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A High-Strength, Metal-Free Alternative to Traditional Denture Prostheses

Innovative techniques provide long-term and patient-pleasing results.

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Implant-supported fixed prostheses have gained acceptance among dentists and laboratory technicians alike for their ability to deliver proven and dependable functionality in combination with desired esthetics.[1] The advent of new implant materials and techniques affords dentists, technicians, and the growing edentulous population opportunities for more comfortable, stable, and natural-looking treatments. When four or more implants are placed to support a full-arch prosthesis, for example, patients experience enhanced support and comfort, as well as decreased bone loss.[2] However, the forces placed on such prostheses as a result of the support provided by implants mandate the use of more durable, odor-free substructures as well as denture teeth that can withstand wear and deformation.[2,3]

High-strength zirconia substructures that are designed and fabricated with CAD/CAM processes represent strong and durable alternatives to conventional denture prostheses. CAD/CAM technology can be used in the office or laboratory to fabricate inlays, onlays, crowns, veneers, implant abutments, fixed partial dentures, and full-mouth restorations.[4] Simultaneously, all-ceramic restorations provide immeasurably better esthetic results compared to their porcelain-fused-to-metal (PFM) counterparts—which have been the traditional crown restoration of choice for dentists over the years. Zirconia-based, all-ceramic restorations with layered porcelain are increasingly used as a dependable and esthetic alternative. However, they have been known to chip.

Because zirconia exhibits thermal diffusivity and heats at a different rate than porcelain, it has the propensity to separate from the substructure and chip or crack.[5] Research has indicated that porcelain stress and the stress between the porcelain/zirconia interface is minimized when the porcelain-layered, zirconia-based substructure is slowly heated, then subjected to a slow-cool thermal cycle.[6,7] Prepared accordingly, the risk of failure for the porcelain overlay has been reduced to less than 6%, and less than 1% for the zirconia core.[7]

Such results indicate that the preparation technique for porcelain-layered, zirconia-based substructures becomes essential to the success of the restorations. There are laboratory ceramists experienced in the successful preparation of zirconia substructures and the application and use of layering ceramics. The secret to strong, reliable zirconia-based restorations is the firing

Fig 1. A diagnostic radiograph showing the existing maxillary denture and remaining lower teeth that were planned for extraction.

Fig 2. A radiographic view of surgically guided implant placement with multi-unit transmucosal abutments for tissue-level emergence.

Fig 3. The implant impression copings were placed for master-cast fabrication.

Fig. 4 A view of the occlusal wax rim to evaluate mandibular tooth arrangement and function.

Fig 5. A view of the substructure prior to scanning.

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technique. The zirconia restoration layering procedure is much the same as for regular porcelain.[8] However, when layering zirconia, firing the first layer at a temperature hotter than recommended by the manufacturer produces the characteristics of a bonding agent, ensuring a long-lasting and reliable restoration.[9] Life-like esthetics can be achieved using porcelain shades and stains that appropriately diffuse light, creating the illusion of depth by incorporating varying opacities to replicate the appearance of natural dentition.

As a result, when zirconia substructures are fitted with customized, pressed all-ceramic restorations instead of prefabricated resin denture teeth, edentulous patients have a predictable and highly esthetic fixed prosthetic that will serve them for the long term.

CASE PRESENTATION

A 68-year-old woman presented with an existing maxillary denture and missing lower teeth. Diagnostic radiographs were taken, along with other records (Figure 1). It was determined that the remaining lower teeth would be extracted and an All-on-4 (Nobel Biocare, www.nobelbiocare.com) prosthesis would be designed. To facilitate a more ideal ridge width at the implant head, occlusal planning of the alveolar ridge would be performed.

CLINICAL PROTOCOL

An implant surgical guide was fabricated to guide placement of the four RP NobleActive™ (Nobel Biocare) implants, in addition to multi-unit transmucosal abutments to facilitate tissue level emergence (Figure 2). Following implant placement, implant impression copings were placed after they were luted together using clear-pattern resin (GC America, www.gcamerica.com) (Figure 3). An impression was then taken for use in fabricating the master cast.

To guarantee the passive and accurate fit of the final prosthesis substructure, a laboratory verification jig was made from the master cast. Then, an occlusal wax rim was created to set up the mandibular tooth arrangement and function. The implant anterior–posterior spread allowed for basic tooth set-up from teeth Nos. 19 through 30 (Figure 4).

At the doctor's office, the set-up was screwed in and the bite was verified. Phonetics, function, and esthetics were approved. A silicone matrix was formed after the mandibular denture was processed with metal temporary abutments in place that were used as a long-term temporary.

LABORATORY PROTOCOL

The substructure that would be scanned or copy-milled for the CAD/CAM zirconia substructure was created to accommodate IPS e.max® (Ivoclar Vivadent, www.ivoclarvivadent.com) pressed restorations and pressed gingival ceramics (Figure 5). This substructure would restore the lost vertical of the alveolar bone process and teeth.

The copy mill substructure was then scanned for the CAD/CAM designing process using the NobelProcera™ Scanner (Nobel Biocare) (Figure 6). The zirconia substructure was then designed using the CAD/CAM software (Figure 7) after the zirconia framework was CAM-milled (Figure 8). A full-contour wax-up of 12 single IPS e.max Press restorations was then performed (Figure 9). To prevent damage to the zirconia surface, the framework was not blasted with aluminum particles.

A specialized bonding liner material, IPS e.max Ceram ZirLiner was mixed to a creamy consistency, and a thin layer was applied to the substructure to ensure a predictable bond and depth of color. The esthetics of the gingival areas were enhanced with berry and rose IPS e.max gingival stains (Figure 10) after the liner was dried and then fired.

A silicone matrix of the denture tooth set-up was used to inject wax onto the zirconia substructure in order to copy the vertical, midline, and tooth arrangement. The exact dimensions would then be incorporated into the final IPS e.max Press tooth restorations. In order to use the full 400-MPa strength of lithium disilicate, a slight cutback and ceramic layering technique was used on the anterior teeth only.

SEATING

The single-unit IPS e.max crown restorations were stained and glazed, then seated back on the zirconia substructure, and a final hand-waxing of the tissue architecture was completed (Figure 11). The crowns were removed, and the case was then sprued, invested, and pressed with IPS e.max ZirPress gingiva 3 (Figure 12). It was divested, cleaned, and separated from the sprues and prepared for staining and glazing in order to mimic nature through form, function, and tissue textures (Figure 13). Ten of the restorations were then carefully bonded into place, resulting in an amazingly esthetic final prosthesis (Figure 14 and Figure 15). The case was cleaned and polished for final delivery,

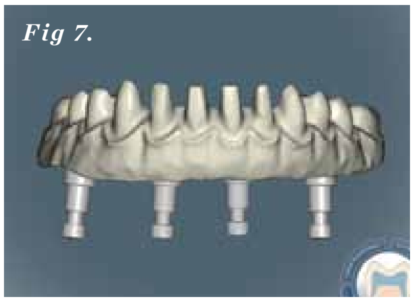

Fig 6. The copy mill substructure was scanned using the NobelProcera laser scanner for the CAD/CAM designing process.

Fig 7. The zirconia substructure was designed using CAD technology.

Fig 8. The zirconia framework was milled using CAM technology.

Fig 9. Full-contour wax-up of 12 single IPS e.max Press restorations.

Fig 10. IPS e.max Ceram Zirliner was applied to the gingival areas then enhanced with berry and rose IPS e.max gingival stains.

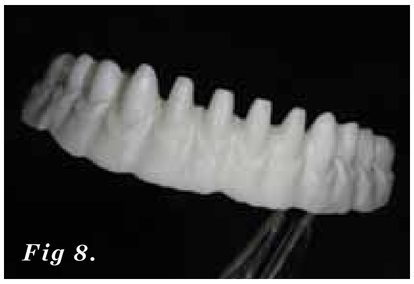


Fig 11.

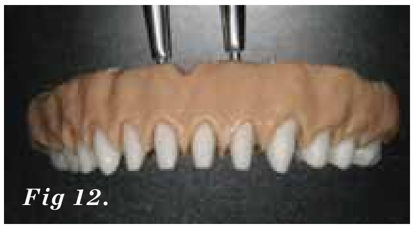
Fig 12.


Fig 13.


Fig 14.

Fig 11. Restorations were seated, and the final hand-waxing of the tissue architecture was completed.

Fig 12. IPS e.max crowns were removed.

Fig 13. The case was sprued, invested, and pressed with IPS e.max gingiva 3.

Fig 14. The 10 restorations were carefully bonded into place on the zirconia substructure.

Fig 15. and Fig 16. Cleaned and polished, the case was delivered and torqued to the implants. The final two bicuspids were bonded to the substructure.

Fig 17. and Fig 18. The final seated restorations.


Fig 15.


Fig 16.


Fig 17.


Fig 18.

where it was torqued to the implants (Figures 16 through Figure 18). The final two bicuspid crowns were then bonded to the substructure.

CONCLUSION

CAD/CAM technology and pressable and milled ceramics enable dentists and laboratories to provide highly esthetic, durable, and stable treatments to edentulous patients.[4] The development of new implant structures and materials provides edentulous populations with innovative longer-term alternatives that provide more comfort and are esthetically advanced compared to conventional options. Because implant-supported prostheses require stronger substructures and more durable tooth formations, materials such as zirconia and IPS e.max ZirPress provide prostheses with superior characteristics.[2,3] The case presented here demonstrates the manner in which a high-strength zirconia substructure, in combination with state-of-the-art implant techniques, can satisfy patient demands for esthetics, strength, and comfort.

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MATERIAL CONSIDERATIONS

IPS e.max ZirCAD (Ivoclar Vivadent)

Specifically designed for use with CAD/CAM technology, yttrium-stabilized zirconia is a zirconia-oxide based ceramic. Yttria oxide stabilizes the zirconia oxide at room temperature. In a "chalk-like," partly sintered state, its approximately 50% porosity enables easy processing.[1] Color versatility is provided with the availability of natural and shaded pre-sintered zirconium oxide blocks. After the restoration has been milled into shape, the material is sintered to densify the microstructure.[1] The final restoration is sintered to approximately 99.5% theoretical density (TD).[1] Once sintered to full density, its hardness and inertness make it an ideal material for dental restorations. Sintered zirconium-oxide blocks boast a fracture toughness of more than twice that of glass-ceramic and a flexural strength of more than 900 MPa.[1] IPS e.max ZirCad blocks achieve exceptional accuracy of fit, high fracture resistance, and a fracture toughness that meets the clinical requirements presented by posterior masticatory forces.

IPS e.max Ceram (Ivoclar Vivadent)

High-strength zirconia substructures layered with highly esthetic ceramic materials can produce the highly durable, functional, and esthetic fixed prosthetic results that patients demand.[2] Specifically indicated for layering over high-strength lithium disilicate (IPS e.max) or zirconia implant and prosthetic substructures that have been pressed or CAD/CAM-fabricated, IPS e.max Ceram demonstrates high bond strength, exact shade matching, and exceptional masking abilities.[2-5] Due to its ability to be characterized, and in consideration of the gingival porcelain shades available, IPS e.max Ceram can be used to fabricate gingival areas in implant-supported prostheses.

IPS e.max (Ivoclar Vivadent)

Characterized by high mechanical strength and superb esthetic properties, IPS e.max lithium disilicate is ideal for anterior and posterior tooth restorations. Developed with controlled size, shape, and density, and containing approximately 70% by volume needle-like crystals in a glassy matrix, IPS e.max possesses unique structural characteristics that ensure greater strength and durability than conventional ceramics.[6,7] Lithium disilicate also demonstrates life-like translucency and superior optical properties due to a relatively lower refractive index.[6-9] Pressable lithium disilicate demonstrates a flexural strength of 400 MPa[7-9] and is the material of choice when using the wax hot-press technique. While press technology ensures exceptional fit, several translucencies and opacities and different brightness effects provide natural-looking shades with optimal light transmission, resulting in highly esthetic, life-like restorations.[10-13] Providing fit and function with outstanding strength, IPS e.max Press offers superior performing and esthetically pleasing all-ceramic pressed restorations.[14]

IPS e.max ZirPress (Ivoclar Vivadent)

While zirconium-oxide ceramic IPS e.max ZirCAD is the material of choice for large restorations exposed to high masticatory forces, IPS e.max ZirPress is specifically designed to press onto IPS e.max ZirCAD and other ZrO_2 frameworks with a CTE of 10.5 to 11.[15] The fluorapatite glass-ceramic IPS e.max ZirPress ingots are indicated for zirconium-oxide–supported gingiva portions, single-tooth restorations, anterior and posterior bridges, inlay-retained bridges, and implant superstructures.[15] Used with press technology, IPS e.max ZirPress ingots press over zirconium-oxide frameworks with less time and effort and produce an esthetic, highly functional, and extremely accurate-fitting restoration. Available in three levels of translucency (HT, LT, and MO) and four bleach shades, two gingiva shades are also available for fabricating the gingival portion of the restoration.[15]

All-on-4 (Nobel Biocare)

The All-on-4 treatment concept can be used in combination with a full-arch zirconia substructure and a variety of implants, such as NobelActive™, to provide edentulous patients with stable, functional, esthetic, and comfortable prosthesis.[16-18] Additionally, a provisional prosthetic set-up can be screwed onto the implants after surgery to facilitate approval and completion of customized and single-unit restorations.[17-21] Because the technique and implants can accommodate a broad range of prosthetics and abutments, high-strength zirconia substructures fabricated with CAD/CAM processes are possible.[21]

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