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Prosthodontic management of ridge deficiencies

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Each dental specialty has different objectives that define successful treatment. The loss of periodontal structures surrounding teeth can be treated with many different grafting methods or removable prosthodontic restorations. Augmentation can be made in the connective tissue, bone, or epithelium. Langer and colleagues [1–4] demonstrated that gingival defects such as clefts or dehiscences could be corrected with connective tissue grafts. Gottlow and colleagues [5–9] described the use of a barrier membrane to limit the extent that epithelial cells could reach into an osseous defect so that boney pluropotential cells could fill a defect with new bone unimpeded. This technique, which is known as *guided tissue regeneration*, has profoundly impacted periodontal grafting so that bone augmentations can be highly successful and residual ridge defects can be improved. With severe maxillary or mandibular alveolar loss or in boney areas next to a pneumatized maxillary sinus, large bone grafts from the hip, rib, or calvaria can effectively be used to minimize the effects of residual ridge reduction. Different surgical treatments for enlarging the amount of bone include sinus lift procedures, osteotomy preparations, staged approaches with block or particulate bone ridge expansion, bone splitting, distraction osteogenesis, and guided bone regeneration. Grafting bone allows for osseointegrated implants to be placed that act as a scaffold to minimize further ridge reduction. Grafting diminishes the space that would need to be filled by the prosthesis and potentially improve the esthetic result of treatment.

Tooth-retained fixed partial dentures

In tooth-retained fixed prosthodontics, grafting procedures are often required to build the volume of the edentulous tissue and better insure

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long-term stability. It often is the intention to create an edentulous area where it appears that the pontic is a natural tooth emerging seamlessly through the tissue. There have been many theories advocating the ideal pontic form including the use of the ridge lap, modified ridge lap, and ovate pontic. Unfortunately, continuous boney and gingival resorption cannot insure long-term stability (Figs. 1 and 2) and as such any pontic-tissue form is dependent on the maintenance of the hard and soft tissue. Another problem seen is that in an attempt to build an ideal edentulous architecture with soft tissue, the space for dental materials is compromised. The metal frame required for a metal ceramic fixed partial denture must be strong enough to resist bending moments and to allow for at least 1 mm of ceramic veneer. The clinician and surgeon may then consider how large a graft must be and if it will itself become a detriment to the overall prosthetic strength and esthetic outcome. Recognizing that there will be graft shrinkage, should one routinely attempt to develop ideal soft and hard tissue, or should the defect size be increased and a prosthetic solution be employed? Often patients do not choose to continue to have multiple grafting procedures to correct defects, particularly after previous results are seen (Figs. 3–5).

To reach an esthetic result, laboratory technology often strives to create illusions. Gingival-colored ceramics have been created to allow the appearance of normal gingival and tooth symmetry. Gingival ceramics can mimic normal alveolar height and architecture. It can be used to create lost or compromised gingival papillae or even minimize the appearance of a long tooth (Figs. 6–8). Without the use of the gingival-colored ceramic, the laboratory technologist often can only create very long teeth that angle at the pontic neck back toward the resorbed edentulous ridge or must resort to a more traditional, removable prosthesis with gingival-toned acrylic resin. Overall, an esthetic result is best reached when gingival tooth symmetry is achieved. Whereas the normal appearance of a tooth-retained abutment restoration is tilted out at the cervical neck, a pontic attempting to cover a residual defect would need to be placed back to the tissue and often would appear to be long. Gingival ceramics may be placed on the pontic to obturate the defect, while normal tooth-colored ceramics may be used to

Fig. 1. A completed anterior metal ceramic fixed partial denture as inserted in 1982.

Fig. 2. Same patient as in Fig. 1 who presented with residual ridge resorption in 2000. Note the large space that exists between the fixed partial denture and the resorbed residual ridge.

create a matching symmetry to the abutment tooth. Not every edentulous ridge can readily accept osseointegrated implants. In many conditions, there is not enough bone for primary stability and coverage. Through the years, the tooth-retained fixed prosthesis has functioned well and remains an acceptable treatment for replacing missing teeth. This design is dependent on the length of the edentulous span and the number, position, and health of the abutment teeth.

Implant-retained fixed partial dentures

To connect the dental implant to the prosthesis, it is often necessary to incorporate a subframe, transmucosal element, or custom abutment into the prosthesis design. With multiple implants, custom abutments are most predictably made of metal and less commonly of ceramics. If over time there is gingival recession, these components can be exposed, creating an unesthetic result. Gingival ceramics can cover these areas, and although recession may develop the esthetic deficiency will be decreased. In the partially dentate patient, implants are placed in highly resorbed ridges. This resorption has a height, width, and directional component that even with grafting may not restore the edentulous ridge to an ideal area to accept a prosthetic tooth. Often these atrophic areas are next to dentate areas with

Fig. 3. A patient with a concave boney defect in the edentulous space.

Fig. 4. A metal ceramic fixed partial denture frame is fit with an extension in the pontic area.

more normal periodontal architecture. Gingival ceramics can restore these areas and allow the technologist to best blend the soft tissue architecture and tooth form into a pleasing prosthetic form.

Grunder and Strub [10] and Neeser [11] described the functional and esthetic advantages of incorporating gingival-colored ceramics in implant prosthodontics. Interest in this area has led to further development in materials and laboratory technique.

To replace missing teeth in fixed or implant prosthodontics on a highly resorbed edentulous ridge, one needs to complete a treatment wax-up to define the ideal position of the teeth with regard to phonetics, esthetics, and incisal guidance. The prosthetic gingival considerations are related to: (1) the amount required to obturate the defect; (2) determining if improvements to lip position are required; (3) gingival tooth symmetry; (4) evaluating the length of the abutment and pontic cervical third and the amount of potential cantilever effect that this design may have; and (5) the potential need to add additional abutments. This treatment wax-up can then be placed in the mouth for dentist, technologist, and patient evaluation [12]. When this is completed the technologist makes an index of the wax-up with a duplicating material and the index can guide the framework design in wax.

Fig. 5. The completed metal ceramic restoration. Note that the gingival ceramic extension in the pontic area has obturated the concave boney defect. This allows the cervical necks of the teeth to be symmetrical.

Fig. 6. A patient who has lost teeth because of a boney alveolar cyst. There exists a vertical and horizontal edentulous defect.

Framework design

The wax-up and the silicone index are used to evaluate space requirements, implant angulation, and component selection. The objectives are to construct a metal frame with the simplest and least components. Retrievability of the implant prosthetic components incorporates a significant safety factor. Often the partially edentulous areas need to be retreated due to changes to the adjacent area. Additional factors such as screw loosening implant loss, surgical reintervention, and hygiene recall need to be considered when deciding on retrievable designs. Such design modifications can be evaluated with a complete wax-up of the proposed restoration. The silicone index serves to convert the wax-up into a full contour castable resin pattern. This conversion is done by either injecting or brush molding to the silicone index. A sequential cutback with metal finishing carbides allows for precise dimensions for the ceramic application and ensures that the framework can be finished with the corresponding instruments after casting. During and after the cut back the silicone index allows for visual control of the required space for ceramic application.

Fig. 7. The completed metal ceramic fixed partial denture. The pontic areas of teeth 9 and 10 obturate the defect with gingival ceramics, which allow the cervical necks of the teeth to be symmetrical.

Fig. 8. The lateral view of the completed metal ceramic fixed partial denture. Marginal buccal butt gingival ceramic was used to provide the appearance of shorter canine lengths on the abutment tooth #12.

The important design criteria must allow for sufficient space in the interproximal area. To create natural three-dimensional contours, the ceramist needs to wrap the porcelain around the interproximal space to create line angles and the illusion of individual teeth. Furthermore, the metal support for the ceramic is evenly spaced to reduce the internal stress build-up caused by thin and thick sections of the ceramic layer.

The castable resin framework is sectioned and rejoined to allow for shrinkage compensation and stress-free alignment between abutments. To prevent cracking of the investment, a thin coating of wax may be placed over the resin to allow for a smooth surface and expansion space during the burnout. On full arch designs, a horizontal crossbar is attached to the most posterior aspect. This crossbar adds stability to the resin framework during investing and casting and limits the expansion and contraction during the ceramic firing. It additionally serves as a stabilizer if the framework needs to be sectioned for soldering. The framework is finished with metal carbides and prepared for intra-oral try-in and fit verification. At the time of frame try-in, the occlusal parameters should be ascertained and the master casts re-mounted to reduce errors and extensive occlusal adjustments (Figs. 9 and 10).

Fig. 9. A patient with an edentulous maxilla and lower anterior teeth with severe periodontal disease requiring extractions.

Fig. 10. The try-in maxillary complete denture and implant-retained metal ceramic fixed partial denture.

Shade selection

When choosing the shade for gingival ceramics, techniques similar to tooth matching must be applied. The different color areas need to be distinguished and mapped according to a color scheme. There are two color zones within the gingival areas that are dissimilar in their anatomy, function, and color. The attached gingiva consisting of highly keratinized epithelium appear lighter in complexion, and the hue can be described as a light pink. The unattached zone (mucogingival tissue) consists of no keratinization and therefore appears more red in hue. Within the two distinct color zones multiple variations can be observed, ranging from light to dark red with whitish opaque, blue-red appearances. The shade guide (d-Sign gingival ceramics, Classic gingival ceramics, Ivoclar Fl) separates the color systems into two color modes. The G (1–5) describes the babe used in either the attached or unattached gingiva. These colors are highly translucense color that can t and should be used as a base build-up to obtain the basic shade. Due to their translucency, they have the ability to blend in to the surrounding contacting tissues to achieve a chameleon effect. The GM (1–4) are intense shades and more opaque than the G colors. Their purpose is to capture the color effects within the attached and unattached gingiva. Small amounts are needed and they should be placed in a second layer between the base shade (G4) of the first ceramic layer and the second or corrective layer. By sandwiching the GM colors between the G colors, a three-dimensional effect can be achieved that creates a realistic appearance.

Ceramic layering

The shrinkage of the feldspathic ceramic requires multiple firings to obtain the final dimension of the restoration. The newer materials are less susceptible to color changes from multiple firings than the ceramics used a decade ago. By using a multiple layering technique, the build-up can be broken into one support bake, one to two main bakes, and one to two

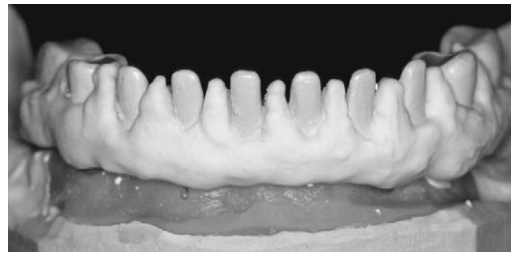

Fig. 11. Opaque feldspathic porcelain is applied and the gingival ceramics are first built up and fired before the application of the tooth-colored ceramic.

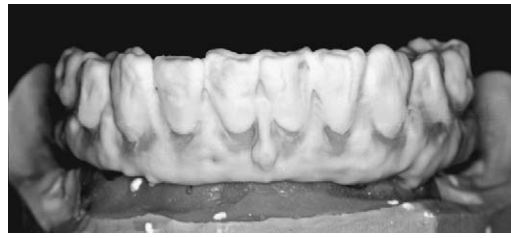

Fig. 12. Modifier and translucent feldspathic gingival stratification buildups are completed to create depth of color and translucency.

Fig. 13. Anterior view of the completed maxillary complete denture and mandibular fixed implant reconstructions in the mouth.

Fig. 14. Lateral right view of the completed maxillary complete denture and mandibular fixed implant reconstructions in the mouth.

Fig. 15. Lateral left view of the completed maxillary complete denture and mandibular fixed implant reconstructions in the mouth.

corrective bakes. The support bake is done with the G (1–5) colors to define the tissue defect; opacious dentin-colored ceramic is used to close interproximal areas and define the cervical contours of the teeth. Prefiring this layer minimizes the correction needed after the main bake and the gingival frame has already been defined. The main layering consists of sandwiching the GM colors that provide the effects of the keratinized gingiva and various color variation defined in the shade map. The layering sequence should start with the gingival layer and subsequent cervical build-up and final tooth contours (Fig. 11). After the main layer has been fired, the color scheme should be visible and the cervical contours well defined. The corrective layer is done by using mostly the translucent G (1–5) colors in the gingival portion and incisal/translucent colors in the teeth build-up (Fig. 12). Smaller corrective layers at low temperatures can be applied to finalize contours and define occlusal parameters.

The completed ceramic fixed partial denture restores all the anatomy that was lost and defined in the diagnostic and treatment wax-ups. In patients that show an extensive amount of gingiva the esthetic results often are remarkable (Figs. 13–16).

Fig. 16. The tissue surface of the mandibular fixed implant prosthesis removed after 13 years. Note the cleanliness of the ceramic surface. Patients are easily able to clean the smooth nonporous ceramic surface.

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