Exploring the Periodontal-Restorative Interface

- Clinical use of the Er,Cr: YSGG laser for osseous crown lengthening
  Robert A. Lowe, DDS

- Use of the Er,Cr: YSGG laser to improve periodontal plastic surgery
  Bobby Butler, DDS, PLCC

With a Foreword by Dr. John C. Kids
Restorative dental care, in any capacity, depends on the clinician's understanding of the biological factors involved. Accordingly, investigators have worked for decades to identify the structures of the intraoral environment and to define their role in the health and harmonious function of the dentition. Although there is considerable variability among patients, research has confirmed the presence of a dentogingival complex (DGC) that influences the biological response of the gingival tissues to intrasulcular margins created during aesthetic dentistry. This DGC has been measured as 3 mm facially to nearly 4 mm interproximally and affects the outcome of any restoration that is placed at the level of the free gingival margin.

Once these parameters are acknowledged and readily understood, they can be applied in implant dentistry, aesthetic care, and periodontal-prosthodontic care—such as osseous contouring. While conventional approaches and instrumentation can be used in the management of the DGC and an unaesthetic gingival architecture, new treatment modalities continue to be developed for this purpose as well. Dental lasers, as evidenced in the following presentations by Dr. Robert Lowe and Dr. Bobby Butler, and as this author is now experiencing firsthand, can be a useful adjunct in the delivery of such restorative dentistry. Such technology shows promise in clinical studies for its ability to support a minimally invasive approach to restorative care, aiding in hemostasis, the conservation of the hard and soft tissues, and allowing treatment to be performed with greater comfort to the patient.

Additional histological results will be necessary to confirm the long-term efficacy of dental lasers for osseous recontouring and similar intracrevicular restorative procedures. Based on results such as those that follow herein, however, dental lasers demonstrate great promise in their ability to redefine the standard of care for periodontal therapy—for dental patients as well as dental professionals.

References
To design the optimal outcome for a patient during aesthetic enhancement, the restorative dentist must seek to create a symmetrical and harmonious relationship between the lips, gingival architecture, and the positions of the natural dentate forms. In the author’s experience, the Er,Cr: YSGG laser has been a useful adjunct for performing aesthetic surgical crown lengthening procedures. This article will highlight the associated biological principles and demonstrate techniques for the application of this laser in closed and open crown lengthening procedures.

Learning Objectives:
This article demonstrates the use of the Er,Cr: YSGG laser for osseous crown lengthening. Upon reading this article, the reader should have:
• Enhanced awareness of criteria for developing a biologically stable free gingival margin.
• Greater familiarity with the open and closed crown lengthening procedures, including case selection and surgical approaches.

Key Words: crown lengthening, biologic width, FGM, laser, Er,Cr: YSGG
When designing the optimal aesthetic outcome for a patient during the smile rejuvenation process, the clinician must create a symmetrical and harmonious relationship between the lips, gingival architecture, and the positions of the natural dentate forms. Spear et al. have referred to this diagnostic methodology as facially generated treatment planning, where the maxillary central incisal edges determine where the soft tissue (i.e., gingiva) and bone should be positioned.

The versatility of the Er,Cr: YSGG laser and its ability to recontour both hard and soft tissues creates the opportunity for a minimally invasive approach in many clinical situations that require repositioning of the periodontal structures for both aesthetic or restorative reasons. The laser can also decrease the need for suturing, reduce postoperative discomfort, and shorten healing times. This article will demonstrate and discuss techniques for the use of the Er,Cr: YSGG laser for osseous crown lengthening procedures, specifically highlighting the associated biologic principles as well as the “open” and “closed” techniques.

The Dentogingival Complex

The dentogingival complex consists of connective tissue attachment, epithelial attachment (or junctional epithelium), and the gingival sulcus. As described by Kois, the most critical relationship for biologic health when the clinician is placing a restoration at or below the free gingival margin (FGM) is the margin location relative to the crest of bone. Kois states that the distance from the FGM to the osseous crest on the facial aspect is 3 mm. Interproximally, on anterior teeth, this distance is 4 mm due to the curvature of the cementoenamel junction; posteriorly it is 3 mm. The height of the interdental papilla can also be predicted to be maintainable 4 mm incisal to the osseous crest between anterior teeth with normal root proximity, approximately 2 mm at the osseous crest (Figures 1 through 4). With these parameters in mind, the clinician must first decide where the restorative margin will be placed. For all-ceramic restorations that do not need to block out undesirable dentin colors or core materials, it may be desirable to place the restorative margin at the free gingival crest or slightly supragingival.3
If an intracrevicular margin is required for aesthetic reasons, however, it should be placed no farther than 0.5 mm into the gingival sulcus to avoid adverse biologic responses due to encroachment upon the attachment apparatus.

Kois,5 Coslet, et al5 also describe a variation in biologic width that compares the distance from the alveolar crest to the FGM and divide this into three categories: 1) normal crest, 2) high crest, and 3) low crest. In simplified terms, normal crest patients (about 70%) have approximately a 2-mm combined epithelial and connective tissue attachment and 1-mm sulcus depth (a total dentogingival complex of 3 mm). If the sulcus depth is greater than 1 mm, the free gingival excess can be safely resected and, upon healing, will result in a dentogingival complex measuring 3 mm on the facial aspect. Patients with a high crest often have a shallower sulcus depth and a combined dentogingival complex measurement of less than 3 mm. These patients have relatively stable FGM positions and are not prone to recession upon manipulation of the tissues. Low-crest patients often have normal sulcus depth (1 mm to 3 mm) and a combined epithelial and connective dentogingival complex measurement that is greater than 3 mm. These patients can be prone to recession and must be treatment-planned accordingly. The FGM of low-crest patients will tend to apically reposition and turn into a normal crest situation after gingival retraction or surgery. Therefore, the most
important factor in postrestorative gingival health and stability is the position of the restorative margin relative to the bony crest, not the preoperative health and/or position of the gingival tissues.

Smile Design and Tooth Dimension

Several parameters must be considered when designing an aesthetic smile, including: 1) Width-to-length ratio of the maxillary central incisors, 2) Mesiodistal proportional width of the maxillary anterior teeth, 3) Position of the maxillary central incisors in the face (ie, the “e” position), and 4) Relative gingival zenith positions and height of contour.

The width of the average maxillary central incisor has been measured at approximately 10 mm. Using the “Golden Proportions” as guidelines, one can arrive at an appropriate measurement for the width and the length of the central incisor. The next consideration is that the width-to-length ratio of an aesthetic maxillary central incisor is 75% to 80%. Thus, the 10-mm central incisor should measure 7.5 mm to 8 mm mesiodistally if it is proportionally correct. The “e” position (ie, when a patient says “e”) shows the relative amount of maxillary tooth display. In the “e” position, it is aesthetically desirable for a patient to show 50% to 70% of the maxillary incisor teeth. Finally, the heights of the gingival tissues over the maxillary central incisors should be slightly higher (1 mm apically) than the heights of the tissue over the maxillary
lateral incisors. The heights of the maxillary canines should be at the same level apically as the central incisors, or slightly more apical. The gingival zeniths should be located at the distolabial line angles, thus creating a “raised eyebrow” over the central incisors."

**Laser-Assisted Crown Lengthening**

Use of the Er,Cr: YSGG laser for gingival and bony recontouring has a tremendous impact on the way periodontal surgery is performed. Since the laser cuts only at the end of the tip, the user has effective control of soft and hard tissue resection. Using the Er,Cr: YSGG with a tapered tip allows the operator to make scalloped gingivectomies with surgical precision and no bleeding. When using traditional rotary instruments to perform osseous resection, there is always a risk that their rotation will damage adjacent root surfaces. Additionally, since the surgical laser wound is less traumatic, there is less chance of bony damage due to frictional heat, which is always possible when using rotary instrumentation without proper irrigation. This minimally invasive technology translates into less postoperative discomfort and quicker healing of the patient."

**The Open Technique**

For an aesthetic gingival display, it is critical that symmetry (right and left) exists as far as cervico-incisal tooth height and gingival zenith positions are concerned.
Patients that exhibit asymmetrical gingival levels, those with greater than 3 mm to 5 mm of maxillary gingival display, or both may be candidates for surgical gingival and/or alveolar bone repositioning to improve their aesthetics. Typically, these patient types have adequate amounts of attached gingiva so that after the resective procedure the mucogingival junction will not be encroached. If adequate amounts of free gingiva exist, minor asymmetries can be corrected with ginvectomy or gingivoplasty alone. A minimum sulcus depth of 1 mm must always remain after any tissue resection unless the alveolar bony crest is also repositioned in the apical direction, as well. To give the appearance of spatially moving teeth in the cervical direction to alleviate excessive gingival display or asymmetry, oftentimes osseous correction must be performed in conjunction with soft tissue resection because of sulcus depth violation.

As previously stated, the finished maxillary central incisors should be 10 mm to 12 mm in length. While the incisal edges can be shortened when adequate freeway space exists posteriorly, the amount depends on the discursive pattern of the patient. The shortened incisal edges must still disclude the posterior teeth in all eccentric movements to maintain occlusal harmony. A tissue marker can be used to plan the soft tissue surgery (Figure 5). Following the guidelines for aesthetic tissue levels, the perceived final gingival level is traced.
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creating heights of contour at the distolabial line angles. The Er,Cr: YSGG laser is used to remove the gingival tissue and create symmetry according to the proposed surgical plan. The preparation margins are then adjusted to the corrected FGM. As the biologic width will be encroached upon, it is important that the same amount of bone be removed to recreate normal biologic parameters. An intrasulcular internal bevel incision is made, and a full-thickness mucoperiosteal flap is elevated. The alveolar crest correction is made using the Er,Cr: YSGG laser and either a 9-mm or 14-mm 600-µm tip. Since the laser only cuts at the tip, it is set against the side of the root parallel with the long axis of the tooth (Figure 6). This ensures that the dentin/cementum surface is never damaged. A black marker can be used to place a line at a point 3 mm from end of the tip. This is used as a guide to apically position the bone 3 mm from the restorative margin. Only the alveolar bone will be ablated by the laser-energized water. The root surface is then planed using a back-action chisel. The alveolar architecture should thus mimic the restorative margin 3 mm apically, allowing for biologic width restoration to a normal crest position.

The interproximal bone on facial aesthetic correction cases is not altered; the flap is sutured back using 3-0 silk and an interrupted suture technique (Figure 7). For this particular case, at the delivery appointment, the heights of the gingival zeniths above the maxillary central incisors were adjusted apically using a closed crown lengthening technique to slightly modify the final FGM position (Figure 8). The definitive restorations are shown 3 years after corrective gingival and bony surgery with the Er Cr, YSGG laser (Figure 9).

The Closed Technique

For minor, localized biologic width and/or aesthetic gingival zenith corrections, the Er,Cr: YSGG laser can be used in lieu of a flap procedure to make the correction and complete the restorative process without the necessary healing time required for open crown lengthening surgeries. Patients with normal or thick biotypes (ie, normal to thick keratinization) are good candidates for this procedure.

The soft tissue is resected using a 400-µm tapered tip on facial areas or a 600-µm tip in proximal areas, creating the new apical position and scallop of the FGM. The osseous crest is sounded using a periodontal probe to determine the distance from the free gingival crest. Using a 9-mm 600-µm tip, the laser is then used to remove bone, holding the tip adjacent to the tooth and "walking" the tip across the affected area using a "sewing machine" (ie, up and down) movement to a 3-mm depth (Figure 10). After establishing the corrected crestal level, the bone is "smoothed" by setting the laser at 50 pulses per second and moving the tip in a horizontal direction over the crestal bone. It is important to note that with both of these movements, the tip of the
the dentogingival complex are 1) pink color (i.e., absence of inflammation), 2) reestablishment of a probable gingival sulcus, and 3) absence of bleeding upon probing (Figures 18 through 21).

Conclusion

Techniques have been described using the Er,Cr: YSGG laser for periodontal crown lengthening procedures. Using the biologic parameters discussed in this article, it is now possible to perform open periodontal procedures both facially and interdentally and predict the level that tissues will heal to based on the position of the restorative margin. It is important for the clinician to use a periodontal probe and sound from the FGM to the alveolar crest to determine the biologic parameters of the patient prior to preparing teeth for restorative materials. This makes it possible to make final impressions on the day of preparation and surgery, deliver the definitive restorations several weeks later, and be confident that the gingival tissues will heal to the appropriate aesthetic levels (Figures 22 and 23). Patients and dentists can enjoy a shortened treatment time by avoiding extended time in provisional restorations while the tissues mature around their new ceramic restorations.

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References

The Er,Cr: YSGG laser has been shown to be safe and effective in osseous procedures. When used in crown lengthening procedures, the clinician must address the biologic width and consider different periodontal biotypes in order to avoid potential complications postoperatively. The biologic width can vary from patient to patient and from anterior to posterior teeth. Thus, the biologic width, periodontal health, and the stability of the gingival margin after crown lengthening are important when one is trying to achieve ideal aesthetics. One additional factor to consider is the periodontal biotype (Figure 1), as gingival recession can vary after crown lengthening depending on the patient’s osseous biotype. The three biotypes are medium, thin, and thick, and they are commonly associated with ovoid, triangular, and square tooth forms, respectively. Whether used in either a closed or open approach, any application of lasers for crown lengthening must address these concepts.

The Er,Cr: YSGG laser can be used in a closed intrasulcular approach to remove bone and re-establish biologic width, the advantages being minimal trauma and improved healing. This can be performed only in patients with medium biotype, where the thickness of the osseous crest is approximately 1 mm. The procedure may be limited to 1 mm to 2 mm of osseous removal as the width increases apically (Figure 2). The thick osseous ledge cannot be shaped or thinned intrasurally. In a patient with a thick biotype, a full-thickness flap is necessary to gain access and perform significant osteoplasty. If the laser is used in a closed approach for such patients, the surgeon creates a site for osseous and gingival rebound or a possible periodontal intrabony defect. In the thin,

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**Figure 1.** Diagram illustrates the various periodontal biotypes that must be considered.

**Figure 2.** Example of thick osseous biotype with osseous level less than 2 mm from the cementoenamel junction.
highly scalloped biotype, the laser can remove too much of the thin gingival volume when performed in a closed approach, resulting in excessive recession thereafter.

While the Er,Cr:YSGG laser has many new applications, including its use in closed and open crown lengthening surgeries, case selection is important for each approach. The Er,Cr:YSGG laser can safely cut bone without burning or altering the calcium:phosphate ratio of the inadverted bone.1 This is true only if the clinician does not misuse the laser, as the wattage and time in contact with bone must be considered. The total energy transmitted to the tissue is the watts/second (ie, joules) in that specific site. It offers extreme precision and can be less traumatic than rotary cutting instruments. To ensure the efficacy and safety of laser-assisted procedures, the clinician should have proper training in the equipment settings, capabilities, and laser techniques.

It is exciting to consider new techniques in conventional procedures, but the clinician must still adhere to proven healing and surgical principles. In this author’s view, the combination of these tenets with future technologies will continue to evolve the way dentists perform these procedures.

References

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**Editorial Commentary continued**

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1. In the "e" position, what percentage of the maxillary incisor teeth is aesthetically desirable for a patient to show?  
   a. 60% to 80%.  
   b. 50% to 70%.  
   c. 25% to 45%.  
   d. 40% to 60%. 

2. What of the following are NOT criteria for clinical health of the dentogingival complex?  
   a. Pink color.  
   b. Reestablishment of a probable gingival sulcus.  
   c. Presence of inflammation.  
   d. Absence of bleeding upon probing. 

4. What is the most important factor in postrestorative gingival health and stability?  
   a. Preoperative health.  
   b. Position of the gingival tissues.  
   c. Position of the restorative margin relative to the bony crest.  
   d. None of the above. 

5. What is the minimum sulcus depth that must remain after any tissue resection?  
   a. 0.25 mm.  
   b. 0.5 mm.  
   c. 1 mm.  
   d. 1.5 mm. 

6. Using the biologic parameters discussed in the article, it is now possible to:  
   a. Perform open periodontal procedures interdentally.  
   b. Predict the level that tissues will heal to.  
   c. Perform open periodontal procedures facially.  
   d. All of the above. 

3. The Er,Cr:YSGG laser can:  
   a. Decrease the need for suturing.  
   b. Reduce postoperative discomfort.  
   c. Shorten healing times.  
   d. All of the above. 

7. The dentogingival complex does NOT consist of:  
   a. Cementoenamel junction.  
   b. Connective tissue attachment.  
   c. Epithelial attachment.  
   d. Gingival sulcus. 

8. The Er,Cr:YSGG laser with a tapered tip allows the operator to:  
   a. Create a symmetrical relationship between the nose and lips.  
   b. Eliminate the need for suturing.  
   c. Make scalloped gingivectomies with surgical precision and no bleeding.  
   d. None of the above. 

9. As the biologic width is encroached upon, it is important that bone be removed to recreate normal biologic parameters.  
   a. Less.  
   b. The same amount of.  
   c. More.  
   d. No. 

10. According to Kois, what is the distance from the FGM to the osseous crest on the facial aspect?  
    a. 1 mm.  
    b. 2 mm.  
    c. 3 mm.  
    d. 4 mm.