buccal aspect of 20).

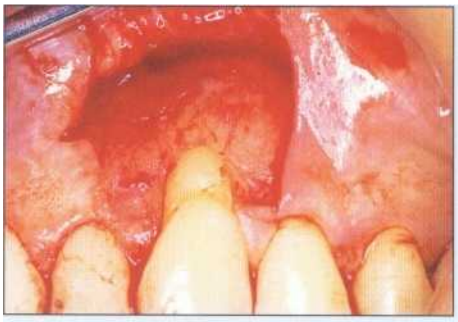
Case 6-13 Comparison of GTR and connective tissue grafts for gingival recession

GTR

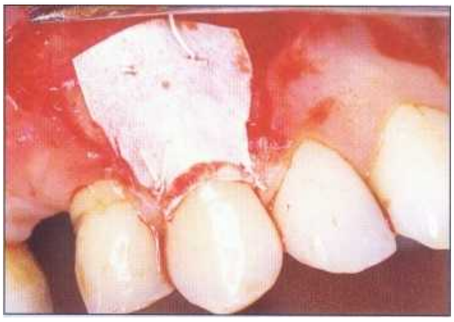
Connective tissue graft



c13-1 **Gingival recession preoperatively.** Maxillary right and left canine (44-year-old woman).



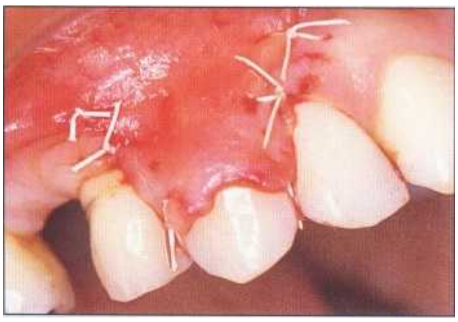
c13-2 **Flap reflection.** The osseous dehiscence from the CEJ to the bone crest is 5 mm on 6 and 11.



Suture of membrane.

Suture of connective tissue graft.

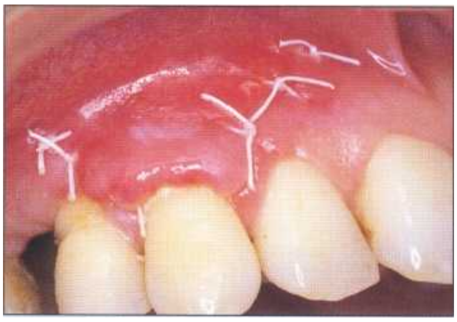
c13-3 Suture.



c13-4 Suture of flap coronally.

c13-5 Prognosis.

GTR | **Connective tissue graft**



One week after surgery.

One week after surgery.

About 1 month after surgery
at the secondary surgery.

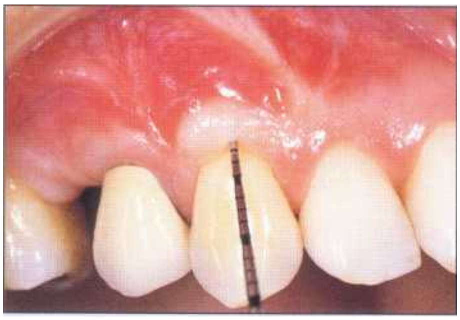
About 1 month after surgery.

C _ year and 9 months after surgery.

About 1 year and 7 months after surgery.

Three years and 4 months after surgery.

Three years and 6 months after surgery.



Three years and 4 months after surgery.

Three years and 6 months after surgery.

Treatment of Mild Gingival Recession and Interdental Papillary Recession

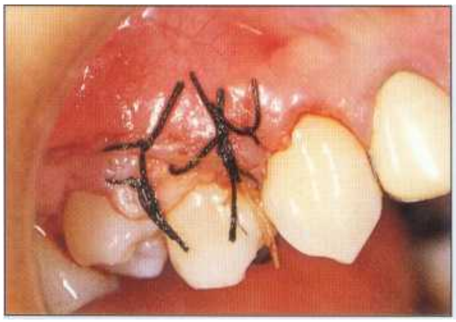
There is no certain surgical procedure for interdental root coverage and in areas where interalveolar septa is lost (Class III or Class IV recession). However, in areas where the interdental gingiva is at the level of the CEJ, a semilunar coronally positioned flap may be used as a simple and minimally invasive treatment, if the width and thickness of the attached gingiva is sufficient and gingival recession is mild (Fig 6-21). This procedure, coronally positioned flap surgery, was introduced by Tarnow.

Fig 6-21 Semilunar coronally positioned flaps.

a. Preoperative status.

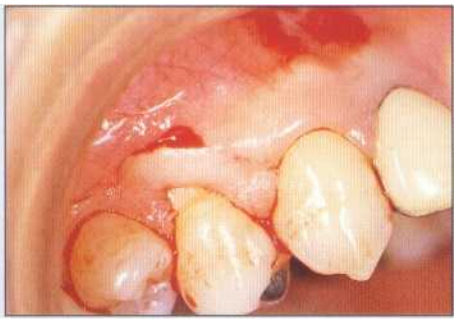
b. A round bur is used to remove the tooth structure defect. **Thorough root planing is performed to reshape the root and** a partial-thickness envelope flap is prepared. Little interdental papilla remains on the distal aspect of 5. There is a 5-mm **osseous dehiscence from the CEJ to the bone** crest.

c. Palatal tissue is thin donor tissue. The graft includes glands and adipose tissue.



d. Suture of flap. The coronal part of the graft with a narrow band of epithelium is exposed.

e. About 6 months after surgery. Some gingival recession, which is 2 mm from **the CEJ to the gingival margin, remains on the distal** aspect. The attachment level is 3.5 mm, with a 1.5-mm attachment gain. There is a 1.5-mm increase in the width of the keratinized gingiva.



f. The thicker gingiva produced by the graft is used to prepare a partial-thickness semilunar flap.

g. Coronal migration of flap.

h. Two months after surgery. There is no hypersensitivity.

Figure 6-21 shows root coverage treatment for a wedge-shaped defect with cervical caries and marked hypersensitivity. The interdental papilla is almost at the level of the CEJ because of the narrow distal interdental papilla due to the buccal malposition of 4 (Class III recession). The extent of the gingival recession is 4 mm, but the condition for root coverage is unfavorable because there is insufficient keratinized gingiva. In such situations, complex treatment is necessary. In this case, a semilunar coronally positioned flap was performed after connective tissue grafting.

Semilunar coronally positioned flaps may also be used as a method in the treatment of mild gingival recession (Fig 6-22). Coverage of the exposed margin is possible if marginal adaptation is good and root planing of the exposed root is performed.

Fig 6-22 Management of mild gingival recession using semilunar coronally positioned flaps.

a. The cervical area of the porcelain-fused-to-metal restoration on 8 is exposed.

b. Root planing of the exposed root.

c. Incision of the semilunar flap.

d. Reflection of the semilunar partial-thickness flap.

e. Coronal migration of the semilunar flap. A connective tissue graft is placed apical to the flap.

f. Nine months after surgery.

Table 6-19 Root Coverage Using Semilunar Coronally Positioned Flaps

Advantages

1. No tension on coronal migration of the semilunar flap.
2. No narrowing of the oral vestibule.
3. Good esthetics because the height of the interdental papilla is preserved (because no incision is made to the interdental papilla and the papilla is not reflected).
4. Flap suture and periodontal dressing unnecessary.
5. Simple surgical procedure and minimal surgical time.
6. Minimal postoperative discomfort.
7. Applicable to minimal gingival recession across multiple teeth.

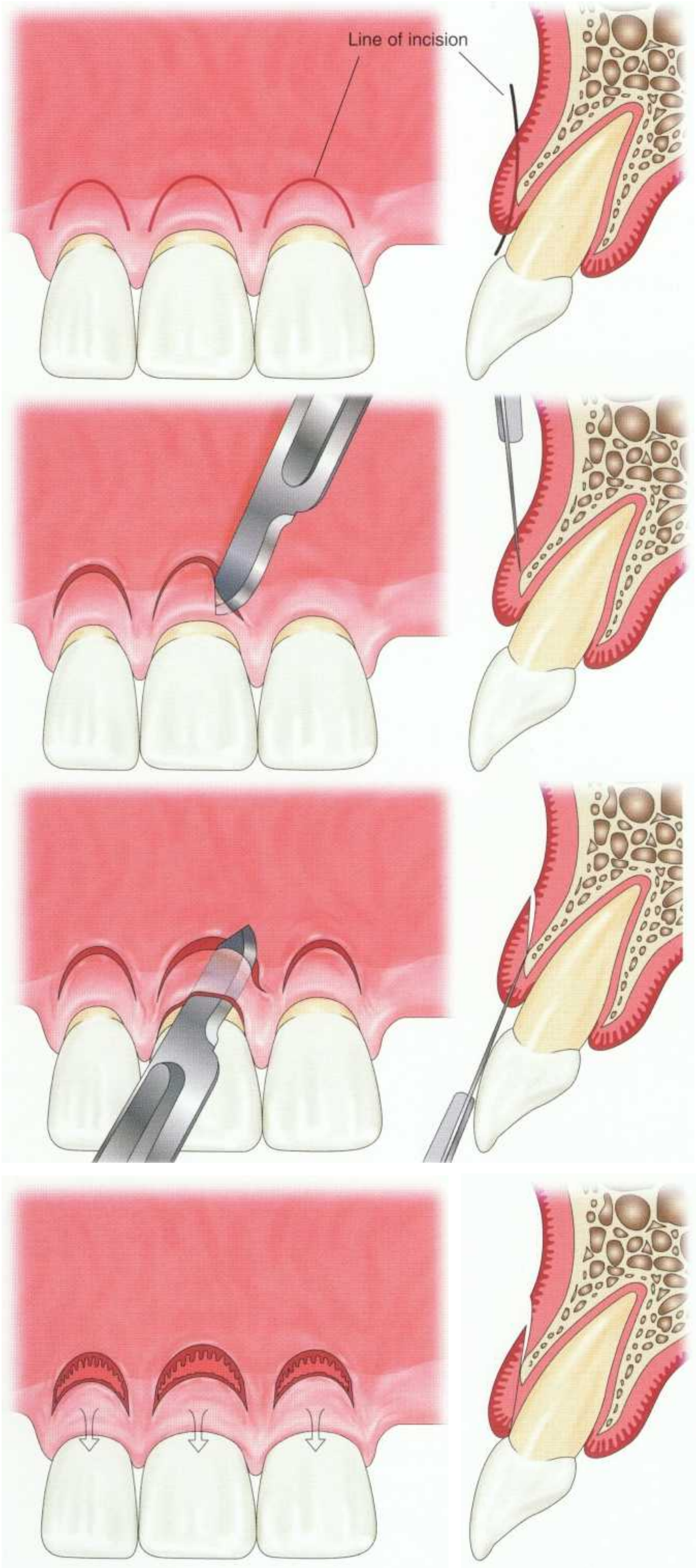
Disadvantages

1. Not applicable in cases of extreme gingival recession.
2. Thick keratinized gingiva necessary for adequate thickness of the partial-thickness flap apical to the gingival recession area.
3. Where an osseous dehiscence or fenestration exists apical to the gingival recession area, free autogenous gingival grafts or connective tissue grafts should be performed apically after coronal migration of the semilunar flap (Fig 6-22).

Indications

1. Maxillary anterior teeth and premolars with 2–3 mm gingival recession. (In mandibular anterior teeth, the center of the flap cannot be displaced coronally because the mesiodistal dimension is short.)
2. As a complementary procedure for small areas of gingival recession remaining after other procedures for root coverage. It is applicable especially to cases where free autogenous gingival grafts or connective tissue grafts are performed because thick keratinized gingiva can be used (Fig 6-21).

Fig 6-23 Semilunar coronally positioned flaps.



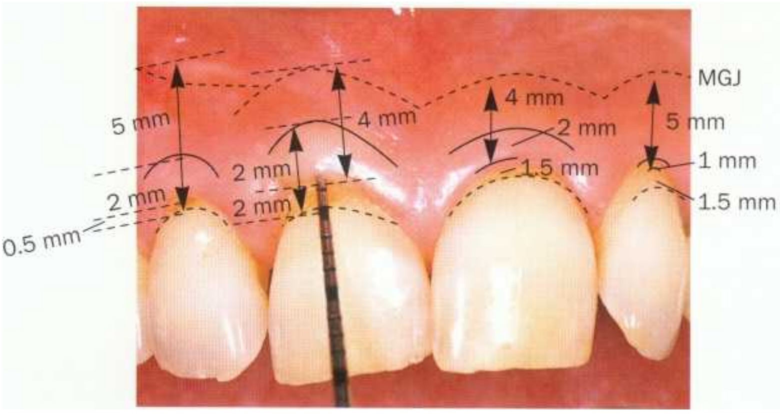
a. Prepare a semilunar partial-thickness incision. It should curve apically in its midfacial portion.

b. Make a semilunar incision coronally to both ends of the incised line. There should be more than 2 mm between the **ends of the incisions** on either side of the flap and the gingival margin.

c. Make a sulcular incision that reaches the semilunar incision. Reflect a semilunar flap.

d. Coronal migration of semilunar flap.

Case 6-14 Root coverage using semilunar coronally positioned flaps 45



Class I gingival recession.

Gingival recession is within 2 mm, the width of the keratinized gingiva is sufficient, and the thickness of the gingiva is adequate. Therefore, a semilunar flap is indicated. Note the receded distal interdental papilla of 8 (57-year-old man).

c141 Root preparation. A curette is used for planing of the exposed root. Tetracycline solution is applied for 3 minutes in root preparation.

Root preparation and incision

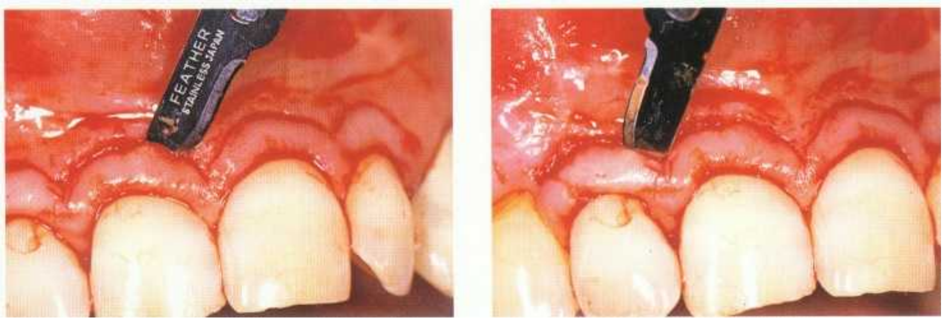
c142 Incision of semilunar flap. A no. 15 blade is used to make a semilunar partial-thickness incision along the curve of the gingival margin.

a. The incision reaches the interdental papilla. Both ends of the incised line are at least 2 mm apical to the gingival margin to maintain sufficient blood supply to the flap.

b. A sulcuiar incision is made to contact the semilunar incision and a semilunar flap is reflected. The side of the blade is used to contact the bone surface to avoid flap penetration.

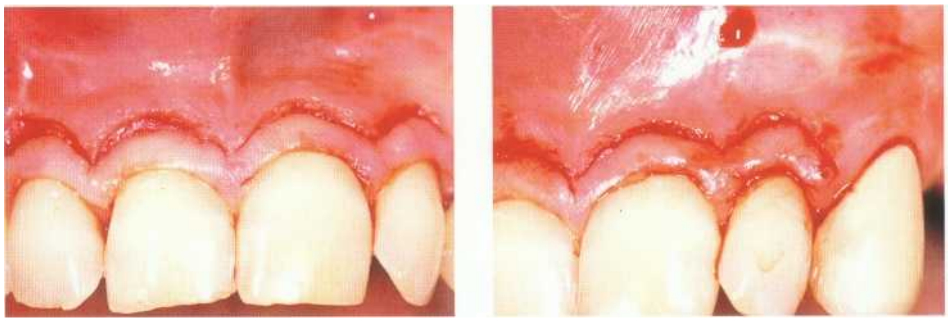
Key point

It is important that the incision is curved apically in its midfacial portion. If the width of the keratinized gingiva is insufficient, prepare 'a semilunar incision to the level of the alveolar mucosa. Turn the blade coronally. Use the blade tip to make a partial-thickness incision to each tooth without contacting the bone.



c143 Reflection of semilunar partial-thickness flap. A partial-thickness incision is again made from the semilunar incision toward the coronal aspect for complete reflection of the semilunar flap.

Coronal migration of flap

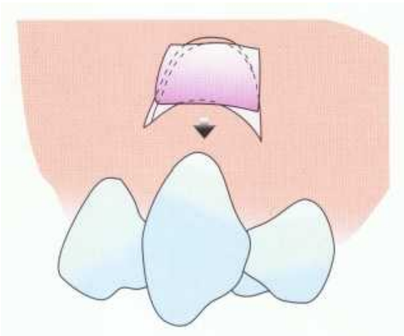


c144 Coronal migration. The center of the flap is displaced coronal to the CEJ. The biggest advantage of this procedure is that coronal migration of the flap can be achieved without tension.

c145 Stabilization. The flap is pressed with a gauze soaked with physiologic saline solution for 10 minutes. Suture and periodontal dressing are not necessary. The patient is restricted to a liquid diet for 1-2 days after surgery. To control plaque, the patient should gargle every day for 2 weeks after surgery and brush with an ultrasoft brush beginning 2 weeks after surgery for 2 months.

Key point

Where the bone surface is exposed due to thin apical gingiva in the gingival recession area, or where there is an osseous dehiscence or fenestration, place a free autogenous gingival graft or connective tissue graft.



Prognosis

c146 Prognosis.

a. Twenty-four hours after surgery.

b. Six days after surgery.

c. Thirteen days after surgery. The patient brushes with an ultrasoft brush.

d. Thirty-six days after surgery. Note the receded distal gingival margin of 8.

e. About 3 months after surgery. There is complete root coverage of 7, 9, and 10, but 8 has only partial root coverage because of the receded interdental papilla before surgery.

f. About 6 months after surgery. A semilunar flap is performed on 8 again. After incision, the flap is migrated coronally.

g. One week after surgery.

h. Nine months after surgery.

Case 6-15 Treatment of multiple root exposure


c15-1 Initial visit.


c15-2 About 2 years after initial visit.

c15-3 Root coverage in the gingival recession areas.

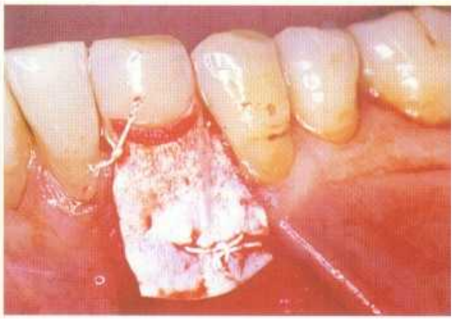
c15-4 About 2 years after initial visit. With the exception of the mandibular anterior teeth, the exposed roots are covered.

Root coverage of the maxillary and mandibular canines using GTR

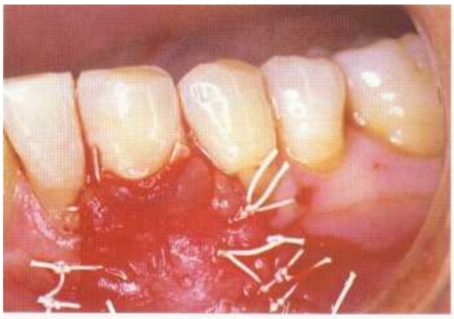
c15-5 Root coverage of 22 using GTR.

a. The gingival recession on 22 is 3.5 mm.

b. Note the 7-mm osseous dehiscence from the CEJ to the bone crest.



c. Suture of nonabsorbable membrane.



d. Suture of flap.

e. Five weeks after surgery. New tissue under the membrane on secondary surgery.

f. Suture.

g. Eight days after secondary surgery.

h. Three months after secondary surgery.

i. Seven months after secondary surgery.

c15-6 Root coverage *of 6* using *GTR.*

a. The gingival recession on 6 is 3.5 mm.

b. Flap reflection reveals a 5.5-mm osseous dehiscence from the CEJ to the bone crest. A concavity on the root surface is prepared.

c. Suture of nonabsorbable membrane.

d. Suture of flap.

e. Four weeks after surgery on secondary surgery. New tissue covers the root surface.

f. New tissue is covered by the flap.

g. About 10 weeks after secondary surgery.

h. About 14 weeks after secondary surgery.

i. About 1 year and 4 months after secondary surgery.

GTR treatment and retreatment

c15-7 Root coverage *of 27* using *GTR.*

a. The gingival recession on 27 is 4 mm.

b. Note the 6-mm osseous dehiscence from the CEJ to the bone crest. Root planing and preparation of a concavity on the root surface are performed.

c. Suture of the nonabsorbable membrane.

d. The flap is displaced coronally and sutured. The collar of the membrane is exposed.

e. Secondary surgery. The distance from the CEJ to the crest of the new tissue is 2 mm.

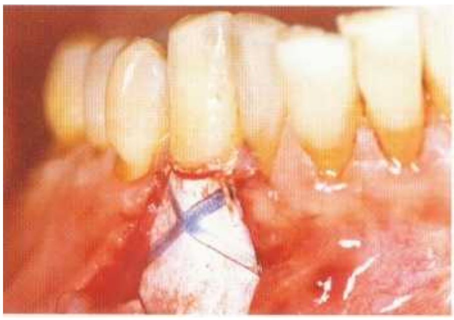
f. The new tissue is covered with the flap completely and sutured. Tension is applied to the flap.

c15-8 Retreatment with GTR using a TR membrane.

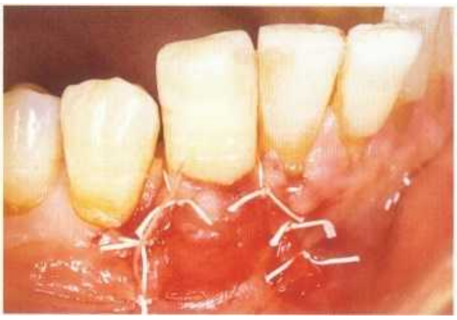
a. Nineteen days after the first GTR.

b. About 4 months after the secondary surgery. Gingival recession (2 mm remains apical to the CEJ).

c. Root coverage is performed using a TR membrane. A marked concavity is prepared on the root surface from the CEJ to the bone crest.



d. The TR membrane (TRN2, WL Gore) is sutured. This membrane is easier to shape and maintains space better than other membranes.



e. The membrane is covered completely by the flap and sutured.

f. Retreatment secondary surgery. The flap is reflected to expose the membrane.

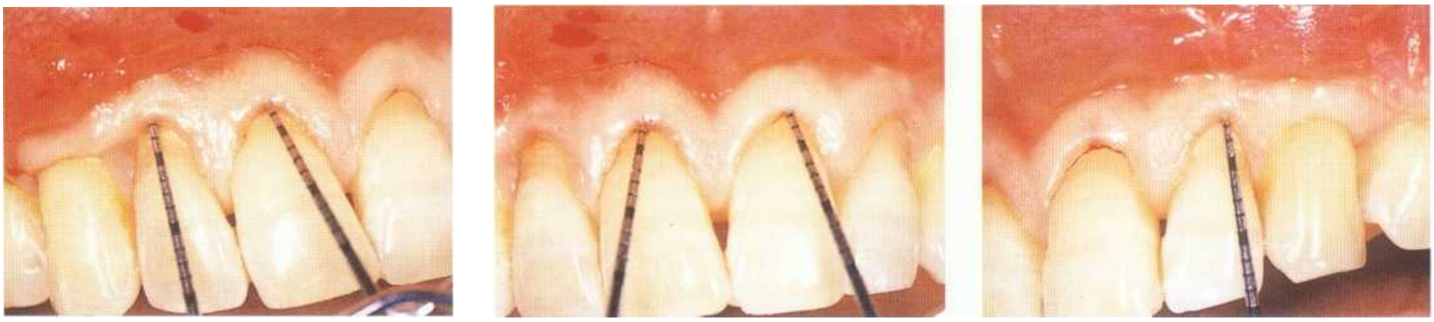
g. The new tissue covering the root surface is thicker than that gained in the previous treatment.

h. Four months after second surgery.

i. About 6 months after surgery.

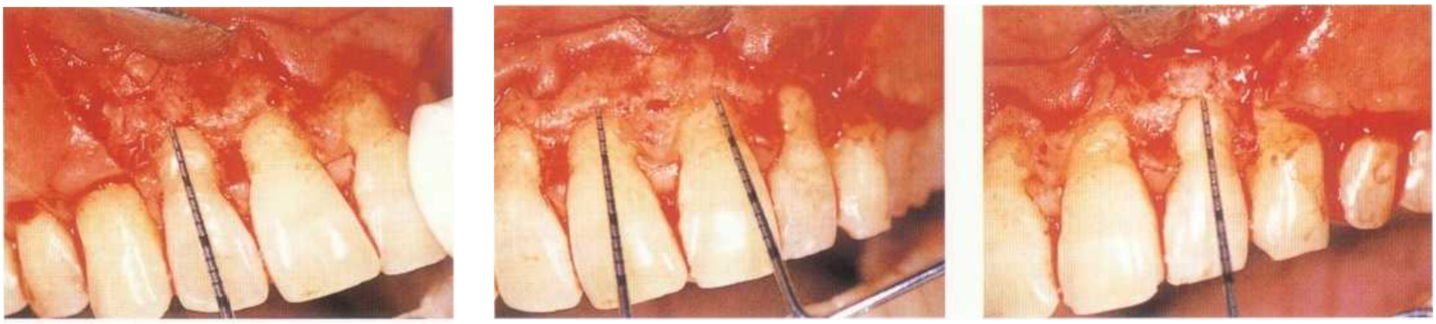
Root coverage of anterior teeth with Class 111 gingival recession

c15-9 Hypersensitivity due to extreme root exposure of the anterior teeth.

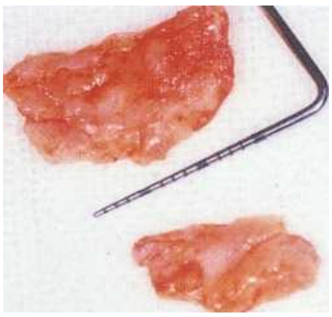


a. **The interdental papilla on the distal** of 10 and the mesial and distal aspects of 7 is narrow mesiodistally. The interdental papilla of 10 has receded.

b. After root planing, tetracycline solution is applied for 3 minutes for root preparation.



c. Partial-thickness flap reflection reveals an osseous dehiscence from the CEJ to the bone crest of 5.5 mm on 7, 4.5 mm on 8, 4.5 mm on 9, and 5mmon10.



d. Connective tissue grafts are harvested from the palate of the right and left molars.

e. Suture of connective tissue grafts. Adequate thickness of grafts cannot be obtained on the maxillary left molars because this site was used to harvest a graft for the connective tissue grafts on 12 and 13 about 5 months previously. Therefore, the thickness of the graft on 9 and 1 0 is less than usual.

f. The flap is displaced coronally to cover the graft and sutured.

g. Sixteen days after surgery.

h. About 5½ months after surgery.

i. About 1.5 mm of root is exposed on 7 and 10.

Complementary treatment for root coverage using a semilunar flap

c15-10 **Root coverage retreatment using a semilunar flap on** 10.

a. A no. 15 blade is used to prepare a semilunar flap.

b. Root coverage using a semilunar flap. The flap margin is coronal to the line of gingival margin of 9 and 11.

c. About 6 weeks after surgery.

c15-11 **Root coverage retreatment using a semilunar** flap on 7.

a. Note the 1.5-mm gingival recession on 7.

b. The semilunar flap is displaced coronally.

c. Seven weeks after surgery.

Ridge Augmentation Procedures

Edentulous Ridge Augmentation Using Soft Tissue Grafts

Ridge augmentation is a valuable periodontal plastic surgery method. In the treatment of the edentulous ridge, GBR procedures (see page 284) have recently been of special interest. Soft tissue plastic surgery, however, remains a valuable method to achieve esthetic results.

Extreme ridge defects have a variety of causes, including advanced periodontal disease, trauma to the alveolar process caused by inept extraction or during surgery, periodontal abscess, tooth fracture, developmental abnormality, trauma by accident, tumor, trauma due to poorly fitting dentures, or implant failure.

Extreme ridge resorption causes esthetic problems, especially in the maxillary anterior region. Various restorative prosthetic approaches have been attempted to solve this problem. Use of pontics with gingiva-colored base mar gins or pontics with long crown lengths are examples that have yielded poor results (Figs 6-24 and 6-25). Depending on the case, various surgical ridge augmentation procedures may be used.

Limitations of prosthetic management in the treatment of ridge deformities

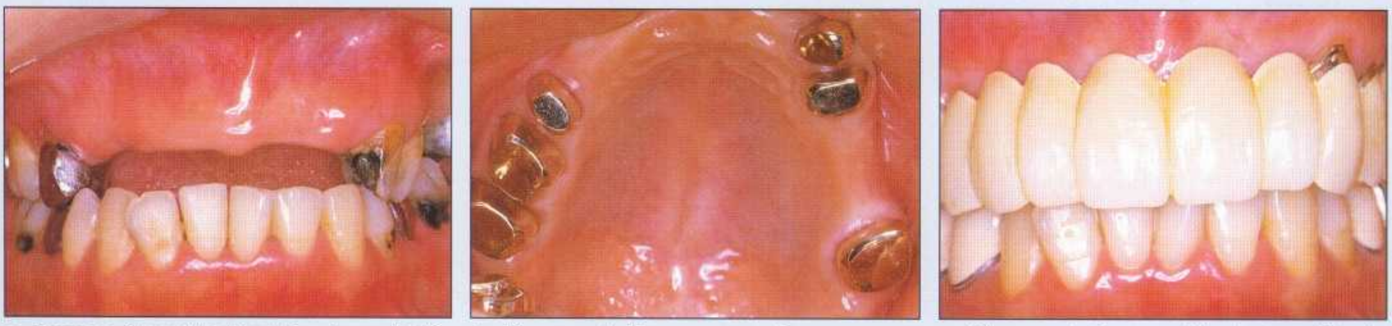
Fig 6-24 Construction of a fixed prosthesis with apical extension of the pontics and artificial gingiva to cover the deformed edentulous ridge.

a. Note the extreme vertical labiolingual Class III ridge deformity on 7, 8, and 9.

b. A fixed partial denture with three pontics with long crown length is placed.

c. Alleviation of the patient's phonetic problem is sought with artificial gingiva.

Fig 6-25 Management with a removable partial denture.



a. Extreme Class III ridge deformity on 5–10.

b. Placement of inner crown of conus crown.

c. Placement of removable denture. The interdental spaces of the pontics 5–10 are closed to contact the alveolar ridge to improve phonetics.

Table 6-20 Classification of Ridge Defects[51]	
Class I	Buccolingual loss of tissue with normal ridge height in the apicocoronal dimension
Class II	Apicocoronal loss of tissue with normal ridge width in a buccolingual dimension
Class III	Combination buccolingual and apicocoronal loss of tissue resulting in loss of normal height and width

Abrams[46] developed the connective tissue pedicle graft (roll procedure) with esthetic results. Orth and Seibert and Louis introduced a combination onlay-interpositional graft procedure, a procedure combining onlay grafts and connective tissue grafts, for the treatment of Class 11 ridge deformities. Langer and Calagna[49] introduced a method using subepithelial connective tissue grafts, Garber and Rosenberg''' introduced connective tissue graft procedures after the preparation of a pouchlike flap in the recipient site, and Seibert intro-duced a ridge augmentation procedure using full-thickness onlay grafts. As described in Chapter 5, ridge augmentation using GBR for alveolar bone regeneration is also used. '

When selecting a ridge augmentation procedure, the degree of ridge deformity should be considered (Tables 6-20-6-22).

There are various soft tissue grafts for ridge augmentation procedures. The connective tissue graft is the most valuable clinical method because it is applicable to Class I-III ridge deformities. While the author used to use onlay graft procedures, he now usually uses connective tissue grafts.

Limitations of Ridge Augmentation Using Soft Tissue Grafts

In ridge augmentation treatment using soft tissue grafts, the amount of donor tissue is limited. In extensive ridge defects, multiple surgeries are necessary, a fact of which the patient must be made aware.

Because grafts shrink postoperatively, it is necessary to predict the amount of shrinkage and to harvest grafts of sufficient dimension. The palate of maxillary premolars and first molars is suitable as a donor site because large amounts of tissue can be harvested there. To avoid the use of two donor sites, soft tissue removed during flap surgery can be used as the graft.

The size of the graft for ridge augmentation is determined by 1) morphology and degree of ridge defects; 2) necessary crown length of the pontic; 3) interdental space between the pontic and abutment and tooth axis; 4) shape of the dental arch; and 5) the patient's lip line. Therefore, provisional restorations should be placed before surgery and used as a guide for the amount and area in which recovery is expected.

The graft shrinks most in the 6 weeks after surgery, and it takes 3 months for stabilization. At least 3 months postoperative prognosis is necessary when soft tissue grafts are placed in the same area.

Presently, resolution of large ridge defects is possible by combining various ridge augmentation procedures. However, increasing the vertical dimension of the alveolar ridge remains difficult. Performing GBR after extraction may be the most effective way to prevent alveolar ridge resorption and to minimize the destruction of the alveolar osseous walls (see page 284).

Table 6-21 Ridge Augmentation Using Gingival Grafts (Onlay Graft Procedures)

Advantages

1. Vertical dimension of alveolar ridge can be obtained.
2. Simultaneous resolution of alveolar ridge defects and increase in the width of keratinized gingiva.

Disadvantages

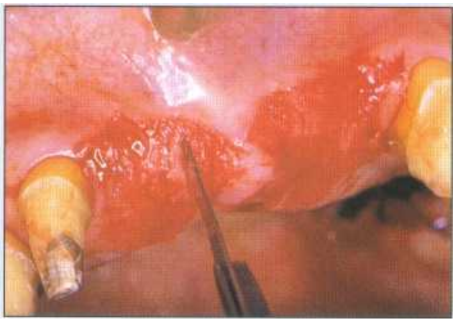
1. Reduced blood supply to the graft.
2. Suboptimal esthetics because of different colors of the graft and surrounding tissue.
3. Possible postoperative pain and delayed healing because of the open wound of the palatal tissue on the donor site.

Surgical management of ridge defects

Fig 6-26 Onlay graft procedures.

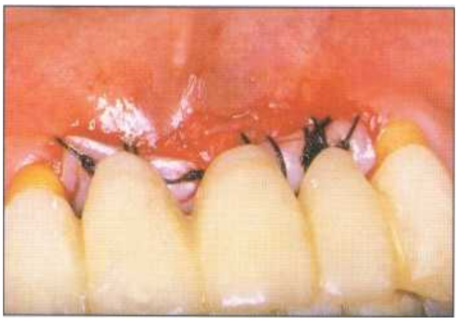
a. Forty-one-year-old man. After the completion of periodontal therapy, provisional restorations are placed. These will determine the amount and area of tissue that should be recovered.

b. The edentulous ridge has a Class III defect horizontally and vertically.

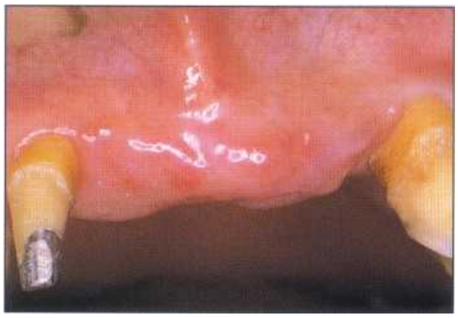


c. A blade is used to remove the epithelium of the alveolar ridge to about 1 mm in depth. The recipient site where the connective tissue will be placed is prepared carefully, with preservation of maximal connective tissue to ensure adequate blood supply. A bevel is made on the recipient site margin. Many **deep cuts are made on the surface of the alveolar ridge.**

d. The full-thickness free autogenous gingival grafts harvested from the palate are sutured.



e. The base of the pontic is reduced to avoid a delay in healing due to pressure on the surgical area.



f. Two months after surgery.

g. Provisional restorations over inner crowns 4 months after surgery.

h. Six years and 4 months after presentation.

i. Ten years and 5 months after presentation.

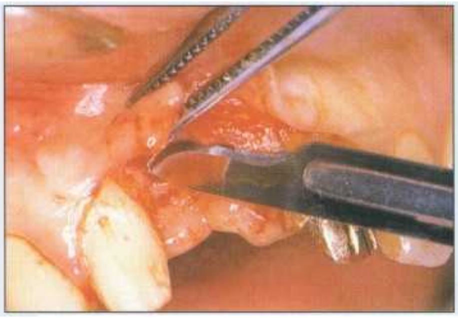
Table 6-22 Indications of Ridge Augmentation Procedures Using Soft Tissue Grafts

Indicated procedure	Ridge defect
Connective tissue pedicle grafts (roll procedure) (Abrams[46])	Class I defect
Connective tissue grafts pouch method (Garber and Rosenberg[50])	Class I defect
Subepithelial connective tissue grafts (Langer and Calagna[49])	Class I defect, mild–moderate Class II–III defect
Gingival grafts full-thickness onlay grafts (Seibert[51,52])	Severe Class II, Class III defect
Combination onlay–interpositional grafts (Orth[47] and Seibert and Louis[48])	Severe Class III defect

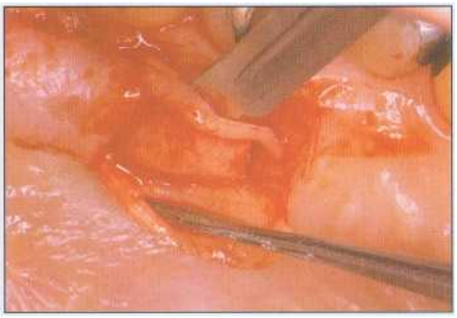
Surgical management of alveolar ridge defects

Fig 6-27 Connective tissue grafts.

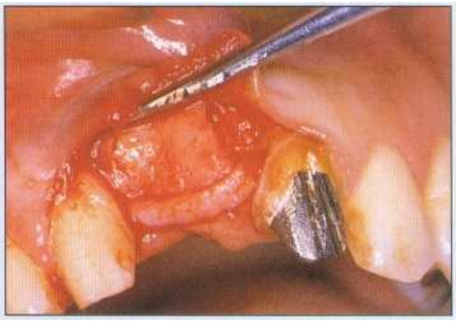
a. Four months after extraction due to root resorption. The resorption of the edentulous ridge is exceptional.



b. A partial-thickness horizontal incision is prepared on the alveolar crest. It is connected with a sulcular incision to enable flap reflection. A solid and nonmobile periosteum-connective tissue recipient site is prepared.



c. A wedgelike connective tissue graft consisting of epithelium-connective tissue with epithelium on the margin of the palate is harvested.



d. Increasing the height of the alveolar ridge is not necessary in this case. Therefore, the epithelial surface of the wedgelike graft is placed at the same level as the surrounding epithelium of the recipient site.

e. The connective tissue graft is placed to increase the alveolar ridge horizontally.

f. The graft is covered by flaps and sutured.

g. Three weeks after grafting.

h. One year and 1 month after grafting, a fixed partial denture is placed.

i. Twelve years and 4 months after presentation, and 5 years and 1 month after the ridge augmentation procedure using a connective tissue graft.

Table 6-23 Ridge Augmentation Procedures Using Connective Tissue Grafts

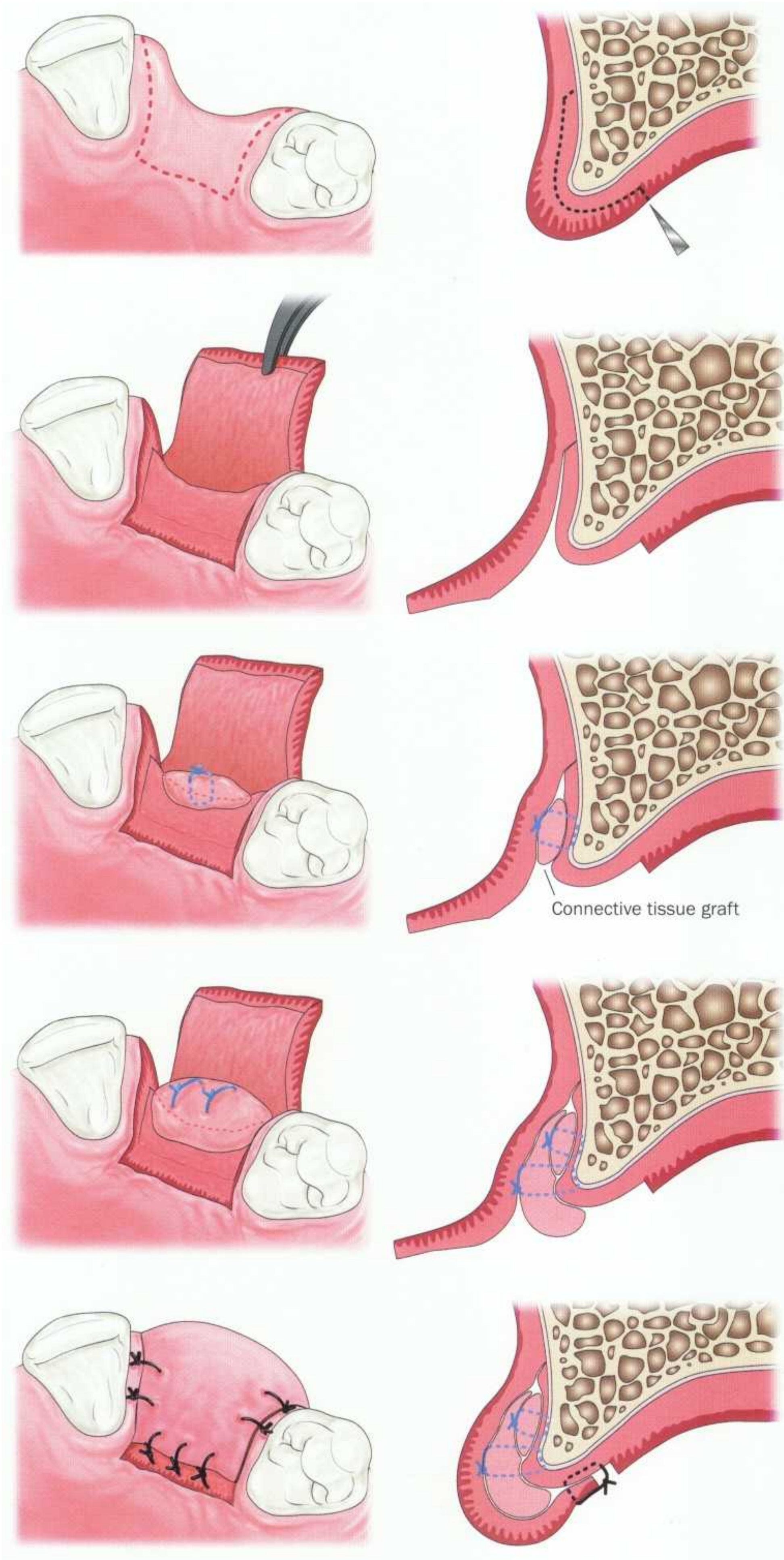
Advantages
1. Excellent blood supply to the graft because the graft receives blood from the periosteum–connective tissue recipient site and the flap.
2. Ability to obtain initial wound closure of surgical area.
3. Easy stabilization of the graft due to the periosteal suture.
4. Faster healing than the onlay graft procedure.
5. Easy hemostasis and less postoperative pain and discomfort because of closed wound at the donor site.
6. Color match of the surrounding tissue.
7. Applicable to Class I, II, and III alveolar ridge defects.
Disadvantages
1. Technically demanding.
2. Less increase of alveolar ridge height compared to onlay graft procedures.
3. Reduction of keratinized gingiva likely because the mucogingival junction becomes more coronal (because the flap is displaced coronally to cover the graft in some cases).

Needless to say, the periodontal environment of the adjacent abutment teeth should not be compromised by plastic surgical procedures. The foremost goal is the improvement of the periodontal environment.

Soft tissue graft considerations:

- Ensure optimal blood supply to the flap and graft.
- Resolve adjacent periodontal pocket and osseous defects before treatment.
- Preserve sufficient width and thickness of the attached gingiva on adjacent abutment tooth.
- Do not put pressure on the grafted tissue with a periodontal dressing or provisional restorations. Do not let the patient wear denture for 1 week after surgery.
- Pressure should be avoided because severe swelling may occur 1 week after soft tissue grafting.

Fig 6-28 Ridge augmentation using connective tissue grafts.



a. Make a partial-thickness horizontal incision to the palatal side from the alveolar crest. Connect it to vertical incisions extending buccally on either side of the ridge.

b. Reflect the flap with partial-thickness.

c. Suture and stabilize the connective tissue graft harvested from the palate.

d. Suture and stabilize the connective tissue graft to increase the vertical dimension.

e. Replace the flap and make an interrupted suture. In this procedure, the flap covers the donor tissue. The bulk created by the donor tissue under the flap creates a gap, exposing the underlying connective tissue. However, do not make a mattress suture that can result in flap tension.

Case 6-16 GBR and connective tissue grafts for ridge deformities

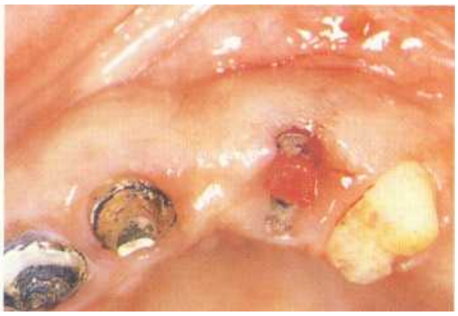
c16-1 Initial visit. There is a 14 mm periodontal pocket on the buccal aspect of 11 (40-year-old woman).

c16-2 After initial therapies. The provisional restorations reflect the planned occlusal plane.

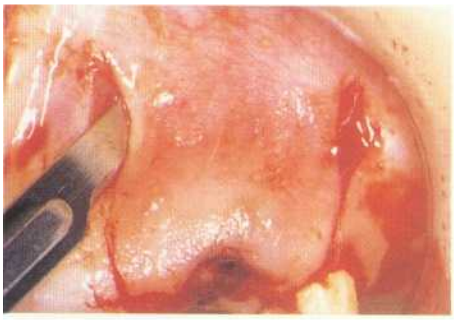
GBR immediately after extraction for preservation of the alveolar ridge

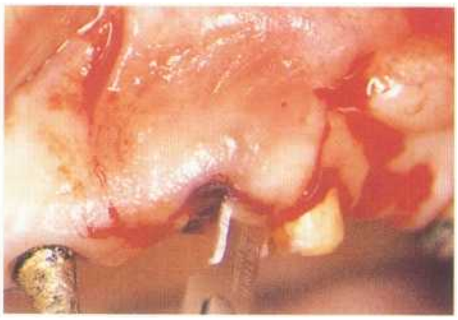
c16-3 Flap design in *GBR* immediately after extraction.

a. Before extraction (buccal aspect).

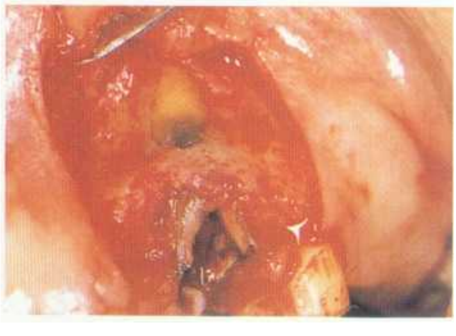


b. Before extraction (occlusal aspect).



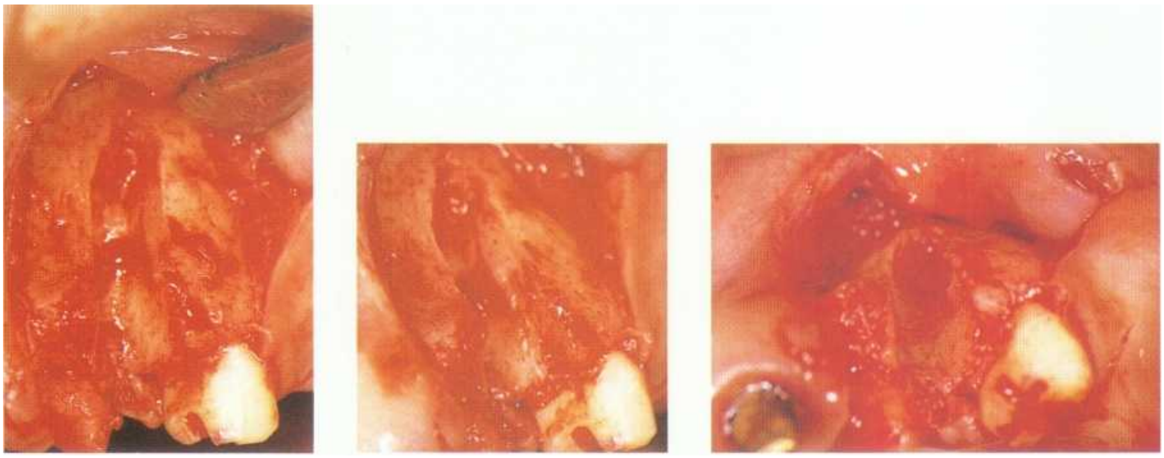


c. A sulcular incision is made to the surrounding tissue of the tooth planned for extraction. Two vertical incisions are made mesially and distally, facilitating relief of flap tension and coronal migration of the flap for complete membrane coverage. Therefore, the incisions extend beyond the mucogingival junction, and the incision outline is broader at the base.



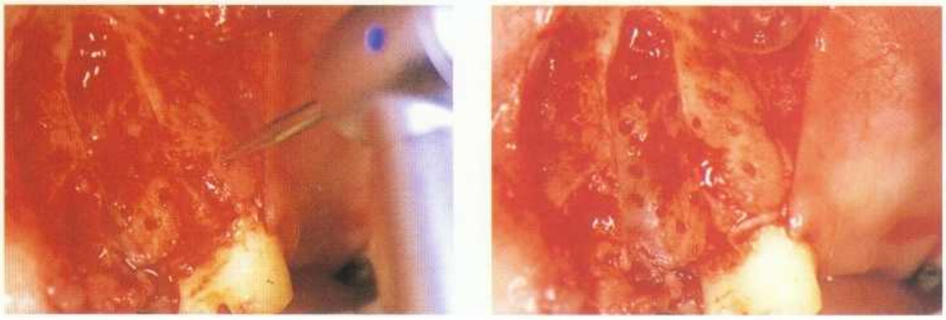
c16-4 Extraction and ***debridement.***

a. The tooth is extracted gently to avoid damage to the bone wall of the extraction socket. The granulation tissue inside the extraction socket is thoroughly removed.



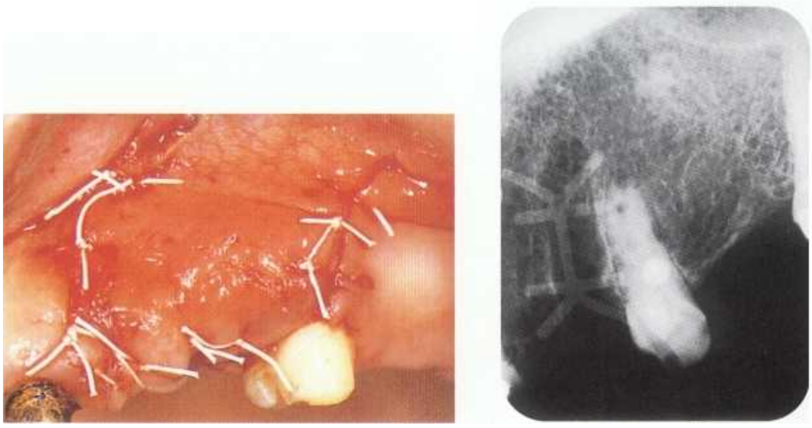
b. The buccal cortical bone plate of the extraction socket is absent. The depth of the osseous defect is more than 17 mm, the mesiodistal dimension is about 5-6 mm, and the buccolingual dimension is about 10 mm. The osseous defect is extensive.

c16-5 Graft membrane placement and suture.



a. A small round bur is used to penetrate the cortical bone around the extraction socket and the palatal cortical bone to facilitate bleeding from the bone surface.

b. The bone is transplanted to the osseous defect area for spacemaking. The TR membrane is trimmed (TR6Y, WL Gore) and stabilized with a membrane pin (Frios).



c. The wound is closed with a mattress suture and an interrupted suture. Radiograph of same area.

From membrane placement to membrane removal

c16-6 **Prognosis.**

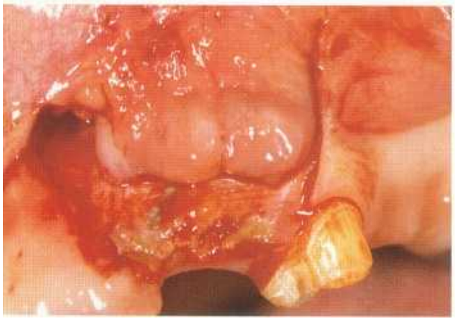
a. Eleven days after surgery.

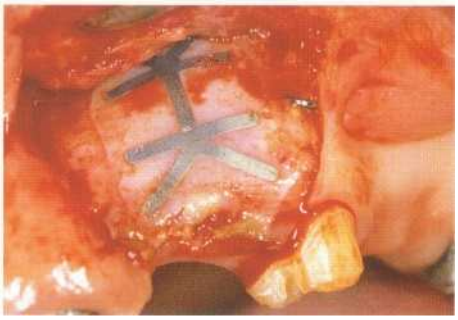
b. Thirty-five days after surgery.

c. Sixty-four days after surgery. A part of the membrane is exposed palatally.

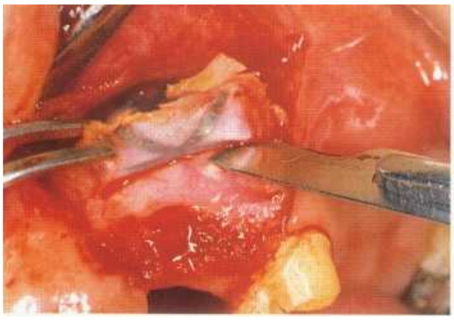
c16-7 Membrane removal.

a. Thirteen weeks after surgery.

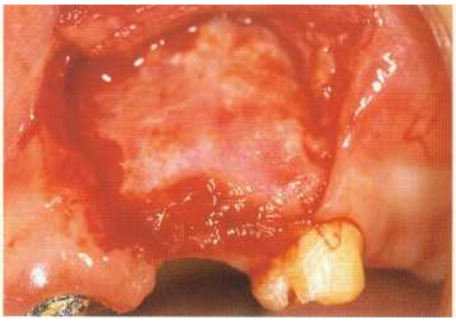




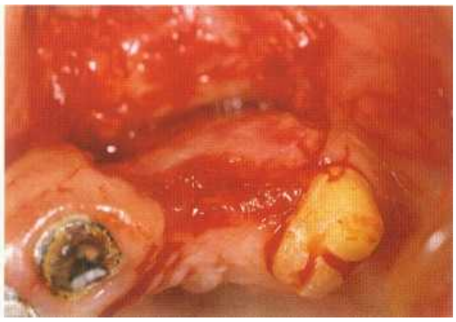
b. A partial thickness flap is prepared to expose the membrane.

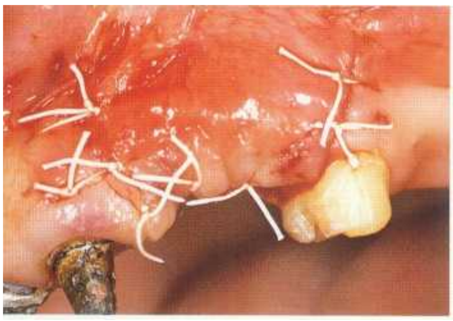


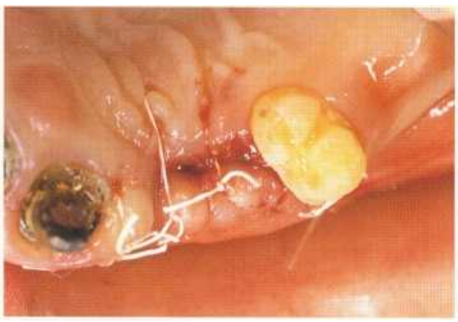
c. The memb i is removed gently with care to avoid damage to the new tissue.

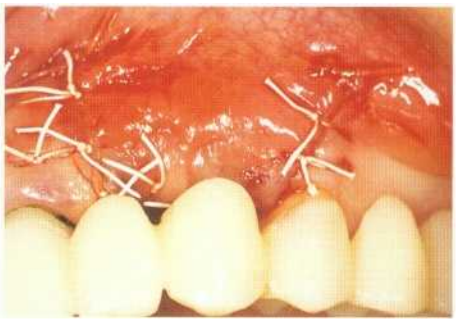


d. Newly formed tissue under the membrane.

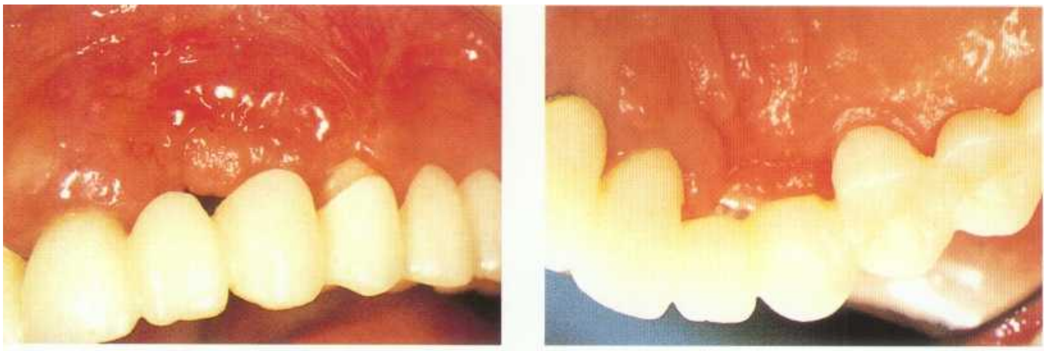








e. The flap is displaced coronally to cover the new tissue completely and sutured.



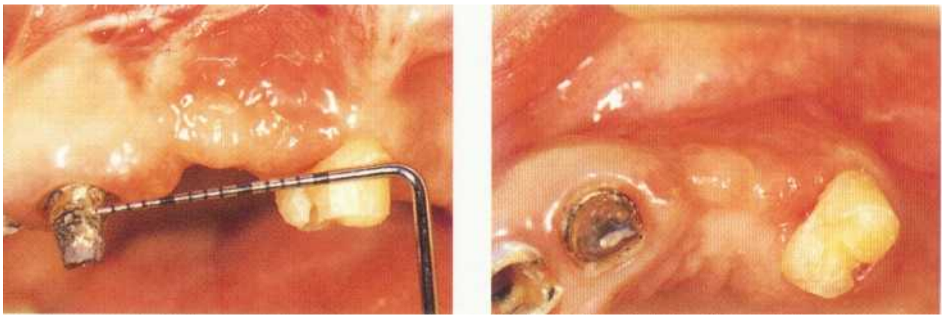
f. Thirteen days after membrane removal.

g. Three weeks after surgery. Note soft tissue recession.

Ridge augmentation using connective tissue grafts

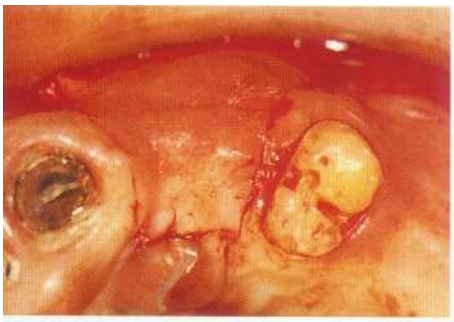
c16-8 Ridge augmentation.

a. Eight months after GBR. Note the marked bone regeneration.

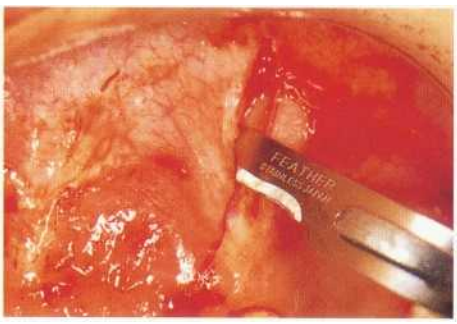


b. The depression on the edentulous ridge is about 2 mm. Ridge augmentation is performed with connective tissue grafts to increase the buccal mucosa soft tissue on the pontic area and to improve the alveolar ridge shape. Nine months after GBR.

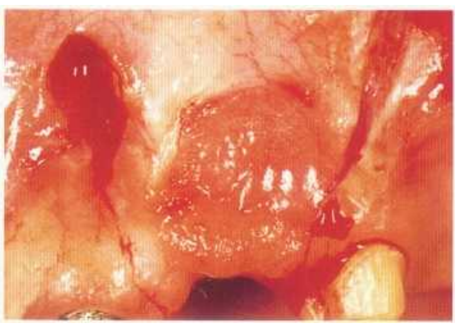
c16-9 Preparation of recipient site.



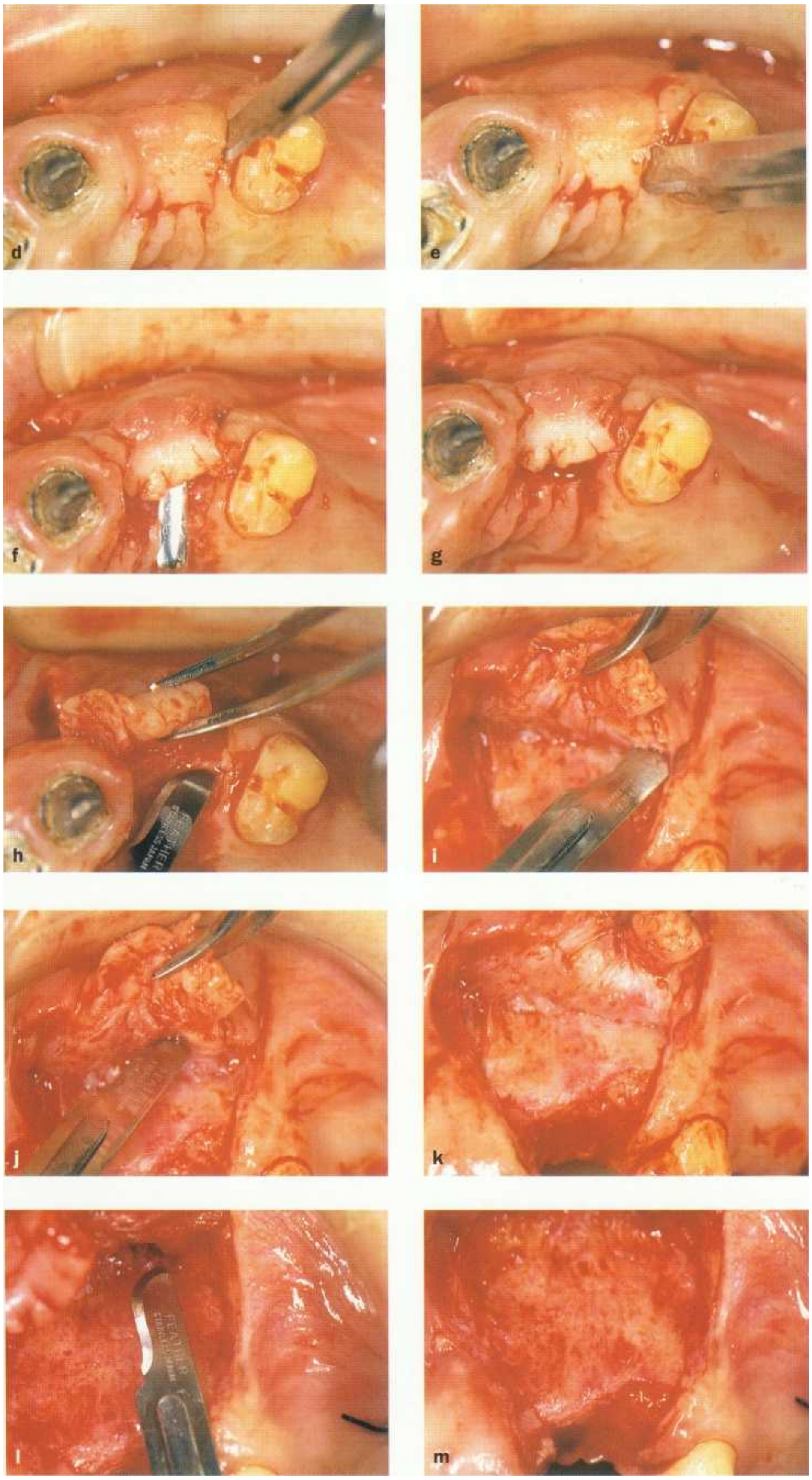
a. A no. 15 blade tip is used to make a horizontal, shallow partial-thickness incision palatal to the alveolar crest. If it is necessary to increase the ridge height, an incision from a palatal approach is made to cover the connective tissue graft with the flap completely.



b. Oblique vertical incisions are made to both ends of the horizontal incision.



c. The incision is extended apically beyond the mucogingivaljunction forfree migration of the flap and to facilitate wound closure.



d, e. The vertical incisions should be 1-2 mm from the adjacent teeth to preserve the adjacent interdental papilla. All vertical incisions should be shallow to avoid contact with the bone for preparation of **the partial-thickness recipient site.**

f, g. An Orban interdental knife is placed into the horizontal incised area of the palate and an incision made to reflect 2-3 mm of the flap margin.

h. Tissue pliers are used to hold the reflected flap margin. A no. 15 blade is used to prepare a partial-thickness flap (1.5-2.0 mm thickness) on the buccal side while the flap is lifted to provide tension.

i. The side of the blade is placed at the periosteum to prepare the nonmobile periosteum-connective tissue and to make the partial-thickness incision. Care is taken to avoid damage to the periosteum.

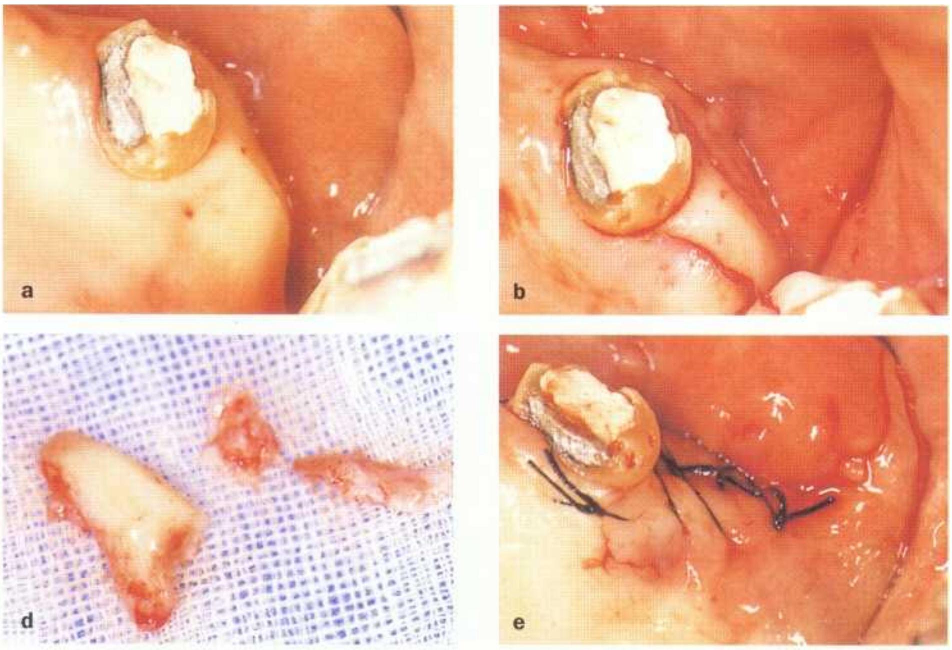
j. The blade is manipulated gently and held parallel to the gingival surface to make an incision. Care is taken to avoid penetrating the flap.

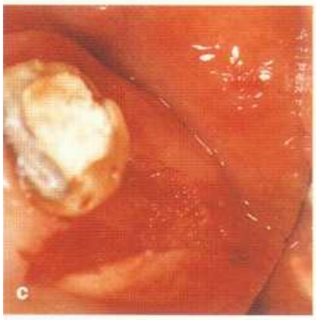
k, l. A partial-thickness flap is prepared beyond **the mucogingival junction, and a releasing incision of the periosteum is made to the base of the buccal flap to facilitate its coronal migration and mobility.**

m. Finally, a recipient site with nonmobile periosteum-connective tissue is prepared.

c16-10 Harvesting of connective tissue graft.

a-e. The distal part of 15 is selected as the donor site because crown lengthening surgery is necessary and the depth of the soft tissue is about 5 mm (a). Two parallel internal bevel incisions (square incisions) are made on the wedge area (b). An interdental knife is used to remove the wedge tissue as one mass using undermining gingivectomy (c). The harvested wedge tissue and the connective tissue chip were removed as a result of the undermining of the buccal and lingual flaps (d). Suture and extended crown length of the distal aspect of 15 (e).



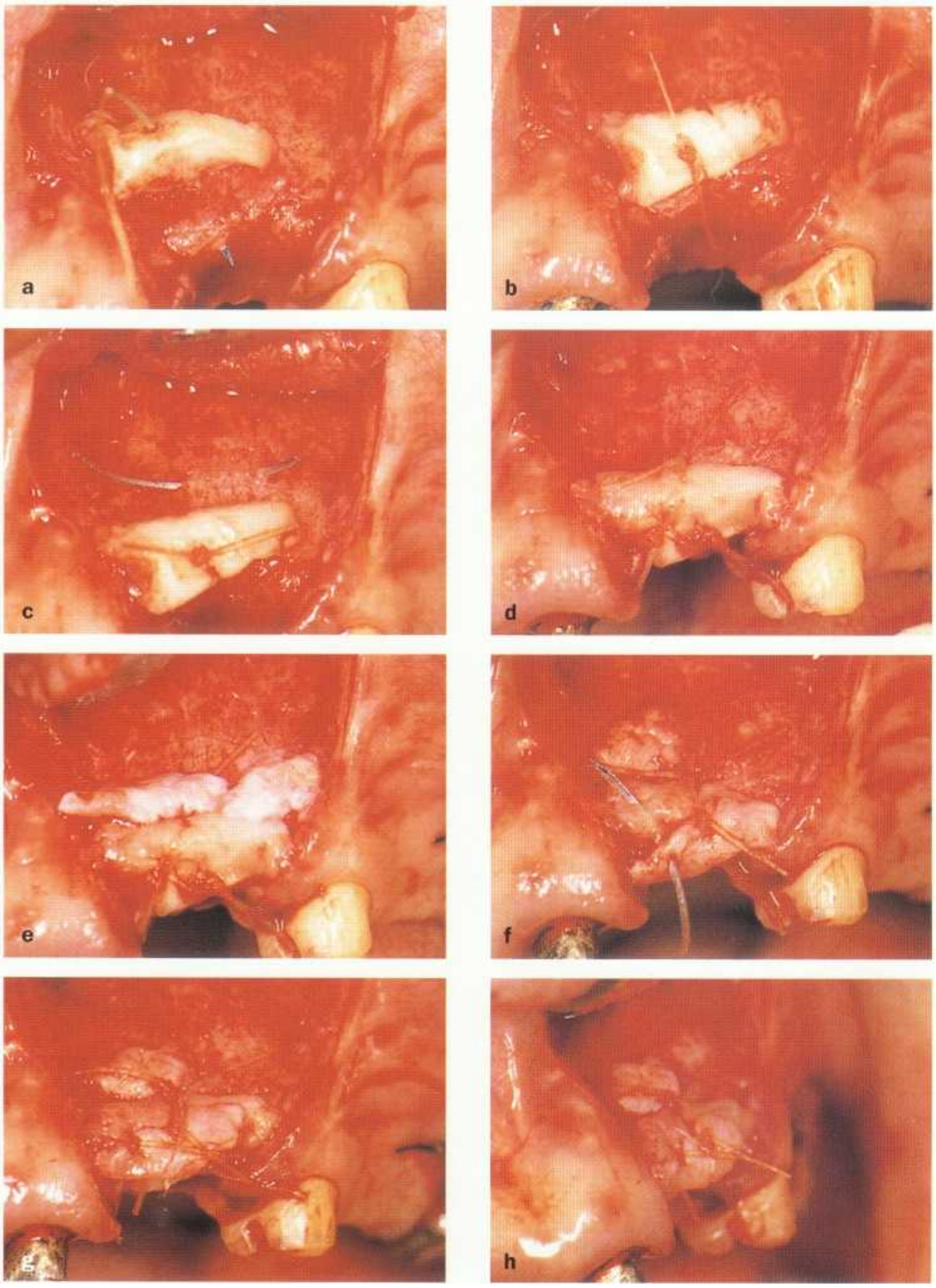


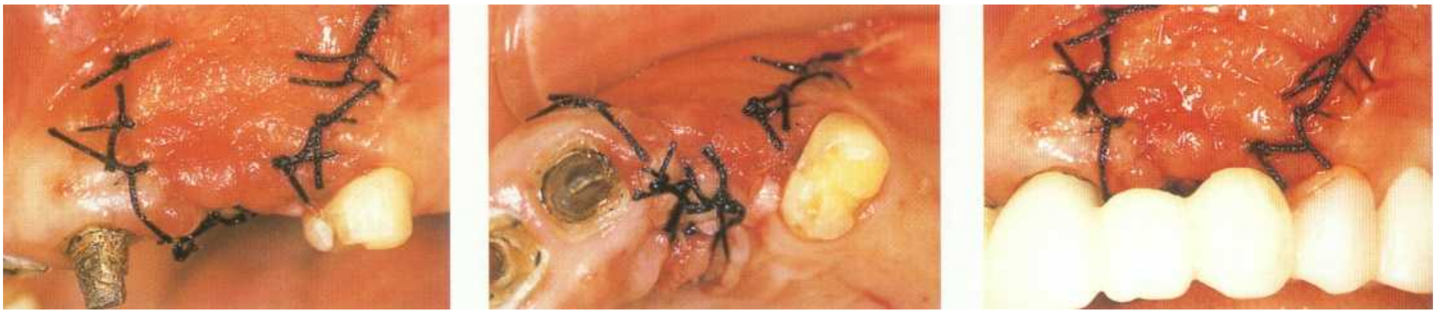
c16-11 Stabilization of graft.

a, b. The epithelium of the wedge tissue is resected to make a graft with connective tissue onlay. It is placed at the position necessary for ridge preparation. Bioabsorbable thread is used for periosteal suture of the graft and recipient site. The needle is inserted into the graft and periosteum-connective tissue site at a right angle. The needle is rotated along the bone surface to engage the periosteal fibers. The tip of the needle is the axis of rotation. The needle is pulled to the surface from inside the graft and the periosteal suture completed with a vertical mattress suture.

c, d. A periosteal mattress suture is made to stabilize the graft.

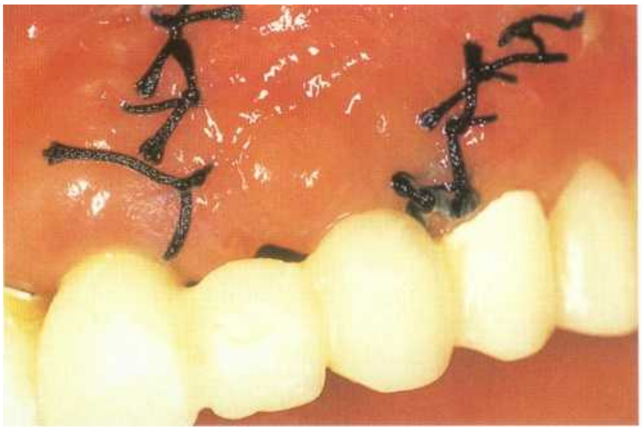
e-h. The graft is placed buccally and a periosteal suture made to stabilize it.



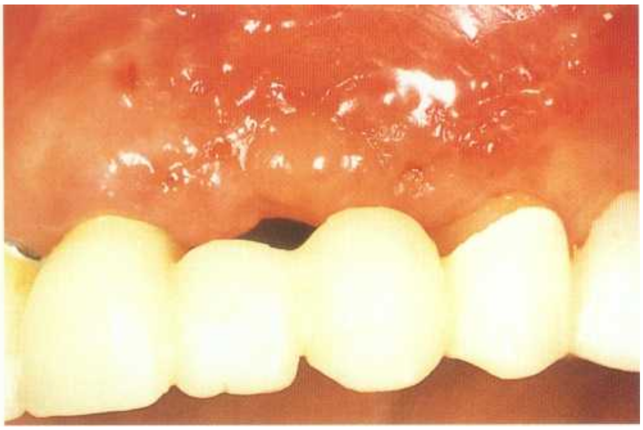


c16-12 Flap suture. The buccal flap is displaced coronally, the connective tissue graft covered, and a suture made with silk thread. This enables the graft to receive blood from inside the flap and periosteum-connective tissue site in the recipient site. In cases where the vertical dimension of the alveolar ridge is extremely reduced, blood supply is provided without covering the entire connective tissue graft with the flap. The pontic base is reduced to relieve pressure on the grafted area.

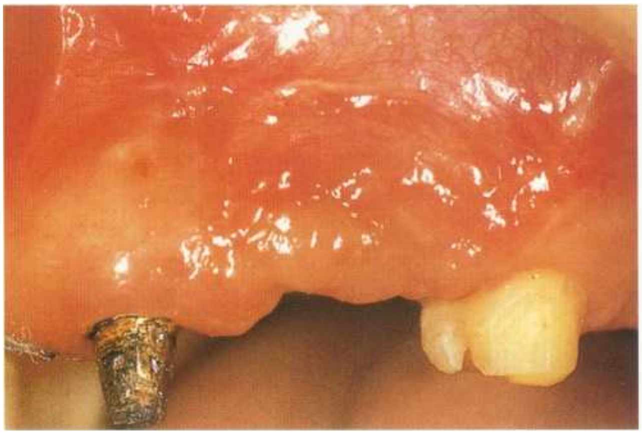
c16-13 Prognosis.

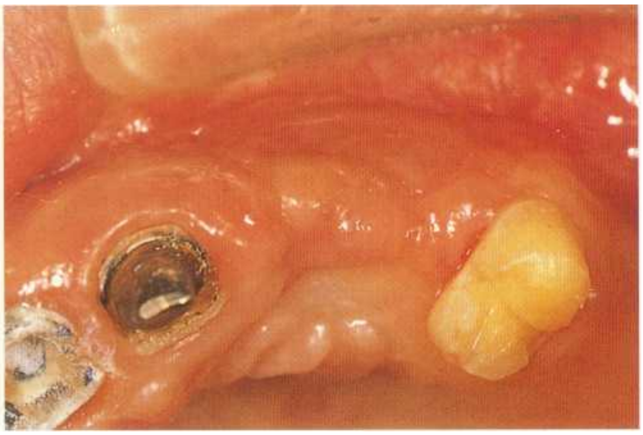


a. One week after surgery.

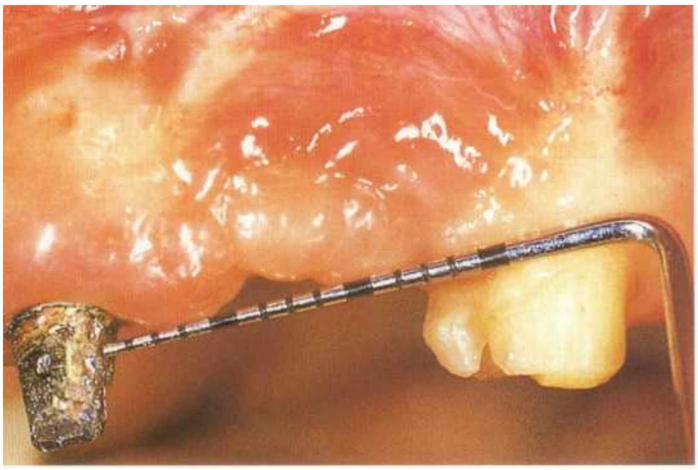


b. Two weeks after surgery.





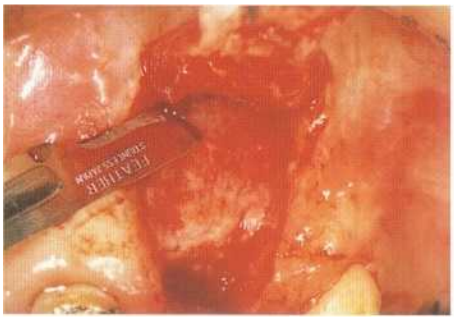
c. Twenty-two days after surgery.



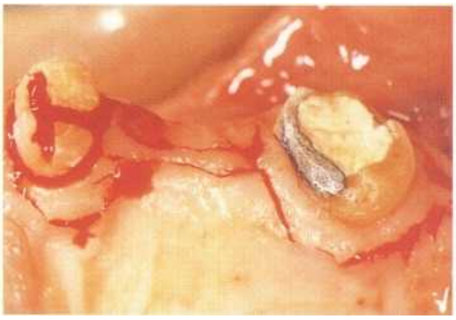
d. Thirty-one days after surgery. The alveolar ridge is increased (compare with c16-8b).

c16-14 Secondary ridge augmentation procedures using connective tissue grafts.

a. Five and one-half months after ridge augmentation. A second surgery is performed to improve ridge shape.

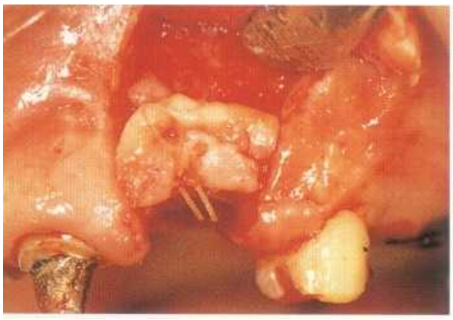


b. Preparation of recipient site with periosteum-connective tissue.

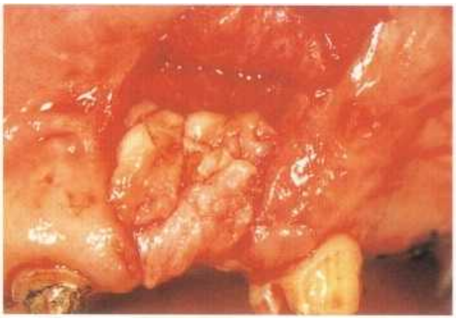


c. Harvesting of donor tissue.

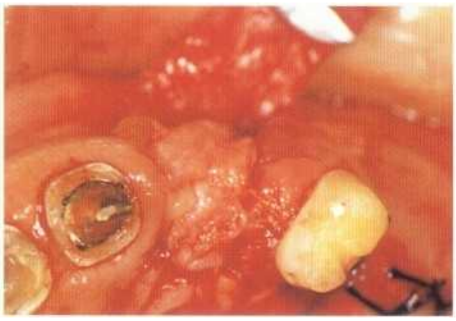
d. The connective tissue removed during the crown lengthening surgery of 13 and 15 is used for the graft.



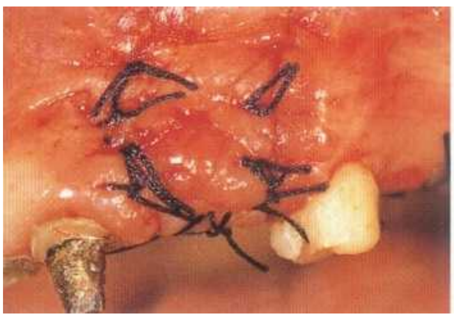
e. Bioabsorbable thread is used for graft su ture in the recipient site. The graft is placed from the buccal to the palatal, like a saddle, over the alveolar crest and sutured.



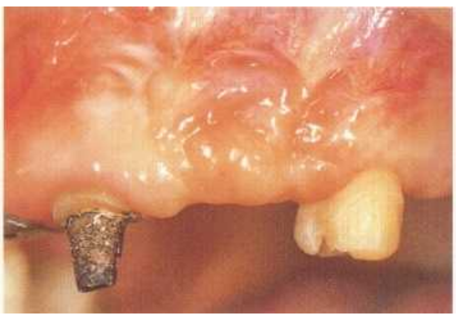
f. The graft is placed on the buccal side and sutured.



g. Palatal aspect after suturing graft.



h. The graft is covered with the flap and sutured.



i. One month after surgery.

j. Seven months after surgery.

Periodontal Plastic Surgery at Second-Stage Implant Surgery

Papilla Regeneration Technique

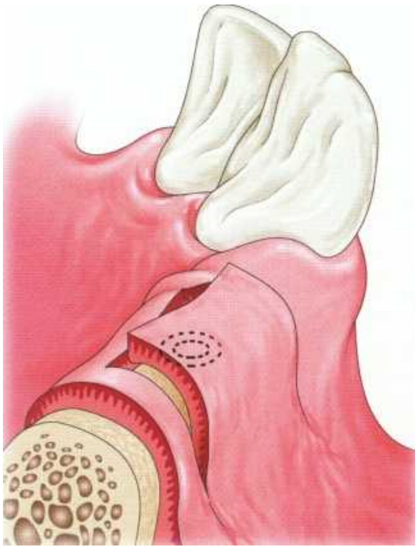
For superior esthetics with implant prostheses, plastic surgeries are available to create natural tissue morphology around the implant. The papilla regeneration technique prepares interdental papillalike tissue between the implant and natural tooth or in the area between two implants. Palacci et al reported creating interdental papillalike morphology using a semilunar pedicle flap (modified pedicle graft, Fig 6-29) at second-stage implant surgery. The labial flap is the donor site. Therefore, thick, wide, and nonmobile keratinized mucosa is necessary on the labial side of the implant placement area.

In this procedure, a horizontal full-thickness incision is made lingually to expose the fixture. The healing abutment is connected and a semilunar pedicle flap is prepared from the full-thickness flap. It is rotated and displaced to the mesial and distal aspects of the abutment, where interdental papillalike tissue is sought, and sutured.

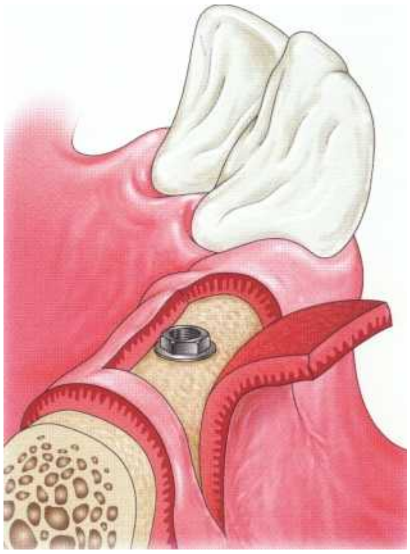
The width and length of the pedicle flap determine the newly formed interdental papillalike tissue morphology. Because the flap will be displaced and rotated 90 degrees, sufficient flap length is necessary to move the flap freely without tension. When suturing, the area of rotation is avoided. The flap is stabilized with a mattress suture. Meticulous care is necessary to maintain sufficient blood supply and to stabilize the grafted tissue. The donor site must have keratinized mucosa of sufficient thickness and width. Where the width is inadequate, the keratinized mucosa may be increased using free autogenous gingival grafts or connective tissue grafts as pretreatment (Case 6-17).

Fig 6-29 Papilla regeneration using a semilunar pedicle flap.

Key point
The larger the tissue used for the preparation of the interdental papillalike tissue, the larger the apical extension of the recipient site.



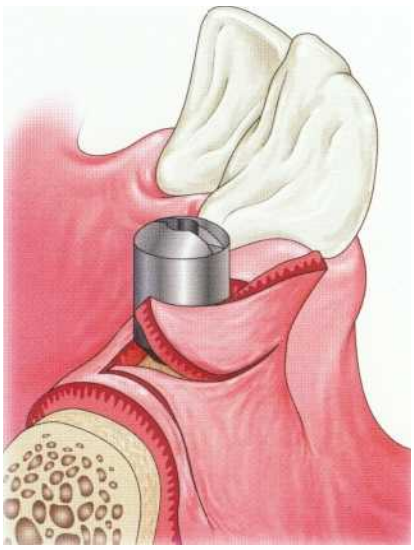
a. Make a horizontal incision on the alveolar crest slightly lingual to the fixture. Make two vertical incisions where the adjacent interdental papilla is preserved.



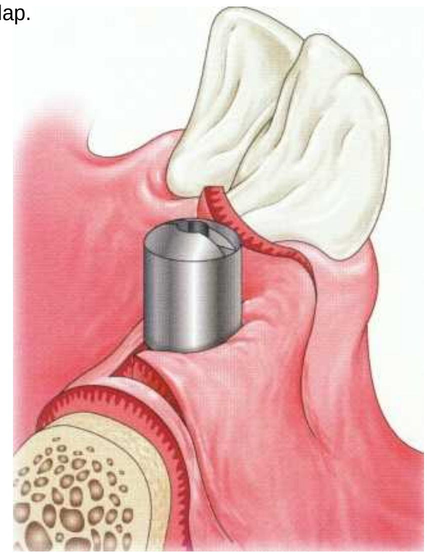
b. After reflecting a full thickness flap and removing the cover cap of the fixture, remove the granulation tissue around the cover cap.

c. Select a temporary healing abutment and connect it. This healing abutment should be long enough to support the grafted pedicle flap.

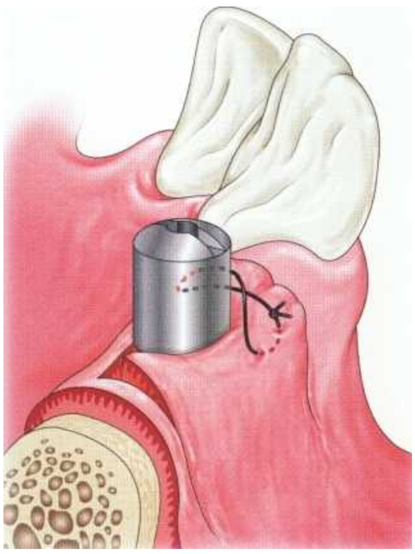
d. Prepare a semilunar pedicle flap on the buccal flap.



e. Make a semilunar pedicle flap long enough to enable rotation and displacement without tension.



f. Rotate the semilunar pedicle flap and displace it to the mesial interdental area of the abutment.

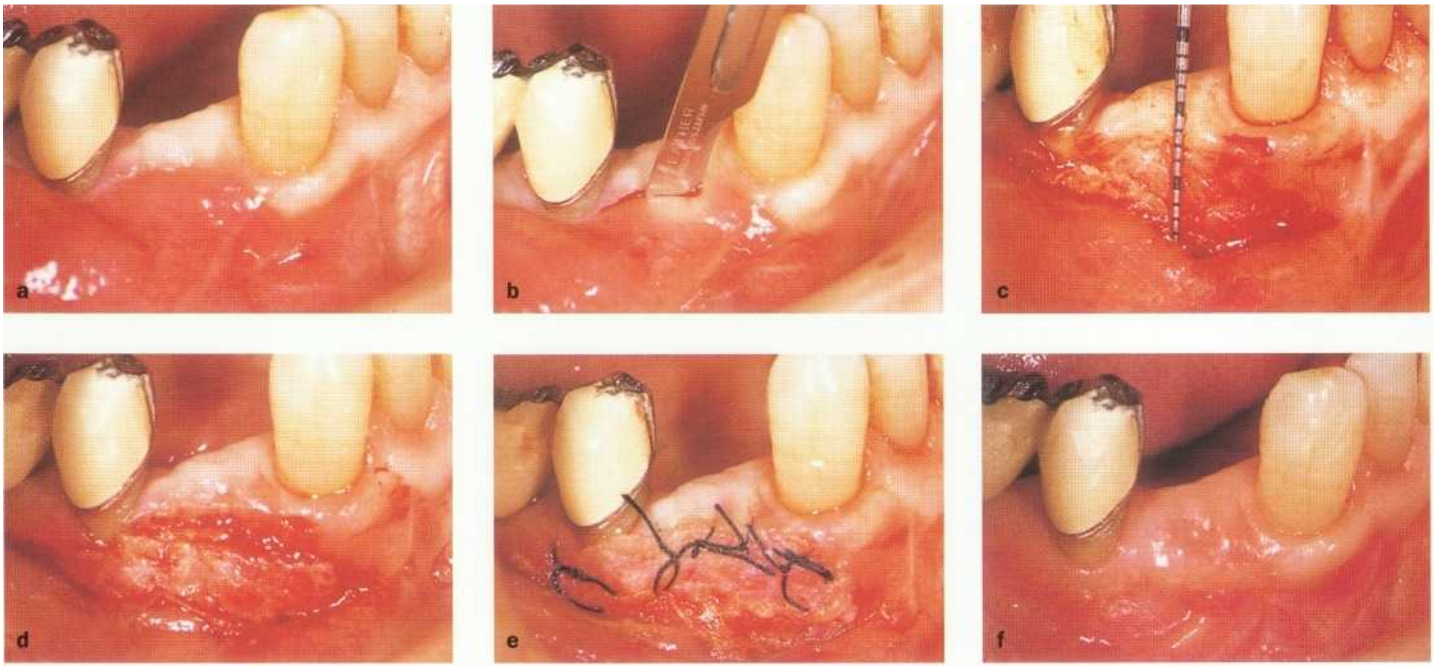


g. After adapting the flap closely, stabilize it with a mattress suture.

Case 6-17 Papilla regeneration technique

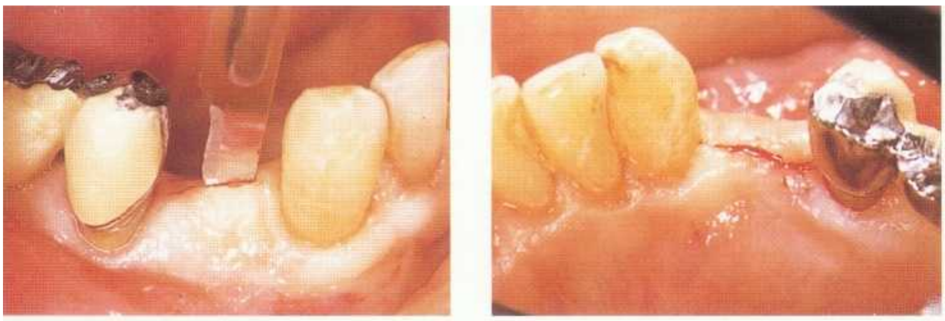
Connective tissue grafts as pretreatment

c17-1 Connective tissue grafts for keratinized mucosa augmentation.



a. An implant is planned on 28, but there is inadequate buccal keratinized mucosa for the papilla regeneration technique.
b. Therefore, a free autogenous gingival graft is required as pretreatment. A horizontal partial-thickness incision along the mucogingival junction is made to prepare the recipient site.
c. The recipient site is prepared with periosteum-connective tissue.
d, e. The connective tissue graft is harvested as thick as possible from the palate and the graft sutured (submarginal graft).
f. Generally, compared with free autogenous gingival grafts, free connective tissue grafts require longer healing periods to epithelialize. About 2% months after connective tissue grafts, sufficient keratinized gingiva (about 8 mm width) has been obtained for the papilla regeneration technique.

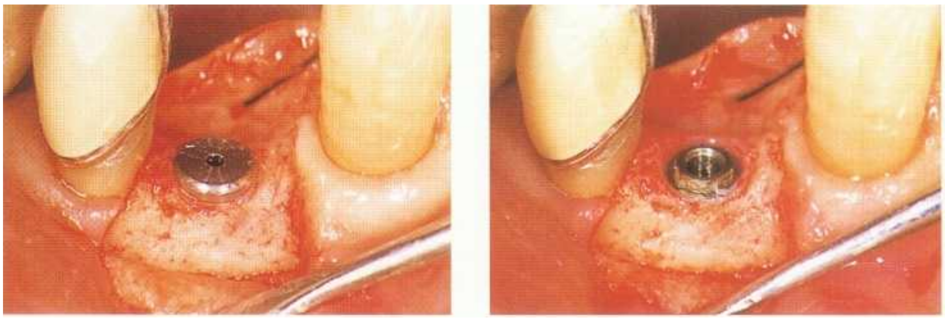
Flap design in the papilla regeneration technique



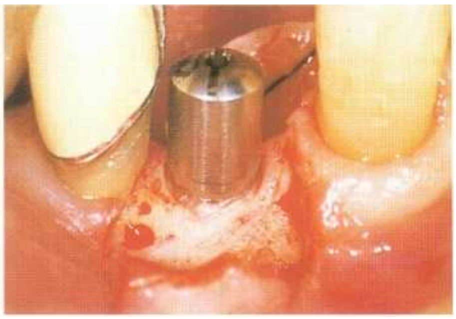
c17-2 Preparation of trapezoidal flap.

a. A horizontal incision is made lingually from the alveolar crest.

b. Two vertical incisions, extending to the mucogingival junction, are made on the mesial and distal aspects of the horizontal incision. The distal interdental papilla of 27 is preserved.

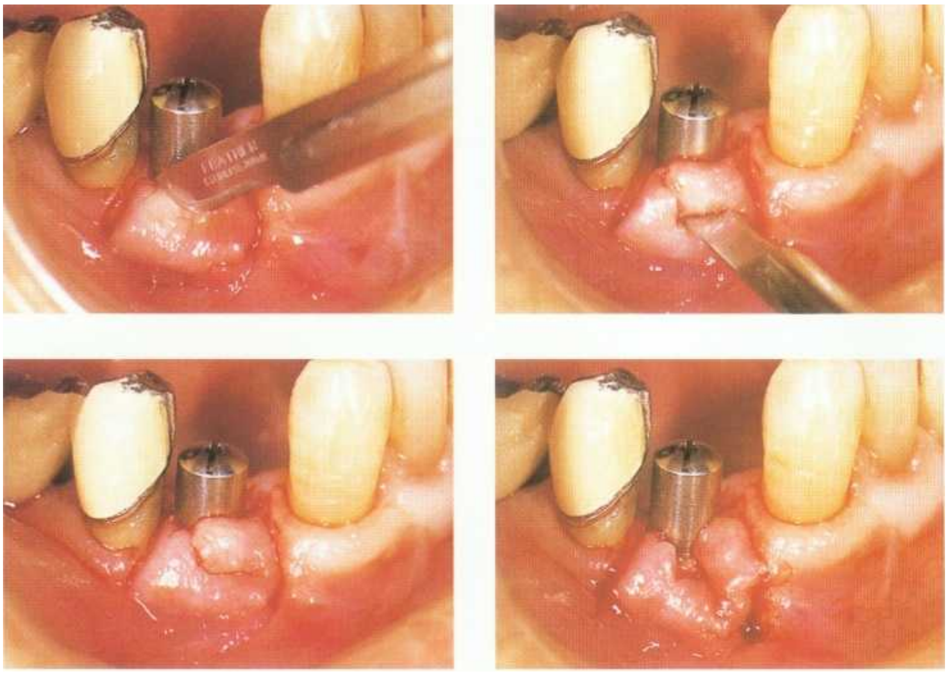


c. A full-thickness flap is reflected. In this case, the bone regeneration in the osseous defect area around the implant was facilitated by GBR.



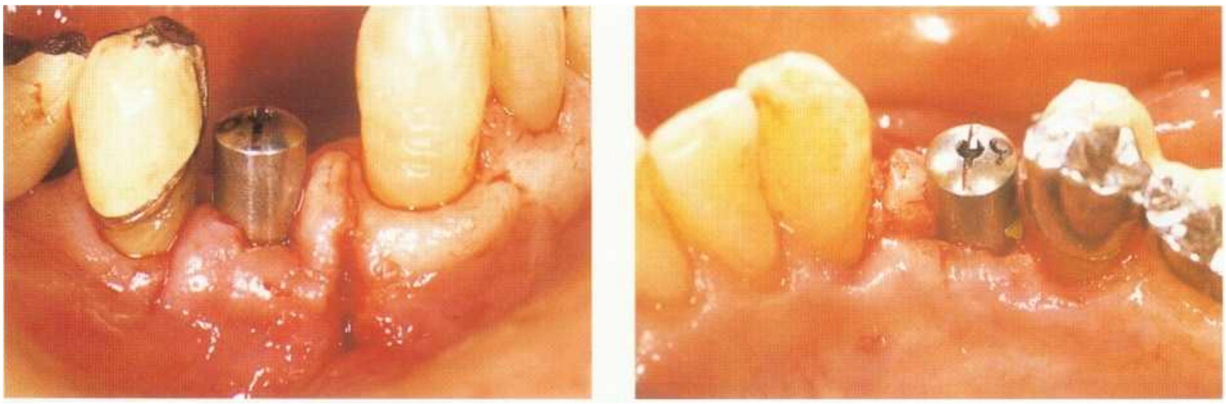
d. A temporary healing abutment is selected and connected. The healing abutment is long enough to support the grafted pedicle flap.

c17-3 Preparation of semilunar pedicle flap. A no. 15 blade is used to make a semilunar pedicle flap on the buccal flap. An incision from the distal to the mesial aspect of the flap is made to prepare the pedicle flap.



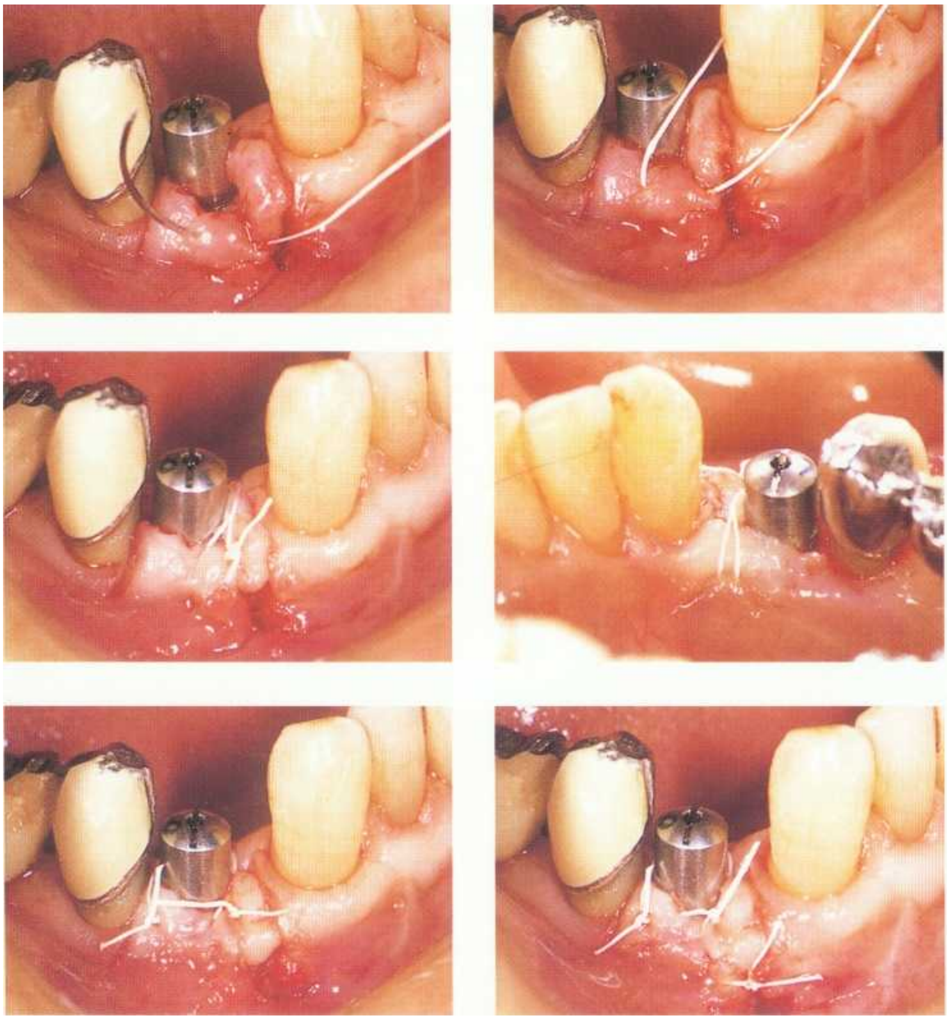
Key point

Make the incision long enough for free movement of the pedicle flap and to avoid flap tension.



c17-4 Displacement of the semilunar pedicle flap. The semilunar pedicle flap is rotated 90 degrees to the mesial interdental area of the temporary healing abutment. The rotated pedicle flap is shaped like interdental papilla.

Stabilization of the semilunar pedicle flap



c17-5 Stabilization of the flap using a horizontal mattress suture.

a. After the flap is approximated closely to the temporary healing abutment, it is stabilized. The needle is inserted horizontally from the semilunar pedicle flap to about 7-8 mm apically with about 4-5-mm width.

b. A horizontal mattress suture is made to stabilize the pedicle flap.

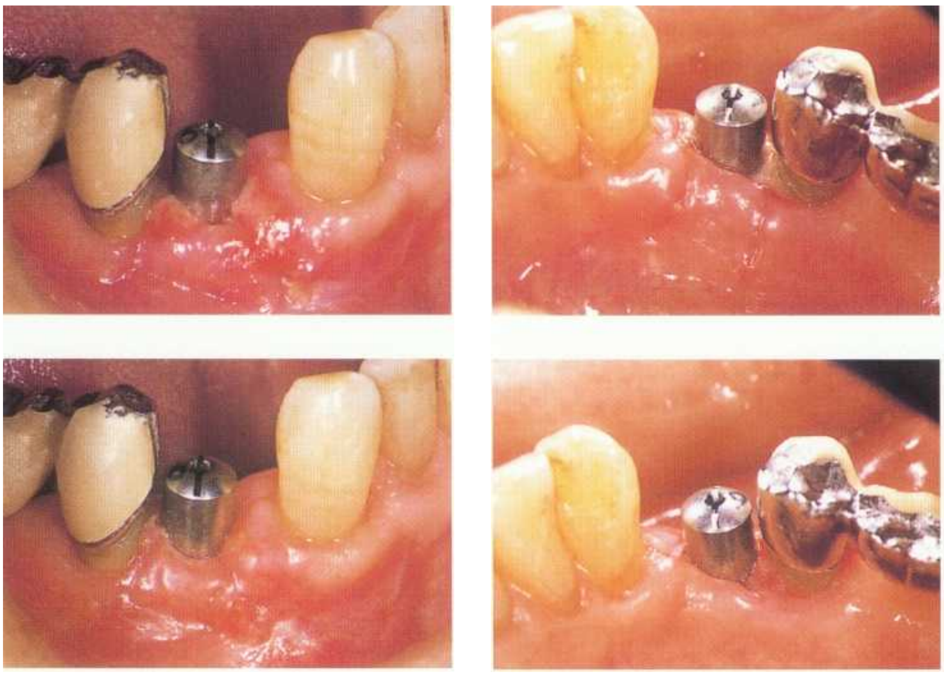
c. An interrupted suture is made on the buccolingual flap distally.

d. The suture is completed on the mesial vertical incised area.

Key point

Use Teflon suture material (WL Gore) for reduced plaque buildup in the surgical area. Do not use a periodontal dressing; it may displace the pedicle flap.

Prognosis

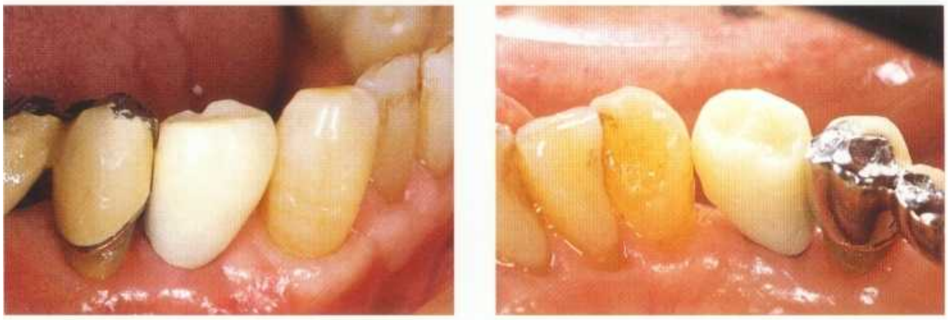


c17-6 **Prognosis.**

a. Eight days after surgery.

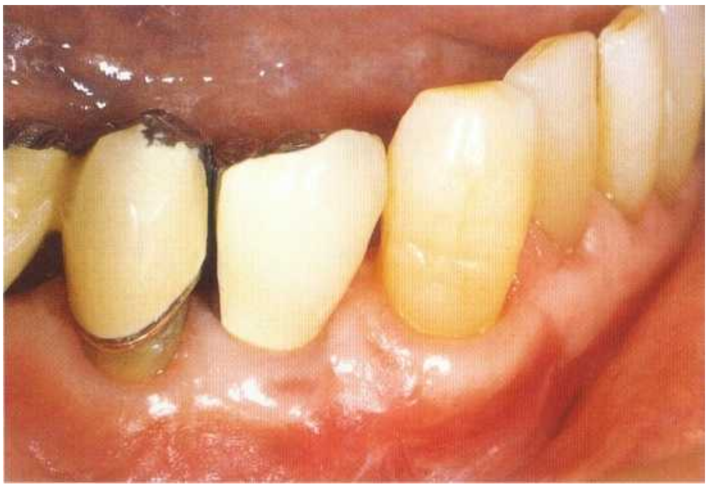
b. Two weeks after surgery.

c. Five weeks after surgery.



d. Placement of temporary restoration.

e. Four months after second-stage implant surgery. After the soft tissue is stable, the esthetic abutment (Hermans) is connected to the fixture.

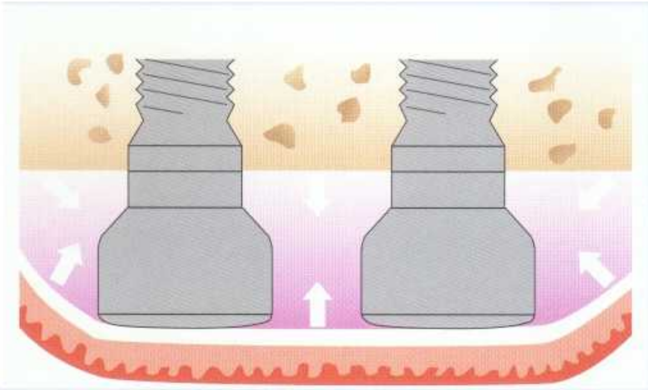


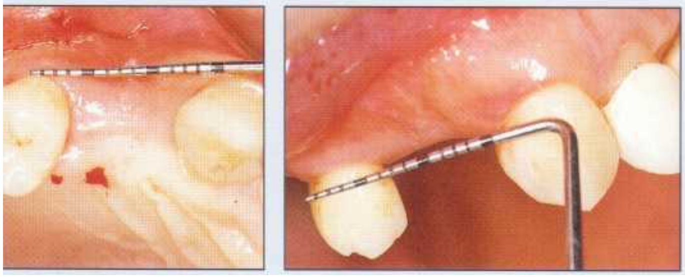
f. Final restoration.

Reduction of Soft Tissue Defects Around Implants

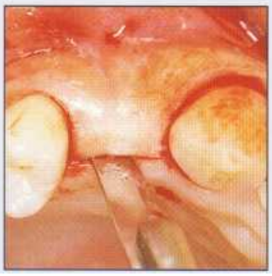
Soft tissue defects around implants compromise esthetic results in implant prosthodontics. There are a number of methods to improve the soft tissue morphology around implants. Salama et al introduced the guided soft tissue augmentation (GSTA) technique, in which the principle of GTR is used to increase the soft tissue around the implant (Fig 6-30). At second-stage implant surgery, the temporary healing abutment is connected at the proper height necessary to resolve the soft tissue defect.

Fig 6-30 Guided soft tissue augmentation (GSTA).



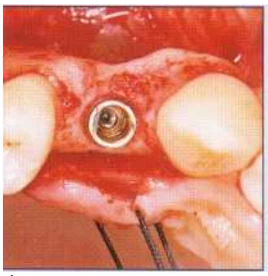


a. Second-stage implant surgery. **Note the soft tissue defect on the buccal aspect.**

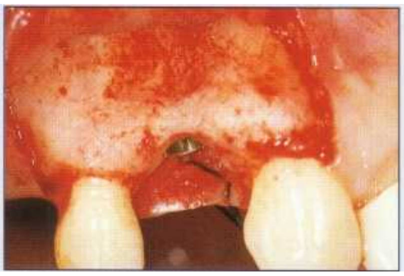


b. A horizontal incision is made on the palatal side and connected with a sulcular incision of the adjacent teeth. The incision is extended buccally.

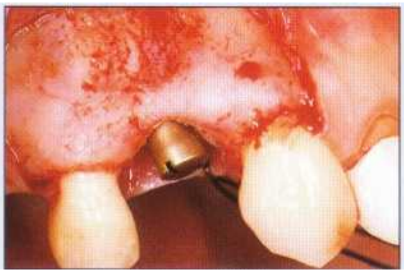
c. Vertical incisions of sufficient length are made on the distal line angle of 4 and the mesial line angle of 6. The incisions are extended across the mucogingival junction.



d. A labial full-thickness flap is reflected to expose the fixture.

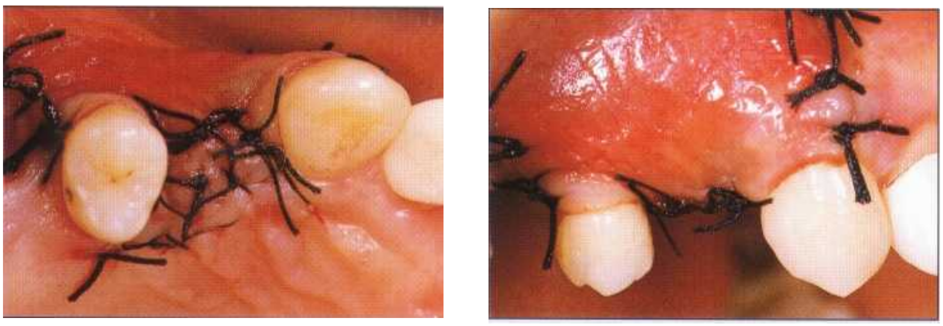


e. Note that the osseous defect area is completely covered by newly formed bone.



f. A healing abutment with height sufficient to preserve space for soft tissue augmentation is selected.

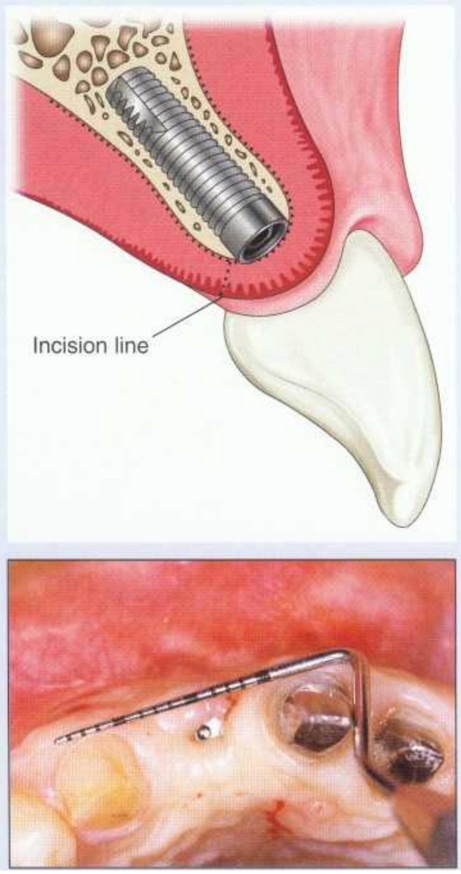
g. A releasing incision of the periosteum is made to facilitate coronal migration of the flap. The flap is secured with a mattress suture.



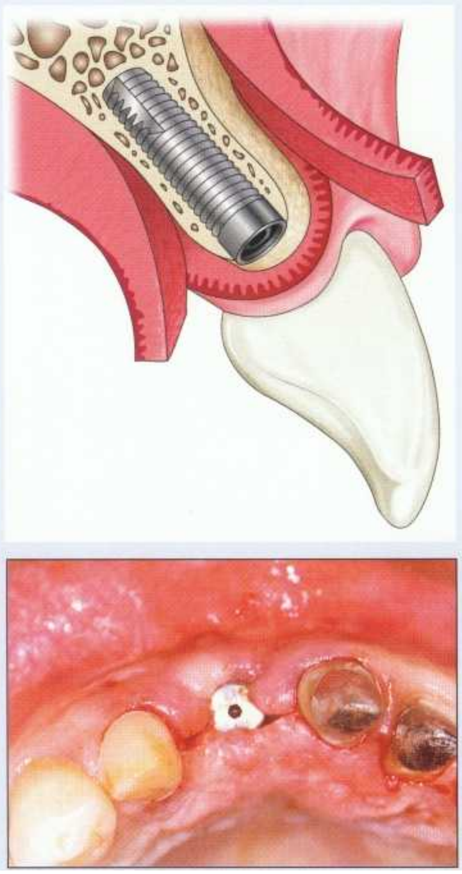
h. The surgical site is closed with an interrupted suture.

The temporary healing abutment maintains space to enable the increase of soft tissue subgingivally. The flap is placed coronally to cover the healing abutment. Hence, soft tissue augmentation necessary around the implant is accom plished. If the soft tissue defect is slight, improvement of morphology can be achieved using subepithelial connective tissue grafts (Fig 6-31) or roll procedures (Fig 6-32) at second-stage implant surgery. However, all of these methods have problems with the long epithelial attachment created around the implant abutment.

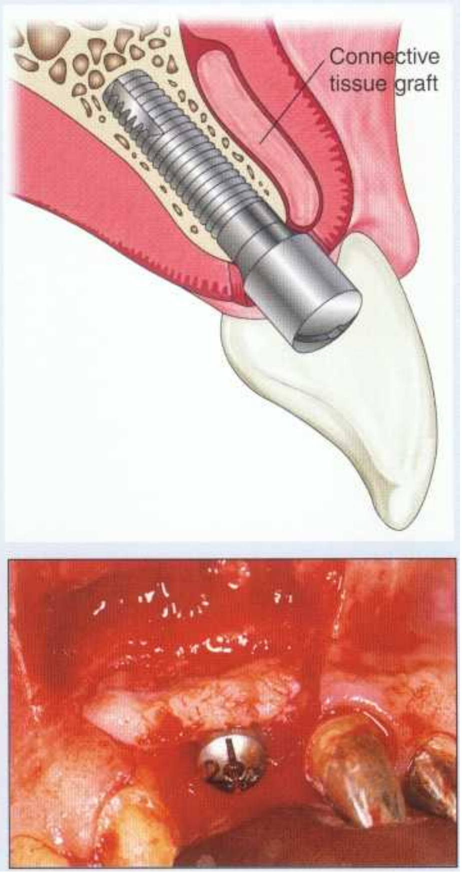
Fig 6-31 Connective tissue grafts at second-stage implant surgery.



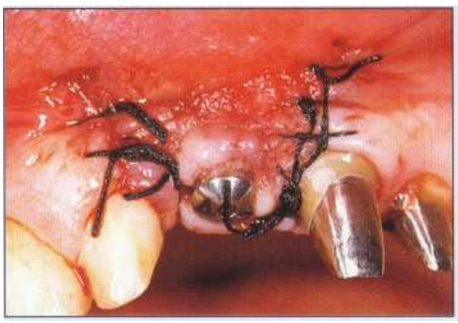
a. Note the soft tissue depression on the labial aspect of 8. Part of the cover screw is exposed.



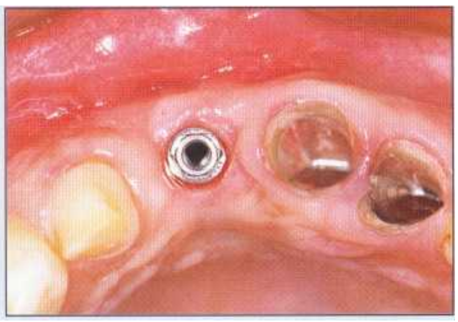
b. A crestal incision to maintain the thickness of the soft tissue is made.



c. The connective tissue harvested from the undermined thick palatal flap is used as donor tissue. The tissue graft is placed on the labial aspect of the healing abutment.

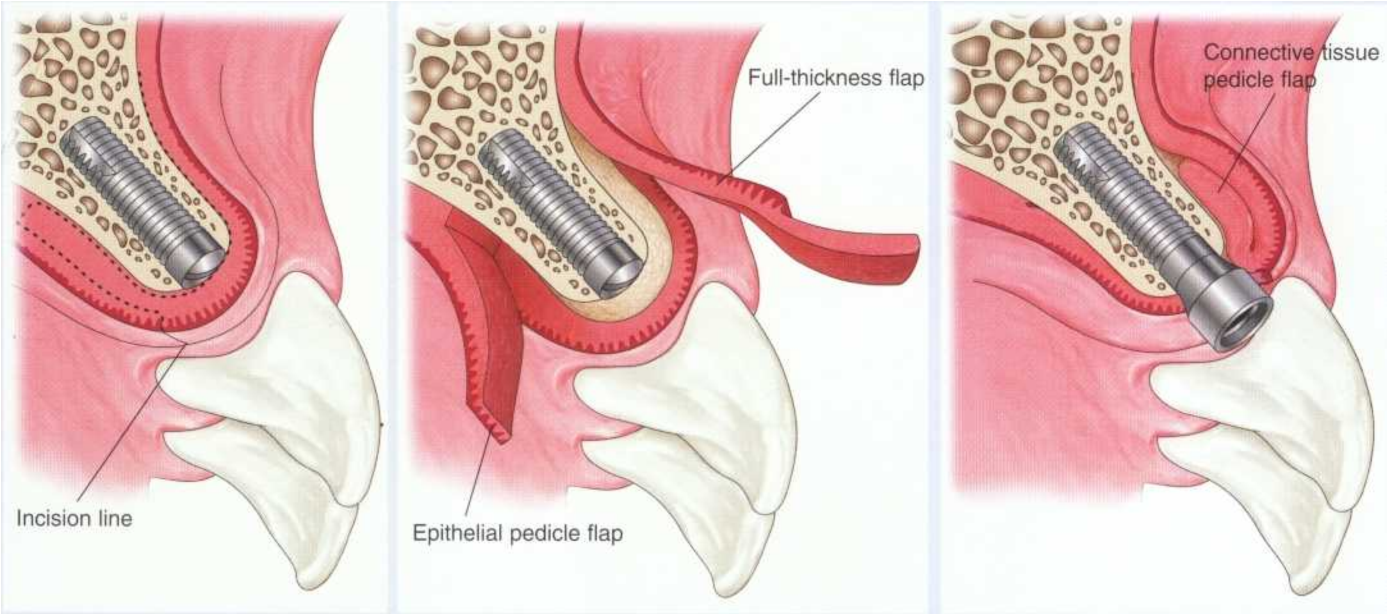


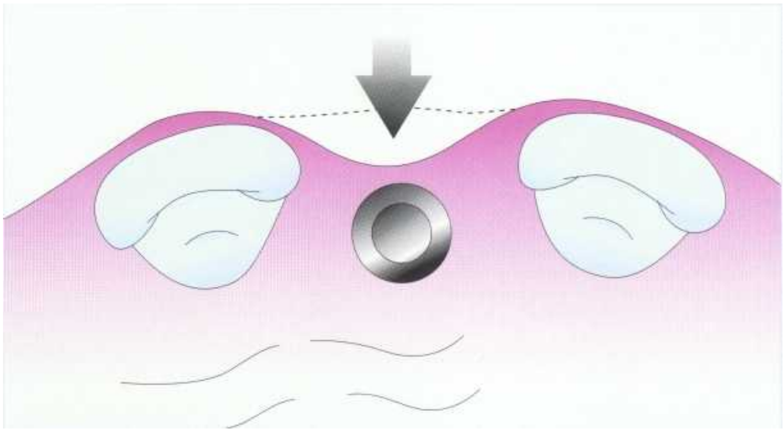
d. Suture of flap.



e. Three months after surgery. Reduced labial depression and adequate contour are obtained.

Fig 6-32 Modified roll procedures [62,63]

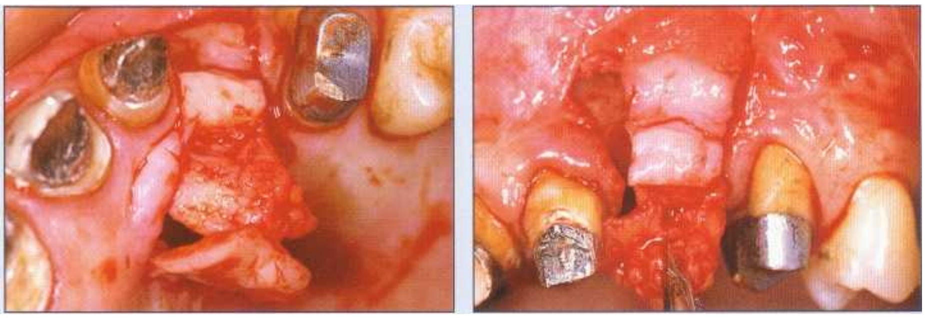




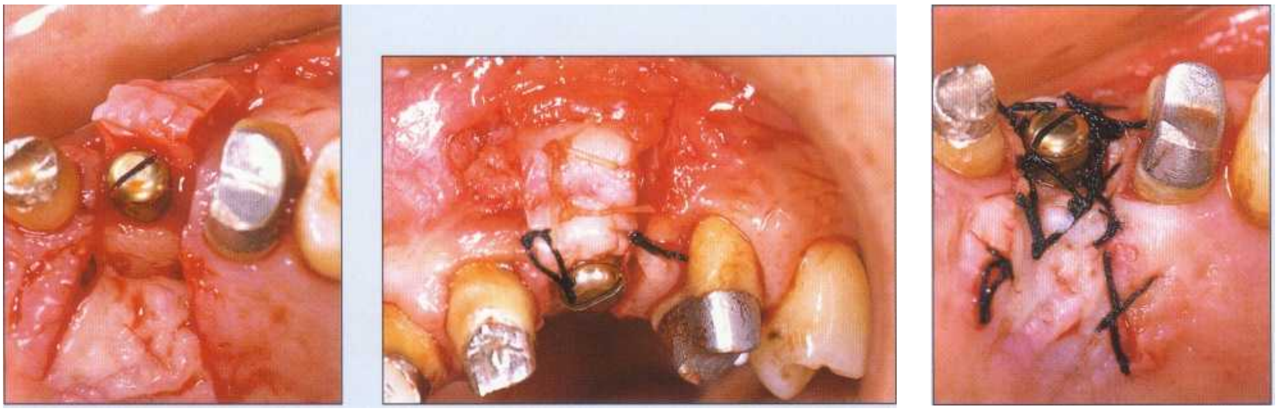
a. Buccal depression in area of fixture placement.

b. **Flap design.** A horizontal partial-thickness incision on the palatal aspect of the alveolar crest is made. Two vertical full-thickness incisions are made. The adjacent interdental papilla in these incisions is preserved and the two vertical incisions extended buccally.

c. To make the epithelial pedicle, the palatal epithelium surrounded by vertical incisions is reflected. The underlying connective tissue is then exposed.

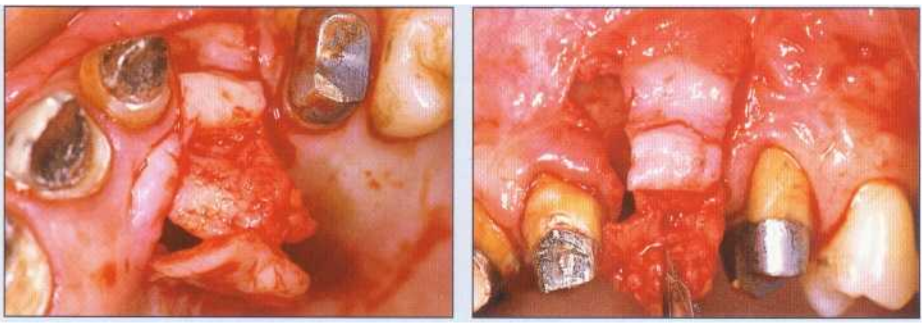


d. The connective tissue pedicle is reflected from the palate to the buccal aspect. The palatal connective tissue and buccal flap are continuous.

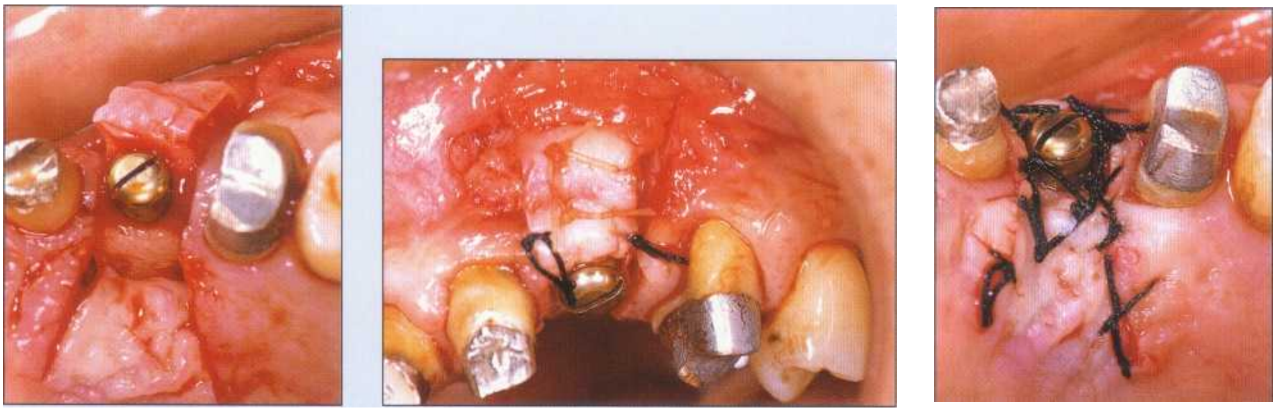


e. After the abutment is connected, the connective tissue pedicle is rolled and placed under the buccal flap and sutured. The epithelial pedicle flap is sutured over the palatal donor site.

c. To make the epithelial pedicle, the palatal epithelium surrounded by vertical incisions is reflected. The underlying connective tissue is then exposed.



d. The connective tissue pedicle is reflected from the palate to the buccal aspect. The palatal connective tissue and buccal flap are continuous.



e. After the abutment is connected, the connective tissue pedicle is rolled and placed under the buccal flap and sutured. The epithelial pedicle flap is sutured over the palatal donor site.

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