Predictable Single-Tooth Peri-Implant Esthetics

Five Diagnostic Keys

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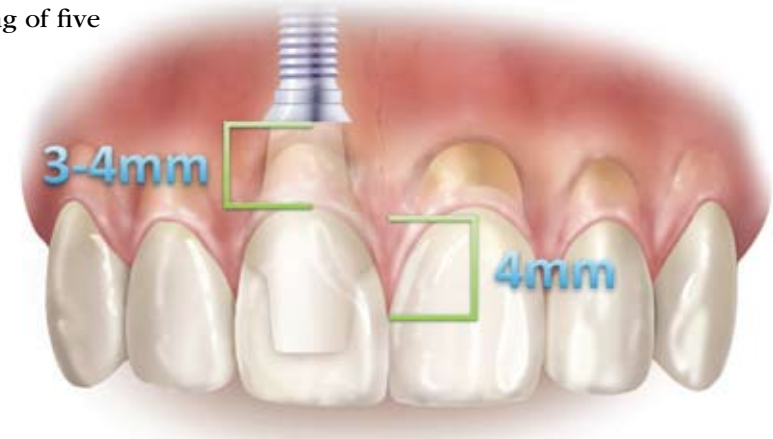
ABSTRACT: *The creation of an esthetic implant restoration with gingival architecture that harmonizes with the adjacent dentition is a formidable challenge. The predictability of the peri-implant esthetic outcome may ultimately be determined by the patient's own presenting anatomy rather than the clinician's ability to manage state-of-the-art procedures. To more accurately predict the peri-implant esthetic outcome before removing a failing tooth, five diagnostic keys are discussed. These keys include relative tooth position, form of the periodontium, biotype of the periodontium, tooth shape and position of the osseous crest.*

After the loss of an anterior tooth, the normal sequela of wound healing will create an unfavorable esthetic soft-tissue complex. The remaining facial mucosa often recedes apically and palatally.[1-4] Typically, this cervical recession results in a restoration that appears too long and may be compounded with the loss of the interdental papilla.[5] In addition, using a single-tooth replacement minimizes the restoration and surgical options necessary to the optimal management of the problem. Therefore, the creation of an esthetic implant restoration with gingival architecture that harmonizes with the adjacent dentition is a formidable challenge.

Five Diagnostic Keys

To more accurately predict the peri-implant esthetic outcome before removing a failing tooth, an understanding of five diagnostic keys is essential:

1. Relative tooth position.
2. Form of the periodontium.
3. Biotype of the periodontium.
4. Tooth shape.
5. Position of the osseous crest.



Any of these five keys can be combined or altered independently. Ultimately, the predictability of peri-implant esthetics may be determined by the patient's presenting anatomy rather than the clinician's ability to manage state-of-the-art procedures. In addition, these five diagnostic keys will enable the clinician to develop treatment options and clinical procedures that are more specific to the desired therapeutic outcome.

1. Relative Tooth Position

The hopeless tooth must be evaluated based on its relative position to the remaining dentition in three planes of space because the existing tooth position will influence the presenting configuration of the gingival architecture. The alteration of this tooth position will be reflected by the change in the configuration of the gingival architecture.

In the vertical (apicocoronal) plane, the cervical portion of the tooth may be more apical, more coronal, or ideal and mimic the facial level of the free gingival margin (FGM). After tooth removal, a minimum of 2 mm of apical migration of the facial FGM may occur during pontic site development, and up to 1 mm of apical migration of the facial FGM will occur during immediate implant site development.[8,9] Therefore, hopeless teeth with the FGM 1 mm to 2 mm more coronal to their harmonious facial gingival position are in a more favorable position *(Fig. 1a, 1b)*. A hopeless tooth with the FGM positioned ideally or more apically would benefit from orthodontic extrusion before extraction *(Fig. 2a, 2b)*.[10,11] In this way, the ensuing apical resorption after wound healing can provide a more harmonious gingival level. In the facial-lingual plane, the tooth position may create different concerns. Teeth positioned too far facially often result in very thin or nonexistent labial bone. These teeth compound the predictability of determining the cervical position of the facial FGM, because there may be more vertical loss and facial collapse of the gingival architecture. These situations are also poor candidates for orthodontic correction because of the inadequate underlying labial bone. It would be preferable to consider grafting procedures both before and after tooth extraction as part of a proactive treatment protocol. In contrast, a tooth positioned lingually may allow for a thicker labial portion of bone or facial tissue. This position is more favorable before extraction because the resultant cervical discrepancy in the facial FGM may be minimal.

Gingival recession is the most common complication of anterior single-tooth implants.

Figure 1a: *Preoperative clinical presentation with a hopeless right central incisor.*

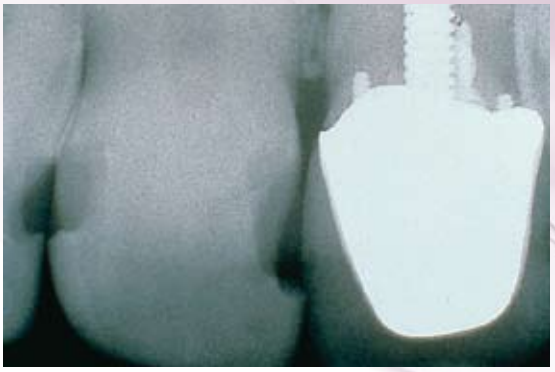


Figure 1b: *Initial radiograph. Note the square tooth shape, which creates thinner interproximal bone.*

The mesiodistal tooth position has two concerns. The first concern is the proximity of adjacent teeth necessary for providing proximal support and volume of the interdental papilla. The second concern is the inclination, which contributes to proximal support but also influences the position of the contact point. The mesially inclined tooth usually creates a contact point more incisally located and a gingival embrasure much larger spatially, which would require more volume to attain the same vertical height. This problem is a more significant concern when the tooth is present. When this tooth is removed, however, the same mesial inclination may be an advantage because the interproximal bone is thicker and at less risk of resorption after wound healing. Hopeless teeth with diastemas have similar advantages because of their thicker interproximal bone. Teeth with root proximity possess very thin interproximal bone. This thin bone creates a greater risk of lateral resorption, which will decrease the vertical bone height after extraction or implant management. Ideally, interproximal bone width should be about 1.5 mm at the crest before extraction to minimize lateral resorp-

Figure 2a: *Preoperative clinical presentation with a hopeless right central incisor.*

Figure 2b: *Initial radiograph. Note the triangular tooth shape, which creates thicker interproximal bone.*

tion of the osseous crest and further resorption caused by lateral violation of biologic width after implant restoration.[12] When teeth are present, the creation of close parallel roots with orthodontics is beneficial for support of the proximal gingival architecture. However, this may be a concern when extraction of one of these teeth is necessary because of the thinner interproximal bone at the height of the crest.

2. Form of the Periodontium

The basic human periodontal forms have been previously described.[13-15] For discussion, three categories of gingival scallop will be included: high, normal and flat. Based on a clinical survey of 100 patients, the average or normal gingival scallop is positioned 4 mm to 5 mm more incisally than the FGM.[16] The same clinical survey found that visually, because a central incisor is approximately 10 mm from the facial FGM to the incisal edge, the interdental tissue will occupy about 50 percent of the exposed tooth length.[16]

Of importance is the relationship to the underlying osseous crest. In the healthy periodontium, the underlying bony crest is about 2 mm apical to the cementoenamel junction (CEJ) and follows the scallop of the CEJ. This scallop of the central incisors is 3.5 mm. Therefore, in the normal and high-scalloped gingival architecture, there is more tissue coronal to the bone interproximally than facially for this scallop *(Fig. 2a)*. The greater this discrepancy, the higher the scallop and the higher the risk for gingival loss after extraction.

Figure 3: *Diagnostic total dentogingival complex measurement of 3 mm facially.*

Figure 4: *Diagnostic total dentogingival complex measurement of 3 mm to the interproximal crest of mesial tooth #9.*

Figure 5: *Diagnostic total dentogingival complex measurement of 3 mm to the interproximal crest of adjacent mesial tooth #7.*

Figure 6: *A Periotomea was used to atraumatically remove compromised tooth #8.*

In contrast, the flatter gingival scallop tends to mimic the osseous scallop, creating less discrepancy and more predictable maintenance of the interproximal papilla *(Fig. 1a)*. A highly scalloped gingival architecture that is the result of facial recession can be misleading. In this scenario, the interproximal papilla may be in the normal or flat position, relative to interproximal bone, but appear to have a highly scalloped form. This interdental papilla is also in a favorable position and not at risk of being lost after extraction.

3. Biotype of the Periodontium

The biotype of the gingiva is typically considered thick or thin. The thick or dense biotype may be fibrotic.[13] Thicker tissue is usually more resistant to recession and results often include pocket formation after any apical migration of the junctional epithelium *(Fig. 1a)*. The thin gingival biotype is often friable and results in increased risk of facial recession and interproximal loss of gingival tissue after any surgical procedure *(Fig. 2a)*.

Gingival recession is the most common complication of anterior single-tooth implants.[17] Thicker tissue is inherently more favorable and thin tissue provides more concerns. For thin tissue, minimally invasive or flapless surgery is more appealing because it minimizes compromises to the blood supply of underlying bone and decreases the risk of recession after implant management protocols.

4. Tooth Shape

Three basic tooth shapes — square, ovoid and triangular — influence peri-implant esthetics. The impact is both coronal and apical to the FGM. Coronal to the FGM, the tooth shape will influence the volume and height of the gingival embrasure. Apical to the FGM, the tooth shape will influence the proximity of the roots and support of the gingival tissue both facially and interproximally.

Coronal to the FGM, the square tooth shape is the most favorable because the proximal contact is longer and more tooth structure fills the interdental area *(Fig. 1a)*. This creates less risk of "black holes." The triangular tooth shape creates the highest risk for black holes because the proximal contact point is more incisally positioned and would require more tissue height to fill the interproximal area *(Fig. 2a)*. Therefore, even minimal amounts of tissue loss may create large black holes. These situations may require modification of the adjacent tooth shape with either direct composite or porcelain veneers after an implant-retained restoration.

Tooth shape will influence the volume and height of the gingival embrasure.

Figure 7: *The socket is inspected for the presence of an intact labial plate.*

Figure 8: *The surgical protocol is followed without a flap to position the fixture with a surgical guide. The position is slightly lingual to allow for ensuing facial shrinkage and 3 mm apical to the predicted free gingival margin to develop the emergence profile. Surgery performed by Dr. Lloyd Dixon.*

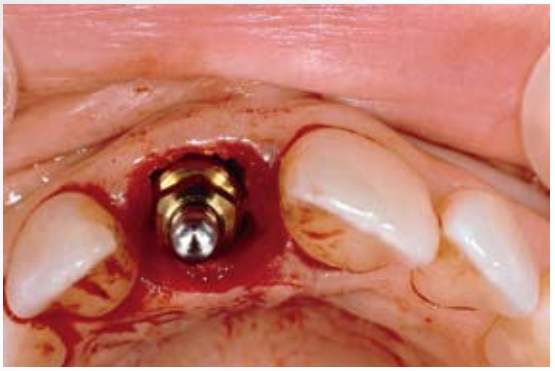


Figure 9: *Implant diameter chosen to allow for thickness of the interproximal osseous crest to minimize vertical loss as a result of lateral resorption after restoration.*

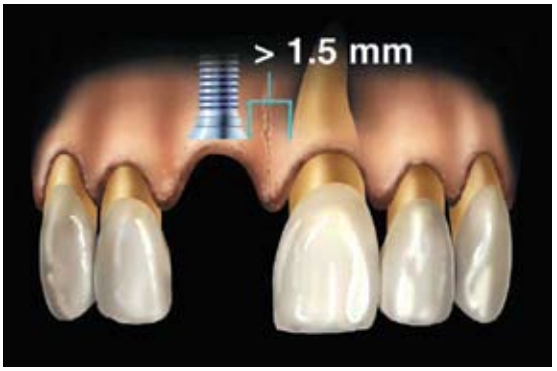


Figure 10: *Graphic depicts fixture diameter selected not to fill socket, but to provide interproximal crest thickness of 1.5 mm.*

Apical to the FGM, the tooth shape creates very different diagnostic concerns. Triangular tooth shapes allow for roots that are positioned farther apart, which provides potentially thicker interproximal bone *(Fig. 2b)*. This may actually minimize loss of vertical bone height after extraction procedures and implant placement as a result of lateral resorption with lateral violation of biologic width.[12] The ovoid and square tooth shape with proximal contact may, therefore, be at a greater risk of more vertical bone loss because the osseous crest is thinner *(Fig. 1b)*. This shape, however, provides more proximal support for the interdental gingival tissue.

The presenting tooth shape will influence the implant-retained restoration shape. The implant restoration will need to mimic its contralateral natural tooth coronal to the FGM; however, apical to the FGM, the implant restoration will not be an anatomic replica. An often-delicate balance must be developed that provides support of the gingival architecture yet does not provide excessive pressure. Although the implant position will dictate the emergence profile of the implant restoration, ideally, the facial contour should be slightly flatter than the contralateral natural tooth to minimize apical displacement of the FGM after insertion.[18]

The interproximal position of the fixture is below the osseous crest of the adjacent teeth. The interproximal emergence profile of the abutment should be straight and scalloped until it is coronal to the osseous crest. This distance occupies approximately 3 mm.

The greater the distance of the osseous crest to the FGM, the greater the risk of tissue loss after an invasive procedure.

5. Position of the Osseous Crest

The osseous crest is a critical foundation for gingival levels. The position of this relationship is an important predictor for gingival levels after any intervention. Previous clinical data on 100 healthy patients developed quantitative data for three different biologic variations.[16] These variations — normal, high, and low — are based on the vertical distance of the osseous crest to the FGM. The greater the distance of the osseous crest to the FGM, the greater the risk of tissue loss after an invasive procedure. If the vertical distance of the total dentogingival complex on the midfacial aspect is 3 mm, a slight apical loss of tissue (up to 1 mm) is anticipated after extraction and immediate fixture placement *(Fig. 3)*.

Greater or less than 3 mm of vertical distance indicates the change will be relative and range from negligible change to potentially >1 mm apical. Measuring the distance from the FGM to the osseous crest before extraction is an important and valuable diagnostic procedure. If the facial gingival levels are harmonious

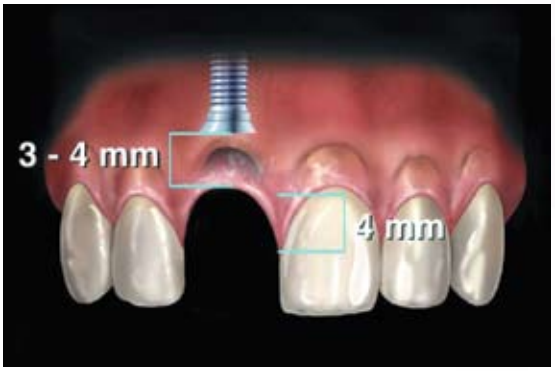


Figure 11: *Graphic depicts ideal vertical fixture position measure of 3 mm to 4 mm apical to the harmonious free gingival margin position.*

Figure 12: *A 3 mm healing abutment with vertical emergence profile is placed.*

Figure 13: *An interim removable partial denture is positioned for lateral tissue support coronal to the healing abutment.*

Figure 14: *Final impressions without stage 2 surgery. The adjacent teeth are prepared for veneers for esthetic reasons.*

and the distance to the osseous crest is 3 mm or more, orthodontic extrusion is recommended to move the osseous crest more coronally to account for subsequent osseous resorption and potentially greater soft tissue loss.

The interproximal relationship has consistent logic, but the measurement is different. In the interproximal area, a vertical distance up to 4 mm measured from the FGM to the osseous crest would present less risk. It is possible to generate greater interproximal distances,[19] but these are not predictably maintained after any surgical intervention. The inter-

Figure 15: *Laboratory result using a milled titanium custom abutment metal-ceramic crown on tooth #8 and porcelain veneers on teeth #6, 7, 9, 10 and 11. Ceramics by Steve McGown, CDT, Arcus Dental Laboratory.*

Figure 16: *Graphic depicts fixture relationship to the restorative result. For this patient, a variety of implant systems and restorative options are possible.*

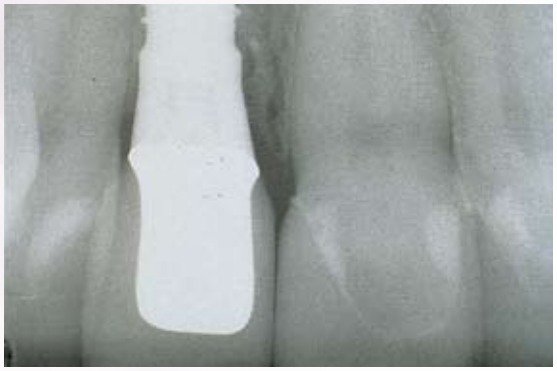


Figure 17: *Final radiograph implant in the #8 position. The implant diameter (4.3 mm) allows for adequate interproximal crest width.*

Figure 18: *Final restorative result with predictable peri-implant esthetics.*

proximal numbers are based on the most coronal portion of the interproximal osseous crest of adjacent teeth and are not related to the interproximal position of the osseous crest of the tooth being removed *(Fig. 4, 5)*. Therefore, if the interdental papilla measures >4 mm (low crest) on the adjacent teeth, there will predictably be some interproximal tissue loss after extraction to the 3 mm to 4 mm vertical distance.

Conclusion

This article has focused on the five diagnostic keys for predictable peri-implant esthetics. Each key is intimately related to the others, making treatment decisions difficult. For example, it is possible to have a thin biotype and triangular tooth in a highly scalloped periodontium that appears at high risk of facial recession and "black holes" after extraction and implant placement. However, because the tooth is positioned slightly more coronally with a vertical distance of <3 mm to the position of the osseous crest facially and interproximally (high crest), it can be managed fairly predictably.

The triangular tooth shape creates the highest risk for black holes.

The most favorable situation, or lowest risk, will be a slightly coronal and lingually positioned failing tooth with flat gingival architecture, thick biotype, square tooth shape and <3 mm vertical distance of the position of the facial and interproximal crest (high crest) *(Table 1)*. In this patient, surgery may be either flapped or flapless, and the implant-retained restorative outcome will be successful *(Fig. 6-18)*. Furthermore,

a variety of implant systems, surgical protocols and restorative options can provide similar therapeutic outcomes for this anatomical clinical situation.[20] In contrast, if the patient presented with unfavorable anatomical keys, the clinician would face much higher risk and a less predictable outcome for peri-implant esthetics, despite state-of-the-art procedures *(Table 1)*.

Using a proactive protocol that alters the periodontium toward less risk and more favorable assessment of the five diagnostic keys before implant placement will provide the most predictable peri-implant esthetic outcome. Reliance on "state-of-the-art procedures" provides different options; however, these results are not as predictable. ■

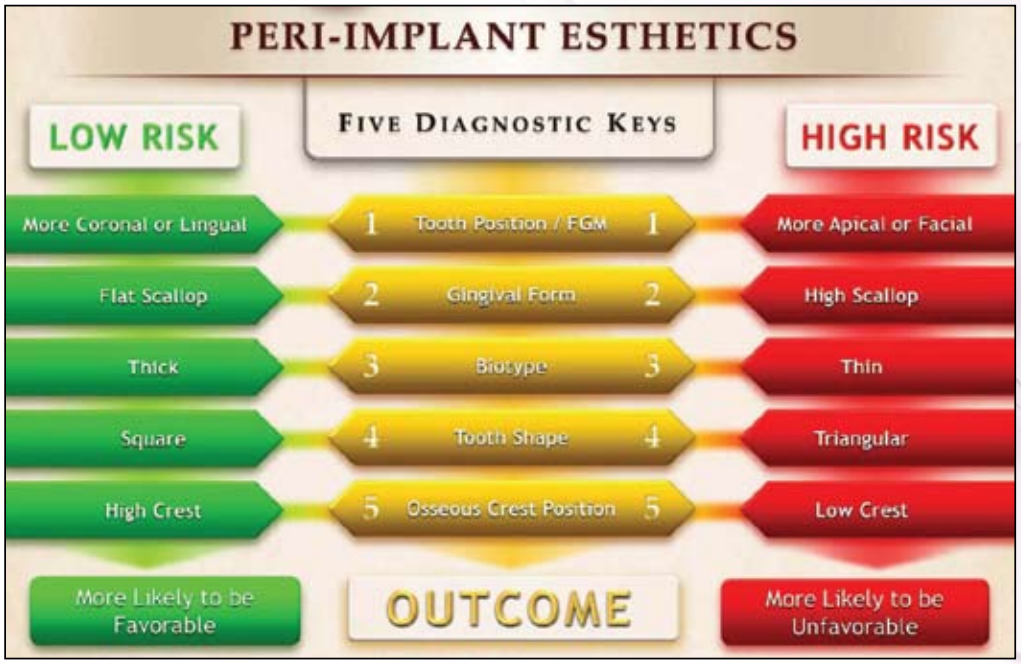


Table 1

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