The Role of the Implant Housing in Obtaining Aesthetics: Generation of Peri-Implant Gingivae and Papillae — Part 1

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The use of osseointegrated implants provides predictable, long-term aesthetics, providing that the implant housing and peri-implant gingivae are adequately maintained. Restoration-driven implant placement must, therefore, result in the development of harmonious peri-implant soft tissue contour as compared to the adjacent natural teeth. This article analyzes the implant housing features that influence aesthetics in implant therapy. Case presentations that include surgical and restorative innovations are described to illustrate methods used to achieve aesthetics with single-tooth implant restorations.

Learning Objectives:
This article analyzes various features of implant housing. Upon reading this article, the reader should:
- Understand the surgical and restorative procedures for implant placement.
- Recognize the role of soft tissues on aesthetic implant placement.

Key Words: implant, soft tissue, integration, peri-implant

Endosseous dental implant restorations, ad modern Bränemark, have proven to be highly predictable, and long-term success is common in complete and partially edentulous cases.14 Success is closely linked to meticulous planning and execution of therapy, and this is no less the case when aesthetics of the single, implant-supported restoration is contemplated. Contemporary aesthetic and functional demands require that the implant restoration be the primary determinant for implant placement.9 Restoration-driven implant placement must, therefore, result in implant restoration and peri-implant soft tissue contour that is harmonious with the adjacent natural teeth.6 The contours and form of the restoration must also guide the development of the definitive peri-implant soft tissue profiles to ensure compatibility with the adjacent natural teeth.6 None of these objectives are attainable if the implant site does not have a suitable hard and soft tissue foundation in which the implant can be ideally placed.

As a result of postextraction bone resorption, the implant site is often insufficient for ideal implant placement, and some form of reconstitution or augmentation is invariably necessary.2 In some situations, postextraction resorption can be prevented utilizing immediate implant placement,15–16 immediate-delayed placement,15,17 or socket preservation techniques.2,18 With regard to immediate placement, it has been suggested that traumatic tooth extraction, without raising flaps and using the provisional restoration to help preserve the papillae, is an advantageous method of performing this type of procedure.2,7 When the alveolar bone in the potential implant site is initially insufficient, procedures can be undertaken to augment deficient ridges prior to or even

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Figure 1. Preoperative probing to bone in an edentulous site demonstrates a 3-mm soft tissue integument in the midcrestal portion of a potential implant housing.
simultaneous with implant placement. Procedures to alter the soft tissues may also be implemented prior to, during, or after implant placement, and the timing of the procedure is based on an assessment of how to best create an acceptable gingival integument with minimal surgical interventions.

It is apparent that the tissues in which the implant will be housed (i.e., implant housing) are pivotal to implant placement and the achievement of aesthetics. This article analyzes those features of the implant housing that are crucial to the attainment of aesthetics in implant therapy, via a critical review of the literature. Case presentations that include surgical and restorative innovations are also described to illustrate methods used to achieve aesthetics with single-tooth implant restorations.

**The Implant Housing**

The implant housing consists of an alveolar bone foundation covered by a soft tissue integument that must support the placement of functional aesthetic implants (Figures 1 through 3). This housing must have definitive qualitative and quantitative characteristics. Qualitatively, the alveolar portion of the housing must have a bone density that will support osseointegration and sustain the implant over time. The soft tissue integument should, from an aesthetic perspective, closely resemble the type of periodontium of the adjacent natural teeth.

Quantitatively, the bony housing should have a three-dimensional configuration that permits placement of a restoration-driven implant, be of optimal length and diameter, and be in an optimal position and angulation. The vertical margin of the central portion of the bone housing should approximate the facial bone level on the adjacent sister tooth. The housing should also have an adequate bone height on the interproximal surfaces of the teeth adjacent to the edentulous area to support the formation of ample interproximal papillae (Figures 1 through 3). The faciopapillary bone dimension should permit implant placement in a position and angulation that approaches that of the adjacent tooth, and the facial contour should correspond to the contours around the adjacent teeth.

Following tooth extraction, the osseous and gingival tissues are often altered, and horizontal and vertical bone resorption are generally evident, as well as soft tissue deformation that causes the soft tissue integument to become parallel to the underlying bone. The predetermined soft tissue integument must be of a dimension that will support development of an aesthetic and functional peri-implant tissue collar. Although the original interdental papillae are reduced in height and are somewhat pyramidal in shape, these tissues should permit the formation of interproximal papillae that fill the...
embrasures between the teeth and the implant. In certain instances, the anticipated implant housing will support implant placement; three-dimensional hard and soft tissue augmentation procedures will be necessary for instances when this support is not available prior to implant placement.5

**Soft Tissue Components**

**The Supracrestal Gingivae**

In the natural dentition, the tissue complex that is found coronal to the alveolar crest of bone includes the connective tissue attachment and the junctional epithelium (ie, the biologic width).34 When coupled with the sulcular depth, the supracrestal gingival (SCG) tissue complex is formed (Figure 4).6 The SCG will be approximately 3 mm to 5 mm when measured adjacent to the tooth and the interdental papilla and approximately 2.7 mm to 3 mm when measured in the midcervical area of the tooth.39,42 These dimensions are considered to be genetically predetermined and are related to the periodontal/dental biotype and alveolar bone structure.40,43-46 Consideration of these dimensions is critical to the achievement of aesthetics in the natural dentition, just as corresponding measurements would be with implant restorations.

**The Supraimplant Gingivae**

While the dimension of the supraimplant gingivae (SIG) has not been definitively investigated in edentulous areas, this parameter has been observed to be in the vicinity of 2 mm to 3 mm, providing tooth extraction was not complicated by untoward postoperative bone destruction or resorption (Figures 1 and 3B). Although the amount of SIG formed is generally related to the amount of tissues present following extraction and healing,44 it can be affected by the varying vertical position of the implant platform.41 When the implant platform is situated approximately 1 mm to 4 mm below the interproximal crest of bone on the adjacent teeth (depending on the periodontal/dental biotype), the midfacial SIG should be in the vicinity of 2 mm to 4 mm when measured from the implant platform to the gingival margin (Figure 5).3,4,44-47 Ideally, the implant platform would then be coincident with the cervical bony crest on the natural teeth, and a 2-mm to 3-mm SIG will be present with a dimension similar to that seen with the natural dentition. In the event the facial bone plate resorbs vertically during the healing process following stage 1 and 2 surgeries, the soft tissue column would extend from the new bone level to the free gingival margin irrespective of the implant platform position. This tissue dimension is variable and its long-term stability is yet to be definitively established.

It has also been reported that facial soft tissue recession can occur in the first year following implant
exposure and loading. In order to compensate for this tissue loss, the soft tissue should be prophylactically positioned more coronally at stage 2 surgery. It is possible that this recession could also be related to the vertical and labiopapillary position of the implant, or to the acuity of the facial contours of the abutment/restoration complex.

Interproximal Papillae
When single-tooth implants are placed, the height of the papilla on the implant side has been found to be in the order of 4 mm to 6.5 mm (Figure 5), which is greater than the 3 mm to 4.5 mm that has been described for the tooth side of the papilla and in the natural dentition. In the natural dentition, the postoperative height of the SCG that forms above the bony crest is predetermined and based on the original dimension found in that area. The same would apply to the tooth side of the papilla adjacent to an implant. In single-tooth implant situations, the eventual height of the papilla associated with a single-implant will, therefore, be largely dependent on the position of the interproximal bony crest on the adjacent natural tooth following placement. The position of the implant platform is less significant in terms of papillary height development. Placement of implants in accordance with the ideal bone levels in the alveolar housing should result in the formation of papillary and peri-implant tissues that are harmonious with the adjacent natural teeth.

The Contact Point
The presence or absence of a papilla is considered to be a function of the distance between the contact point and the crest of bone. In the natural dentition, the papillae were present 100% of the time when the contact points between the teeth were situated 3 mm to 5 mm from the crest of bone. When the distance exceeded 6 mm, the chances that the papillae would fill the embrasure diminished. Although interproximal papillae with dimensions that resemble the situation around natural teeth have been found in association with single implants, it should be noted that, in terms of papillary form, the predictive value of the associated contact points is lost when the tooth is extracted. The height of the interproximal bone, its predetermined SCG integument, and how these are managed during the surgical and molding phases of treatment will, therefore, determine the final configuration of the papillary complex during treatment. The form and position of the interproximal hard and soft tissue portion of the implant housing, the form of the teeth adjacent to the papilla complex, the “sculpting” effect of the adjacent implant restoration/abutment surfaces, and the position of the contact between them
will influence whether the postoperative papillae will fill the embrasure between the implant and the teeth.

**Optimal Implant Placement and the Implant Housing**

**Mesiodistal Implant Position**

During implant placement, the minimal distance between the implant and the adjacent tooth that will permit adequate interproximal bone and papilla formation is 1.5 mm. Development of a thinner space will result in a bony septum of predominantly cortical bone that will be vulnerable to resorption during the healing process and may preclude acceptable papilla formation.

The suggested diameter for implants in the central incisor and canine areas is approximately 5 mm to 6 mm. The suggested implant diameter for lateral incisors is approximately 3 mm to 4 mm. Regardless of the implant diameter selected, the implant position within the housing must ensure adequate clearance for development of an aesthetic interdental papilla and peri-implant tissue collar. In addition, the soft tissue integument should be of a dimension that will permit molding by the restoration/abutment complex and result in a papilla of appropriate form that fills the space between the implant restoration and the tooth. It is suggested that development of a 2-mm dimension between the implant and tooth would result in moldable interproximal soft tissues and the formation of acceptable papillae (Figure 6).

**Vertical Implant Position**

The midportion of the alveolar housing is often depressed in an apical direction as a result of postextraction resorption. If this bone level approximates that of the facial bone of the adjacent tooth, it can be used as a guide for vertical implant positioning. Should this not be the case, the bone level should be vertically augmented prior to or during implant placement if only minor additions are required. The authors suggest the use of osseous coagulum, collected in bone traps or with osseous coagulum collectors (eg, Osseous Coagulum Bone Collector, G. Hartzel & Son, Concord, CA) during the implant placement surgery, and a resorbable membrane (BioGuide, Osteohealth, Shirley, NY) to guide vertical bone regeneration around positioned implants in cases of minimally deficient ridges (Figures 7 through 9). When the implant platform is positioned at the suggested level, postoperative soft tissue formation will generally be of a dimension that will provide a suitable and aesthetic peri-implant soft tissue collar.

In the natural dentition, the periodontal/dental biotype is critical in determining the position and quality of the hard and soft tissues around the teeth.
In the flat, thick biotype (Figure 10), no great disparity exists in height between the interdental and facial crestal bone levels and their gingival covering. Placement of the implant 1.5 mm to 2 mm apical to the interproximal crest (Figure 8) would usually bring the implant platform into an almost ideal relationship with the facial bone level around the corresponding adjacent sister tooth and implant. In the thin, more scalloped biotype (Figure 11), there is a greater disparity between the cervical and interproximal levels, hence the more scalloped arrangement. In these situations, the implant would require more apical placement, 3 mm to 4 mm below the bone crest, depending on the degree of scallop, in order to achieve an acceptable apicocoronal position. Since vertical implant placement is so critical to the achievement of appropriate soft tissue proportions and aesthetics, locating implants coincident to the associated osseous crests is a dependable method for promoting aesthetic results. If the flap design does not permit visualization of the facial bone position on the adjacent teeth, this position can be determined by transseptal probing. The aforementioned proposals for vertical positioning are contrary to those traditionally advised. These advocate that the vertical position of the implant be situated 3 mm to 4 mm below the anticipated gingival margin, 2 mm apical to the CEJ of the adjacent teeth, or in a position that will permit the formation of 3 mm to 4 mm of biologic width. Placement in accordance with these recommendations may or may not result in implant platforms that are coincident with the facial bone on the adjacent tooth.

Faciopalatal Implant Position

The single implant placed in the maxillary anterior region should be situated palatal to an “imaginary line” that outlines the curve of the arch formed by the facial surfaces of the adjacent teeth. The correct positioning is obvious in cases of immediate implant placement.

(Figure 8). In instances in which the housing is adequate labiopalataly, the implant can be favorably embedded in its alveolar housing so that a minimum of 1.5 mm to 2 mm of cortico cancellous bone will always be found labial and palatal to the implant. When this is not possible, an augmentation procedure is necessary prior to or during implant placement (Figure 7). Just as in instances where vertical augmentation is needed, the authors often use osseous coagulum with resorbable membranes to augment thin labial plates simultaneous to implant placement. This approach also permits the attainment of bone topography facial to the implant that mimics the adjacent natural teeth. The correct labiopalatal positioning is also important because an implant restoration requires approximately 2 mm of space labial to the abutment for sufficient restorative material that will effect proper tooth form and shade and still remain in line with the adjacent teeth. This requires that the implant be placed palatal to the imaginary line or that the custom abutment be modified to attain this situation.

A faciatically positioned implant will be in close contact with the thin, vulnerable, labial cortical plate and may result in undesired bone loss during the healing...
process with subsequent soft tissue change. Another critical factor that must be considered is the approximate 1 mm of peri-implant bone loss that generally occurs up to the first thread in circumferential fashion with ad modern Bränemark implants, in the first year following exposure. If the implant is placed too far labially, the thin resultant labial plate of bone will be lost in this resorption process. The result would be a soft tissue vertical collar around the exposed implant that exceeds that found around the adjacent tooth, which may be more difficult to maintain and susceptible to undesired change. These possible contingencies reinforce the need for alveolar implant housings of sufficient dimension and quality that will preclude untoward resorptive events and permit optimal labiopalatal restoration-guided positioning.

Clinically, facially positioned implants may result in thinner peri-implant tissues that are facially positioned apically to the tissues on the adjacent teeth (Figures 1.2 and 1.3). This is similar to what occurs in labiobifurcated natural teeth, which often exhibit gingival recession and thin, less keratinized, periodontal tissue than the adjacent, correctly situated teeth. If the implant is placed too far palatally, the soft tissues may result in a more incisal situation relative to the adjacent tissue levels as it does in the natural dentition. In either of these two instances, abutment fabrication or selection becomes more complicated and aesthetics are compromised.

**Alveolar Ridge Morphology and Implant Position**

In situations in which immediate or immediate-delayed implant placement is feasible, the angulation of the implant in its alveolar housing can only closely approximate that of the original or adjacent tooth. This becomes quite apparent when examining CT scans of teeth adjacent to implant sites or prior to extraction, where the maxillary natural teeth are often more vertical and labial in the alveolar bone than the implant could be (Figures 1.4 and 1.5). In these cases, extremely thin labial plates cover the teeth and they are often lost following extraction. The use of immediate or immediate-delayed implant placement techniques improves the chances of obtaining the optimal angulation while simultaneously diminishing the chances of untoward resorption. Nevertheless, it is still possible for restoration-driven, aesthetic implant placement to be incorporated in cases where some labiolingual resorption has occurred and ideal angulations are not possible. This is achieved with the use of custom abutments (Figures 1.6 through 1.8) or, in some cases, even prefabricated angled abutments. Care must be taken to ensure that the resultant surface topography of the implant abutment/restoration complex does not impede the formation of an aesthetic peri-implant soft tissue integument. The labial bone resorption that commonly occurs following tooth extraction can often render it impossible to mimic original natural tooth position and angulation, or even provide a partially acceptable one, during delayed implant placement. The attainment of ideal aesthetics may, therefore, necessitate augmentation of ridges that are deficient labiopalatally.
Creating Interproximal Papilae and Peri-Implant Soft Tissue

The height of the papilla created at single-tooth implant sites will depend on the predetermined amount of soft tissue present in the implant housing and the height of the underlying bone present at stage 2 surgery, regardless of the technique used.\textsuperscript{53,55} It is possible that the height may be slightly increased when papillary molding or sculpting by the abutment/restoration is coupled with the surgical exposure procedure (Figures 19 through 23).\textsuperscript{9} Papilla generation procedures favored by the authors are generally implemented following the placement of a horizontal incision between the natural teeth, which is in line with their palatal line angles. Without making vertical releasing incisions, an envelope flap is elevated to the facial aspect, and the implant is exposed by semilunar incisions around the healing abutment. The custom abutment and provisional crown complex (i.e., the healing abutment) is fabricated after indexing at the stage 1 surgery, fitted, and the flap is scalloped to conform to the abutment/tooth shape and the patient's biotype. The above procedure may be modified by scalloping the primary incision in anticipation of the final flap form rather than using a straightline incision. Internal mattress sutures are used to maintain the height of the surgically developed papillae and are removed following 1 week. When the provisional restoration is used, molding of the papillae and peri-implant soft tissues commences immediately, as material can be added to or removed from the restoration, and continued until the desired tissue form is achieved. Tissue molding should be implemented with the understanding that the surface topography of the restoration will greatly influence the gingival form.\textsuperscript{5,56}

When the provisional custom abutment/restoration complex has not been prefabricated, the indexing and/or impression are made at stage 2 surgery and delivered to the laboratory for fabrication of the provisional restoration. A larger diameter healing abutment may be selected and trimmed chairside until it resembles the form of the adjacent tooth, particularly on its facial and interproximal surface. This is, however, a time-consuming procedure. The abutment is placed in position, and guidance of soft tissue form will commence as the healing progresses. The provisional restoration will be inserted one week later, and the molding process can be more definitively continued. The surgical approach presented and the molding process will ensure highly predictable results if the soft tissue integument of the implant housing was acceptable.

Conclusion

This report concludes that aesthetic single-tooth implants are largely dependent on the quality and quantity of the potential implant housing. Implants should be surrounded by 2 mm of bone to prevent untoward bone resorption and enable correct implant placement for development of a moldable peri-implant soft tissue collar. The vertical position of the implant platform should be in line with the facial bone of the adjacent tooth anywhere from 1.5 mm to 4 mm below the interproximal crests, depending on the periodontal dental biotype. In addition, papillae formation with appropriate form to fill the embrasures is a function of the interproximal implant housing, the form of the restoration and adjacent tooth, the position of the contact point, the surgical technique, and the sculpting of the soft tissue collar.

Part Two of this article will discuss customization of the peri-implant soft tissues as well as the development of an aesthetic emergence profile for restorative success.

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