ACHIEVING OPTIMAL GINGIVAL
ESTHETICS AROUND RESTORED
NATURAL TEETH AND IMPLANTS

Rationale, Concepts, and Techniques

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The interface between dental restorations and the surrounding soft tissue is of critical importance for restorative success. The esthetic appearance of the dentition is determined to a considerable extent by the shape, contour, color, and health of the labial gingiva and the interdental papillae.\(^8\) Meticulous attention to the overall appearance of the dentogingival interface is a prerequisite for a comprehensive, functional, and esthetic restoration.

An individual tooth is esthetically inseparable from the adjacent gingiva. The free gingival margins should be narrow and smooth; the attached gingiva is generally 0 mm to 6 mm wide, stippled, and apically attached.\(^{21,31}\) These two gingival components maintain a keratinized epithelium, with the exception of the interproximal papillae. Therefore, the delicate interdental region of the gingiva is sensitive and more susceptible to external irritations.

The loss of interdental papillae may be caused by a variety of restorative and conventional surgical resection techniques. New techniques have been developed to minimize postsurgical gingival recession, preserve the interdental papillae,\(^{16,46}\) and correct gingival asymmetries.

This article presents combined restorative techniques to enhance the esthetic appearance of the gingival restorative complex. Using these techniques, the periprosthetic envelope (i.e., the soft tissue surrounding the cervical aspect of the restored tooth or implant) is manipulated to improve the contour by redesigning the cervical aspect of the involved tooth and by using a prosthetic restoration.

CHANGING GINGIVAL TOPOGRAPHY

Current esthetic treatment modalities for anterior dentition enable the clinician to address specific clinical situations. Direct composite resin restorations are

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indicated for correction of limited defects and minor cosmetic modifications in the anterior dentition. Free-hand composite resin bonding is the most common technique and achieves immediate results.\textsuperscript{4a}

Case 1

The patient in Case 1 presented with a large diastema, excessively long maxillary central incisors, and missing lateral incisors, which were replaced by the canines (Fig. 1A). Hybrid composite resin increments (Enamel Plus HFO, Mycerium, Avegno, Italy) were bonded to the canines, to their mesioincisal inclines. The newly formed mesial aspects of the canines reduced the incisal embrasures and created the illusion of a lateral incisor shape to these teeth. The two central incisors were shortened and bonded mesially by the composite resin to improve their proportions and decrease the diastema significantly (Fig. 1B). The flat shape of the central papilla preoperatively (see Fig. 1A) was adapted to the restorations and reorganized to form a pyramid-shaped confluence of the gingival margins of the restored central incisors.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{case1.png}
\caption{Case 1. A, Preoperative frontal view: missing lateral incisors and large central diastema. B, One-year postoperative frontal view: bonded composite resin supplements recontour canines to lateral incisors shape. The diastema between the central incisors is decreased and the shape of the central papilla is sharpened by supporting and guiding the soft tissue by means of the direct composite resin supplements.}
\end{figure}
COMBINED TREATMENTS OF UNESTHETIC GINGIVAL PATTERNS AROUND DENTAL RESTORATIONS

Esthetic requirements dictate that the margins of full-coverage anterior restorations be placed subgingivally. Two primary requisites must be achieved:

1. The adaptation of the restoration margins to the prepared tooth must be precise.
2. The cervical contour of the restoration should be of anatomic curvature because it affects the cervical embrasures and periodontal health.

A flat cervical contour causes a tapered unnatural shape, whereas an overcontoured crown may impair periodontal health and result in chronic inflammation. The effect of the crown margin location on dental plaque and gingival health is well documented. Intracrevicular margins should follow the normal scallop of the sulcus base, particularly in the interproximal aspect. When the restoration margins are placed apically to the base of the sulcus, they impinge on two anatomic components—the junctional epithelium (epithelial attachment) and the connective tissue fibrous attachment.

The periodontal connective tissues are organized into specific characteristics and form; they provide tone and support to the free and attached gingivae and reinforce the soft tissue/tooth interface. Collagen fibers are the most prominent components of the periodontal connective tissue. They are arranged in coarse bundles that exhibit a distinct orientation and are named according to their general direction and coarseness.

The epithelial tissue displays either parakeratinization or orthokeratinization, depending on the nature of the underlying tissue substrate. Epithelium loses its capacity for keratinization when it abuts enamel; dentin; cementum; and artificial substrates, such as porcelain, acrylic resins, and metals. The inability of the junctional, col, and sulcular epithelia to keratinize has been attributed to a disturbed connective tissue, marked by deficient collagenation, inadequate connective tissue fiber orientation, and evidence of fibroblastic degeneration.

When preparation is performed too close to the osseous crest, the restoration margins impinge on the supracrestal fibers. This error results in a violation of the biologic width, and iatrogenic damage to the periodontal support structure results. In the thick flat type of gingiva, a hyperplasia usually occurs. In such cases, a surgical restorative procedure may be required to recreate the normal biologic width. This procedure results in longer clinical crowns with adverse esthetic and phonetic effects. When executed in the visible anterior region, the surgical treatment is often accompanied by orthodontic forced eruption to avoid esthetic discrepancy. The gingival tissue may require up to 3 years postsurgery to establish its final contour and scallop.

In the thin confluenced type of gingiva, this violation usually leads to a recession. Interproximally, the cementoenamel junction and the alveolar crest of the anterior teeth follow a deep scallop, whereas the anatomic soft tissue col is concave and does not mimic the underlying bone crest, which is normally flat or convex. These factors explain the occurrence of inadvertent violations of the biologic width during proximal tooth preparation. Such violations result in acute inflammation or recession (or both) because the inflammatory process proceeds through the circular gingival fibers, especially when thin, scalloped facial gingiva is involved, which compromises the esthetic result of the treatment plan.
Case 2

In Case 2, the two crowned maxillary central incisors exhibit deficient labial gingiva of the right central incisor (Fig. 2A, B). The recession probably occurred because of the overcontoured and deep crown margins and improper management of the tissues during the prosthodontic treatment phases. An orthodontic forced eruption was performed to pull the tooth incisally in order to level the discrepancies of the gingival margins (Fig. 3A). Removal of the old crowns (Fig. 3B) revealed underpreparation in volume of the teeth and an inadequate finish line for ceramometal crowns. After repreparation of the central incisors and preparation of the lateral incisors (previously restored with faulty composite resin restorations), a four-unit, all-ceramic fixed partial denture was cemented, serving also as a splint after the orthodontic movement (Fig. 4A, B).

Case 3

In Case 3, the patient presented with an esthetically deficient ceramic crown (Fig. 5A), in which the original subgingival margin became supragingival. Reces-

Figure 2. Case 2. A, Preoperative view: note gingival recession of right crowned central incisor and of intact left canine. B, Preoperative close-up of the anterior maxillary dentition.
vision of the inflamed tissue exposed the root surface and unesthetic black interproximal space as a result of a partial loss of the papilla. The unesthetic appearance was accompanied by a severe bone loss and a deep periodontal pocket (Fig. 5B). When a deficient full-coverage restoration preexists, its removal is required as part of the initial preparation. Treatment includes meticulous root planing, curettage, fabrication of sound provisional restoration, and sometimes prescription of antibacterial therapy, as applied in this case. After this initial preparation, the hyperplastic tissue shrank, but the remnant of the interproximal papilla was completely lost (Fig. 6A). Hence the improvement in the biologic conditions of the supporting tissues was accompanied by a deterioration in esthetic appearance. In this case, to resolve the unesthetic result, the two central incisors had to be widened at their cervical mesial aspects in order to apically place the contact point and decrease the distance between the bone crest and the contact point. The chances of papilla presence in natural teeth is as high as 100% when the distance from the contact point to the bone crest is ≤5 mm. When the distance is ≥7 mm, the papilla presents <30% of the time. The contact point was apically positioned as close as possible to the bone crest within the esthetic criteria of the natural anterior dentition. The intact left tooth was bonded in its cervical area by a hybrid composite resin to support a newly formed short papilla, and the provisional acrylic crown of the right tooth was
Figure 4. Case 2. A, Postoperative frontal view of four crowned incisors immediately post-cementation (Courtesy of R. Lahav, MDT). Note harmony of gingival architecture but transitional stage of gingival healing. B, One year postoperatively. Note gingival health and harmony of the restored central incisors and of the orthodontically erupt left canine.

widened in its cervical area mesially to support the other side of the central papilla. Figure 6B, C show the final preparation of the right tooth and the periprosthetic soft tissue, which was redesigned by the provisional restoration.

After 6 months, the provisional crown was replaced by a permanent all-ceramic crown (In-Ceram, Vident, Baldwin Park, CA) (Fig. 7A). A marked improvement of the bony support was evident after 12 months (Fig. 7B). Despite overcontouring of the direct and indirect restorations in their mesial interproximal aspect, none of the biologic aspects were compromised.

The redesigned periprosthetic envelope permits overcontouring of the restorations between the buccal and the palatal papillae, which supports the additional height of the interdental papilla. The cervical profile in this area can be overcontoured to provide relief for the transceptal collagen fibers; the interpapillary collagen fibers are not affected, and the intracircular fibers are enhanced. By applying the soft tissue principles inherent in an ovate pontic receptor site, the lateral aspect of the proximal tissue surrounding the abutment can be considered a semipontic. These contours are used to manipulate the form of the soft tissue, altering its topography when direct or indirect restorations are placed.

The mesial contours of the restoration were developed to emanate horizon-
Figure 5. Case 3. A, Preoperative frontal view: note unesthetic crown of right central incisor and evidence of soft tissue inflammation. B, Preoperative radiograph. Note bony defect of right central incisor although crown margins are accurate.

tally from the restoration margins toward the tissue (see Fig. 7A, B). Once in contact, pressure was exerted, displacing the tissue laterally to create the desired contour. As the mesial contours of the restorations approach the primal contact areas above the interdental papilla, they turn incisally. The intracrevicular area must be convex in form to allow conical form of the tissue which facilitates self-cleansing and enhances the efficiency of oral hygiene. Application of the toothbrush from the buccal and palatal aspects permits cleansing of the exposed proximal crown surfaces, the proximobuccal and proximopalatal line angles, and the interdental soft tissue cones.

Case 4

The patient in Case 4 presented with a gummy smile, uneven gingival margins, and two unesthetic crowns covering the central incisors (Fig. 8A). The overbite of the two central incisors was deep, and the contours of the crowns

were rhomboid, unnatural, and disharmonized with the contours of the adjacent natural teeth (Fig. 8B). To decrease the excessive gingival tissue, the front maxillary teeth were lengthened by periodontal surgery to elongate their clinical crown (Fig. 8C), thus creating interdental spaces in between the exposed narrower roots.

The primary response after gingival resection consists of an acute inflammatory reaction marked by such events as edema, exudation, neutrophilic infiltration, vasodilation, vascular injury, collagen resorption, and matrix liquefication in the gingival connective tissue. This is followed by a gradual convalescence of the inflammatory state and the commencement of epithelialization and connective tissue repair, including vascular proliferation. In essence, the reparative phenomenon is grossly composed of the formation of a lamina propria of connective tissue and a new epithelial sheath over the area of excision. The connective tissue becomes increasingly more collagenous and less vascular. New sulcus formation after gingivectomy occurs as the result of epithelial progression into the shallow crevice present between the tooth and the devel-
opposing soft tissue margins. During these phases, the healed tissues should remain intact if possible and in case of need handled with meticulous care.

In this case, only after 6 months of initial healing were the two central incisors reprepared for full coverage and the adjacent front teeth partially prepared for porcelain veneer restoration (Fig. 9). The final restorations (Fig. 10A, B) presented not only a harmonious appearance of the teeth, but also a healthy soft tissue, an improved overbite, and a dramatic change in the previous "gummy smile" (Fig. 10B).

In restored teeth, the restorations must meet the requirements of oral biology and physiology, form, function, and phonetics and satisfy the patient’s expectations. Inadequate techniques contribute to plaque accumulation and periodontal breakdown; a direct relationship exists between the degree of marginal discrepancy of subgingival crown margins and the severity of periodontal inflamma-

The cervical profile of the restoration affects general tooth contour, cervical embrasures, and periodontal health.3, 24, 36, 44, 45, 49, 50

Meticulous execution of the restorative phase of the treatment plan, correctly designed cervical contours of the restorations, and appropriate manipulation of the soft tissue result in recreation of damaged periodontal tissues, including the regeneration of recessed interdental papillae, which are the foundation of a comprehensive restorative success. A modified approach is used when treating the soft tissue surrounding implant restorations.
Figure 9. Case 4. Occlusal view 6 months after surgery; central incisors are reprepared for crown restorations. Lateral incisors and canines are partially prepared for porcelain laminate veneer restorations.

Figure 10. Case 4. A, Two years postoperative frontal view: note harmony of ceramic restorations (Courtesy of R. Lahav, MDT) with gingival tissues. B, Six months postoperative frontal view of restored dentition and plastic surgery of the lips (Courtesy of M. Sheflan, MD). Note harmony in relationship of soft and hard tissues.
COMBINED TREATMENT OF THE GINGIVA AROUND IMPLANT-SUPPORTED RESTORATIONS IN THE ESTHETIC ZONE

The achievement of an esthetic implant-supported restoration is a constant challenge to the restorative dentist. Because of the circular shape of the implant and its smaller diameter, when compared with the root of a natural tooth, a dilemma inevitably occurs of how to construct an artificial crown and abutment system that imitates the natural tooth crown form when emerging from the gingiva with narrow margins to fit the implant head. In natural teeth, the emergence profile angle is relatively straight.\textsuperscript{9,10,14} Any attempt to reproduce this angle in an implant-supported crown results in a restoration that in most cases appears unnatural and artificial.

To compensate for the discrepancies between the implant head and the natural root diameter, several clinical techniques have been proposed for reshaping the gingival profile, provided that a sufficient volume of soft tissue is present:

1. Wide temporary healing abutments\textsuperscript{32} are used to allow gingival maturation around a wider cap. Because the diameters of these abutments are standardized and available only in limited sizes, it is not possible to achieve an optimal gingival contour in every clinical circumstance.

2. Gingival electrosurgery was recommended to cut the desired gingival contour.\textsuperscript{31} The results are not always predictable because shrinkage of the free gingiviva and gingival recession may result.\textsuperscript{1,2,17}

3. Gingivoplasty has been suggested with high-speed diamond burs at the appointment of the final crown delivery.\textsuperscript{25} This rotational curettage might cause unfavorable recession, especially when thin facial tissue is recontoured.\textsuperscript{28}

4. A two-section porcelain-fused-to-metal crown might be fabricated in which a ceramometal intracrevicular substructure is connected directly to the implant.\textsuperscript{26} Its profile guides maturation of the periabutment gingiva during the healing period.

5. Prosthetically induced gingival alteration is the most commonly used solution; it has been developed by various prosthodontists in different ways. Because all cemented implant-supported crowns require transmucosal abutments, this prosthetic component has gained attention in implant prosthodontics in recent years. Where implant location and planned crown size permit, use of a prefabricated anatomic abutment is the simplest and most readily achieved solution. These abutments can be slightly modified, if required, and can even be cut intraorally when already attached.\textsuperscript{29} Modification of a prefabricated titanium abutment has been suggested to allow a proper abutment design.\textsuperscript{42,48}

The use of a prefabricated titanium abutment, to be modified with gold overcasting to an individual shape, has also been suggested.\textsuperscript{41} Another alternative is the use of a custom-made abutment with porcelain-fused-to-metal subcervical region.\textsuperscript{24} Advanced prefabricated anatomic abutments were introduced,\textsuperscript{11,13} followed by the Bio-Esthetic abutment system.\textsuperscript{12} The introduction of a tooth-colored ceramic abutment\textsuperscript{38-40} is not only configuration oriented, but it also augments the abutment by its fourth dimension—color. The most common procedure for obtaining the desired abutment configuration is the use of modified plastic cylinders in the lost wax technique to produce customized gold cylinders.\textsuperscript{47}
CERVICAL CONTOURING CONCEPT—THE EXTRAORAL DESIGN OF THE TRANSMUCOSAL PROSTHETIC UNIT

The prosthetic components, apical to the free gingival margins, form the transmucosal prosthetic unit (TPU). The TPU can be composed of several combinations:

1. **Implant head alone**—the implant head is located supragingivally.
2. **Implant head plus abutment**—the abutment shoulder is supragingival (implant head-subgingival).
3. **Implant head plus crown**—the crown is screwed directly to the implant (UCLA type) without an intermediate abutment (implant head-subgingival).
4. **Implant head plus abutment plus crown**—the apical part of the crown is subgingival and sits on the abutment that is screwed to the implant. This is the most commonly found combination.

The cervical contouring concept addresses the achievement of predictable results. It is logical to conclude that the most important factor responsible for a natural appearance of the restoration is the desired configuration and dimension of its surrounding soft tissue. Therefore, regardless of the type of TPU selected, this concept places emphasis on the design of the soft tissue. The periprosthetic region is envisioned to an optimal configuration and redesigned previously in the laboratory phase. This ideal design is transferred to the vital oral tissue through the abutment and provisional restoration, which are fabricated accordingly, guiding the surrounding soft tissue to imitate the model replica. The peri-implant gingival tissue is duplicated by a rigid acrylic resin (Dura-Lay, Reliance, Worth, IL) to allow improved control of the remodeling process. Carving the periabutment gingiva in the working model allows fabrication of the prosthetic components in the desired dimensions, which are placed intraorally, where the periabutment tissue adjusts itself to the TPU components (abutments, provisional restorations, and final restorations).

The cervical contouring concept focuses on shaping the abutment and the cervical crown region following the prior design of the surrounding tissues and facilitates predictable, proper fabrication of an implant-supported crown, despite the difficulties created by the shape of the implant fixture.

**Case 5**

In Case 5, a 47-year-old female patient accepted a treatment plan requiring restoration of the anterior maxilla, involving three natural teeth and two implant-supported restorations. After optimal placement of the two implants to replace the left lateral incisor and canine and surgical augmentation techniques, an impression of the implant heads was taken and poured (Fig. 11A). Following the desired modification of the soft tissue replica (Fig. 11B), two individual type IV gold abutments (BIO-H, APM-Sterngold, Attleboro, MA) were fabricated according to the cervical contouring concept (Fig. 11C) and connected to the implants intraorally. The natural teeth abutments, adjacent to the customized implant transmucosal abutments, were prepared according to conventional crown-and-bridge techniques, and final preparation of the implant abutments was performed intraorally (Fig. 12A). Provisional acrylic resin single crowns
Figure 11. Case 5. A, Preoperative view of master model. Note circular configuration of peri-implant soft tissue (Duralay is a duplication of the soft tissue). B, Laboratory modification of peri-implant soft tissue replica according to the Cervical Contouring Concept. C, Customized gold transmucosal abutments. Note a lateral incisor and canine configuration optimally designed, regardless of the shape of circular implant heads and soft tissue.

were adapted chairside and cemented temporarily for an evaluation period of 2 months.

The impressions were taken using a conventional cord-retraction double-mix technique (Fig. 12B), and a Geller model was produced, whereby the soft tissue impression was cast-replicated in hard plaster stone (Fig. 12C). A small amount of the stone in the interdental sulci was removed, creating a gap between the abutments and the inner aspect of the free gingiva. This prosthetic adjustment was performed to restore the anatomic curvature in the sulci and allow intracrevicular convexity of the crown restorations.4, 53 Noble composite alloy copings (Captek, Longwood, FL) were fabricated in the laboratory to elicit a favorable response from the adjoining vital tissues and enhance a natural background for the veneering materials.50, 7, 33, 34a, 43a-c, 47a, 52, 53 Porcelain (Creation, Jensen, North Haven, CT) was baked onto the copings of the natural teeth because of its natural opalescent and fluorescent effect in creating intensified optical depth and brilliance of the porcelain restorations.

The implant copings were covered with polyglass resin (Artglass, Heraeus Kulzer, Irvine, CA) to provide a more flexible material because these implant-supported crowns shared in the anterior guidance and lateral movements in the
Figure 12. Case 5. A, Frontal view of prepared natural teeth and intraoral final preparation of connected transmucosal abutments to implant heads. B, Traditional impression of all abutments with tissue retraction and additional polyvinylsiloxane material in the double-mix technique. C, Laboratory Geller master model. Soft tissue duplication in hard plaster is necessary in order to achieve optimal restoration's cervic’s design.

occlusal pattern of the patient. Although asymmetric, this combination created a harmonized and esthetic anterior dentition (Fig. 13).

SUMMARY

The role of prosthetic restorations in the final appearance of the surrounding soft tissues has long been recognized. Innovative prosthodontic concepts as described should be used to enhance the biologic as well as the esthetic data of
Figure 13. Case 5. One-year postoperative frontal view. Natural teeth restored with porcelain fused to Captek crowns. Implants restored with customized transmucosal abutments and polyglas fused to Captek crowns (Courtesy of C. Landsberg, DMD, and S. Silberstein, CDT).

the supporting tissues, in natural teeth and implants alike. Combined dental treatment modalities of different kinds (i.e., orthodontics, periodontal treatment) are often required for optimal results. Meticulous care and attention to the delicate soft tissues should be given throughout all phases of the treatment, with a view to achieving a functional, healthy, and esthetic oral environment.

References


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