Dental Implants and Esthetics

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Continuing Education Units: 1 hour


Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

This continuing education course is intended for general dentists, dental hygienists and dental assistants. Dental implants offer patients a means to replace one tooth or multiple teeth in a way that meets functional and esthetic needs. This course reviews various categories of esthetic complications, including: environmental morphology; surgical and soft tissue healing protocol; implant location; crown/prosthesis form and type of abutment; facial esthetics; and prosthesis discoloration.

Conflict of Interest Disclosure Statement
• Dr. Goodacre reports no conflicts of interest associated with this course.
• Dr. Anderson has done consulting work for P&G.

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Overview
Dental implants have been used for decades to replace one tooth or multiple teeth in a way that meets functional and esthetic needs. Reports indicate that more Americans are choosing dental implants as replacement options than in the past. This course reviews various categories of esthetic complications, including: environmental morphology; surgical and soft tissue healing protocol; implant location; crown/prosthesis form and type of abutment; facial esthetics; and prosthesis discoloration.

Learning Objectives
Upon completion of this course, the dental professional should be able to:
• Discuss factors affecting environmental morphology.
• Understand surgical and soft tissue healing protocol.
• Discuss the importance of proper implant positioning.
• Understand the use of different types of abutments.
• Understand factors affecting crown form.
• Explain the relationship between implants and facial esthetics.
• Outline steps to avoid prosthesis discoloration.

Course Contents
• Implant Esthetics
• Environmental Morphology
• Surgical & Soft Tissue Healing Protocol
• Implant Location
• Crown/Prosthesis Forum & Type of Abutment
• Facial Esthetics
• Prosthesis Discoloration
• Course Test
• References
• About the Authors

Implant Esthetics
Dental implants offer patients a means to replace one tooth or multiple teeth in a way that meets functional and esthetic needs. There are several factors that can affect the esthetic result achieved with single crowns, fixed partial dentures, and complete arch prostheses attached to root form implants. The following categories of esthetic complications have been identified:

1. Environmental morphology
2. Surgical and soft tissue healing protocol
3. Implant location
4. Crown/prosthesis form and type of abutment
5. Facial esthetics
6. Prosthesis discoloration

Environmental Morphology
Environmental morphology is affected by the amount of available bone (bone volume) and its form and location; the amount of soft tissue present coupled with its type, form, and location; and the coronal morphology of the natural teeth.

Bone Volume, Form and Location
Occlusocervical Dimension
The occlusocervical height of the residual ridge should be sufficient to accommodate the shortest implants (7 millimeters). In the posterior mandible, at least 2 millimeters of additional bone is required to maintain a safe distance from the inferior alveolar canal. Therefore, the minimal occlusocervical bone height in the posterior mandible is 9 millimeters whereas 7 millimeters is the minimal dimension in the anterior mandible. However, it should be remembered that short implants (7–10 millimeters) have higher failure rates than longer implants. Recently, implants that are shorter than 7 millimeters have been introduced for use when the available bone dimensions are very limited but there is currently a lack of long-term clinical data from a broad range of practitioners.

In the maxilla, 7 millimeters of bone height is sufficient to accommodate short implants. However, the use of 7–10 mm long implants is a greater concern in the maxilla than the mandible because the implant failure rate is higher in the maxilla. Therefore, 13 mm is the recommended minimum occlusocervical bone dimension in the maxilla.

Interarch Space
Occasionally, there may be excessive vertical bone height that limits the space available for ideal prosthesis fabrication. There needs to be adequate space available into which a crown or prosthesis can be placed that possesses the required esthetic and structural forms. The distance from the
Implants

TOOTH LOSS
Tooth loss can have a far-reaching effect on your dental health and personal appearance. When you lose one or more teeth, your remaining teeth can drift out of position. This can lead to a change in the bite, the loss of additional teeth, decay and gum disease.

DENTAL IMPLANTS
Dental implants can be an effective method to replace one tooth or several teeth. Each implant consists of a metal anchor that is inserted into the jawbone, and a protruding post, which is outfitted with an artificial tooth. Implants can also support a bridge, replace a partial denture or secure a fixed denture. The process requires surgery and may take up to a year to complete.

PROCEDURES
Several steps are usually necessary to place and implant. Depending on the type of implant, the steps may vary. The placement of a single-tooth endosteal implant is illustrated below:

Replace a missing tooth
Support a bridge
Secure a removable denture
Secure a fixed denture

The first step is completed under local anesthesia. A metal anchor, or artificial root is placed into the jawbone. Bone grows around the anchor. This takes about three to six months.

Next, a “healing cap” is placed when the implant is uncovered.

Then, the healing cap is removed and a metal post, or abutment, may be attached to the anchor.

When your gums and jawbone have healed, a crown (artificial tooth) is constructed, then screwed or cemented to the post. Fitting your new crown properly may take several appointments.

Brush and floss your implant twice daily, just like your natural teeth. Be sure to brush the back of the abutments and floss around the front, back and sides. Avoid chewing on hard objects or extremely sticky food. Proper oral hygiene will help keep your implants and your mouth healthy.

Be sure to follow the special home care instructions provided by your dental professional.
occlusal plane to the edentulous mucosa at the crest of the ridge should meet the following criteria:

- For anterior single crowns, there should be adequate space present between the opposing tooth and the implant to permit fabrication of a crown. Since many maxillary anterior crowns are not aligned with the long axis of the implant, an intermediary abutment is required to create an angulation change between that of the implant and the desired facial angulation of the crown. There needs to be sufficient space between the abutment and the opposing teeth for the type of restoration being fabricated (Figures 1A, 1B, 2). One millimeter is the recommended minimal space for metal ceramic and all-ceramic crowns. If a maxillary anterior metal ceramic crown will be fabricated with metal forming the lingual occluding surface, less than one millimeter of space may be adequate.

- 3-4 millimeters of minimum vertical space is required for structural integrity in posterior single crowns and fixed partial dentures. However, dimensions greater than 3-4 mm are required to achieve an esthetic result (Figures 3A, 3B). In the presence of minimal space, it may not be possible to produce the best esthetic result in terms of morphology and depth of color/translucency in porcelain. All-metal crowns/prostheses may be required when minimal space conditions are present (Figures 4A, 4B).

- The distance from the occlusal plane to the implants is important when planning complete arch implant prostheses (fixed complete dentures and overdentures) and a determination of the occlusal vertical dimension must be made using the established methods (closed speaking space, resting vertical dimension vs. occlusal vertical dimension, aesthetics, phonetics, and facial contours). There should be 10–12 millimeters of vertical space for complete arch prostheses made for edentulous patients (fixed complete dentures or overdentures) (Figures 5A, 5B). The minimum space required for overdentures is about 8 millimeters (includes retentive mechanism and overlying resin base). When a bar is used as the retentive mechanism, this dimension includes a 2-mm space between the bar and soft tissue for oral hygiene access.
Figure 3A. A single implant has been placed with an appropriate distance between the top of the implant and the occlusal surface, thereby permitting the replication of an acceptable crown form.

Courtesy of Dr. Thomas Kepic.

Figure 3B. The completed metal ceramic crown has been attached to the implant.

Figure 4A. A situation where there is only 4 millimeters of space between the implant and the opposing occlusal surface.

Courtesy of Dr. Guillermo Bernal.

Figure 4B. The limited distance does not allow space for a structurally adequate thickness of metal and also an esthetic thickness of porcelain. An all-metal prosthesis will be fabricated.

Courtesy of Dr. Guillermo Bernal.

Figure 5A. A complete arch fixed prosthesis (fixed complete denture) has been attached with screws to five mandibular implants. This type of prosthesis requires at least 10-12 millimeters of vertical space for a metal framework with cervical access spaces for oral hygiene and the overlying pink denture base resin and prosthetic teeth.

Figure 5B. An implant overdenture requires a minimum of 8 millimeters of space. There must be about a 2 millimeter space below the bar for oral hygiene access and the bar must possess sufficient dimensions to be rigid. Additionally, there must be space for the retentive mechanism that will attach to the bar as well as the denture base resin and prosthetic teeth.
Faciolingual Dimension

The required faciolingual bone thickness is related to the diameter of the implant being placed. Since 3.25 mm diameter implants are the smallest available, the bone thickness must be sufficient to accommodate an implant of this dimension. It is generally felt that 6 millimeters of faciolingual dimension is the minimal thickness into which 3.25 and 4 mm diameter implants can be placed. Larger diameter implants (5 and 6 mm) require minimal faciolingual bone dimensions of 7 and 8 mm, respectively. These minimal dimensions make implant placement very critical in order to avoid bone fenestration/dehiscence during placement of the implant. It should also be noted that minimal faciolingual dimensions do not permit changing the implant angulation in the bone since the existing faciolingual angulation of the bone determines the long-axis orientation of the implant.

Bone Form After Resorption

In the anterior maxilla, bone resorption usually produces an edentulous ridge where the bone is located lingual to the desired position for the teeth. This relationship places the implants lingual to the facial surfaces of fixed partial dentures, creating esthetic challenges in the cervical aspect of the prostheses (Figure 6). In addition, there is often a flared form to the residual bone that may prevent implants from being ideally aligned with each other (Figure 7).

With facially inclined implants, the internal implant threads used to attach other components to the implants flare away from each other, requiring the use of prefabricated angled abutments or custom abutments so prostheses can simultaneously attach to all the flared implants. This process often requires increased time and associated laboratory costs. In addition to the fabrications challenges, there may be esthetic and phonetic challenges with the overlying prostheses. The implant alignment may also make it difficult to avoid open cervical embrasures with single crowns (Figures 8A, 8B) or the units of a fixed partial denture (Figure 9).

Bone Grafting/Distraction Osteogenesis

When there is a deficiency in the occlusocervical bone dimension, the faciolingual dimension, or the bone form, it may be necessary to enhance the existing bone morphology through bone grafting or the use of distraction osteogenesis.

Soft Tissue Volume, Form, Type, and Location

Achieving ideal soft tissue form and interdental papilla height can be a challenge when placing implants into highly visible edentulous areas. Interdental dark spaces may be present (Figures 10, 11A, 11B), the marginal tissue may be thicker than the gingival margin present around adjacent teeth (Figure 12), the apical location of the soft tissue margin may not be at the same height as adjacent or contralateral natural teeth, interdental papillae may not possess the most desirable form or height (Figure 11B), and recession of the soft tissue may lead to crown length variations and/or exposed metal (Figures 13A, 13B).

When bone is present at the proper height interproximally, the soft tissue will usually fill cervical embrasure spaces (Figures 14A, 14B).
Figure 8A. The maxillary lateral incisor implant was placed into the form of the resorbed bone.

Figure 8B. The bone form contributed to the open cervical embrasure.

Figure 9. The maxillary three-unit fixed partial denture has some open cervical embrasure due to the bone form that was located lingual to the ideal position.

Figure 10. The interdental papilla does not quite fill the cervical embrasure space on the mesial surface of the lateral incisor single crown.

Figure 11A. Two implants have been placed in the positions of the congenitally missing maxillary lateral incisors.

Figure 11B. Following cementation of the crowns, the interdental papillae do not possess the required height and form and therefore they failed to fill the cervical embrasure spaces.
Figure 12. The peri-implant mucosa covering the facial aspect of the maxillary lateral incisor implant is thicker than the gingiva covering the adjacent natural teeth.

Figure 13A. Following healing of this one-stage dental implant, it was located below the crest of the peri-implant mucosa.

Figure 13B. Several years after crown placement, the soft tissue receded and exposed the cervical metal of the crown and the incisal aspect of the implant.

Figure 14A. The interproximal bone is within 5 millimeters or less of the proximal contact location with the adjacent teeth. Courtesy of Dr. Joseph Kan.

Figure 14B. Following placement of the central incisor crown on the implant abutment, the soft tissue filled the cervical embrasures because of the favorable bone-to-proximal contact distance. Courtesy of Dr. Joseph Kan.
The distance from the soft tissue crest to the bone is important in maintaining the presence of papillae between natural teeth and implants. One study evaluated 52 anterior maxillary papillae in 26 patients to determine the effect of the proximal bone crest on the presence or absence of papillae between an implant and an adjacent tooth. A papilla was present 100% of the time when the distance from the proximal contact to the bone was 5 millimeters or less. The papilla was only present 50% of the time when the distance from the contact point to the bone was equal to or greater than 6 millimeters.

Measurements have also been made of the distance from the soft tissue crest to the underlying bone crest adjacent to implants and also the distance from the gingival margin to the bone on the natural teeth adjacent to the implants. The measurements from the proximal bone to the crest of the peri-implant mucosa were 5–7 millimeters most of the time. When the distance between the bone and the desired interproximal height of the soft tissue adjacent to implants is greater than 5–7 mm, there will likely be dark cervical embrasure spaces adjacent to the implants. The measurements between the mid-facial soft tissue crest and the facial bone of implants was usually in the 3–4 millimeter range. When the distance between the mid-facial bone and the desired facial location of the soft tissue is greater than 3–4 millimeters, it is not likely that the soft tissue will be located at the desired position on the facial surface of the implant restoration. This information is helpful in determining the likelihood of interdental papillae filling the cervical embrasures adjacent to implant prostheses and the facial soft tissue being located at the desired apical position.

The effect of the periodontal biotype (thick versus thin soft tissue) on the peri-implant mucosa has also been assessed. Individuals with thick mucosa had greater distances between the underlying bone and the margin of the peri-implant mucosa than patients with thin mucosa. As a result of this data, the authors propose that papillae adjacent to implants can seldom be recreated when the distance is more than 4 millimeters between the bone crest and the desired height of the interdental papillae when treating patients with thin peri-implant mucosa.

Natural Tooth Crown Morphology
When the facial crown outline form of natural teeth is triangular as opposed to being square, there is a much greater difference between the height of the interdental papilla and the mid-facial gingival crest (Figures 15A & 15B). This relationship produces a gingival architecture that is quite scalloped in form. The underlying bone follows the gingival morphology. As a result, esthetic challenges are magnified following the loss of teeth in patients with highly scalloped soft tissue. The bone remodeling associated with post-extraction healing results in recontouring of the relatively tall interproximal bone and that often leads to open cervical embrasure spaces.

Additionally, teeth that are triangular in form are more often associated with thin, delicate gingiva that is more susceptible to recession.

Surgical & Soft Tissue Healing Protocol
When placing single dental implants, the use of a conventional surgical flap that includes the interdental papillae has been compared with a modified design that did not sever the two interdental papillae. The modified flap design preserved at least 1 millimeter of the papillae adjacent to the natural teeth. A reduction in crestal bone loss was noted and this enhanced bone preservation could improve the esthetic result achieved.

The longer the area has been edentulous, the more likely there will be a soft tissue discrepancy due to bone resorption and concomitant changes in the soft tissue contour. Therefore, it is generally felt that emphasis should be placed on retaining soft tissue form rather than restoring lost tissue. Methods of retaining soft tissue form and location include immediate implant placement and immediate placement of a provisional restoration when these procedures are indicated.

Immediate implant placement and provisionalization following extraction of a tooth has shown successful results in the maxillary esthetic zone and papillae have been preserved. It has been judged to be most predictable when the distance from the free gingival crest to the osseous crest is 3 millimeters on the facial surface of the tooth to be extracted and 4.5 millimeters on the interproximal surfaces of the
adjacent teeth since greater measurements will likely produce deficits in the soft tissue esthetics.

A technique has been reported whereby the papilla can be retained between adjacent single implants. This inter-implant papilla preservation involves alternate immediate implant placement and provisionalization, one following the bone integration period of the other. The process involves extracting one of the two teeth, immediately placing the implant, and then attaching a provisional restoration with the desired profile as it emerges from the soft tissue. In this way, the soft tissue around the implant is preserved in its normal location. After six months, the procedure is repeated for the adjacent tooth, thereby preserving the inter-implant papilla.

It is important to make impressions for implants that record the existing position of the peri-implant mucosa so crowns and fixed partial dentures can be fabricated with forms that support or enhance the soft tissue form. It is also important to make the impressions after all healing has occurred so there will be no additional mucosal changes that negatively affect the esthetic result after a restoration has been fabricated or placed. The amount of soft tissue recession that occurs following abutment connection surgery has been measured in a one-year prospective study. The authors indicate about 1 millimeter of recession can generally be expected following abutment connection surgery. Since most of the recession occurred within the first three months, the authors proposed waiting three months after abutment connection surgery before making the definitive impression.

**Implant Location**
Proper incisocervical, occlusocervical, and faciolingual positioning of implants promotes the development of restoration contours that transition from the round form of the implant to the desired tooth form. These transitional contours allow the artificial replacement to possess a normal profile when it emerges from the soft tissue. Proper implant positioning also promotes the development of normal soft tissue form and location.
Location For Single Crowns
The implant should be centered mesiodistally in the edentulous space for esthetic reasons (Figure 1A). Centering the implant facilitates the development of normal proximal emergence profile, permits better morphologic replication of the contralateral tooth, and prevents the replacement tooth from appearing tilted in the arch (Figures 16A, 16B).

Faciolingually, the implant should be located at the center of the edentulous space or be located slightly to the facial. A position slightly to the facial can sometimes be advantageous when the existing bone dimensions permit (Figure 1A) since centering the implant may produce a crown with a deficient cervical contour (Figures 17A, 17B) or a crown where porcelain must overlap the facial soft tissue to create the desired cervical crown morphology (Figures 18A, 18B). Overlapping the soft tissue makes oral hygiene more difficult, and it presents an esthetic liability should the soft tissue position recede apically.

When an implant is placed lingual to the faciolingual center of the adjacent teeth, it may be necessary to have the crown substantially overlap the facial soft tissue (like it occurs with certain fixed partial denture pontics) to achieve a normal cervical form. Alternately, a horizontally submerged ovate form (similar to an ovate pontic) can be developed that supports the soft tissue in a more esthetic fashion (Figures 19A, 19B, 19C).

Placing an implant too far facially creates serious esthetic challenges that often cannot be overcome (Figures 20A, 20B). The implant may have to be removed, bone fill allowed to occur, and another implant subsequently placed in a more favorable position.

The incisocervical/occlusocervical location of the implant is largely determined by the location of existing bone since the top of the implant is surgically located at about the level of the bone or slightly apical to the bone crest. The
Figure 18A. The maxillary premolar implant was placed lingual to the faciolingual center of the adjacent teeth.

Figure 18B. The lingual position of the implant required the facial porcelain to overlap the soft tissue much like the pontic of a fixed partial denture overlaps the edentulous ridge mucosa. The overlapping of the soft tissue produces an acceptable esthetic result but creates oral hygiene challenges and would produce an esthetic liability if the mucosa ever recedes apically.

Figure 18B. Note the lingual position of the implant and the soft tissue form created by the cervical shape of the metal ceramic crown.

Courtesy of Dr. Roy Yanase.

Figure 19A. A maxillary canine crown has been fabricated with an ovate form to mold the soft tissue in a facial direction so an acceptable esthetic result can be achieved. The crown has been attached to an implant analog for the picture.

Courtesy of Dr. Roy Yanase.

Figure 19B. The peri-implant mucosa was molded to the ovate form of the crown and an acceptable esthetic result achieved.

Courtesy of Dr. Roy Yanase.
incisocervical/occlusocervical location is also determined by the esthetic need to transition from the round form and smaller diameter of the implant to the larger diameter of the crown that needs to possess a specific cross-sectional geometric form. Typically, implants have been placed apical to the cementoenamel junction of adjacent natural teeth to permit the required changes in morphology to occur somewhat gradually. Initially, it was recommended that implants located in the esthetic zone be placed 4 millimeters or more apical to the cementoenamel junctions of adjacent teeth. However, this location places the implants far below the bony crest and bone healing subsequent to implant placement can then produce interproximal bone form changes that negatively affect the soft tissue height and may prevent the soft tissue from filling cervical embrasure spaces. Therefore, when the adjacent bone level is located at a normal incisocervical level, a distance of about 2 mm apical to the cementoenamel junction of adjacent teeth is recommended (Figure 21).

In the anterior maxilla, it is often necessary to fabricate custom abutments to create an angular transition between the long axis alignment of the implant and that desired for the crown. When this need is present, it is important that the implant(s) be positioned incisocervically so a custom metal abutment can be used and it will be not visible. Alternately, ceramic abutments may be needed to provide an acceptable soft tissue color.

It should be remembered that the existing bone morphology may prevent implants from being placed in the desired locations, and bone grafting or distraction osteogenesis may be required before acceptable implant positioning can be achieved.

**Location For Fixed Partial Dentures**

When multiple implants are placed into the esthetic zone for the support and retention of fixed partial dentures, the implants should be mesiodistally located so they will be centered beneath the individual units of the prosthesis. When the implants are not centered beneath the prosthesis...
units, the cervical crown forms and embrasures will not appear normal in form. Should this abnormal form be visible during talking or smiling, there will be an esthetic liability (Figures 22A, 22B).

Faciolingually, the implants should be located at the center of the edentulous space or slightly to the facial when the existing bone dimensions permit. Centering the implants may produce prosthesis with deficient cervical contours, or it may be necessary to have porcelain overlap the facial soft tissue to create the desired cervical morphology. As stated with single crowns, overlapping the soft tissue makes oral hygiene more difficult, and it presents an esthetic liability should the soft tissue position recede apically.

When the implants are placed lingual to the faciolingual center of adjacent teeth, the prosthesis units may have to overlap the facial soft tissue (like occurs with natural tooth fixed partial denture pontics) to achieve a normal cervical form. Alternately, a horizontally submerged ovate form (similar to an ovate pontic) can be developed that supports the soft tissue in a more esthetic fashion.

For biomechanical reasons, implants are sometimes placed in a slightly staggered (offset) relationship to one another. The facial or lingual offset of one implant improves the capacity of the prosthesis to resist faciolingual forces. This type of alignment is more often used with posterior prostheses where the leverage forces are greater and the esthetic challenges are less critical. However, offset implants should still be contained without the normal peripheral contours of the overlying units of the prosthesis.

Placing the implants too far facially creates serious esthetic challenges that may result in the need to remove one or more of the implants, allow bone fill to occur, and then subsequently place the implants in a more favorable location.

As with single crowns, it should be remembered that the existing bone morphology may prevent implants from being placed in the desired locations and bone grafting or distraction osteogenesis may be required before acceptable implant positioning can be achieved. Additionally, when bone grafting or distraction is not employed or cannot create the desired result, it may be necessary to recreate the missing soft tissues through the use of gingivally-colored ceramic materials at the cervical aspect of the prosthesis.

The mesiodistal distance between adjacent implants can affect the presence of an interdental papilla. When radiographic measurements of crestal bone loss were made in 36 patients who had two adjacent implants, the average crestal bone loss between implants with more than 3 millimeters of separation was 0.45 millimeters. When the implants were separated by 3 millimeters or less, the average crestal bone loss was 1.04 millimeters. Therefore, it has been proposed that 3 millimeters or more of bone should be retained between adjacent implants to minimize crestal bone loss, particularly in esthetic zones.

**Location For Complete Arch Prostheses**

Implants that support/retain overdentures are commonly located in the canine and premolar areas of the mouth and they should be centered beneath the prosthetic teeth or slightly lingual to the center of the prosthetic teeth. When the implants are located anterior to the teeth (Figures 23A, 23B) or substantially posterior to the teeth, the denture base has to be enlarged to encompass the implant and retentive mechanism.
The enlarged base dimensions prolong the time it takes for a patient to adapt to the new prosthesis and can make the adaptation challenging.

There is another negative aspect of placing implants too far facially or lingually. With malaligned implants, efforts are commonly made to reduce the amount of resin base overcontouring, and this process frequently leaves only thin areas of resin over the retentive mechanisms. The thin resin is more prone to fracture.

With fixed complete dentures (complete arch prostheses affixed to multiple implants with screws), the implants should be placed beneath the desired locations for the prosthetic teeth (Figure 5A). These locations permit the development of a normal prosthesis form with cervical contours that support the facial soft tissues and appear appropriately esthetic. The long axes of the implants should ideally be aligned with each other and the long axes should emerge through the lingual aspect of the anterior denture teeth and the occlusal surfaces of posterior teeth. These locations permit the screw access holes (required to affix the prosthesis to the implants) to be located in areas where they have minimal impact on the esthetic result, and the holes can be filled with esthetically colored composite resin fillings that have a minimal impact on the esthetics of the denture teeth. For biomechanical reasons, the implants should also be placed in accordance with the desired arch curvature so there is at least a 10 millimeter anteroposterior dimension to the curved alignment of the implants (Figure 24).

**Crown/Prosthesis Forum & Type of Abutment**

It is important for a single crown or the units of a fixed partial denture to emerge from the peri-implant mucosa with a form that replicates that of the missing natural tooth/teeth and also provides an environment for optimization of the soft tissue form. When the implant is located below the margins of the peri-implant mucosa, the crowns can be shaped so they emerge from the soft tissue with the desired diameter and circumferential form. The peri-implant mucosa will mold itself to the form created by the crown.
or fixed partial denture unit. If the interproximal bone is of sufficient height (5 mm apical to the proximal contact when there is thick soft tissue present and 4 mm apical to the contact when the soft tissue is thin), the soft tissue will also fill the cervical embrasure space.

When the peri-implant mucosa will not fill the cervical embrasure space, the cervical crown contours may have to be increased (greater lateral flaring of the crown) to reduce the dark cervical embrasure space. The use of gingival-colored ceramics may also be needed to close the cervical embrasure space and simulate the missing soft tissue.

When the implant is only slightly below the soft tissue margin and the tissue height is therefore minimal, the transition of the restoration from the round diameter of the implant to the form of a natural tooth is more challenging and must occur over a shorter distance, requiring a greater transitional angle (greater lateral flaring) to be developed in the cervical aspect of the crown. Another challenge related to an implant being located close to the soft tissue crest is the potential for visibility of any cervical metal present in the crown where it attaches to the implant.

In the anterior maxilla, it is often necessary to fabricate custom abutments to create an angular transition between the long axis alignment of the implant and that desired for the crown. When this need is present, it is important that the implant(s) be positioned incisocervically so a custom metal abutment can be used and it will be not visible. Alternately, ceramic abutments may be needed to provide an acceptable soft tissue color when a metal abutment would be visible through the mucosa.

The base of implant overdentures and the cervical aspect of fixed complete dentures must have forms that support the facial soft tissues and yet permit access for oral hygiene procedures.

Facial Esthetics

Facial Support
Fixed partial dentures that attach to implants must support the lip in the same manner as that required of prostheses attaching to natural teeth. With completely edentulous patients, the prosthetic teeth and base must appropriately support the facial soft tissues in accordance with the criteria used for conventional complete dentures. The clinical and laboratory steps required to locate the most appropriate prosthetic tooth positions are the same as that used with conventional complete dentures (esthetics, tooth-lip relationships, phonetics, anatomic landmarks, occlusal vertical dimension, and muscular neutrality (neutral zone).

One of the deficiencies that can occur with fixed complete dentures is a lack of adequate support for the facial soft tissues since the cervical aspect of the prosthesis does not have border extensions similar to that of a complete denture. To provide proper facial support, a more substantial denture base may be needed, necessitating the use of an implant overdenture as opposed to a fixed complete denture.

Smile Line
It is important to determine how much of the teeth and soft tissue are visible during a maximal smile. As with conventional single crowns and fixed partial dentures, the display of significant amounts of soft tissue increases the esthetic difficulty of implant single crowns and implant fixed partial dentures. With fixed complete dentures, patients may smile in a manner that the border of the prosthesis would be visible, producing an undesirable esthetic result and necessitating the use of an implant overdenture.

Prosthesis Discoloration
With complete arch implant prostheses for edentulous patients, the retentive mechanisms for overdentures and the underlying metal frameworks for fixed complete dentures can be visible through the denture base resin, producing an undesirable esthetic result. Ideally, the retentive mechanism for overdentures should be positioned so it cannot be seen through the visible portion of the denture base, does not interfere with proper positioning of prosthetic teeth, and does not excessively enlarge the denture base.

Because of the potential for implant overdentures to fracture under occlusal loading when the bases are relatively thin, metal reinforcing meshworks are sometimes used. These meshworks can discolor
the prosthesis, and one study of maxillary implant overdentures noted that three patients did not like the esthetic result achieved in the prosthesis because the base metal reinforcing meshwork cast a gray color through the resin base.\textsuperscript{10}

The same type of discoloration can occur from the metal framework of a fixed complete denture discoloring the overlying pink denture base resin (Figures 25A, 25B). Also, leakage between the denture base resin and metal over time can create staining.

The metal visibility through the resin and the discoloration from leakage can be reduced or eliminated by bonding an opaque resin to the metal framework of a fixed complete denture or the reinforcing meshwork of an overdenture before the denture base resin is processed to the prosthesis.
Course Test Preview
To receive Continuing Education credit for this course, you must complete the online test. Please go to:

1. Categories of esthetic complications with single crowns, fixed partial dentures, and complete arch prostheses attached to root form implants have been identified. These include ____________.
   a. environmental morphology
   b. surgical & soft tissue healing protocol
   c. prosthesis discoloration
   d. All of the above.

2. About how much recession can generally be expected following abutment connection surgery?
   a. 1 millimeter
   b. 1.5 millimeters
   c. 2 millimeters
   d. 2.5 millimeters

3. Implants that support/retain overdentures are commonly located in the canine and premolar areas of the mouth.
   a. True
   b. False

4. The clinical and laboratory steps required to locate the most appropriate prosthetic tooth positions for fixed partial dentures are not the same used with conventional complete dentures.
   a. True
   b. False

5. _______ is the recommended minimum occlusocervical bone dimension in the maxilla to accommodate implants.
   a. 6 mm
   b. 7 mm
   c. 10 mm
   d. 13 mm

6. The required faciolingual bone thickness is related to the diameter of the implant being placed.
   a. True
   b. False

7. It may be necessary to enhance the existing bone morphology through bone grafting or the use of distraction osteogenesis when there is a deficiency in the ____________.
   a. occlusocervical bone dimension
   b. faciolingual dimension
   c. bone form
   d. All of the above.

8. The authors propose that papillae adjacent to implants can __________ be recreated when the distance is more than 4 millimeters between the bone crest and the desired height of the interdental papillae when treating patients with thin peri-implant mucosa.
   a. always
   b. often
   c. seldom
   d. never
9. Teeth that are square in form are more often associated with thin, delicate gingiva that is more susceptible to recession.
   a. True
   b. False

10. The longer the area has been edentulous, the more likely there will be a soft tissue discrepancy due to bone resorption and concomitant changes in the soft tissue contour.
    a. True
    b. False

11. The metal visibility through the resin and the discoloration from leakage can be __________ by bonding an opaque resin to the metal framework of a fixed complete denture or the reinforcing meshwork of an overdenture before the denture base resin is processed to the prosthesis.
    a. evaluated
    b. reduced or eliminated
    c. maximized
    d. None of the above.

12. Methods of retaining soft tissue form and location include __________ when these procedures are indicated.
    a. immediate implant placement
    b. immediate placement of a provisional restoration
    c. Both of the above.
    d. None of the above.

13. Proper incisocervical, occlusocervical, and faciolingual positioning of implants promotes the development of ___________.
    a. normal soft tissue form
    b. restoration contours that transition from the round form of the implant to the desired tooth form
    c. normal soft tissue location
    d. All of the above.

14. As with conventional single crowns and fixed partial dentures, the display of significant amounts of soft tissue __________ the esthetic difficulty of implant single crowns and implant fixed partial dentures.
    a. decreases
    b. does not affect
    c. increases
    d. None of the above.

15. Researchers have proposed waiting __________ after abutment connection surgery before making the definitive impression.
    a. three weeks
    b. one month
    c. three months
    d. six months
References


About the Authors

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Dr. Goodacre received his DDS degree from Loma Linda University School of Dentistry in 1971. He completed a three-year combined program in Prosthodontics and Dental Materials at Indiana University School of Dentistry and in 1974, earned his MSD degree. He began full-time teaching at Indiana University School of Dentistry in 1974 and has three times received awards from senior dental classes as the outstanding clinical instructor or outstanding lecturer. He served as Chairman of the Department of Prosthodontics at Indiana University, and currently is Dean of the Loma Linda University School of Dentistry.

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Dr. Anderson is a Research Instructor in the Department of Prosthodontics and Operative Dentistry at Tufts University School of Dental Medicine with a focus on clinical materials research. During his graduate work he developed a digital system that quantitatively analyzes small increments of color change. This process in the past ten years has been used in clinical research around the world. He has presented and authored abstracts and articles in the area of color science and materials in dentistry. Dr. Anderson has also worked with companies such as Procter & Gamble, Philips Electronics, Ultradent, Kerr, Parkell, and Dentsply Caulk in developing and testing new products that are currently available for professionals and for over the counter consumer use.

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