Root Reshaping: An Integral Component of Periodontal Surgery

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It is the aim of this article to present a surgical option to the traditional method of returning lost biologic width where invasion of the junctional and/or connective tissue attachment associated with a tooth has occurred. The alternative to conventional osseous resection involves reshaping the existing tooth surface in combination with conservative removal of the supporting alveolar bone to create the width needed for the restoration to be biologically acceptable. This procedure accomplishes several goals: (1) *minimum supporting bone is removed;* (2) *deleterious root surface anatomy, such as grooves, concavities, and cementoenamel projections, is diminished;* (3) *a smooth root surface that is more biologically acceptable to soft tissue is created;* (4) *Class I and II furcation lesions may be decreased or eliminated; and* (5) *improved gingival contours and space for restorative materials can be created in situations in which close root proximity is present. This article will present a step-by-step approach to using root reshaping as an alternative to traditional crown lengthening.* (Int J Periodontics Restorative Dent 2001;21:297–304.)

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As the general population continues to age, the perception is that a greater percentage of these people are keeping their dentition. This is largely a result of the efforts of the dental community in implementing preventive programs to curb the loss of teeth. Many of these teeth have been restored over the past 50 years with materials that are substandard in nature as they relate to today's restorative advances in strength and stability. When these materials begin to break down and lose their structural integrity, it becomes necessary for the cognizant dentist to realize the limitations of replacement with respect to the periodontal implications. Specifically, as these restorations are replaced multiple times, invasion of the physiologic dimension of the dentogingival complex is often the result because new margins of restorations will continue to creep apically or become overextended.

This physiologic dimension, or biologic width, is defined as the dimension from the alveolar crest of bone to the base of the sulcus (2.04 mm), and it includes the connective tissue (1.07 mm) and the epithelial

attachment (0.97 mm).[1] The maintenance of the biologic width has been a pillar of the periodontal-restorative relationship for many years.[2,3] As this necessary dimension is encroached upon, the resultant damage is resorption of crestal bone and apical migration of the junctional epithelium, which may lead to the development of a chronic inflammatory response.[1] This may become associated with both hygienic and esthetic concerns for the dentition involved.

A number of articles have given direction as to how to recreate the biologic width through crown-lengthening or crown-extension procedures.[4–6] These articles have given instructions regarding restorative measures prior to surgery, incision design, osseous recontouring (including both ostectomy and osteoplasty), closure, and postoperative treatment.

With reference to osseous recontouring, it is accepted as a general rule that 3.0 to 4.0 mm of alveolar bone is removed, as measured from the anticipated new restorative margin to the new alveolar crest.[1] However, many times the new restorative margin is not evident, and the clinician may choose to err on the aggressive side during recontouring. Not only must bone be removed from the tooth in question, but it must also be removed surrounding the adjacent teeth, as soft tissue will not follow acute bone angles.[7] The result of such bone removal is ultimately an increase in the crown-to-root ratio and elimination of the commodity that periodontists hold so valuable: bone. In addition, the surgeon has weakened the support of not only the tooth requiring relief, but also the two adjacent teeth. In this common surgical scheme, it is believed that Gargiulo's average biologic width holds true for the entire population. However, when one reviews this classic article, it is apparent that there is a range for each of the three components of the biologic dimension.[1] With this in mind, each individual tooth should be allowed the opportunity to develop its proper dimension postoperatively.

The purpose of this article is to provide the dental surgeon with an alternative to conventional crown-lengthening procedures. The intent of both procedures is to reestablish the lost physiologic dimension to ensure biologic acceptance of the future restoration. This alternative to aggressive osseous resection is to reshape the existing tooth surface in combination with conservative removal of the supporting alveolar bone to create the width needed for the restoration to be biologically acceptable. The benefits of this procedure are: *(1)* minimum supporting bone is removed; *(2)* unacceptable root surface anatomy, such as grooves and concavities[8,9] and cementoenamel projections, is diminished or removed; *(3)* a smooth root surface, which has been associated with decreased subgingival plaque formation and is more biologically acceptable to the soft tissue, is created[10,11]; *(4)* Class I and II furcation lesions may be decreased or eliminated; and *(5)* roots in close proximity can be altered to allow formation of a hygienic gingival contour as well as space for restorative material. This article presents a step-by-step approach to using root reshaping as an alternative to traditional crown lengthening and for possible inclusion in osseous resective surgery to treat periodontitis.

Case 1

A 54-year-old man presented to his restorative dentist for a new-patient exam. It was determined that the large amalgam restorations in the mandibular left posterior segment had poor marginal integrity as well as secondary decay. The teeth were determined to be best restored using complete-coverage restorations. All old restorative materials were removed, and core buildup restorations were placed using Enamel Shade Core Paste (Denmat). The crowns were then prepared with the knowledge in mind that crown lengthening would need to be performed to reestablish the necessary biologic width. In addition, it was the goal of the restoring clinician that the final margin placement remain supragingival to ensure biologic compatibility and facilitate proper oral hygiene. Temporary crowns were fabricated with excellent marginal adaptation. This was accomplished by using Jet Acrylic (Lang Dental) in a vacuum-formed matrix. Once set, the acrylic was relieved internally, relined, and seated. An apron of acrylic was placed at the free gingival margin to capture

the newly prepared crown margin. The patient was then referred to the periodontal surgeon for crown lengthening.

A medical history review revealed no contraindication to periodontal surgical therapy, and the patient was treatment planned for quadrant therapy. Local anesthesia was used for patient comfort (2% lidocaine with epinephrine 1: 100,000, Astra). Preoperatively, the temporary restorations were removed and kept intact (Fig 1a). A partial-thickness flap was created on the buccal aspect with a 12B surgical blade (Becton-Dickinson AcuteCare) following initial intrasulcular incisions. This flap design was applied to retain a maximum amount of keratinized tissue as well as to allow the surgeon to place the soft tissue just apical to the crest of the alveolar bone. The flap should initially be elevated approximately 1 to 2 mm past the mucogingival junction. The lingual incision was full thickness using an intrasulcular incision and a distal wedge to facilitate apical positioning of the soft tissue posteriorly. Thorough debridement of all granulation tissue was accomplished to allow unobstructed visualization of the underlying bony architecture and root surface anatomy. In Fig 1b, it is apparent that the old restoration extended to the coronal aspect of the furcation in the mandibular left first molar. Once this was completed, an F82 coarse diamond bur (Vic Pollard Dental) was used to remove all existing restorative margins peripherally on each tooth. Once the old margins were removed, all developmental grooves, root surface accretions, Class I and II furcations, and cementoenamel projections were eliminated as well. At the furcations, the tooth was grooved, with this groove extending to the occlusal surface. This created a barreled-in effect. If any length is required to create the necessary ferrule effect, this is also accomplished at this time. The surgeon must take care not to "ditch" the root as it emerges from the supporting bone. This bur was then followed by an F82 fine and F82 superfine diamond bur to redefine and smooth the surfaces of the teeth. An 848F bur (Vic Pollard Dental) can be used to open the embrasures interproximally. Finally, an 8 round bur (Vic Pollard Dental) was used to properly contour the alveolar bone to create a physiologic architecture consistent with health and to allow flap adaptation. As the entire periphery of the tooth is being treated, the surgeon always attempts to create an environment in which no osseous defects remain and proper contours are established. In addition, removal of old crown margins will allow the reestablishment of the biologic width as required by each individual tooth.

It is important to state that wherever restorations that impinge on the biologic width exist, it is necessary to create 3.0 to 4.0 mm of sound tooth structure between the restoration and the crest of bone. However, many times this can be accomplished through reshaping of the external surface or periphery of the tooth and the core buildup

Fig 1a *Mandibular left posterior segment. The temporary restorations have been removed and core buildup material previously placed. The teeth pictured are the mandibular left second molar, first molar, second premolar, and first premolar.*

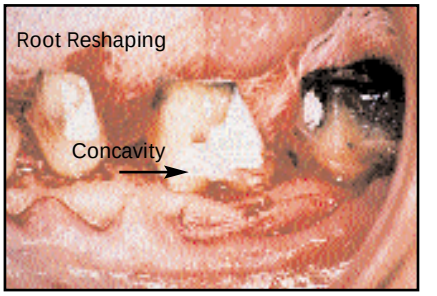

Fig 1b *Mandibular left posterior region. The gingival tissue has been reflected and granulation tissue debrided to reveal the relationship of the dental structure to the supporting alveolar bone. The buccal restoration into the furcation region is evident associated with the first molar.*

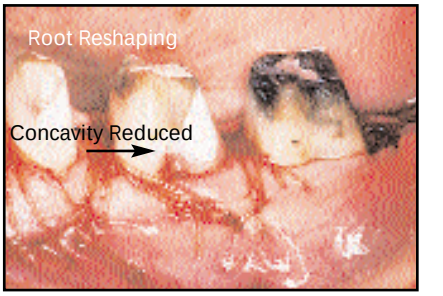

Fig 1c *Mandibular left posterior region. The surgical crown-lengthening and root-reshaping procedures are completed, with a definitive barreled groove developed on the buccal aspect of the first molar. In addition, the gingival tissue is apically positioned to allow supragingival placement of the restorative margins.*

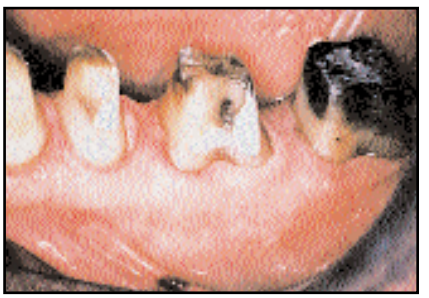

Fig 1d *Mandibular left posterior region after 4 months of postoperative healing. The gingival tissue remains apically positioned and appears healthy.*

Fig 1e *Mandibular left posterior region from the lingual aspect shows the final restorations. It is important to note that the contours of the surgically reshaped dentition have been recreated in the final restoration. The restorations are porcelain-fused-to-metal with margins placed at the free gingival margin.*

Fig 1f *Mandibular left posterior region from buccal aspect shows the metal struts used to mimic the underlying reshaped dental anatomy, ie, the barreled-in furcation region.*

restoration, ie, as the circumference of the tooth decreases, the restoration contained within the tooth will often "move" coronally. This is often seen radiographically in the advancing caries front. The decay is generally wider at the dentoenamel junction, and as it penetrates the dentin it will narrow. This coronal advancement of the restoration may mean the difference in removal of 1.0 to 2.0 mm of bone. If a shoulder preparation has been used by the restorative clinician and the preparation extends to the alveolar crest or just coronal to it, then it will be necessary to remove 1.0 to 2.0 mm of alveolar bone to allow the root to be reshaped without creating an acute angle at the bone-to-tooth interface.

Flap closure was accomplished with 4-0 or 5-0 chromic gut suture (Ethicon/Johnson & Johnson) (Fig 1c). The soft tissue flaps were positioned just apical to the crest of bone, which allows the area treated to heal by secondary intention. This ensures the elimination of postoperative pocket depths, which may be seen associated with the coronal migration of a replaced-flap technique (healing by primary intention). In addition, this apical flap positioning may be associated with an increase in the amount of keratinized

tissue postoperatively.[12] An adequate amount of keratinized tissue has been suggested to be beneficial for the periodontal-restorative relationship.[13,14]

Once the flaps were sutured, 4% chlorhexidine (Zeneca Pharmaceuticals) was used to bathe the surfaces of the teeth for 30 seconds. This provided an antimicrobial effect,[15] eliminating as much accessible bacteria as possible. Then, with the teeth moderately dry, potassium oxalate (Phoenix Dental) was used to seal the existing open dentinal tubules to aid in the reduction of postoperative sensitivity. The provisional restorations were then recemented and adjusted accordingly. If the tooth has been barreled in at the buccal and/or lingual furcation, the temporary restoration should also be barreled to allow the patient adequate access for appropriate oral hygiene measures and eliminate overcontoured restorations. The temporary restorations were cemented with Temp Bond NE (Kerr). No periodontal dressing was placed. The patient was instructed to use Periomed (Omni) twice daily for the first week postoperative in addition to applying Periomed with a cotton swab at the free gingival margin. Following the initial week, the patient was then instructed in using a toothbrush in combination with Periomed for daily home care. A proxabrush (Oral B) was added to the hygiene regimen after 2 weeks for efficient interproximal cleaning. The teeth were then polished to remove staining at 3 weeks postoperative.

Following 1 month of healing, the patient returned to the restorative office for a reline of the temporary restorations. Typically, the preoperative clinical crown has been altered so much that remaking the temporary restoration is often needed. No remargination of the tooth surface takes place at this time, and the restorative dentist is asked to leave the margins of the temporary restorations at least 1.0 mm coronal to the free gingival margin. This will allow the biologic width adequate space for continued maturation.

Patients are seen at 2-week to 1-month intervals to evaluate home care effectiveness and to remove staining as needed. At 4 months postoperative, the patient was seen in the restorative office for tooth preparation and impressions (Fig 1d). The temporary restorations are relined or remade at this time if indicated. A 4-month interval is used to ensure adequate establishment of the biologic width, assess the patient's commitment to home care, and allow any necessary instruction in oral hygiene efficiency.

The crucial point in the treatment plan is now at hand. It is vital to the overall success of the restoration that the laboratory technician thoroughly understand the necessity of keeping the height of contour to a minimum on the buccal and lingual aspects. Also, if barreling in the furcation region was accomplished during the surgical procedure, it must be developed in the final restoration (Figs 1e and 1f).

Following final cementation of the permanent restoration, the patient was kept on a strict maintenance regimen. This included a 3-month supportive periodontal therapy program as well as instruction in daily use of a stannous fluoride to inhibit root-surface caries.

Case 2

In the second case, a 45-year-old white woman presented with evidence of generalized recession, unesthetic marginal tissue contours, and chronic inflammation on the facial aspect of the maxillary left central incisor (Fig 2a). The old restorations and caries were eliminated, and core buildup material was placed (Figs 2b and 2c). In Fig 2d, it is apparent that a developmental groove existed on the facial aspect, just apical to the existing restorative margin. F82 coarse, fine, and superfine diamond burs were used to create the dental anatomy desired through elimination of the old restorative margins, creation of a biologic width, and elimination of the developmental groove (Fig 2e). An 8 round bur was used to create a bony architecture consistent with a positive physiologic morphology. In addition, a gingivectomy procedure was performed to ensure an esthetic length to the maxillary anterior region and provide symmetry throughout the arch. Closure was accomplished with 5-0 chromic gut to facilitate repositioning of the gingival flaps to maintain the desired cosmetic result. Again, a healing period of 16 weeks was allowed prior to continuation of the restorative phase

Fig 2a *Maxillary anterior segment. Soft tissue recession is evident associated with the left and right lateral incisors, the right central incisor, and the left canine. In addition, exposed margins of complete-coverage restorations are apparent associated with the right canine and lateral incisor and the left central incisor.*

Fig 2b *Maxillary anterior region. Underlying decay is apparent. To reestablish a symmetric and esthetic gingival architecture, the patient was referred for a periodontal evaluation.*

Fig 2c *Maxillary anterior region. Carious lesions are removed and core buildup material is placed. The patient then receives temporary restorations in preparation for periodontal surgery.*

Fig 2d *Maxillary anterior region. External bevel incisions are completed to achieve the desired gingival symmetry. This is followed by intrasulcular incisions and soft tissue reflection. A developmental groove is apparent on the facial aspect of the maxillary left central incisor.*

Fig 2e *Maxillary anterior region. Conservative osseous recontouring and reshaping of the root structure are completed. The soft tissue is then positioned to achieve the desired esthetic outcome.*

Fig 2f *Maxillary anterior region 2 years following completion of the restorative phase of therapy. The gingival tissue remains healthy and the gingival esthetic quality is significantly improved.*

and placement of the final prosthesis (Fig 2f). The final contours created in the teeth during the root-reshaping and crown-lengthening procedure were imitated in the final restorations.

Discussion

This article discusses a variation in thought processes in the planning stage and implementation of surgical crown lengthening. Traditional crown-lengthening procedures have resulted in a significant amount of iatrogenic bone loss. As private practice clinicians, we have searched for an alternative to osseous resection as a means of achieving a biologically

and restoratively acceptable tooth contour. As these case reports demonstrate, root reshaping alone or the addition of this technique to minimal resective therapy can greatly reduce the overall quantity of bone removal traditionally seen in crown-lengthening or osseous-resective surgical procedures.

It has long been established that creating a biologically acceptable root surface will enhance the outcome of both surgical and nonsurgical treatment of periodontitis.[10,11] After the final finishing bur has been used and all old restorative margins eliminated, the clinician will be able to appreciate a final tooth contour with grooves and furcations eliminated or substantially decreased and subgingival calculus completely removed. A physiologically acceptable width between the new restoration and the alveolar bone can then be allowed to form in the dimensions that "fit" that patient/tooth/site. The smooth, flat root surface created will be amenable to cleaning with dental floss, whereas a concavity or irregular surface will not. Finally, this flat surface will allow the dental hygienist more certainty in scaling during maintenance visits, whereas concavities increase the level of difficulty.

In addition, this procedure focuses not only on the hard tissues, but also retains keratinized tissue as part of the protocol. The split-thickness buccal flap and full-thickness lingual flap encourage maintenance of keratinized tissue and promote an increased quantity of this tissue once healing is complete. As the literature has shown, keratinized tissue is an important component in the overall health and development of the periodontal-restorative relationship.[16]

Once the surgical therapy is complete and an adequate healing period has been observed, the restorative dentist must relay the importance of maintaining the new morphology of the dentition in the final prosthesis. Translating this architecture into the final restoration will allow the patient access for daily hygiene, which is the foundation of providing a long-term stable restoration. If the permanent prosthesis is placed without the areas of the furcations grooved, the resultant overcontoured crown will be a significant plaque trap that will be difficult to access hygienically. As a result, the bulky prosthesis will likely have a poor prognosis. Previously, it has been necessary to use metal struts (as demonstrated in the final restorations shown here) in the furcation regions to create this barreled-in effect. However, with the significant advances in restorative all-ceramic materials, cosmetic margins may soon be used to replace these metal collars and struts.

Not yet mentioned is the advantage to reshaping roots that are in close approximation. Root reshaping will allow an improved embrasure that permits favorable oral hygiene and development of normal gingival form.[17] In previous publications, clinicians have indicated that close root proximity may be an indication for root removal to improve the periodontal condition and allow adequate space for restorative material.[18] With the addition of this tool to periodontal surgical procedures, the clinician takes into consideration the often deleterious anatomy of the circumference of the tooth, which includes furcations, grooves, cementoenamel projections, progression characteristics of caries, enamel pearls, concavities, and root proximity.

The authors recognize that this is a major paradigm shift for periodontists but feel that the advantages this method provides in overall health far outweigh the antiquated method of traditional osseous resection. In using what we have learned from traditional resective procedures, we have attempted to expand our focus from strictly an ostectomy/osteoplasty standpoint. In doing so, we feel we will be able to create a biologically acceptable root surface without excessive removal of supporting alveolar bone and move forward into a conservative yet effective means of treatment.

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