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Treatment outcomes for implant dentistry are generally positive, but implants do occasionally fail. One cause of ailing and failing implants is retained subgingival cement. This case report documents treatment of an ailing implant due to retained cement following final crown cementation.

A 37 year old Asian male presented to our office with a chief complaint of severe pain and gingival swelling around his implant supported crown at the mandibular right second molar. Both the patient and restorative doctor were very interested in saving the implant. Following administration of local anesthesia, flap reflection enabled observation of retained excess subgingival cement. Granulation tissue associated with subgingival cement was removed along with the cement. The contaminated dental implant surface was detoxified with chlorhexidine and rinsed with sterile saline. The peri-implant intrabony defect was grafted with freeze dried bone allograft (Life Net Health, Virginia Beach, Virginia, USA) and guided tissue regeneration was achieved with a bioabsorbable collagen barrier (Geistlich Pharma NA, Princeton, New Jersey, USA). The surgical site then healed without further incident, and the pain was resolved.

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**KEY WORDS:** Dental implants, peri-implantitis, guided tissue regeneration, bone grafting

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Disclosure
The author reports no conflicts of interest with anything mentioned in this article.

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The field of maxillary sinus augmentation and dental implant placement is expanding rapidly. A recently released American Dental Association (ADA) survey reveals a significant and consistent increase in the number of implants placed annually. Although numerous studies have shown the overall implant survival rate in the maxillary region to be over 91%, invasion of the maxillary sinus cavity is a frequent complication in dental implant treatment. The main contribution to this phenomenon is likely due to a simple increase in the number of implants placed. Yet, there is a paucity of reports in the literature of implants migrating into the sinus space. This case study presents two different types of invasion of the maxillary sinus by dental implants. These cases serve to remind specialists in dentistry that an aberrantly extruded implant can be occupied in two different spaces within the maxillary sinus cavity, and the necessity to differentiate and/or identify these two spaces.

**KEY WORDS:** Dental implants, sinus lift, complications

1. Private practice, Las Vegas, Nevada, USA
INTRODUCTION

The field of maxillary sinus augmentation and dental implant placement is expanding rapidly. A recently released American Dental Association (ADA) survey reveals a significant and consistent increase in number of implant placed.\(^1\) Although numerous studies have shown the overall implant survival rate in the maxillary region to be over 91%,\(^2\) invasion of the maxillary sinus cavity is a frequent complication in dental implant treatment. The main contribution to this phenomenon is likely due to a simple increase in the number of implants placed. Yet, there is a paucity of reports in the literature of implants migrating into the sinus space.\(^3\) This case study presents two different types of invasion of maxillary sinus by dental implants. These cases serve to remind specialists in dentistry that an aberrantly extruded implant can be occupied in two different spaces within the maxillary sinus cavity, and the necessity to differentiate and/or identify these two spaces. Clarification of different spaces within maxillary sinus will be further discussed later.

CASE REPORTS

Case 1: Two Extruded Implants in the Maxillary Sinus Cavity Space

The patient is a healthy 51 year-old female with fully edentulous maxilla. In 2009, she received two dental implants in right maxillary region. The patient later presented in April of 2010 with complaints of “hearing transient clicking sounds and sinus congestion” that started about a month after her implant surgery. The panoramic radiograph revealed two extruded dental implants in the right maxillary sinus cavity. It was speculated from the residual bone height that no grafting or sinus elevation techniques were performed. It was agreed that 6 implants should be placed with a temporary prosthesis, and the two aberrant extruded implants be extracted. An initial radiograph was taken before implant surgery, and the positions of the aberrant implants were located to be in the most lateroinferior region within the maxillary sinus cavity. Six implants were placed avoiding right maxillary sinus region for extraction procedure, and another radiographs was taken (Figure 1). A second radiograph revealed the extruded...
implants had relocated to a more superior lateral region. This movement was speculated to the fact that patient had been in supine position for more than 30 minutes for the new implant placement procedure. To confirm that these aberrant implants had perforated Schneiderian membrane into the sinus cavity space (SCS), one more panoramic radiograph was taken after patient's head was in anatomical position for 10 minutes. As expected, the aberrant implants had migrated back down to lateroinferior region in the maxillary sinus cavity (Figure 2), and it was confirmed that these implants were in sinus cavity space rather than sinus membranous space. After exact positions of aberrant implants were determined, the Transmaxillary Trapezoidal Ostectomy technique (TTO) was performed to extract the implants. Prognosis is expected to be good, and the patient is expected to return for one year follow up.

**Case 2 – One Extruded Implant in the Maxillary Sinus Membranous Space**

The patient is a 57 year-old male smoker but otherwise healthy, with partially edentulous maxilla and mandible. In 2010, he received three dental implants in his maxilla by a colleague. On the date of surgery, the patient presented with 6mm of vertical residual bone height on the left maxilla. A total of 5mm maxillary elevation was performed using hydraulic sinus condensing technique, and xenograft was placed into the sinus. Following sinus elevation, a 4.5 x 11.5mm tapered implant was placed (Figure 3). Final torque achieved for the implant was not noted. At the one month follow-up visit, a panoramic radiograph revealed an extruded dental implant in the left maxillary sinus cavity (Figure 4). The patient presented without any symptoms and discomfort. However, to avoid any future complication, he was referred to us for extraction of the aberrant implant. The patient’s history and post-surgical radiograph suggested that the Schneiderian membrane had not perforated. Based on this information, we surmised that the aberrant implant most likely had not invaded into the maxillary sinus cavity space, but rather was entrapped within the space between sinus membrane and bony wall of maxilla. In order to confirm
which space the implant was embedded in, 3 radiographs were taken at different time intervals. One radiograph was taken after patient was lying down in supine position and two additional radiographs were taken in an anatomical position to see if the implant was in any motion. All three radiographs revealed that the aberrant implant stayed in a static location. Again, the Transmaxillary Trapezoidal Ostectomy (TTO) technique was used to remove the implant after locating its exact position. Prognosis is expected to be good, and the case is in process of waiting for 1-year follow up.

**DISCUSSION**

In this study, we present two cases of invasion of the maxillary sinus by dental implants. These two cases clearly present extruded implants residing in two different spaces within the sinus cavity. Because differentiation of these two spaces has never been classified in anatomy, we would like to introduce novel terms that better describe the two spaces within sinus cavity. In anatomy, the maxillary sinus cavity has been defined as one of the paranasal sinus spaces that occupy the bodies of the maxilla. Present at birth as rudimentary air cells, it develops throughout childhood as the largest paranasal sinus. The first novel term, *sinus cavity space* (SCS), refers to the space within maxillary sinus cavity surrounded by Schneiderian membrane (Figure 5). The significance of recognizing this space is that an extruded implant can reside in this space only if the Schneiderian membrane had perforated, thus providing passageway to this space. The second novel term, *sinus membranous space* (SMS), describes the space between the lining of an elevated Schneiderian membrane and bony surface of maxillary sinus (Figure 6). This space is normally non-existent (thus was never described by anatomy literature), but can be created either by separating the sinus membrane during a surgical procedure or by an end-

---

**Figure 5:** Aberrant dental implant located in the sinus cavity space (SCS). A perforation of the Schneiderian membrane must exist in order to enter this space.

**Figure 6:** Aberrant dental implant located in the sinus membranous space (SMS). A perforation of the Schneiderian membrane does not have to exist in order to enter this space.
Table 1: Description of Proposed Sinus Spaces

<table>
<thead>
<tr>
<th>Sinus Cavity Space (SCS)</th>
<th>Can only be reached by a perforation of sinus membrane</th>
<th>Must remain as a cavity space</th>
<th>Naturally occurring from birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus Membrane Space (SMS)</td>
<td>No sinus membrane perforation should exist</td>
<td>Can be filled in with bone graft</td>
<td>Created by surgical separation of the sinus membrane from the bone or by endodontic lesion</td>
</tr>
</tbody>
</table>

odontic lesion in maxillary teeth. Classifications of the two spaces are summarized in Table 1.

CONCLUSION
The authors feel that it is important to acknowledge and distinguish the different spaces within the maxillary sinus cavity. Depending on whether an extruded implant is occupied in sinus cavity space (SCS) or sinus membrane space (SMS), diagnosis, extraction planning, and surgical procedure should be changed. A standard diagnosis and surgical protocol for implant extraction procedures can be formulated in the future studies with larger sample for either space.

Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

References

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Expansion of Atrophic Posterior Mandibular Ridge: A Case Report

Marcus J. Blue, DDS¹ • Charles M. Cobb, DDS, PhD²

Abstract

Background: Reduced function due to edentulation is related to skeletal change such as residual ridge resorption and loss of cortical bone thickness. Even with adequate cortical plate thickness, the ridge itself may present inadequate buccal-lingual dimensions, thereby requiring lateral expansion to facilitate successful dental implant placement.

Methods: A single case report is presented that involves lateral expansion of an edentulous atrophic posterior mandibular alveolar ridge to facilitate dental implant placement. The surgery consisted of a detached bone segment technique, stabilized by bone screws, and the adjunctive use of a particulate bone graft covered by a resorbable barrier membrane. Primary wound closure was achieved, healing was uneventful, patient morbidity was minimal, and a dental implant was successfully positioned and restored.

Results: The initial 3 mm atrophic ridge was expanded to 10 mm following the surgery that utilized a detached bone segment graft stabilized with bone screws and an adjunctive particulate bone graft. A 4.8 x 10mm bone level implant was successfully placed following 4 months of post-graft healing. The implant site appeared well vascularized and exhibited Type II bone density.

Conclusions: This single case report demonstrates that the detached bone segment technique can achieve substantial gains in horizontal ridge width of the edentulous posterior mandible. The increase in lateral dimension and maintenance of viable cortical bone allowed successful positioning of a large diameter dental implant.

KEY WORDS: Alveolar bone loss, alveolar ridge augmentation, dental implants, mandible,

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INTRODUCTION

Reduced function due to long-standing edentulation is known to induce skeletal change such as residual ridge resorption and loss of cortical bone thickness. Even with adequate cortical plate thickness, the ridge itself may present inadequate buccal-lingual dimensions; a scenario commonly encountered in the edentulous anterior mandible and less so in mandibular molar regions. The placement of dental implants in an alveolus with inadequate horizontal dimensions is likely to compromise long-term stability and prognosis. Consequently, a variety of surgical approaches have evolved to increase the horizontal dimension of the deficient mandibular alveolus, including, among other procedures, guided bone regeneration, autogenic, allogenic, and xenogenic block grafts, distraction osteogenesis, and ridge-splitting techniques.

Based on the work of Miyamoto et al., it appears that cortical bone thickness is important to initial implant stability, more so than implant length. Assuming this observation to be true then the dimensions of available cortical bone should be considered when selecting the preferred implant site. In cases of severe alveolar resorption, the posterior mandible is considered a difficult region for reconstruction with the ultimate goal of implant placement. Localized bone defects in the posterior mandible are frequently reconstructed with autogenous mono-cortical bone blocks prior to the placement of dental implants. In the current case, the authors present a single case report detailing the technique first presented by Basa et al. in which the posterior mandibular buccal plate is completely detached, moved laterally to increase horizontal alveolar ridge dimensions, and stabilized until appropriate healing occurred to allow insertion of a dental implant. The characteristic biomechanics of cortical bone and how such features can dictate the choice of surgical technique for the posterior mandible are discussed.

METHODS

Patient Presentation

The patient, a 44 year old male, presented to the University of Missouri-Kansas City (UMKC) undergraduate dental clinic with a chief complaint of a toothache associated with the mandibular left first molar (#19) of 2-weeks duration. A diagnosis of chronic irreversible pulpitis was determined. The patient's medical history was essentially negative, i.e., no allergies, no use of tobacco, and no current medical conditions. Past medical history included a back surgery and removal of a colon polyp. The patient was classified as ASA 1.
Tooth #19 was treated by endodontic therapy. In the process of preparing the tooth for an endodontic post and crown build-up the mesial root developed a longitudinal fracture leading to difficult extraction with loss of buccal bone. The patient was subsequently seen 18 months later in the UMKC Graduate Periodontics Department for evaluation of a dental implant to replace tooth #19.

The periodontal examination noted slight plaque induced gingivitis, 12/132 sites exhibited bleeding on probing (9%), and there were no probing depths greater than 3 mm. At presentation the patient was missing all molar teeth except for #14 and #30 (Fig. 1). Occlusal analysis revealed bilateral group function with obvious occlusal wear on all remaining teeth. The patient admitted to a clenching habit. Evaluation of the #19 area edentulous ridge revealed an atrophic ridge with a Seibert class III contour (Figs. 2 & 3). A CBCT showed the ridge measured 3 mm in the horizontal dimension and featured a severe slant to the buccal of approximately 25-30 degrees, indicating loss of the buccal cortical plate during the extraction. In addition, the CBCT revealed that the crestal buccal and lingual cortical plates were fused with no intervening cancellous bone to a depth approaching 4 mm. The patient was informed that to achieve implant placement a horizontal ridge expansion would be necessary.

**TREATMENT**

Local anesthesia was achieved by using 2.5 carpules of Septocaine® (articaine HCl 4%, 40 mg/mL) with 1:100,000 epinephrine. The anesthetic was delivered by inferior alveolar field block and lingual infiltration to anesthetize any aberrant branches extending from the superior root of the ansa cervicalis.

Following anesthesia, buccal and lingual intrasulcular incisions were made, starting at the distal of tooth #22 which joined at the distal of tooth #20 to become a single
crestal incision extending distally up the anterior border of the mandibular ramus. This incision design allowed for a relaxed full-thickness mucoperiosteal flap reflection and exposure of the underlying bony ridge, confirming the Seibert Class III defect, the horizontal dimension of approximately 3 mm, and the buccal slant. Given

the ridge dimension and architecture a horizontal expansion of the ridge was undertaken using a combination of in situ autogenous bone block supplemented with a graft of allogenic bone particles, all covered by a barrier membrane. The initial step was to place two pilot-hole indentations in the buccal cortical bone for future
positioning of titanium bone screws (Fig. 4). The pilot-holes were centrally placed, approximately 8 mm apart, within an area measuring 10 mm x 20 mm, representing the size of the intended in situ block of bone. The next step utilized a NSK VarioSurg® piezo-electric unit (NSK America Corp., Schaumburg, IL) fitted with a SG1 titanium nitride coated 0.5 mm blade and copious amounts of sterile water to place a 20 mm cut along the crestal ridge. Vertical cuts of 10 mm length were placed, one from each end of the initial crestal incision, and extending downward to the buccal. The final cut was then made with a SG2R blade, connecting the two vertical incisions (Fig. 5).

Figure 8: Placement of particular bone graft material in the space crated under the in situ autogenous bone block, within the cut margin spaces, and over the bone block.

Figure 9: Covering of the grafted sites with pericardial membrane.

Figure 10: Primary closure of the surgical area using an interlocking continuous suture technique.

Figure 11: Facial view following exposure of graft site at 4 months post-surgery showing extent of bone regeneration.
All bony cuts passed through the cortical plate thereby allowing for eventual free separation of the bone block. At this point, the pilot-holes were extended through the buccal cortical plate using a #4 carbide round surgical length bur. Immediately prior to freeing the bone block, shallow indentations were made in the buccal surface of the lingual cortical plate with a #4 carbide round bur to allow insertion of fixation screws in their proper position. OsteoMed™ (OsteoMed, Addison, TX) Auto-Drive® self-drilling screws (2 mm diameter x 14 mm length) were then placed in the bone block and gently screwed to place until they engaged the lingual cortical plate (Fig. 6). This action, aided with osteotomes, effectively lifted the bone block from the underlying cancellous bone while insuring proper positioning and stabilization and allowing lateral expansion of the atrophic ridge. Following fixation of the bone, a 5-6 mm gap remained between the in situ bone block and the lingual cortical plate (Fig. 7). Sharp edges and corners of the in situ block were smoothed and rounded slightly to insure a lack of irritation during healing.

The next step consisted of compacting Puros Allograft® (Zimmer Dental, Carlsbad, CA), hydrated in sterile water, within the space beneath the stabilized bone and included covering the entire in situ bone block and ridge (Fig. 8). The grafted area was then covered with Puros Copios® pericardium membrane (Zimmer Dental, Carlsbad, CA). The membrane was tucked under both the lingual and buccal mucoperiosteal flaps (Fig. 9). The buccal flap was released slightly by two periosteal releasing incisions without vertical components to insure blood supply.

Primary closure was obtained and stabilized with Vicryl™ 4-0 suture (Ethicon, Inc., Somerville, NJ) using a continuous interlocking technique (Fig. 10). The patient was placed on amoxicillin 500 mg, t.i.d., for 10 days and instructed to use an alcohol-free chlorhexidine oral

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**Figure 12:** Occlusal view of graft site at 4 months post-surgery showing a buccal-lingual ridge width of approximately 12 mm.

**Figure 13:** Occlusal view showing wound closure following placement of a bone-level implant and healing abutment.
rinse twice a day for three weeks. Sutures were removed at 2-weeks post-surgery.

**POST-TREATMENT RESULT**

Following a 4-month healing period, the site was re-entered and measurements taken prior to implant placement. The initial measurement of a 3 mm atrophic ridge was expanded to 10 mm following the surgery (Figs. 11-12). The titanium bone screws were removed and osteotomy prepared and a 4.8 x 10 mm Straumann® bone level implant (Straumann USA, LLC, Andover, MA) was positioned and a healing abutment placed (Fig. 13). During placement of the implant the bone appeared to be well vascularized and to exhibit a Type II bone density. At 4 months post-implant insertion the quality of healing was considered to be excellent (Fig. 14). The final restoration of the implant was achieved at 4 months post-insertion and the patient was evaluated at 1 month and then 3 and 6 months post-restoration (Figs. 15 & 16). Following restoration of the implant the patient was fitted with a mouth guard to counter the biomechanical stresses from the clenching habit.

**DISCUSSION**

The literature is replete with reports of effective bone augmentation using a variety of techniques. Blue et al. 3,14 Regardless of anatomical location or surgical approach, successful bone augmen-
tation requires atraumatic manipulation of host bone, stabilization of grafted sites, preservation of adequate blood supply, space maintenance allowing ingrowth of osteogenic cells, prevention of connective tissue invasion that would encapsulate interpositional bone grafts, and avoiding tension on soft tissues when achieving primary wound closure. In cases involving expansion of atrophic alveolar ridges, stability of dental implants is primarily dependent on cortical bone.

The alveolar process of the posterior mandible, assuming the presence of teeth, typically exhibits a well developed buccal and lingual cortical plate comprised of a relatively thin outer layer of lamellar bone and a thickened subjacent layer of Haversian bone that transitions into cancellous bone. Various reports have estimated the thickness of cortical bone in the dentate mandibular 1st molar area to range from 0.6 mm to 2 mm near the crest or 0.8 mm to 3.4 mm measured at 9 mm apical of the CEJ. However, with extraction of teeth the histologic and macroscopic anatomy of the alveolar ridge undergoes dramatic change. It has been determined that cortical bone from all regions of the facial skeleton of edentulous individuals is thinner than in dentate skulls. Thus, depending on individual variation in bone turn-over and duration of edentulism, the cortical plates of the posterior mandible may or may not be of sufficient thickness to offer adequate support to implant placement. In the present case, several issues were considered that ultimately determined the surgical approach. First, although the time from extraction to the initial evaluation for implant placement was only 15 months, there was significant resorption mandibular posterior alveolus. Second, expansion of the alveolus by a simple ridge splitting osteotomy was contra-indicated due to the horizontal crestal width of 3 mm and, as noted on the CBCT, fusion of the crestal buccal and lingual cortical plates with no intervening cancellous bone to a depth of 4 mm. Third, the lack of elasticity associated with cortical bone in the posterior mandible would require either an apical hinge cut or a more aggressive osteotomy through the entire thickness of the cortex, thereby allowing lateral repositioning and avoidance of an adverse fracture. Cortical bone exhibits a higher modulus of elasticity than cancellous bone, is stronger and more resistant to deformation, and will bear more load in clinical situations than cancellous bone. Indeed, it has been demonstrated that the edentulous mandible exhibits greater inelasticity than the dentate mandible in the retromolar region. As Bravi et al. noted, the inelasticity of mandibular cortical bone generally dictates a two-stage delivery of dental implants. Thus, it is not surprising that the absolute amount of cortical bone has more influence on implant stability than does cancellous bone. Based on the work of Baumgaertel and Hans, thickness of the buccal cortical bone in area of implant placement in the present case was estimated to range from 1.83 to 2.49 mm – a thickness that certainly would not allow horizontal repositioning of the buccal plate without an apical osteotomy. Furthermore, as Flanagan based on clinical experience, the mandibular lingual cortex is generally thicker than the buccal cortex. This observation appears to be supported by the fact that clinicians often utilize the lingual cortex for bracing osteotomes without inducing fractures. Thus, the lingual cortical plate can be used to anchor bone screws for stabilization of a detached bone segment.

The rate of ridge atrophy in this case was
relatively rapid and severe. The rate of atrophy is highly unpredictable as it can vary greatly between patients and even within the same person at different times or in different regions within the jaw.\textsuperscript{34} Alveolar atrophy is greatest during the first year post-extraction and without functional stimulation\textsuperscript{35} can become a life-long process.\textsuperscript{34} Given these observations, the rate of alveolar atrophy in the present case appears to be within normal boundaries.

It has been suggested that success of implants placed in pristine bone should be validated after 5 years of function.\textsuperscript{36} One could argue that a similar standard be used for validation of implants placed in sites following a lateral expansion procedure. In this regard, it should be noted that the most common complication during a lateral ridge expansion surgery is fracture of the buccal cortical plate.\textsuperscript{3} In the current case this possibility was avoided by using the detached bone segment approach.

Other reported complications observed during ridge expansion include loosening or fracture of bone screws, prolonged morbidity, paraesthesia, and membrane exposure with resulting loss of graft.\textsuperscript{3} Interestingly, lack of osseointegration has been reported in a relatively small number of cases.\textsuperscript{3} None of the reported complications was encountered in the current case. Thus, after six months of implant function the long-term success of the current case would appear favorable.

CONCLUSION

This single case report demonstrates that the detached bone segment technique first reported by Basa et al.\textsuperscript{20} can achieve substantial gains in horizontal ridge width of the edentulous posterior mandible without the morbidity associated with a secondary donor surgical site. The increase in lateral dimension and maintenance of viable cortical bone allowed successful positioning of a large diameter dental implant.

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A variety of barrier membranes have been utilized over the years for guided bone regeneration. Each membrane type has its own unique set of advantages and disadvantages. Vicryl® mesh is an absorbable, synthetic barrier composed of polyglactin 910. When used for guided bone regeneration, this material demonstrates minimal absorption until 8 weeks after placement and is typically resorbed completely within 60 to 90 days. In this article, the author provides a concise review and pictorial description of the use of Vicryl® mesh for guided bone regeneration in the practice of surgical dentistry. The author has performed thousands of cases with this technique over the past 20 years.

**KEY WORDS:** Guided bone regeneration, Vicryl mesh, bone graft, dental implant

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The author reports no conflicts of interest with anything mentioned in this article.

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Lasers, whether they are used to perform hard or soft tissue procedures, are rapidly becoming an integral part of dental practice. The authors of this editorial opinion would like to give an overview of their own personal recommended guidelines for the use of lasers in periodontal treatment, and more importantly, when they should not be used, particularly when extensive restorative treatment is required. Several case examples will be used to illustrate these points. These suggested guidelines are those of the authors and do not reflect any of the views or opinions regarding lasers by the Journal of Implant and Advanced Clinical Dentistry (JIACD), its editorial board, or anyone else associated with the journal. Counterpoints and alternative views are encouraged to be submitted by anyone that desires to do so.

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Lasers appear to have outstanding benefits for reducing inflammation associated with periodontal disease. Multiple wavelengths of lasers and protocols are currently available in treating periodontal disease. A protocol used by the authors utilizes an Nd:YAG laser which involves the ablation and vaporization of the interior epithelial lining of the periodontal pocket with the laser, scaling and root planning with ultrasonics, chlorhexidine irrigation, laser hemostasis and clot formation, occlusal adjustment therapy to eliminate occlusal interferences, and stabilization of mobile teeth with composite splinting.

There is no question that lasers have much benefit in removing infection. Is it any better than general conventional surgery, i.e. pocket elimination via flap surgery? The authors would surmise that given the minimally invasive nature of the laser that it has benefits of less discomfort and sterilization of pockets over conventional surgery. Conventional surgery however does have the benefits of visibility and definitive removal of any pockets, at least in theory. However, the authors also realize that the operator plays a large part in any surgical treatment. Success may vary greatly depending the didactic training and surgical training of the operator. When contemplating using lasers in treating periodontal disease, the operator should consider if a laser can do the following:

A. Change the amount of attached gingiva present?
B. Correct biologic width invasion?
C. Change irregularities on root surfaces?
D. Change locations of existing crown margins or location of decay?
E. Change involvements of furcations?
F. Correct altered active and passive eruption or change locations of bone related to proximity of the CEJ?
G. Is using the laser a definitive procedure and can restorative dentistry be placed after the procedure?

The challenge will be to discuss the above topics and place a guideline on the best way to correct the issues present that could determine the success of the procedure.

**Attached Gingiva**

Attached Gingiva (AG) serves as major protection to the underlying periodontium. By its makeup of having minimal vascularity and dense connective tissue, it resists bacterial infiltration. It is well documented in the literature that when there is deficient AG, adding connective tissue via grafting procedures has long lasting rewards. Further, when doing restorative work it appears to be even more critical to make sure bound down connective tissue is present to resist the materials that are often placed within the sulcus during impressions (retraction cord) thus affording protection to the biologic width. There has been no evidence to show the laser can increase attached gingiva, especially when insufficient keratinized tissue also exists. Therefore the operator must distinguish the amount of attached gingiva present before choosing the appropriate treatment and perform the necessary procedure of adding connective tissue if insufficient tissue is noted.

**Biologic Width Invasion**

Biologic width invasion (BWI) is an involvement of the protection to the periodontium. The biologic width (BW) is made up of approximately
1mm of connective tissue inserted into the root surface and 1mm of cells closely adapted to the enamel called junctional epithelium (JE). The cells of the JE are closely adapted by a glycoprotein but do not serve as a significant protection from bacteria. When a margin of a crown is placed within the BW, an inflammatory response is set up. Documented evidence shows that osseous breakdown occurs and in fact the author will present multiple cases to substantiate the destruction that occurs. To correct BWI, either the existing crown margin needs to be removed allowing for a new BW to establish or bone must be removed to allow for a new BW to establish in order to avoid the new crown from being replaced within the BW. There is no evidence to show that the laser can in any way change the location of the crown margin or the bone levels thus making a very poor choice to correct BWI.

Root Surface Irregularities
It is well documented that root surface irregularities such as developmental grooves, root concavities, cervical enamel projections, abfraction lesions and so on, can be detrimental to the stability of a tooth. The author will show cases where simply removing these irregularities can solve the problems and prevent further damage. The laser has no ability to change root surface deformities and thus would again be a very poor choice in this treatment.

Location of Crown Margins and/or Decay
As discussed above, many times a previous margin of an existing crown is placed in an undesirable location, which could compromise the outcome of a perio-restorative case. Teeth with extensive subgingival decay can also result in a margin being placed in an unfavorable location. Properly executed periodontal surgery can easily change the location of a previous crown margin by simply removing them or by removing a conservative amount of bone so that there is sufficient root surface available for a connective tissue attachment to form. It must be remembered that cores and provisional restorations are vital to this procedure. The laser has absolutely no ability to change margin locations and is of no benefit in these types of procedures.

Furcation Defects
Furcation defects on molars are one of the greatest causes of molar loss. Class 1 and 2 furcation defects are generally easily treated by simply removing the overhanging tooth structure causing the defects. The procedure is definitive and usually prevents further breakdown. This procedure can be done with no concern for needing a crown, though when an existing crown is present it is advisable that a core if necessary and provisional be placed for proper surgical access. Though there has been discussion that the laser can regenerate bone in furcation defects, it cannot be concluded that this is a definitive procedure for these areas as it only addresses the effects and falls short of addressing the causes. The author is comfortable that if a laser procedure were to be performed on a tooth that is not to be restored, such treatment would do no harm and provide some benefit. But if the tooth is to be restored, definitive periodontal treatment is recommended and removal of the furcation would therefore be more appropriate. Predictability and being definitive are the hallmarks of periodontal treat-
ment. At this point in time the laser falls short when used for furcations in the authors’ opinion.

**Passive Eruption**

Passive Eruption is broken down into two parts, Altered Passive Eruption and Altered Active Eruption. The distinction is fairly simple:

Altered Passive Eruption occurs when the soft tissue is more coronal on the enamel than normal creating a short clinical crown. There is however sufficient space between the CEJ and bone for the connective tissue attachment of the BW. Soft tissue alteration may be all that is necessary to correct the problem.

Altered Active Eruption occurs when the gingival tissue is too coronal on the enamel and the bone closely approximates the CEJ so that there is no space for the connective tissue attachment of the Biologic width between CEJ and bone. Osseous removal may be necessary to create a space for the BW allowing for the proper placement of tissue and a normal appearance of the clinical crown. Reshaping of this bone may carry a significant surgical procedure for correction that cannot be accomplished with the laser.

**A Definitive Procedure to Facilitate Final Restorations?**

Is the laser a definitive procedure and can restorative dentistry be placed after the procedure? The answer to this question is obviously dependant on many factors. From all that has been discussed and demonstrated in this article thus far, it should be apparent that the most important factor to consider, above any treatment modality, is diagnosis. Once, however, the proper diagnosis is made the limitations of the laser or other procedures must be understood so that the proper definitive treatment can be undertaken. Apply the above information to the proper use of the laser procedure and choose the treatment that best suits a definitive result.

It is imperative that clinicians, especially those with limited training and experience in the diagnosis and treatment of various periodontal conditions invest much time and effort in attaining the knowledge and skills needed before attempting any periodontal procedure on patients, whether it be with a scalpel, a laser, or even a curette. In treating periodontal disease, a basic understanding of biology is critical so that an accurate diagnosis can be established so that an appropriate course of treatment may be chosen, keeping in mind that some courses of treatment will require the skills and expertise that only our periodontal specialty team members can provide.

The following cases are intended to demonstrate the need for careful diagnosis and planning prior to consideration of laser use in periodontal and restorative dentistry.
Case 1

This case (Figures 1a-c) depicts teeth in the mandibular right quadrant in need of restorations with a lack of attached gingiva. There is no way other than adding connective tissue to change the present environment. A Laser procedure will not create a connective tissue attachment where no connective tissue exists.

Figure 1a: Tooth #28 in need of restorative with a lack of attached gingiva. There is no way other than adding connective tissue to change the present environment. A Laser procedure will not create a connective tissue attachment where no connective tissue exists.

Figure 1b: Tissue reflected and a subepithelial graft is placed to add connective tissue.

Figure 1c: Final restorations in place with significant increase in connective tissue for long term maintenance of the periodontal foundation.
Case 2
This case (Figures 2a-f) depicts a developmental groove causing bone loss on tooth #9. Laser therapy has no ability to correct anatomic defects on teeth.

Figure 2a: Developmental groove causing bone loss on tooth #9. Laser has no ability to correct anatomic defects on teeth.

Figure 2b: Flap elevated showing visible developmental defect.

Figure 2c: Removal of developmental defect creating a smooth root surface for long term maintenance.

Figure 2d: Adding connective tissue for long term periodontal stability.

Figure 2e: Flap repositioned to cover connective tissue graft.

Figure 2f: Post-op photograph showing stable environment with minimal probing.
Case 3
This case (Figures 3a-e) depicts severe subgingival location of tooth structure following caries removal. A laser has no ability to correct this problem which requires both removal of bone and possible tooth surface to create a space for establishment of a new biologic width (BW) that will not be violated by future restorations.

Figure 3a: Severe subgingival location of tooth structure following caries removal. A laser has no ability to correct this problem which requires both removal of bone and possible tooth surface to create a space for a new biologic width (BW).

Figure 3b: A core has been placed for the Periodontist to use as a marker to gauge the amount of space needed for a new Biologic Width to form.

Figure 3c: Flap reflected exposing location of cores to bone and revealing need for crown lengthening procedures. This could not be accomplished effectively with laser in the author’s opinion.

Figure 3d: Completed crown lengthening and suturing. Removal of previous margins and a conservative amount of bone will allow for a new BW to establish during healing. A new crown margin will be placed just coronal to the gingival collar so no future periodontal interference will occur.

Figure 3e: Occlusal view showing 360 degrees of perfect tooth surface interface with bone for long term maintenance.
Case 4
This case (Figures 4a-d) depicts altered active eruption caused by excess bone in the maxillary anterior. A laser has no ability to correct this problem which requires removal and recontouring of bone in order to establish a new biologic width and the prevention of soft tissue regrowth.

Figure 4a: A patient with excessive display of gingiva and orthognathic surgery has been ruled out. Crown lengthening will be necessary. Lasers cannot be used to effectively treat this case. Simply removing gingival tissue with a laser will result in gingival tissue regrowth at a later date.

Figure 4b: Upon reflection of the gingival tissue, bony exostoses are noted.

Figure 4c: Surgical removal of bone to create a biologic environment between the bone and soft tissue.

Figure 4d: Simple interrupted sutures placed using 5-0 chromic gut.
Closing Comments
The authors hope that this opinion piece will serve as a stepping-stone in the formation and development of a general set of guidelines in the use of the lasers in treating periodontal disease so that current and future laser operators will have a better understanding of when a laser should be used, and more importantly, when it should not be used. With an accurate diagnosis and a good understanding of biology, choosing the most appropriate course of periodontal treatment will be easy!

Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

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