Challenges in Achieving Gingival Harmony

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ABSTRACT  Gingival harmony is an important element in the esthetics of the smile. Clinicians need to have the essential knowledge to create an optimal soft-tissue profile around teeth and implant restorations. The goal of this article is to describe the requirements for ideal gingival architecture and techniques used to achieve them. The patient presentations in this article will demonstrate different aspects of esthetic soft-tissue surgery as well as treatment challenges and limitations.

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PROVIDING patients with a healthy, functional and esthetic dentition is the focus of the dental profession. The surrounding soft tissues, supporting bone, and temporomandibular joints, have also gained equal attention. It is now evident that in order to achieve success in patient treatment all the different elements in the oral cavity as well as the related structures need to be considered. A significant part of this success is achieving the ultimate goal of patient satisfaction. Currently, advances in dental materials, technology, and surgical techniques allow patients to benefit from a variety of predictable and esthetic procedures.

When blending the dentist’s proficiency and talent with the dental technician’s mastery, a life-like restoration can be created. However, in order to achieve an ultimate esthetic outcome, as well as patient satisfaction, it is crucial to have proper soft tissues surrounding the restoration.

The goal of this article is to describe the key requirements for harmonious gingival architecture and their importance in the esthetics of the smile. The clinical case reports presented in this article will demonstrate the inherent difficulties in achieving gingival harmony as well as the limitations of such treatments.

Gingival Harmony

Proper gingival architecture is a crucial complementary element in the esthetic success of restorations. As an analogy, the gingiva is similar to a frame enclosing beautiful painting. The frame complements the painting’s beauty but
can detract from it, if unsightly. Various soft-tissue factors have been extensively described in the literature and it is the clinician’s responsibility to understand them and their impact on the final outcome. A review of the literature provides an abundance of information on ideal tissue factors, specifically in relation to gingival health, quantity, quality, as well as particular positioning and symmetry.

First and foremost, presence of healthy gingivae is an essential criterion for esthetic success. Periodontal health should be continuously maintained with minimal probing depths, as well as absence of edema, erythema, and bleeding on probing. Persistent gingival inflammation, in spite of meticulous oral hygiene, may indicate a flaw in the restoration design or placement. Therefore, restorative treatments should also be mindful of the attachment apparatus with proper margin placement and fit. Anatomical restorative contours, with no impingement on the biologic width, are critical for tissue health and will therefore contribute to the long-term esthetics of the gingivae.

Variability in gingival color is not always related to inflammation but can also stem from ethnic factors and different concentrations of melanotic gingival pigments. As such, it is typically not an esthetic concern for patients due to the generalized distribution. Conversely, a localized dark appearance of the gingivae is unsightly and can sometimes be attributed to a discolored root following endodontic therapy. In combination with a thin gingival biotype, the root’s dark hue can show through the gingivae. A similar problem occurs with titanium dental implants and abutments surrounded by thin bone and soft tissue. The latter problem is usually preventable by adequate tissue grafting prior to and simultaneously with the implant surgery. Preoperative evaluation of tissue biotype could assist clinicians in avoiding these particular complications.

Anesthetic gingival margins have a scalloped appearance and a balanced transition between teeth. Knife-edge marginal gingiva that is tightly adapted to the tooth surface was described as ideal. In general, symmetry is a significant esthetic attribute and also applies to the gingival line. This necessitates the presence of identical tissue levels between contralateral teeth. The gingival margins of the maxillary central incisors and the canines should be symmetric and more apical to the lateral incisors. Additionally, Garber and Salama suggested that in optimal gingival architecture the maxillary gingival line follows the upper lip line.

The gingival zenith is a component of the gingival line and refers to the most apical point of the gingival tissue on the buccal aspect of the clinical crown. It extends an average of 1 mm distal to the axial inclination of the maxillary incisors and 0.5 mm on lateral incisors. The zenith of the maxillary canines usually coincides with the vertical axis of the tooth. In the vertical dimension, the zenith of the lateral incisors is found approximately 1 mm coronal to the adjacent central incisors and canines.

Improper vertical gingival levels can be characterized as either deficient or excessive. Both conditions affect normal teeth proportions and have a direct correlation to esthetics.

The majority of patients exhibit some gingivae in a smile. However, excessive gingival display can lead to patient dissatisfaction. Kokich et al. demonstrated that gingival display of more than 4 mm in a smile is considered unesthetic by lay people. Well-documented procedures for the reduction of excessive gingivae are available and their application depends on the patient’s particular diagnosis. Delayed passive and active eruption or attrition and compensatory eruption are ideally treated with surgical crown lengthening. The procedure reduces the gingival display as well as restores normal teeth proportions. The use of orthodontic intrusion was also suggested as well as orthognathic surgery for the correction of vertical maxillary excess and improvement of the excessive gingivae shown in a smile.

Gingival recession may cause teeth to appear abnormally long and therefore unesthetic. Another esthetic compromise is due to exposure of root anatomy and discoloration. A variety of root coverage techniques are available to treat patients presenting with this problem. They include subepithelial connective tissue grafting, coronally repositioned flaps, soft-tissue allografts and guided-tissue regeneration procedures.

The interdental papillae are of special esthetic significance since they are usually visible in a smile. This tissue defines the most incisal extent of the gingival line and creates different levels of a scalloped appearance. A normal interdental papilla fills the embrasure space to the contact point and any deviation will cause the appearance of a “black triangle” esthetic deficiency.
The height of the papilla depends on the underlying interproximal bone as well as the periodontal attachment to the two adjacent teeth. Tarnow stated that the papilla is likely to be present if the distance between the interproximal bone crest and the contact point is 5 mm or less. This was an attempt to predict the presence of the papilla as it relates to the above-mentioned distance.16

The papillae are especially susceptible to trauma and should always be treated with the utmost care during surgical and restorative procedures. Several case reports describing surgical reconstruction of the interdental papilla are found in the literature.17,18 However, due to the lack of proper scientific research and in the experience of the authors, surgical reconstruction of damaged interproximal tissue is currently considered nonpredictable. Therefore, gentle minimally traumatic techniques should always be applied and papillae reflection should be avoided where possible.

From this summary it is apparent that gingival esthetics is rather complex and depends on a multitude of elements. Achieving gingival harmony can be defined as achieving a pleasing combination of all the different elements mentioned previously. Although satisfying each separate requirement may be challenging, it is the clinician’s responsibility to aim for an optimal soft-tissue result. The following patient presentations demonstrate, in a step-by-step fashion, surgical treatment for root coverage and implant replacement of a maxillary central incisor. They emphasize the need for close attention to details and an attentive approach toward esthetics. Certain challenges as well as critical analysis of the techniques and outcomes are outlined.

Clinical Case Report No. 1 — Root Coverage

A healthy 63-year-old female presented with a chief complaint of an esthetically displeasing fixed partial denture (FPD) and recession on tooth No. 11 (Figure 1). Teeth Nos. 9 and 10 have been missing for more than 20 years and the edentulous space was restored in her home state with a FPD bonded to the palatal aspect of teeth Nos. 8 and 11. While it was functional for many years, the patient expressed dissatisfaction with its color and shape and wanted to improve the esthetics of her smile. CT scan analysis revealed sites Nos. 9 and 10 were inadequate for implant placement without significant hard- and soft-tissue augmentation. The patient declined the option of implant placement and elected to have a new FPD with improved esthetics. Tooth No. 11 presented with 7 mm gingival recession extending coronally to the mucogingival junction and with less than 1 mm of attached gingivae. A noncarious lesion was noted on the cervical aspect of the tooth. The recession was attributed to the patient’s traumatic brushing technique and possibly to occlusal trauma as a co-factor in the recession process. Tissue loss was also observed on the FPD pontics, Nos. 9 and 10, and on the mesial aspect of tooth No. 11.

The latter was a concern in regard to the intended soft-tissue grafting procedure. Blood supply for a soft-tissue graft depends on the presence of interproximal tissue. Therefore, the potential blood supply appeared to be compromised and the predictability of papilla formation on the mesial aspect of No. 11 was determined to be low. The distal interproximal tissue was adequate. In lieu of that, a decision was made to perform soft-tissue grafting without flap elevation to maximize blood supply to the graft.

The initial restorative step was removal of the existing FPD and replacement with a provisional restoration (Figure 2). The provisional FPD was then removed to allow access to the surgical site (Figure 3). Following adequate local anesthesia, an incision was carried into the gingival sulcus of the left maxillary canine using a 15C blade. An Orban knife was used to create sharp dissection beyond the mucogingival junction (Figures 4 and 5). This dissection separated the peristeum from the overlying connective tissue, thus creating a pouch to accommodate a soft-tissue graft. The pouch was extended sufficiently apically and laterally to create a vascular site (Figures 6 and 7). Following this step, the pouch could be seen communicating with the gingival sulcus of tooth No. 12 by...
design (Figure 8). Care was taken not to perforate the overlying flap by keeping the blade parallel with the bone and constantly observing the tissue response from the buccal aspect. Flap perforation compromises the blood supply and can potentially jeopardize the vitality of the graft. Additionally, the perforated site is a port of entry for oral bacteria to cause infection.

A subepithelial connective tissue graft (SECTG) was harvested from the palatal aspect of teeth Nos. 12, 13, and 14. The harvest was initially done by creating two parallel incisions. The first was a superficial incision leaving the epithelial layer intact. The second was a profound incision slightly above the bone layer leaving the peristeous intact. To complete the harvest procedure, mesial, distal, and apical incisions were necessary. The harvested graft measured 20 mm in mesiodistal length and about 8 mm in apicocoronal length. Hemostasis was achieved using adequate pressure and placement of an absorbable gelatin sponge (Gelfoam, Pfizer Manufacturing, Belgium) in the donor site.

Additionally, the donor site was sutured with absorbable gut 5/0 suture material. The connective tissue graft was then trimmed to remove tissue tags and adipose tissue and two separate absorbable gut 5/0 sutures were connected to each end. This step was essential to allow precise placement of the graft into the pouch recipient site. The graft was pulled into the pouch’s mesial aspect using the preattached suture (Figure 9). It was stabilized by suturing the mesial end to the attached gingivae of the edentulous ridge. The distal aspect of the graft was then placed in the distal aspect of the pouch using the same technique (Figure 10).

The buccal flap was then coronally repositioned to cover the graft using a sling suture with an absorbable monofilament polyglyconate 6/0 suture material (Maxon, Covidien Syneture, Mansfield, Mass.) (Figure 11). Stability of the graft was verified by a light pull on the lip. The provisional restoration was then recemented using temporary cement. Routine postoperative instructions were given to the patient and included an antibiotic regimen, analgesics and anti-inflammatory medications.

A one-week postoperative examination demonstrated adequate healing and vitality of the graft characterized by redness and slight swelling. Six-month postoperatively, a definitive restoration was completed (Figure 12). The buccal tissue was of adequate levels with a significant root coverage result and the esthetic outcome was satisfactory to the patient. As anticipated during the diagnosis and treatment planning phase, the tissue between Nos. 10 and 11 and between Nos. 9 and 10 was deficient. The papillae were of inadequate volume due to compromised bone height. It is of note, that a slight residual gingival recession was still apparent on the buccal aspect of No. 11, emphasizing the limitations of treatment in this particular case. Figure 13 shows tissue stability at a two-year postoperative appointment. The probing depths were minimal demonstrating stable periodontal attachment to the previously denuded root surface (Figure 14).

This report demonstrated a technique for root coverage using a connective tissue graft and a pouch procedure. The principles of obtaining blood supply for the graft and a conservative flap management were applied. It demonstrated the limitations of soft-tissue grafting and the importance of their preoperative recognition.
Case No. 2 — Implant Replacement of a Maxillary Central Incisor

A healthy 27-year-old female presented with a chief complaint of pain associated with tooth No. 8 (Figure 15). The cingulum and part of the root fractured below the osseous level rendering the tooth nonrestorable. Extraction with implant placement was recommended to the patient. The timing of implant placement after the extraction was considered (immediate versus delayed placement protocols). An immediate implant placement necessitates that the osteotomy primarily engages the palatal aspect of the socket. Due to the presence of an acute infection associated with the palatal aspect of the tooth, this option was not advisable and a delayed protocol was recommended. The patient was also advised to consider orthodontic treatment due to teeth crowding and less than ideal space status. She declined this option and stated that her objective was to replace the damaged tooth with an implant-supported crown that would resemble the original tooth. A treatment plan was formulated to include extraction of No. 8 with simultaneous bone augmentation, immediate replacement with an interim removable partial denture (RPD), CT scan analysis, possible additional hard- and soft-tissue grafting, a two-stage implant surgery, and a definitive fixed restoration.

Following adequate local anesthesia, tooth No. 8 was luxated using straight elevators, periotomes, and universal forceps. Care was taken not to traumatize the soft tissue and the osseous envelope and the tooth was extracted atraumatically. The extraction socket was debrided and the granulation tissue was removed. The buccal bony wall was verified to be intact (Figure 16). The socket was then grafted (Figure 17) with a cancellous bone allograft (Puros Cancellous Allograft, particle size 0.25-2 mm, Zimmer Dental Inc., Carlsbad, Calif.). A collagen plug was placed to seal the socket at its coronal aspect (CollaPlug Collagen Wound Dressing, Zimmer Dental Inc.) and an absorbable gut 4/0 suture was used (Figure 18). An immediate interim RPD was inserted.

One week postoperatively, the patient appeared to be healing properly with no complications. Due to the severe infection, five months were needed for the site to reach its maximal healing potential from a clinical and radiographic aspect. The patient was then referred for a CT scan to evaluate the site for implant placement. The CT scan showed adequate bone for implant placement. However, bone loss was evident. Implant surgery was recommended and the patient was informed that additional tissue grafting would be necessary.

The patient was scheduled for implant surgery not until three months later due to...
her work and study schedule (Figure 19). Following adequate local anesthesia, a crestal palatal incision was made and combined with two vertical releasing incisions (Figures 20 and 21). This incision is commonly known as the "papillae-sparing" technique since it leaves adequate proximal tissue attached to the mesial aspects of teeth Nos. 7 and 9. A full thickness flap was then elevated to expose the implant site. A surgical guide was used for optimal implant placement from a prosthetic perspective. A 3.8 mm in diameter by 13 mm in length tapered implant was placed and achieved initial stability with 35 Ncm insertion torque.

Following placement of a cover screw, the tissue was sutured primarily using nonabsorbable monofilament 4/0 suture (Gortex, Gore Medical, Flagstaff, Ariz.) and absorbable gut 5/0 materials (Figures 22 and 23). The implant was left to heal for five months and then evaluated for the planned uncovering procedure. A buccal tissue deficiency was noted (Figure 24), and the goal was to enhance the soft-tissue profile around the implant once it is uncovered.

Following adequate local anesthesia, a crestal palatal incision was made with two vertical releasing incisions repeating the previous incision lines (Figures 25 and 26). A full thickness flap was then elevated to expose the implant that seemed to be osseointegrated. The buccal tissue was undermined using an Orban knife to create a similar pouch to that described in case 1 (Figures 27 and 28). A small spoon-shaped elevator was used to extend the pouch apically and laterally (Figures 29 and 30). Additional horizontal soft-tissue augmentation was obtained by using a soft-tissue allograft (Puros Dermis Allograft, Zimmer Dental Inc.). Two absorbable gut 5/0 sutures were attached to the graft on its mesial and distal aspects (Figure 31). These sutures were then used to guide the tissue into the pouch in their corresponding sides (Figures 32 and 33).

The graft was then secured with the very same guiding sutures and sutured to the adjacent attached gingivae. A healing abutment was connected and the palatal tissue was repositioned buccal to it. Flap suturing around the healing abutment was completed using absorbable monofilament polyglyconate 6/0 (Covidien Syneture, Mansfield, Mass.) and absorbable gut 5/0 suture materials (Figures 34 and 35). Postoperative evaluations showed adequate healing with increased horizontal tissue volume (Figures 36 and 37). The patient was then referred to her restorative dentist to complete the restorative process.

At a one-year follow up appointment, the patient expressed satisfaction
with the esthetic outcome (Figures 38 and 39). The gingival margin was symmetrical between the two central incisors and interdental papillae were present. Radiographically, the implant bone levels appeared stable with proper restorative contours (Figure 40). Stable results were observed at the two-year follow-up appointment (Figures 41 and 42).

Subsequently, the following deficiencies were not apparent in the patient smile but are of note for critical analysis of the treatment outcome and are relevant in the context of this article’s topic.

As anticipated in the diagnostic phase, the mesiodistal width of No. 8 was slightly greater than the contralateral tooth. It is assumed that the recommended orthodontic treatment would have allowed for better tooth proportions to be created.

It can be observed that the tissue texture around No. 8 is not identical to tooth No. 9 and presented with slight surface irregularities. Additionally, scar tissue on the mesiobuccal gingival area of No. 8 can be observed. This scar tissue is a result of the vertical releasing incisions in the area.

From a treatment planning perspective, it might have been beneficial to graft the buccal bone and soft tissues at the time of implant placement. This would have been a surgical opportunity to create additional horizontal augmentation of the alveolar ridge that underwent significant horizontal resorption throughout the lengthy treatment process.

Of note were the changes in the gingival margin of tooth No. 9 over time. The gingival zenith that was visible prior to tooth No. 8 extraction was not present at the one-year follow-up and the gingival architecture appeared round (Figure 39). Studies have shown continuous maxillary skeletal growth with continuous eruption of teeth adjacent to implants.19-21 This may ultimately result in an infraocclusal positioning of a single-implant restoration. The changes in the gingival line of tooth No. 9 could be attributed to the above-mentioned reasons. Surgical trauma was not a likely reason, since the soft tissue on tooth No. 9 was never reflected given that the "papillae-sparing" incision design was utilized (Figures 20 and 28). In effect, this was a favorable change since the gingival architecture is now symmetrical to the adjacent implant crown.

The issue of implant placement timing following tooth extraction is of great...
importance. Using immediate placement protocols offers a shortened treatment time and a reduced number of surgical procedures. It appears that immediate implants have a comparable survival rate to delayed implants (>95 percent). However, the data on esthetic outcomes and soft-tissue complications is still lacking. Additionally, immediate implantation is not able to prevent the horizontal resorption of the alveolar ridge. Therefore, it may be prudent to allow for soft- and hard-tissue healing prior to implant surgery and to consider compensatory tissue grafting as demonstrated in this case.

Conclusions
Gingival esthetics is an important component of an attractive smile and depends on a multitude of factors. Tissue health, quantity, quality, symmetry, and balance are among the most essential of them. It is important for clinicians to have the knowledge about the ideal esthetic goals as well as the clinical skills to achieve them.

The clinical reports in this article demonstrated different aspects of soft-tissue management in an attempt to achieve pleasing gingival esthetics around restorations. Clinicians are encouraged to give emphasis to the diagnosis and treatment-planning phase and recognize treatment challenges and limitations preoperatively. It can be anticipated that careful soft-tissue management, along with adherence to biologic and esthetic principles, will increase the likelihood of successful outcomes.

REFERENCES

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