Corrective/Surgical phase

Therapy for periodontal disease, which encompasses many techniques and procedures, depends on the *disease status* and *objective of the final outcome*. Early problems can be corrected with successful phase I therapy, consisting of biofilm removal by the patient on a daily basis, scaling, and root planing when necessary.
Many moderate to advanced cases cannot be resolved without surgically gaining access to the root surface for root planing and reducing or eliminating pocket depth to allow the patient to remove biofilm. The surgical phase of therapy is also referred to as phase II therapy. **The surgical techniques used for the following purposes:**
• Controlling or eliminating periodontal disease
• Correcting anatomic conditions that favor periodontal disease, impair aesthetics, or impede placement of prosthetic appliances
• Placing implants to replace lost teeth and improving the environment for their placement and function

Objectives of the Surgical Phase

The surgical phase of periodontal therapy has the following objectives:
1. To improve the prognosis for teeth and their replacements
2. To improve aesthetics

Surgical techniques are used for pocket therapy and for correction of related morphologic problems (i.e., mucogingival defects). In any cases, therapies are combined to provide one surgical intervention that fulfills both objectives.
Surgical techniques (1) increase access to the root surface, allowing the clinician to remove all irritants; **(2)** reduce or eliminate pocket depth, making it possible for the patient to maintain the root surfaces free of biofilm; and **(3)** reshape soft and hard tissues to attain a harmonious topography.

Resective or **regenerative** surgery, or both, is used to reduce pocket depth (Box 57.1).
The second objective of phase II therapy is to correct anatomic defects that favor plaque or biofilm accumulation and pocket recurrence or impair aesthetics. The aim of correcting anatomic problems is to alter defects of the gingival and mucosal tissues that predispose these areas to disease.

Three types of techniques are performed on noninflamed tissues and **in the absence of periodontal pockets** (see Box 57.1):
• *Plastic surgery techniques* are used to create or widen the attached keratinized gingiva by placing grafts of various types.
• *Aesthetic surgery techniques* are used to cover denuded root surfaces resulting from recession and to recreate lost papillae.
• *Pre-prosthetic techniques* are used to modify the periodontal and neighboring tissues to receive prosthetic replacements. They include crown lengthening, ridge augmentation, and vestibular deepening.
Fig. 57.1 provides a three-tiered classification of the surgical procedures used in periodontics: pocket reduction surgery, periodontal plastic surgery, and pre-prosthetic surgery.

BOX 57.1 Periodontal Surgery

Pocket Reduction Surgery
- Resective (e.g., gingivectomy, apically displaced flap, undisplaced flap with or without osseous resection)
- Regenerative (e.g., flaps with grafts, membranes)

Correction of Anatomic or Morphologic Defects
- Plastic surgery techniques used to widen attached gingiva (e.g., free gingival grafts)
- Esthetic surgery (e.g., root coverage, recreation of gingival papillae)
- Pre-prosthetic techniques (e.g., crown lengthening, ridge augmentation, vestibular deepening)
- Placement of dental implants, including techniques for site development for implants (e.g., guided bone regeneration, sinus grafts)

Periodontal access surgery:

In moderate to advanced cases, and in cases with furcation invasion and infrabony defects, it may be difficult and even impossible to resolve periodontal inflammation completely with nonsurgical therapy alone. Adjunctive periodontal access surgery is necessary in many of these cases to **treat** the periodontal disease definitively, **create** anatomies that are maintainable long-term by both the patient and the clinician, and, when feasible, **reconstruct** lost periodontal structures.

Periodontal access surgery enhances access for root instrumentation and allows for reduction of periodontal pockets and correction of osseous defects. However, periodontal access surgery frequently results in *gingival recession* and *loss of interdental papillae*.

In the anterior maxilla, where **aesthetics is of high priority**, recession and loss of interdental papillae can present major aesthetic problems that are both difficult and unpredictable to treat. As such, in the anterior aesthetic area, periodontal disease is treated first and foremost nonsurgically, and periodontal access surgery is reserved for instances where surgical access is absolutely necessary.

Fortunately, the anterior location of these teeth and their singlerooted and convex root surface anatomies facilitate nonsurgical root instrumentation. When specialized instruments such as mini Gracey curettes and Vision Curvettes are used in conjunction with illumination and magnification, access to these periodontal pockets are enhanced, and nonsurgical periodontal therapy can be very efficacious.

In the posterior sextants, access for definitive root instrumentation is much more restricted due to multiple anatomic factors, especially around multirooted teeth. Wide proximal surfaces, root grooves and concavities, furcations, angulation and proximity of roots, depth of the periodontal pocket, the cheek, the tongue, and the opposing dentition can all contribute to hinder the removal of subgingival biofilm and calculus on these teeth. Fortunately, **gingival recession** and **loss of interdental papillae** generally **do not present aesthetic problems** for most patients. Many patients and clinicians are willing to accept recession and the associated transient root sensitivity and food impaction in exchange for periodontal health. As such, **periodontal access surgery is a treatment modality** that is essential and frequently used in the treatment of periodontal disease in the **nonaesthetic area.**

Periodontal access surgery is an adjunct to nonsurgical periodontal therapy and should occur only once the patient has demonstrated effective biofilm control. The **primary objective** of periodontal

access surgery is **to obtain access for root instrumentation** to remove bacterial biofilm and calculus accretion on the root surfaces thoroughly.

The **secondary objective** of periodontal access surgery is **pocket reduction** via soft and hard tissue resection or periodontal regeneration to facilitate home care and long-term professional supportive maintenance.

These objectives are achieved by two main modalities of periodontal access surgery, gingivectomy and periodontal flap surgery. *Both gingivectomy and flap surgery provide access for root instrumentation.* Pocket reduction is achieved only by resection of the suprabony soft tissue pocket in gingivectomy, whereas with periodontal **flap surgery** pocket reduction is achieved via **soft tissue resection, osseous resection, or periodontal regeneration**.

- Resective (e.g., gingivectomy)
- Regenerative (e.g., flaps with grafts, membranes)

Gingivectomy

The word *gingivectomy* means "excision of the gingiva." By removing the pocket wall.

Although gingivectomy was widely performed in the past, improved understanding of healing and the development of sophisticated flap techniques have relegated it to a lesser role in periodontal surgery. However, it remains an effective form of treatment when indicated (Fig. 60.11).

* Gingivectomy may be performed for the following indications:

1. Elimination of suprabony pockets if the pocket wall is fibrous and firm
2. Elimination of gingival enlargements

* Contraindications to gingivectomy include the following:

1. Access to bone required
2. Narrow zone of keratinized tissue
3. Aesthetics
4. Patients with high postoperative risk of bleeding

The step-by-step technique for gingivectomy is as follows:

Step 1: The periodontal pocket is mapped out on the external gingival surface by inserting a probe to the bottom of the pocket and puncturing the external surface of the gingiva at the depth of probe penetration (see Figs. 60.11C and D; Figs. 60.12 and 60.13).

Step 2: Periodontal knives (e.g., Kirkland) are used for incisions on the facial and lingual surfaces. Orban periodontal knives are used for interdental incisions (see Fig. 60.11E to G). Bard–Parker blades (#12 and #15), and scissors are used as auxiliary instruments.

The external bevel incision is started apical to the points marking the course of the pockets, and it is directed coronally to a point between the base of the pocket and the crest of the bone. It should be as close as possible to the bone without exposing it to remove the soft tissue coronal to the bone. Exposure of bone is undesirable. If this occurs, healing usually presents minimal complications if the area is adequately covered by the surgical dressing.

Either interrupted or continuous incisions may be used. The incision should be beveled at approximately 45 degrees to the tooth surface, and it should re-create the normal festooned pattern of the gingiva. Failure to bevel the incision will *leave a broad, fibrous plateau* that will delay development of a physiologic contour.

Step 3: Remove the excised pocket wall, irrigate the area, and examine the root surface.

Step 4: Scale and root plane.

Step 5: Cover the area with a surgical dressing (see Fig. 60.11I).

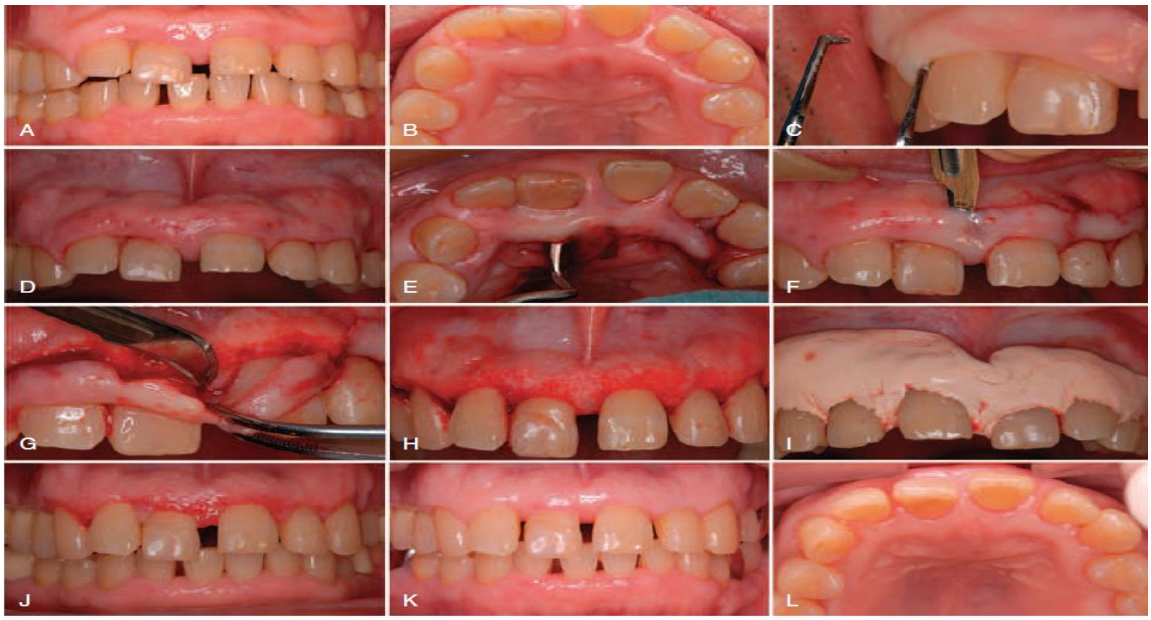


Fig. 60.11 Results obtained by treating a suprabony pocket with gingivectomy

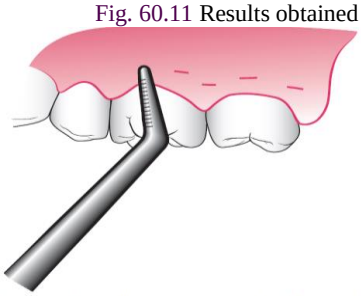


Fig. 60.12 The pocket marker makes pinpoint perforations that indicate pocket depth.

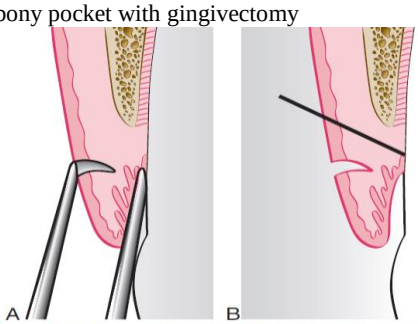


Fig. 60.13 Marking the depth of a suprabony pocket. (A) A pocket marker in position. (B) The beveled incision extends apical to the perforation made by the pocket marker.

❖ The advantages of gingivectomy are:

1. Simple surgical procedure with provides visibility and accessibility for complete calculus removal and thorough root planing.
2. Restoration of a physiologic gingival contour.
3. Complete elimination of suprabony pocket

The disadvantages are:

1. More postoperative discomfort and an increased chance of postoperative bleeding and pain.
2. It also sacrifices keratinized tissue.
3. Does not allow for osseous recontouring.
4. Primary closure of the wound is not possible, and healing is by secondary intention.
5. Aesthetic problem in the anterior area with sensitivity due to exposure of cervical area of the tooth.

Flap Surgery

Periodontal laps are used in surgical periodontal therapy to accomplish the following:

1. Access for root instrumentation
2. Gingival resection
3. Osseous resection
4. Periodontal regeneration

To fulfill these purposes, five different flap techniques are used:
(1) the modified Widman flap, (2) the undisplaced flap, (3) the apically displaced flap, (4) the papilla preservation flap, (5) and the distal terminal molar flap.

The modified Widman flap facilitates root instrumentation. It does not attempt to reduce the pocket depth, but it does eliminate the pocket lining. The objectives of the *undisplaced and apically* displaced flaps include *root surface access* and the *reduction of probing* depth. The choice of which procedure to use depends on two important anatomic landmarks: the **transgingival probing depth** and the **location of the mucogingival junction**. These landmarks establish the presence and width of the attached gingiva, which are the basis for the decision.

The papilla preservation flap is used when possible in regenerative and aesthetic cases to minimize recession and loss of interdental papillae. The *distal terminal molar flap* is used for *treating pockets and osseous defects on the distal surface* of the terminal maxillary and mandibular molars.

Modified Widman Flap

The original Widman flap used *two vertical releasing incisions* connected by a *submarginal scalloped internal bevel incision* to demarcate the area of surgery. A full-thickness flap was reflected and the marginal collar of tissue was removed to provide access for root instrumentation and osseous recontouring.

In 1974, Ramfjord and Nissle published the "modified Widman flap" (Fig. 60.14), which used only horizontal incisions. This technique offers the possibility of establishing an intimate postoperative adaptation of healthy collagenous connective tissue to tooth surfaces, and it provides access for adequate instrumentation of the root surfaces and immediate closure of the area.

The step-by-step technique for the modified Widman flap is as follows:
Step 1: The first incision (Fig. 60.15A) parallel to the long-axis of the tooth is a scalloped internal bevel incision to the alveolar crest starting 0.5 to 1 mm away from the gingival margin (see Fig. 60.14C). The papillae are dissected and thinned to have a thickness similar to that of the remaining flaps.
Step 2: Full-thickness flaps are reflected 2 to 3 mm away from the alveolar crest (see Fig. 60.14D).
Step 3: The second, crevicular incision (Fig. 60.15B) is made in the gingival crevice to detach the attachment apparatus from the root.
Step 4: The interdental tissue and the gingival collar are detached from the bone with a third incision (Fig. 60.15C; see Fig. 60.14E and F).
Step 5: The gingival collar and granulation tissue are removed with curettes. The root surfaces are scaled and planed (see Fig. 60.14G and H). Residual periodontal fibers attached to the tooth surface should not be disturbed.
Step 6: Bone architecture is not corrected unless it prevents intimate flap adaptation. Every effort is made to adapt the facial and lingual interdental tissue in such a way that no interdental bone remains exposed at the time of suturing. The flaps may be thinned to allow for close adaptation of the gingiva around the entire circumference of the tooth.
Step 7: The flaps are stabilized with sutures (see Fig. 60.14I and J) and covered with a surgical dressing.

Fig. 60.14 Modified Widman flap technique.

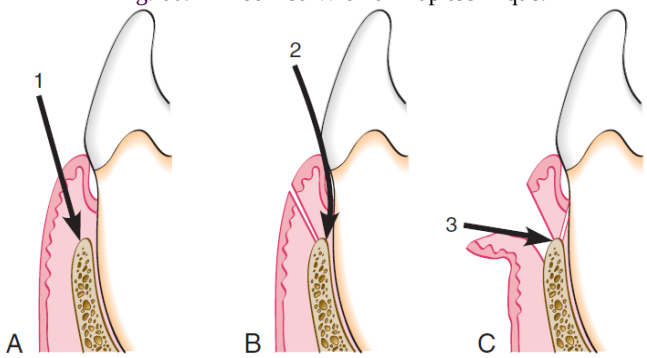


Fig. 60.15 The three incisions necessary for flap surgery. (A) First (internal bevel) incision; (B) second (crevicular) incision; and (C) third (interdental) incision.

Guided Tissue Regeneration

GTR is used for the prevention of epithelial migration along the cemental wall of the pocket and for maintaining space for clot stabilization. This method is based on the assumption that periodontal ligament and perivascular cells have the potential for regeneration of the attachment apparatus of the tooth. GTR consists of placing barriers of different types (membranes) to cover the bone and periodontal ligament, thus temporarily separating them from the gingival epithelium and connective tissue. Excluding the epithelium and the gingival connective tissue from the root surface during the postsurgical healing phase not only prevents epithelial migration into the wound but also favors repopulation of the area by cells from the periodontal ligament and the bone.

Clinical case reports indicate that GTR results in a gain in attachment level. Histologic studies in humans provided evidence of periodontal reconstruction in most cases, even with horizontal bone loss.

The use of polytetrafluoroethylene (PTFE) membranes has been tested in controlled clinical studies in mandibular molar furcations and has shown statistically significant decreases in pocket depths and improvement in attachment levels after 6 months, but bone level measurements have been inconclusive. A study of maxillary molar furcations did not result in significant gain in attachment or bone levels.

With the regenerative success associated with the use of nonresorbable membrane, the advantages and disadvantages of this approach became apparent. Notably, problems such as membrane exposure, which resulted in no or limited regeneration and the need for a secondary procedure for surgical removal, resulted in the development of biodegradable membranes. Today in clinical practice, most GTR procedures use biodegradable membranes, whereas the nonresorbable membranes, especially those with titanium reinforcement struts, are used for regeneration of large inftrabony defects and implant site development.

Extraction of Hopeless Teeth

Extraction of hopeless teeth is followed by provisionalization with fixed or removable prosthetics. Retention of hopeless teeth without periodontal treatment may result in bone loss around the adjacent teeth. It is also important to consider the extraction of teeth with a poor prognosis when implant replacement has become a predictable alternative to keeping and attempting periodontal therapy. Extraction of hopeless teeth can also be performed **during periodontal surgery** of the adjacent teeth. This approach reduces the number of appointments needed for surgery in the same area.

Periodontal plastic surgery:

Periodontal plastic surgery is defined as the surgical procedures performed to **correct or eliminate** anatomic, developmental, or traumatic deformities of the **gingiva or alveolar mucosa**. Mucogingival therapy is a broader term that includes non-surgical procedures such as papilla reconstruction by means of orthodontic or restorative therapy. Periodontal plastic surgery includes only the surgical procedures of mucogingival therapy.

➢ Mucogingival surgery

The term *mucogingival surgery* was initially introduced in the literature by Friedman to describe surgical procedures for the **correction of relationships** between the gingiva and the oral mucous membrane, with special reference to three problem areas: attached gingiva, shallow vestibules, and a frenum interfering with the marginal gingiva.

Recognizing this, the 1996 World Workshop in Clinical Periodontics renamed mucogingival surgery as *periodontal plastic surgery* to include the following areas:

- Periodontal-prosthetic corrections
- Crown lengthening
- Ridge augmentation
- Aesthetic surgical corrections
- Coverage of the denuded root surface
- Reconstruction of papillae
- Aesthetic surgical correction around implants
- Surgical exposure of unerupted teeth for orthodontics

The periodontal plastic surgical techniques included in the traditional definition of mucogingival surgery are (1) widening of attached gingiva, (2) deepening of shallow vestibules, and (3) resection of the aberrant frena. Aesthetic surgical therapy for natural dentition and tissue engineering (i.e., biologic mediators) also included.

Objectives

Five objectives of periodontal plastic surgery are:

1. Problems associated with attached gingiva
2. Problems associated with a shallow vestibule
3. Problems associated with an aberrant frenum
4. Aesthetic surgical therapy
5. Tissue engineering

- ## Problems Associated With Attached Gingiva

* The ultimate goal of mucogingival surgical procedures is the creation or widening of attached gingiva around teeth and implants. The width of the attached gingiva varies in different individuals and on different teeth of the same individual. Attached gingiva is not synonymous with keratinized gingiva because the latter also includes the free gingival margin. The width of the attached gingiva is determined by subtracting the **depth of the sulcus or pocket** from the **distance between the crest of the gingival margin and the mucogingival junction**.

* The original rationale for mucogingival surgery was predicated on the assumption that a minimal width of attached gingiva was required to maintain optimal gingival health. However, several studies have challenged the view that a wide, attached gingiva is more protective against the accumulation of biofilm than a narrow or a nonexistent zone. No minimal width of attached gingiva has been established as a standard necessary for gingival health. People who practice good, atraumatic oral hygiene can maintain excellent gingival health with almost no attached gingiva. However, individuals whose oral hygiene practices are less than optimal can be helped by the presence of keratinized gingiva and vestibular depth. Vestibular depth provides space for easier placement of the toothbrush and prevents brushing on mucosal tissue.

* To improve aesthetics, the objective is the coverage of the denuded root surface. The maxillary anterior area, especially the facial aspect of the canine, often has extensive gingival recession. In these cases, the covering of the denuded root surface widens the zone of attached gingiva and creates an improved aesthetic result. Recession and the resultant denuded root surface have special aesthetic concerns for individuals with a high smile line.

* A wider zone of attached gingiva is also needed around teeth that serve as abutments for fixed or removable partial dentures and in the ridge areas bearing a denture. Teeth with subgingival restorations and narrow zones of keratinized gingiva have higher gingival inflammation scores than teeth with similar restorations and wide zones of attached gingiva. In these cases, techniques for widening the attached gingiva are considered preprosthetic periodontal surgical procedures.

* **Widening the attached gingiva accomplishes four objectives:**

1. Enhances plaque removal around the gingival margin
2. Improves aesthetics
3. Reduces inflammation around restored teeth
4. Allows gingival margin to bind better around teeth and implants with attached gingiva

- **Problems Associated With a Shallow Vestibule**

Another objective of periodontal plastic surgery is the **creation of vestibular depth** when it is lacking. Gingival recession displaces the gingival margin apically, reducing vestibular depth, which is measured from the **gingival margin to the bottom of the vestibule.** With minimal vestibular depth, proper hygiene procedures are jeopardized. The sulcular brushing technique (i.e., Bass technique) requires placement of the toothbrush at the gingival margin, which may not be possible with reduced vestibular depth.

Minimal attached gingiva with **adequate vestibular depth** may **not** require surgical correction if proper atraumatic hygiene is practiced with a soft brush. Minimal amounts of keratinized attached gingiva with no vestibular depth benefit from mucogingival correction. Adequate vestibular depth is also necessary for the **proper placement of removable prostheses**.

- **Problems Associated With an Aberrant Frenum**

An important objective of periodontal plastic surgery is correction of frenal or muscle attachments that may extend **coronal to the mucogingival junction**. If adequate keratinized, attached gingiva exists coronal to the frenum, it may not be necessary to remove the frenum. A frenum that encroaches on the margin of the gingiva can interfere with biofilm removal, and the tension on the frenum tends to open the sulcus. In these cases, surgical removal of the frenum is indicated.

- **Aesthetic Surgical Therapy**

* Recession of the facial gingival margin alters the proper gingival symmetry and results in an aesthetic problem.

* The interdental papilla is also important to satisfy the aesthetic goals of the patient. A missing papilla creates a space that many call a *black hole*. Regeneration of the lost or reduced papilla is one of the most difficult goals in aesthetic periodontal plastic surgery.

* Another area of concern is an excessive amount of gingiva in the visible area. This condition is often called as a *gummy smile,* and it can be corrected surgically by crown lengthening. Correction of these anatomic defects has become an important part of periodontal plastic surgery.

- **Tissue Engineering**

The future of periodontal plastic surgery will encompass the use of tissue-engineered products at the recipient site to reduce donor site morbidity. Results of numerous experimental and clinical studies support the clinician's use of a minimally invasive approach to periodontal plastic surgery.

Aesthetic crown lengthening

In aesthetic crown lengthening, only a **facial flap** is raised to prevent loss of papillary fill. Initial gross osteoplasty is accomplished with a round bur to **reduce excessive bone thickness**, followed by **alteration of the crestal level** with hand chisels and curettes. It is important to reduce the osseous crest so that the new position parallels the CEJ at each tooth facially and proximally. However, the height of the *interdental crest is not reduced in aesthetic* crown lengthening. If full exposure of the anatomic crown is desired, the alveolar crest should be reduced to a position 3 mm apical to the CEJ. Excessive bone thickness interdentally is reduced with a round bur to produce a slight prominence of the roots relative to the alveolar ridge. Care should be exercised to maintain adequate bone thickness over the root surfaces. Creation of an ideal osseous form leads to predictable and stable soft tissue position and ideal crown exposure.

Flap closure is accomplished with interrupted 7-0 sutures. Postoperative instructions are focused on biofilm control to prevent soft tissue rebound. eFig. 65.22 demonstrates a clinical case of aesthetic crown lengthening to correct the gummy appearance in the maxillary anterior aesthetic zone.

Preprosthetic Surgery

Crown-Lengthening Procedures

* Surgical crown-lengthening procedures are performed **to provide retention form** to allow for proper tooth preparation, impression procedures, and placement of restorative margins (eFig. 69.4), and **to adjust gingival levels for aesthetics.**

* It is important that crown-lengthening surgery is done in such a manner that the biologic width is preserved. The *biologic width* is defined as the physiologic dimension of the junctional epithelium and connective tissue attachment. This measurement has been found to be relatively constant at approximately 2 mm (±30%). The healthy gingival sulcus has an average depth of 0.69 mm.

* It has been theorized that infringement on the biologic width by the placement of a margin of a restoration within its zone may result in gingival inflammation, pocket formation, and alveolar bone loss. Consequently, it is recommended that there be at least 3 mm between the gingival margin and bone crest. This allows for adequate biologic width when the restoration is placed 0.5 mm within the gingival sulcus (eFig. 69.7).

* Surgical crown lengthening may include the removal of soft tissue or both soft tissue and alveolar bone. **Reduction of soft tissue alone is indicated** if there is adequate attached gingiva and more than 3 mm of tissue coronal to the bone crest (eFig. 69.8). This may be accomplished by either gingivectomy or flap technique. Inadequate attached gingiva and less than 3 mm of soft tissue require a **flap procedure and bone recontouring** (eFig. 69.9). In the case of caries or tooth fracture, to ensure margin placement on sound tooth structure and retention form, the surgery should provide at least 4 mm from the apical extent of the caries or fracture to the bone crest (eFig. 69.10).

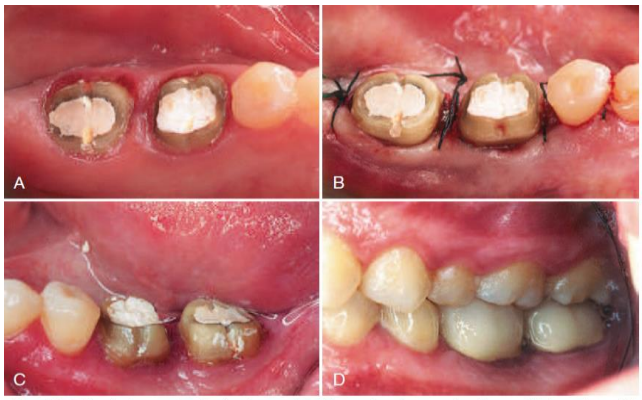
* With the advent of predictable implant dentistry, it is important to carefully evaluate the value of crown lengthening for restorative therapy as opposed to tooth removal and replacement with a dental implant.

Indications

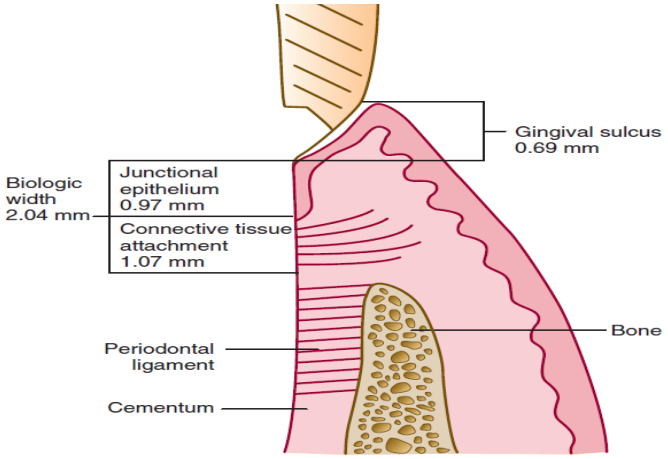
1. Subgingival caries or fracture.
2. Inadequate clinical crown length for retention.
3. Unequal or unaesthetic gingival heights.

Contraindications

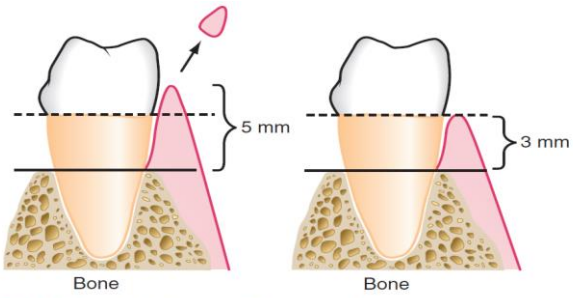
1. Surgery would create an unaesthetic outcome.
2. Deep caries or fracture would require excessive bone removal on contiguous teeth.
3. The tooth is a poor restorative risk.



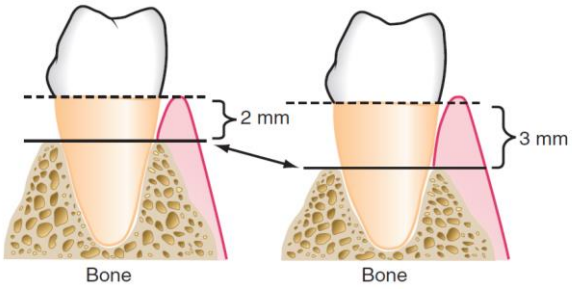
eFig. 69.4 Surgical crown lengthening has provided these otherwise unrestorable mandibular molars with improved retention and restorative access for successful restorations. (A) Before crown lengthening. (B) Crown-lengthening surgery completed. Note increased clinical crown. (C) Buccal view after surgery. (D) Final restorations.



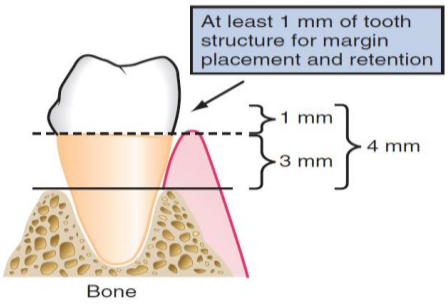
eFig. 69.7 Placement of the restorative margin 0.5 mm into the sulcus allows for the maintenance of the biologic width.



eFig. 69.8 Greater than 3 mm of soft tissue between the bone and gingival margin, with adequate attached gingiva, allows crown lengthening by gingivectomy.



eFig. 69.9 With less than 3 mm of soft tissue between the bone and gingival margin, or less-than-adequate attached gingiva, a flap procedure and osseous recontouring are required for crown lengthening.



eFig. 69.10 In the case of caries or fracture, at least 1 mm of sound tooth structure should be provided above the gingival margin for proper restoration.

- **Implant Site Preparation**

Basic Principles of Implant Therapy to Achieve Osseointegration with a high degree of predictability:

1. Implants must be sterile and made of a biocompatible material (e.g., titanium).
2. Implant site should be prepared under sterile conditions.
3. Implant site should be prepared with an atraumatic surgical technique that avoids overheating of the bone during preparation of the recipient site.

4. Implants should be placed with good initial stability.
5. Implants should be allowed to heal without loading or micromovement (i.e., undisturbed healing period to allow for osseointegration) for 2 to 4 or 4 to 6 months, depending on the bone density, bone maturation, and implant stability.

The surgical site should be kept aseptic, and the patient should be appropriately prepared and draped for an intraoral surgical procedure. Prerinsing with chlorhexidine gluconate for 1 to 2 minutes immediately before the procedure will aid in reducing the bacterial load present around the surgical site.

Successful osseointegration occurs predictably for submerged and nonsubmerged dental implants when proven clinical guidelines are followed. Well-controlled studies of patients with **good plaque control** and **appropriate occlusal forces** have demonstrated that root form, endosseous dental implants show little change in bone height around the implant over years of function. After initial bone remodeling in the first year (1 to 1.5 mm of resorption described as "**normal remodeling around an externally hexed implant"**), the bone level around healthy functioning implants remains stable for many years afterward. The average annual crestal bone loss after the first year in function is expected to be 0.1 mm or less. Hence, implants offer a predictable solution for tooth replacement.

Regardless of the surgical approach, the implant must be placed in healthy bone with good primary stability to achieve osseointegration, and an atraumatic technique must be followed to avoid damage to bone. Drilling of the bone **without adequate cooling generates excessive heat**, which injures bone and increases the risk of failure.

The anatomic features of bone quality (**dense compact versus loose trabecular**) at the recipient site influences the interface between bone and implant. **Compact bone** offers a **much greater** surface area for bone-to-implant contact than cancellous bone. Areas of the jaw exhibiting thin layers of cortical bone and large cancellous spaces, such as the posterior maxilla, have lower success rates than areas of dense bone. The best results are achieved when the bone-to-implant contact is intimate at the time of implant placement.