
Clinical scenarios where crown lengthening procedures are indicated within the esthetic zone require special consideration to achieve predictable restorative results. Whether they are performed for the purposes of exposing sound tooth structure, or to enhance the appearance of the definitive restorations, these procedures must be planned to satisfy biologic requirements, while simultaneously avoiding deleterious esthetic effects. The implementation of diagnostic criteria, along with evidence-based surgical and restorative protocols, in addition to state-of-the-art instrumentation, such as soft-tissue lasers, may assist the clinician in maximizing predictability when treating the esthetic zone.

Clinical Rationale and Anatomical Considerations

Crown lengthening procedures are often performed to provide access for treatment of subgingival caries, fractures, or defective restorations. Its surgical objectives include the exposure of an area of sound tooth structure suitable for placement of a restorative margin, and the establishment of adequate biologic width space.1-4 Crown lengthening procedures are also occasionally required for the treatment of chronic gingivitis caused by the placement of a restoration in violation of the biologic width5,6 (Figures 1 and 2).

Regardless of the clinical indications, consistent biological parameters must be taken into consideration during crown lengthening surgery, and it is therefore essential to possess a basic knowledge of the anatomic structures involved.

The basic functional unit that supports the teeth is the periodontium, which includes the alveolar bone, periodontal ligament, cementum, junctional epithelium, and gingiva.7 The gingiva is comprised primarily of connective tissue, which is covered by an epithelial layer that provides a
protective barrier against bacterial, mechanical, and immunological challenges. Collagen fibers within the gingival connective tissue insert into the periosteum of the alveolar process and into the root cementum.

The junctional epithelium constitutes the attachment interface of the epithelial layer to the tooth surface. It forms an epithelial tissue collar along the cervix of the tooth, and extends in an apical direction from the bottom of the sulcus to the level of the gingival connective tissue attachment. The cells of the junctional epithelium are adapted for adherence to the enamel or cementum surfaces through a mechanism termed hemidesmosomal attachment.\(^8\) Intercellular junctions are less prevalent within the junctional epithelium than in the oral and sulcular epithelium. The low cohesive forces between cells in the junctional epithelium result in an increased susceptibility to stretching and tearing during periodontal probing and retraction cord placement.\(^9\)

**Biologic Width**

The concept of biologic width is widely used as a clinical guideline during the evaluation of periodontal-restorative interrelationships. This concept assumes the existence of a constant vertical proportion of healthy supraalveolar soft tissues, with a mean dimension of approximately 2.0 mm, measured from the bottom of the gingival sulcus to the alveolar crest.\(^10\)

The biologic width encompasses the junctional epithelium and the connective tissue attachment. According to Gargiulo and colleagues, the average dimension of the epithelial attachment was 0.97 mm and the average dimension of the connective tissue attachment was measured at 1.07 mm, yielding a combined measurement of 2.04 mm.\(^11\) Although these dimensions are quoted in the literature, more recently published and histomorphometrically accurate data suggests that junctional epithelium dimensions as well as mean gingival...
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Sulcus depths are larger than initially described\(^1\) (Figure 3).

Because the biologic width appears to constitute a constant feature in the human periodontium, it has been suggested as an inviolate therapeutic parameter.\(^3\) Clinical observation indicates that impingement of the biologic width will result in attempts by the gingival tissue to reestablish its original dimension through bone resorption or, in the presence of a thick alveolar crest, chronic gingival inflammation.\(^5,6\)

Furthermore, there is evidence suggesting that the biologic width and the entire gingival complex will reestablish itself during healing of the periodontal tissues after surgical procedures.\(^13,14\)

Over the years, several authors have provided therapeutic guidelines to be used in crown lengthening procedures, consistent with the published dimensions of the human dentogingival junction. From a clinical perspective, however, it appears to be more practical and equally efficacious to consider the total dimensions of the dentogingival complex rather than its individual components. Kois reported the dentogingival complex dimension to measure 3.0 mm on the midfacial and 3.0 mm to 4.5 mm in the proximal areas.\(^15\)

The dentogingival complex was comprised of connective tissue attachment, junctional epithelium, and gingival sulcus. For therapeutic purposes, each one of these components is assigned an approximate
dimension of 1.0 mm. Using this approach, the amount of osseous resection necessary in a crown lengthening procedure will be determined by measuring a distance of 3.0 mm from the anticipated location of the restorative margin, a methodology similar to that described previously by other authors.¹⁰,¹⁶,¹⁷

**Influence of Surgical Technique on Gingival Margin Stability**

Studies evaluating gingival margin levels after healing from crown-lengthening surgery have reported coronal gingival proliferation as a consistent finding. Deas concluded that there was a significant tissue rebound after crown lengthening procedures that had not fully stabilized at 6 months.¹⁴ Pontoriero reported that during a 1-year healing period after apically positioned flap surgery and osseous resection, the marginal periodontal tissue demonstrated a distinct tendency to grow in a coronal direction from the levels defined at surgery.¹³

The predictability of gingival margin levels after crown lengthening procedures, and the healing time required to achieve it, are essential factors to consider in restorative dentistry procedures. Not only are they crucial in determining finish line placement, but also in planning the timing of definitive preparation and impression procedures. Additionally, it is necessary to develop surgical protocols that will not only increase gingival margin predictability but additionally reduce healing times, particularly as it pertains to the esthetic zone, where prolonged exposure of the subgingival structures may be unacceptable to the appearance conscious patient.

A review of the literature seems to identify specific technique factors that may affect coronal tissue proliferation as well as the healing period. For example, Deas reported an apparent relationship between the amount of gingival tissue regrowth and the position of the sutured flap relative to the postsurgical alveolar crest level. In fact, there was a significant inverse correlation between the distance of the flap to the osseous crest at the time of suturing and the amount of tissue rebound, indicating that greater gingival rebound occurred when the flap margin was positioned closer to the bony crest. These findings indicate that the periodontium will tend to proliferate during the healing period to regain its original dimension and further suggest that the use of periosteal sutures to tightly bind the flap to the underlying alveolar crest should be avoided¹⁴ (Figure 4).

Additionally, Lanning and colleagues reported on a protocol where the dimension of the gingival complex was determined preoperatively and later added to the anticipated restorative margin position to determine the amount of osseous resection to be performed during crown lengthening surgery. Adequate osseous con-

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**Figure 13**—The full-thickness flap is repositioned to its original level to minimize subgingival exposure at this stage. Internal vertical mattress sutures that avoid compression to the papillae are used, decreasing risk of necrosis.

**Figure 14**—After a 3-month healing period after flap surgery, the esthetic diagnosis appliance is used to determine the amount of soft-tissue excision required to achieve the preestablished restorative objectives.

**Figure 15**—Gingival margin design being finalized. Incision outline has been designed to converge into line angle areas to preserve maximum papilla height.

Because the biologic width appears to constitute a constant feature in the human periodontium, it has been suggested as an inviolate therapeutic parameter.
tours was verified with measurements from stents and surgical guides. This approach resulted in bone removal equal to or greater than 3.0 mm at 90% of the treated sites, which is considerably more than what had been previously reported. Interestingly, their findings demonstrated that the gingival margin position became stable at 3 months, and remained subsequently unchanged through the remainder of the 6-month duration of their study.

The evidence seems to be leading toward the use of specific surgical guidelines that will result in increased gingival margin predictability after crown lengthening surgery. This approach would include the use of full-thickness flaps to preserve the entire dimension of the dentogingival complex, followed by adequate osseous resection measured from a restorative landmark to ensure sufficient bone removal, and finally, avoidance of periosteal sutures to apically position the flap. Provided that this protocol is used, stable gingival margins should allow definitive tooth preparation and impression making to take place 3 months after surgery, even in the esthetic zone.

Diagnostic Considerations in Esthetic Crown Lengthening

Crown lengthening surgery has become an important component of the esthetic armamentarium, being frequently used to enhance the appearance of maxillary and mandibular anterior restorations. Although an abundance of case reports have been published in the dental literature, it is essential for clinicians to understand the diagnostic criteria, treatment planning process, and biological parameters involved to determine the appropriate indications, as well as the surgical and restorative protocols that are available to enhance the potential for predictable outcomes in the esthetic zone.

Most crown lengthening procedures are performed as an adjunct to prosthetic therapy. An awareness of the restorative-driven nature of crown lengthening surgery is therefore essential. This means that during the diagnostic and treatment planning process, the identification of restorative objectives should be completed before determining surgical endpoints. Specifically applied to esthetic crown lengthening, the author recommends the evaluation of key diagnostic factors using the following sequence:

1. Identify the desired incisal edge position.
2. Determine an adequate clinical crown length.
3. Design the postsurgical gingival margin outline.

Only after these therapeutic endpoints have been established, can an analysis of the existing soft-tissue/hard-tissue relationships be initiated to determine the amount of gingival excision and bone removal required (Figures 5 through 7).

Bone sounding is used to determine the thickness of the soft-tissue layer and the level of the alveolar
crest during the planning stages of crown lengthening procedures. After applying local anesthesia, a measuring instrument is introduced into the gingival sulcus, subsequently penetrating the junctional epithelium and connective tissue attachment until contact is made with the alveolar crest (Figure 8).

For esthetic crown lengthening procedures, bone sounding is performed in an attempt to determine the location of the alveolar crest on the labial aspect, but frequently includes the proximal areas as well. Factors such as periodontal biotype and site-specific characteristics, including recession, root anatomy, and tooth morphology may influence the clinician’s ability to accurately determine osseous crest levels. Generally, the presence of a thicker plate of bone (e.g., with thick, flat periodontium) will provide a more accurate evaluation of the alveolar crest position through transgingival probing. Conversely, when a thin labial plate or bone dehiscences are present, identification of the alveolar crest may become difficult. This may not be consequential, because thin or dehisced labial plates will more likely resorb postoperatively.

As soon as the dimensions of the dentogingival complex and the position of the alveolar crest have been determined, an appropriate surgical approach and treatment sequence can be developed that will favor the achievement of the preestablished restorative outcome.

Staged Surgical Approach

A restorative-driven classification system has been proposed with the purpose of streamlining the diagnostic process and providing therapeutic guidelines. It is based on the location of the anticipated restorative margin and its relationship to the dentogingival complex and alveolar crest (Table). Measurements taken from this restorative landmark are used to identify 4 distinct clinical scenarios, each one carrying specific treatment recommendations.

Of particular interest are the Type II and Type III categories, which may be amenable to a staged surgical approach. Completing the gingival excision and osseous resection as separate procedures may enhance postoperative gingival margin predictability while improving the management of the esthetically conscious patient (Figures 9 through 19). Treatment may be sequenced so that a provisional restoration is placed during the gingivectomy appointment, thus avoiding the exposure of root surfaces, subgingival margins, and open embrasures.

Laser-Assisted Gingivectomy and Gingivoplasty

Esthetic crown lengthening is a technically demanding endeavor that requires gingival incisions exhibiting a higher degree of precision than what may be achieved with a scalpel blade. Electrosurgery has been used as an alternative to excise gingival tissue while providing adequate hemostasis and is therefore preferred by many restorative dentists. Heat generation with this technique, however, is a concern and recession has been a consistent finding.

Soft-tissue lasers offer a superior degree of operator control while exhibiting decreased biologic side effects. Very fine incisions and surgical revisions are easily achieved with a degree of hemostasis that results in a clean surgical field (Figure 16). Diode lasers operate at a wavelength that is easily absorbed by the gingival tissues, while posing little risk of damaging the tooth structure, and may be used in close proximity to enamel, cementum, existing restorations, or dental implants (Figures 16 and 17).

Diode lasers may be used in either contact or noncontact mode. The former is preferred by many clinicians, however, because the enhanced tactile feedback exhibits more similarity to traditional cutting or drilling procedures in dentistry, potentially decreasing the learning curve (Figure 16). Power settings are adjustable, and the laser energy may be delivered in a constant or pulsed emission mode.

Because the energy is concentrated at the tip of the fiber, the laser...
must be oriented along the incision plane and subsequently advanced through layers. Alternatively, the laser beam may be used in the constant mode to provide faster cutting, but increased thermal transfer to the adjacent tissues may then be a concern. Operating in the pulsed emission mode, and incorporating additional cooling methods such as the use of an air current or water irrigation may assist in avoiding excessive temperatures.

At 100° C, laser energy causes vaporization of water particles within the cellular and interstitial spaces, resulting in the removal of the targeted soft tissue; a phenomenon known as ablation. Because bacteria are destroyed during this process, the surgical site is disinfected simultaneously contributing to the improved postsurgical healing often observed with laser-assisted gingival procedures (Figure 19).

However, temperatures above 200° C will result in excessive carbonization and the formation of a charred layer, which absorbs heat and may interfere with the subsequent transfer of laser energy. Removal of the carbonized residue from the tooth structure is cumbersome, and could become an esthetic concern when using translucent all-ceramic restorations. Therefore it is important for the operator to closely monitor the procedure so that an appropriate technique and laser settings are selected to achieve an acceptable balance between optimum ablative efficiency and a minimum degree of carbonization (Figure 18).

Conclusion

Crown lengthening surgery is an important adjunct to restorative dentistry, potentially enhancing treatment outcomes in the esthetic zone. Taking into consideration recently published evidence, a contemporary surgical protocol may be developed with the purpose of increasing postsurgical gingival margin predictability while decreasing the healing period. Factors influencing the latter include incision design, osseous reduction, and flap management. Additionally, a staged surgical approach may be used to sequence the gingival excision and osseous resection procedures and improve gingival margin predictability. This approach may also allow the placement of a provisional restoration during the gingivectomy appointment, assisting with the management of the esthetically conscious patient as well. Soft-tissue lasers offer unparalleled precision and operator control and may be beneficial for finely tracing incision lines and sculpting the desired gingival margin outline, while also achieving excellent hemostasis and postsurgical healing.

References