Replacing congenitally Missing Lateral Incisors and Enhancing Soft-Tissue Esthetics with Metal-Free Three-Unit Fixed Restorations

INTRODUCTION

Replacing a missing anterior tooth has traditionally been a daunting and frustrating endeavor for esthetic dentists and their laboratory ceramists to undertake. The difficult task of creating natural-looking restorations that blend seamlessly with the surrounding dentition is compounded by the challenges of re-establishing or maintaining the gingival architecture.

In the past, the treatments for a missing anterior tooth have included, but were not limited to, a flipper partial denture, orthodontic movement, or a three-unit porcelain-fused-to-metal bridge. With the advent of new dental materials and techniques intended to raise the level of esthetic and functional outcomes, different treatment alternatives are available to close the gap between natural and artificial dentition. For example, dental implants are rapidly becoming the treatment modality of choice, particularly for the replacement of a single tooth.

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However, there are still situations in which the replacement of a single missing tooth is most appropriately accomplished with an anterior bridge. For example, despite the availability of small-diameter implants, inadequate inter-tooth space may eliminate some patients from consideration for implant therapy to replace a missing anterior tooth. For such patients, a three-unit bridge esthetically created using metal-free materials may be the best alternative.
The astute clinician and laboratory technician can conquer the challenges associated with reproducing tooth form, function, color, and esthetics while blending anterior three-unit bridge restorations into the dental-facial composition by developing a well thought out and implemented treatment plan. Such treatment plans should incorporate diagnostic and provisionalization techniques so that all members of the dental team (e.g., dentist, laboratory technician, and patient) are able to evaluate the anticipated effects of proposed restorations designed to replace the missing anterior tooth/teeth. They should account for such aspects of the dental-facial composition as the face, lips, gingival tissues, and teeth as they relate together in smile design.

This article presents in detail a case in which the tooth replacement method of choice was a zirconium-based anterior bridge. Paramount to the success of the case was the manner in which the treatment plan was developed using diagnostic wax-ups, as well as how the patient was provisionalized with an ovate pontic that was developed using a gravity technique. Equally significant to the success of the case was how the gingival architecture was managed throughout the treatment protocol.

**CASE PRESENTATION**

**CHIEF COMPLAINT**

A 21-year-old female patient was referred specifically for treatment of the anterior region (Fig 1). She presented with an existing acrylic partial denture with wire clasps to replace the congenitally missing upper left and right lateral incisors (i.e., teeth #7 and #10) (Fig 2). The patient was in the restaurant industry and very self-conscious about her appearance. She felt her partial denture did not look natural, and she did not like having to remove it from, and return it to, her mouth. Therefore, she was seeking to replace the partial denture with a more natural-looking and fixed alternative, one that would not produce a dark gingival margin such as she had seen in elderly people.

Additionally, the patient did not like the yellow color of her teeth and was aware of the mottled appearance of the central incisors, the diastema between them, and the misshapen canines (Figs 3 & 4). She was anxious to address the unesthetic appearance of her anterior teeth as soon as possible, and she also wanted to take advantage of this opportunity to whiten the rest of her dentition.

**MEDICAL AND DENTAL HISTORY**

**FINDINGS**

A comprehensive examination and review of the patient’s medical history showed her to be in good health, with no significant abnormal findings. The soft tissue in the palate had severe candidiasis from the maxillary partial retainer. Her tonsils were present.

Her upper and lower lips were thin, exhibiting a normal smile line. Her gingival health was fair, with minimal areas of recession and no pocketing greater than 4 mm upon probing. The teeth had light areas of staining and supragingival calculus. There were hypocalcification spots/stains present on the facial aspects of some of her teeth that resulted from the orthodontic therapy she had in her teens. Her occlusion was Class...
I with a 3-mm overbite and 2-mm overjet. The maximum opening was 1.75 inches, and centric relation equaled centric occlusion. The temporomandibular joint and muscles of mastication were asymptomatic.

Radiographically, mild root resorption from the orthodontic treatment was noted for teeth #8 and #9. At the #7 and #10 sites (Fig 5), the space between the roots was 4.5 mm. If an implant were to be placed, we would need 1 mm to 1.5 mm on either side of the implant to adjacent root, meaning that we would have to place a 1.5- to 2.5-mm implant perfectly. To make room for it we would need to consider doing orthodontics again. The patient declined this option as the previous orthodontic therapy had contributed to the shortening of the roots of the upper anterior teeth. It appeared that tooth #6 was also missing, but the retained primary canine demonstrated a solid root and was not mobile. The #7 and #10 pontic areas had been distorted by the partial denture, and it appeared that no attempt had been made to create an ovate pontic site in the tissue. The ridge had collapsed mildly from the facial at the #7 and #10 sites.

The patient had had all four wisdom teeth extracted as a teenager, and the previous dentist had begun to change some of her posterior restorations from amalgam to composite. She still had existing amalgam restorations on teeth #2, #3, #13-15, #18, #19, #30, and #31. Composite restorations were present on teeth #12, #20, #21, and #28.

**Diagnosis and Planning**

Several challenges were noted after a thorough examination of the digital photographs, evaluation of stone casts, and discussions between the restorative clinician and the laboratory technician. The maxillary midline was 2 mm to the right of the facial midline and the central incisors looked quite long due to the width-to-length ratio being 75%. The smile was canted, being lower on the left side than the right, and the teeth were not axially aligned. The gingival heights, contours, and zeniths could be improved on both canines.

The upper and lower arch forms were ovoid. The buccal corridor was fairly well developed in the natural dentition, and the contact points migrated apically moving posteriorly. It should be noted that having minimal buccal corridors has been found to be a preferred esthetic feature in both men and women, with large buccal corridors being something to be included in the problem list during treatment planning.

After discussing all the possible restorative options, including implants, the patient opted for a full-coverage three-unit zirconium-based bridge for teeth #9-11. This option also would enable the restorative team to address the patient’s desire for better anterior esthetics on the abutment teeth.

A three-unit zirconium-based bridge was also planned for the retained primary right canine to tooth #8 in order to match the left bridge. While it was possible to include tooth #5 in the treatment plan, it was decided not to sacrifice...
a virgin tooth in order to increase the lifespan of the bridge. Since the primary tooth had not demonstrated any signs of mobility, it was decided that the combination of group function, and regular examinations for signs of root resorption would ensure that the bridge would last the patient well into her 30s.

To address all of the patient’s requests, as well as satisfy all clinical requirements, the treatment plan/sequence was as follows:

1. Treat the maxillary candidiasis with nystatin lotion.
2. Whiten teeth with Zoom 2 (Discus Dental; Culver City, CA) in-office whitening.
3. Perform ridge augmentation with connective tissue grafts at the #7 and #10 sites.
4. Fabricate diagnostic wax-up and reduction guides.
5. Prepare teeth, create ovate pontic sites, and provisionalize (Luxatemp, Zenith/DMG; Englewood, NJ).
6. Refine prepared teeth and take final impressions for porcelain-pressed-to-zirconium (IPS e.max ZirCAD/ZirPress, Ivoclar Vivadent; Amherst, NY) bridges.
7. Create two three-unit bridges.
8. Insert bridges with a dual-cure resin cement (Multilink, Ivoclar Vivadent).
9. Follow-up treatment with hygiene and home care for optimal gingival health.

**Clinical Protocol**

Following treatment of the candidiasis with nystatin lotion and in-office whitening (Zoom 2), pre-operative maxillary and mandibular full-arch impressions were taken using Precision (Discus Dental) light-body polyvinyl siloxane (PVS) wash material and Precision medium-body PVS matrix material in a full tray. A facebow relation also was taken (Kois Dento-Facial Analyzer, Panadent; Colton, CA), in addition to a stick bite to relate the horizontal plane. A diagnostic wax-up was fabricated and sent back to the clinician.

**Tissue Management**

The augmentation of edentulous sites can permit the placement of three-unit bridges with highly esthetic pontics. The periodontist was given a stone model and diagrammatic photographs to serve as a guide for where the tissue should finish. The pontics on the partial denture were shortened, and the connective tissue graft was allowed to heal for eight weeks. With the swelling subsided and the facial and lingual tissue in the pontic space bulked up, the development of the ovate pontic areas could begin.

** Provisionalization**

After determining overall healing of the pontic areas, the abutment teeth were prepared with heavy 1.5-mm reduction and 360° chamfer margins using coarse and fine bullet-nose diamond burs (Fig 5). All line angles were polished to ensure that there were no sharp ones.

A wax-up of the proposed bridges had been returned from the technician with a putty matrix for creation of provisional restorations. The putty matrix was filled with temporary material (Luxatemp acrylic shade A1) in the areas of the bridge preparations and placed over the teeth. The bis-acrylic was allowed to set for two minutes before being removed to ensure that the provisional did not lock onto the teeth. The margins of the provisional were trimmed using finishing burs and discs.

To create the ovate pontics, a light-cured flowable acrylic (Luxaflow, Zenith/DMG) was added to the pontics in increments using a “gravity technique” (Figs 6 & 7) until slight blanching of the tissue was visible. The egg-shaped pontic was polished until it was glassy-smooth, and the embrasures were contoured to ensure that the interproximal papilla was not pinched, yet received the guidance necessary to create a symmetrical papilla and close off any black triangles. It should be noted that unless care is taken to ensure proper healing of the papilla, clinicians could witness an unwanted gingival overgrowth or limited re:
generation potential in this esthetically demanding area.\textsuperscript{12}

The polished provisional bridge was cemented with temporary cement (Systemp.link, Ivoclar Vivadent), after which the occlusion was checked for clearance (Figs 8 & 9). The patient was instructed to keep the area clean by flossing and using a hydrogen peroxide infuser tip.

After two weeks, the provisional restoration was removed and the pontic sites assessed. The future sites were checked using a periodontal probe to ensure that the 1-mm to 3-mm depths of the ovate pontic sites were above the underlying bone by 1 mm or more. The sites were successfully created, and each resembled a freshly extracted tooth. The areas were cleaned with hydrogen peroxide and compared to ensure similarity of the facial contours of the #7 and #10 sites. The provisional bridge was replaced using temporary cement (Systemp.link).

The preparations were refined and final PVS impressions, bite registrations, and records were taken for the laboratory. A detailed prescription that included digital photographs, a shade map, and the final shade of Chromascope 110/040 (Ivoclar Vivadent) was provided to the laboratory technician (Fig 10). It is important to note that although the patient approved the selected shade, she was adamant that the restorations mimic the natural incisal translucency exhibited in her natural mandibular teeth. These characteristics were noted and also forwarded to the laboratory. A Kois facial analyzer record also was sent, along with an impression of the approved provisional with midline and horizontal plane placement for the definitive bridgework.

**LABORATORY FABRICATION**

When the impressions were received at the laboratory, they were poured in a Class IV die stone and allowed to harden for 24 hours. Careful attention was paid to the water/powder ratio to ensure the proper expansion. Working models (Fig 11) were fabricated and mounted on a Panadent articulator using the Kois Dento-Facial Analyzer, and the approved provisional was also mounted to the opposing model. A matrix of the approved provisional was fabricated and used to evaluate facial and proximal reduction.

Because these bridge restorations needed to satisfy a combination of functional and esthetic requirements, it was determined that a single restorative system should be selected that would meet these criteria and blend seamlessly with the natural teeth. Therefore, a recently introduced universal all-ceramic system that combines computer-aided design/computer-aided manufacturing (CAD/CAM) and pressable technologies (IPS e.max) was selected. This system’s integration of high-strength zirconium substructures enabled the use of connectors that were small enough to allow natural-looking interproximal contours, yet with the required separation between abutments and pontics.\textsuperscript{13,14}

In preparation for the CAD/CAM design process, the dies were carefully trimmed and all undercuts were blocked out with wax. The working model was powder-coated with a scanning spray (Dentaco, Vident; Brea, CA) and scanned.
using the InEos Scanner (Sirona Dental Systems; Charlotte, NC). The opposing cast was also scanned to ensure that the frameworks would demonstrate sufficient room for lingual porcelain.

The zirconium frameworks (Zir-Cad) were designed and milled using a CEREC 3D milling machine (Sirona). The margins were cut back to minimize the opacifying effect of material at the margins. Note that zirconium is milled in a partially sintered state that allows for easier milling, and the majority of the framework contouring was accomplished at this time. Final sintering was achieved by using a sintering oven that baked the zirconium at 1515°C over a seven-hour period.

The frameworks were evaluated for fit, and final adjustments were made (Fig 12). After steam cleaning, the frameworks were coated with ZirLiner (Ivoclar Vivadent) to create an optimal bonding surface and baked at 960°C. The zirconium frameworks were placed on the working model (Fig 13), after which a full-contour wax-up was created, with careful attention paid to matching the approved provisionals (Figs 14 & 15).

The waxed bridges (Fig 15) were sprued and invested utilizing the speed press technique and pressed in ZirPress using the LT B1 ingots. After cooling and divesting, the bridges were evaluated for fit and then ready for layering. As one of the patient’s primary requests was that her new restorations exhibit the same type of translucencies and subtle colors as her lower anteriors, after a careful examination of the digital photographs, the ZirPress material was cut back to create the many nuances and characteristics required to make the bridges “disappear.” A foundation bake was created with a small amount of Transpa ceramic and Essence powders (Ivoclar Vivadent) and baked at 750°C (Fig 16). The bridges were layered with Incisal white, bamboo, blue, and amber powders (Ivoclar Vivadent) to create the dispersion of colors that were present in the patient’s natural dentition and then baked at 750°C. The bridges were checked with the matrix to ensure that the effects were in the proper places. A final layer of Transpa and Opal Incisals (Ivoclar Vivadent was added to create the translucency necessary to achieve seamless integration with the patient’s natural teeth.

The bridges were contoured using various diamonds and rubber wheels, with careful attention given to reflective and reflective areas. The matrix of the approved provisionals was used to ensure that the final contours of the restorations were consistent with the patient’s expectations. The interproximals were contoured to create room for the interdental papillae to grow and mature; spe-
Figure 10: Close-up retracted view of the patient’s provisional restoration. Note the immediately enhanced symmetry, color, and appearance of the gingival architecture despite the need for more long-term healing.

Figure 11: The final shade for the restorations was determined to be Chromascope 110/040.

Figure 12: Working models were created at the laboratory using Class IV die stone. Careful attention was paid to the water/powder ratio to ensure the proper expansion.

Figure 13: After milling, the zirconium frameworks were tried back on the model to verify fit, and the shoulders were cut back circumferentially at the margins to reduce the likelihood of high value in this area.

Figure 14: View of the bridge framework with a 360° cutback following application of the ZirLiner to enhance bonding and application of the layering porcelain.

Figure 15: Using a matrix of the approved temporaries as a guide, the size of the bridge connectors are verified to ensure sufficient space for correctly applying and layering the porcelains.
cifically, the clinician’s instructions called for 2 mm of open embrasures (Fig 17).

The bridges were lightly stained and baked once. The final polish was accomplished by hand using a soft bristle brush and Diashine (VH Technologies; Bellevue, WA) to achieve the prescribed polished gloss (Fig 18).

**Final Placement and Cementation**

When the bridgework was returned from the laboratory, it was inspected for fit and color on the models. Then the provisionals were removed, the preparations cleaned with hydrogen peroxide, and the bridges tried in. The fit was verified, and the pontics were checked for a snug placement.

The restorations were removed from the mouth and their internal aspects treated with 35% phosphoric acid for one minute. After rinsing and drying, the bridges were treated with Multilink zirconium primer (Ivoclar Vivadent). The manufacturer asserts that this process results in significantly higher bond strengths of approximately 25 to 35 MPa.15,16

The preparations were cleaned with chlorhexidine and rinsed. Multilink primer A and B were mixed and applied to the preparations for 15 seconds. Multilink dual-cure resin cement was mixed and applied to the bridge abutments.17

The bridges were placed, excess cement removed, and the abutment’s spot tacked with a 2-mm tacking tip. By using a Butler gum stimulator (Sunstar Americas; Chicago, IL) and micro brushes, almost all excess cement was removed. The bridges were flossed and glycerin was placed around the margins to
ensure curing of the oxygen-inhibited layer. The restorations were cured for one minute using a light-emitting diode curing light (bluephase, Ivoclar Vivadent). The margins were polished using a #12 scalpel blade, an extra-fine football-shaped diamond, and ET9 carbide (Brasseler USA; Savannah, GA). The occlusion was checked, and any areas adjusted were polished with a porcelain polishing kit (CeraGlaze, Axis Dental; Coppell, TX).

CONCLUSION

The use of full-coverage, metal-free bridges in this case enabled the restorative team to meet the patient’s immediate esthetic demands in viable, positive ways (Figs 19 & 20). The combination of pressed porcelain and high-strength zirconium oxide on the natural teeth allowed the team to realize esthetic and functional possibilities.

Since the case was inserted more than 12 months ago, the tissues and the pontic sites have matured nicely (Figs 21-23). The natural teeth, having been whitened, may need touching up periodically to maintain the increased value. Future dental treatment includes finishing the posterior amalgam replacements (at the patient’s request), addressing the spacing of the lower anterior teeth, and possible orthodontic treatment with clear aligners (Invisalign, Align Technology; Santa Clara, CA) if the patient desires. The possibility of future implant dentistry is not out of the question should it be necessary to replace the primary retained cuspid C, which might be lost due to its short clinical length.

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