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DENTAL TECHNIQUE

A digital protocol for the fabrication of anatomic-contour implant zirconia crowns directly screwed on external hexagonal implant connections without the interposition of a Ti-base component

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ABSTRACT

A straightforward and effective restorative option is proposed for implant-supported fixed prostheses with external connections by using monolithic zirconia without the interposition of a Ti-base component. The technique is based on a modification of the Brånemark connection used to link metal-ceramic or metal-composite resin restorations directly to the implant. (J Prosthet Dent 2023;■:■-■)

Although the familiar external hexagonal connection, as described by Brånemark, is reliable in the long term,[1-3] recent developments have led to the widespread use of different internal connections and platform switching solutions to reduce bacterial penetration[4,5] and enhance tissue stability.[6,7] While the connection types may differ, all are designed to survive in the contaminated oral environment.[8]

Key features of the external hexagon connection have remained largely unchanged from the original configuration, which is characterized by a flat-to-flat surface, with varying hexagon dimensions corresponding to the implant platform width.[9-11]

A common solution for the fabrication of screw-retained crowns on external hexagon implants is to use a titanium base (Ti-base) that engages the antirotational feature of this type of implant.[12,13] As monolithic zirconia has become increasingly popular because of its esthetics, mechanical properties,[14] and biocompatibility,[15] it can be used for direct connection of screw-retained crowns to the implant without a Ti-base.[16] Direct connection is contraindicated for internal connection implants, where screw-retained crowns require the interposition of a Ti-base to compensate for the brittle zirconia and to avoid wear of the titanium implant.[17-20]

High-performance computer-aided manufacturing (CAM) milling machines can reproduce the external hexagon in anatomic-contour implant zirconia restorations with high precision, in both the antirotation versions designed for single crowns and in those allowing rotation for splinted fixed partial dentures (FPDs) (Fig. 1). The flat-to-flat geometry of external hexagons ensures adequate zirconia thickness and provides sufficient strength to fabricate zirconia restorations entirely digitally without a Ti-base. The titanium antirotational feature has been reported to exhibit some deterioration and wear in internal hexagon connections.[21-25] Zirconia abutments in external hexagon implants present sufficient mechanical stability to be clinically reliable.[26,27] This might be considered indirect proof that monolithic crowns and FPDs with a complete zirconia-implant interface can be successfully used clinically.

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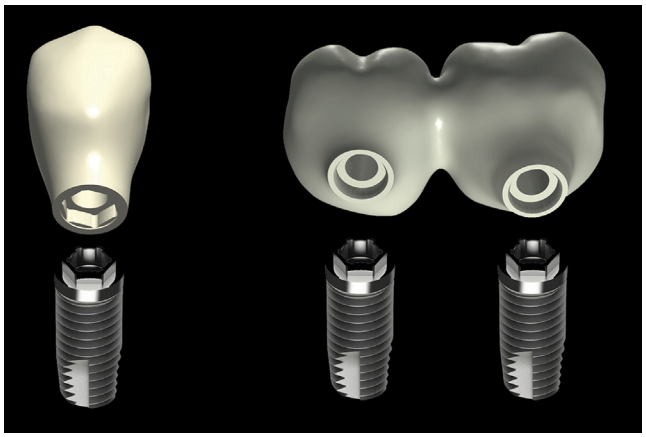

Figure 1. Shape of restoration engagement. Left: single implant (single crown) with hexagonal antirotation connection. Right: multiple implants (fixed partial denture) with rounded connection.

TECHNIQUE

A step-by-step procedure for fabricating zirconia crowns and FPDs screwed directly onto external hexagonal connections is described with some key points for the success of this approach.

1. Make an intraoral scan (TRIOS 4; 3Shape A/S) of single or multiple implants using the corresponding scan bodies (SCAN BODY AQ; New Ancorvis Srl) and send them to the dental laboratory technician. It is essential that the dental laboratory technician use a computer-aided design (CAD) software program that incorporates the specific mathematical files corresponding to the scan bodies used.
2. Match the scan body with the relative implant mathematical file in the CAD software program (Dental System; 3Shape A/S). The dental laboratory technician checks the accuracy of the intraoral scan by superimposing the scan body mathematical files in the CAD software program on the scan body detected in the intraoral scan.
3. Design the crown or the FPD using the CAD software program respecting minimum strength requirements. The thickness of the screw rest should be 1.5 mm (Fig. 2) with a flat-to-flat interface (Fig. 3). Use screws with flat heads by applying a maximum torque of 32 Ncm. The axial wall thickness in the screw engagement area should be greater than 0.5 mm (Fig. 4). Use only high-strength tetragonal zirconia with a fracture resistance greater than 1000 MPa.
4. Use a flat-head milling bur during the CAM phase to create a flat screw rest and a crown-implant interface. Use Ø0.3-mm angle-breaking burs to optimize the tolerance and fit between the implant head and the engagement of the zirconia restoration (Fig. 5).

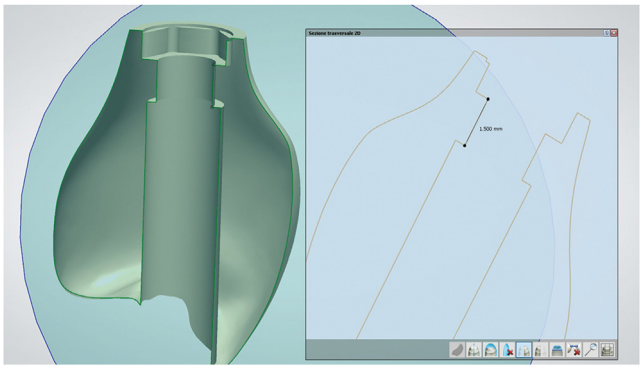

Figure 2. Screw rest with thickness of 1.5 mm.

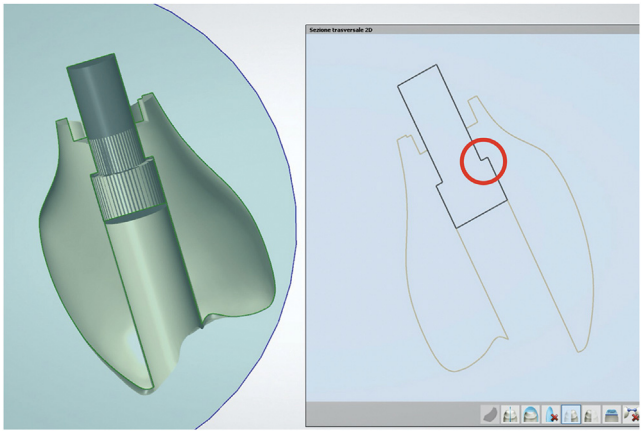

Figure 3. Flat-to-flat screw rest using screw with flat head.

5. Upload the mathematical file values for anatomic-contour implant zirconia crowns with direct connection into the CAD laboratory software program.

DISCUSSION

The use of a directly screwed zirconia connection on implants with an external hexagon presents some advantages. Eliminating abutments and Ti-base components allows straightforward and cost-effective fabrication procedures without risking decementation of the titanium components.

Additionally, the use of a highly biocompatible material in the mucosal tunnel contributes to enhanced tissue health and stability over time[28] (Fig. 6).

The flat-to-flat connection is suitable for zirconia, with high resistance to compressive axial loads.[29] Although some wear has been reported in vitro after cyclic loading,[30] it does not seem to damage the antirotational features of the connection (Fig. 6). In the present technique, the maintenance of connection integrity is ensured by the increased thickness of the zirconia material at the screw rest and at the axial walls of

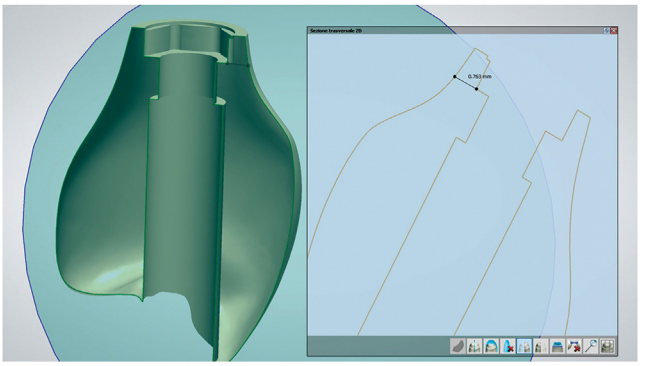

Figure 4. Minimum 0.5-mm axial wall thickness in screw engagement area.

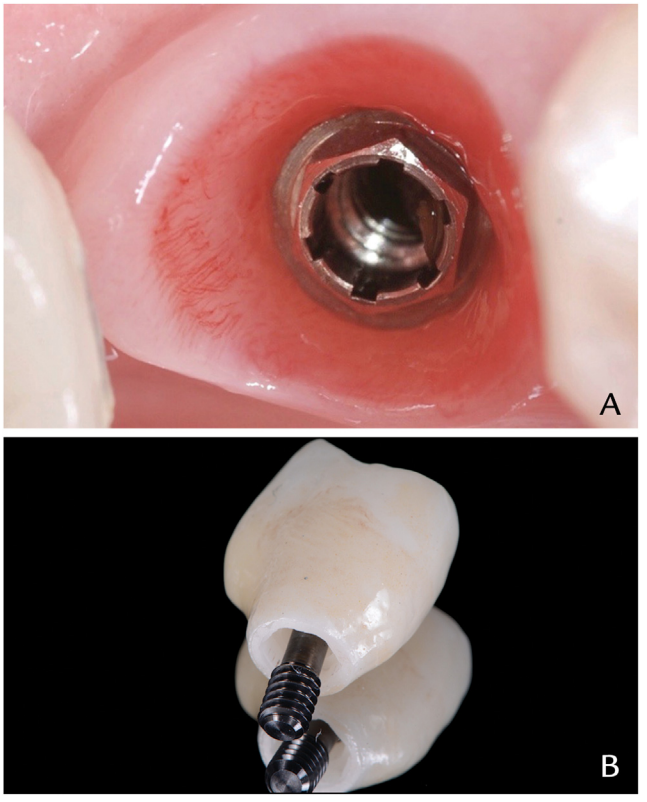

Figure 6. Hexagonal connection after 5 years of function. A, No signs of deterioration of connection visible on implant. B, No signs of deterioration of connection visible on restoration engagement.

the connection, the use of a flat screw head to avoid potentially harmful wedging, and the use of angle-breaking burs. In the milling phase, the 6 sharp angles at the intaglio surface of the zirconia interface which correspond to the vertices of the hexagon on the implant head are difficult to reproduce with a round cutting instrument. Therefore, this area is finished with very small (Ø0.3-mm) diameter burs, creating a slight mechanical tolerance at the tip of the angle (angle-breaking), thus optimizing the fit between the 2

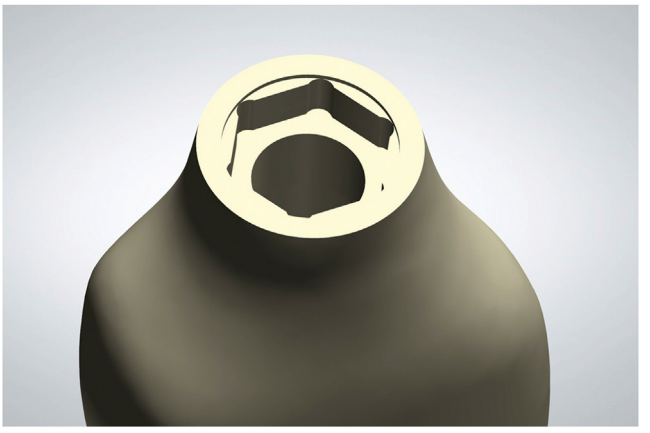

Figure 5. Angle-breaking Ø0.3-mm burs necessary to optimize tolerance and fit between implant head and engagement in zirconia restoration.

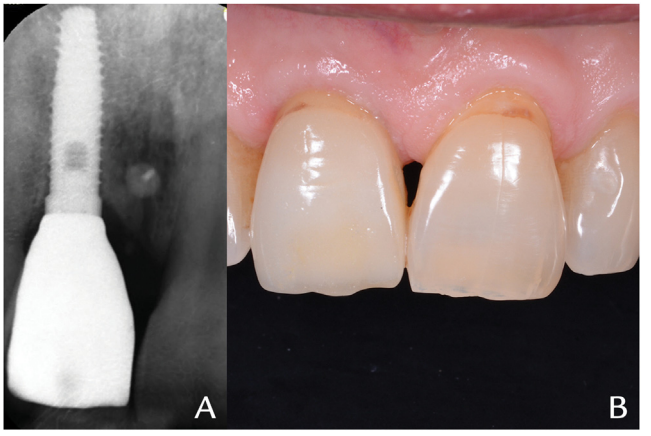

Figure 7. Single crown directly screwed onto hexagonal connection after 9 years. A, Periapical radiographic. B, Clinical photograph.

components of the connection (implant head and crown interface). Most milling centers and companies provide mathematical files for CAD laboratory software programs free of charge.

This technique has limitations. Mispositioned implants must be addressed with caution, as restoration design may lead to thin walls in the screw area. Restorations with an unfavorable crown-to-implant ratio should be avoided. For crowns more than 13 to 14 mm,[31] it is preferable to insert a Ti-base component to reduce the risk of fracture at the neck of the restoration. Also, this technique is contraindicated for molar restorations on narrow platforms. Cubic zirconia should be avoided because the resistance values of the connection would be insufficient for its long-term stability. High-strength tetragonal zirconia (greater than 1000 MPa) should be used.

This procedure has been used by the authors for anatomic-contour implant zirconia single crowns and FPDs with long-term follow-up (Fig. 7) in all areas of the mouth regardless of whether the antagonist is a natural tooth or a tooth-supported or implant-supported

restoration. In the authors' clinical experience, the incidence of technical complications is extremely low, occurring only rarely as fractures of the zirconia connection in single crowns with an unfavorable crown-to-implant ratio or FPDs subsequent to inaccurate impressions. Clinical data are being collected for future publication.

SUMMARY

A prosthetic procedure over implants with conventional external hexagonal connections is described using monolithic zirconia without the interposition of a titanium component. This straightforward, cost-effective, and high-performing solution, both from an esthetic and a mechanical point of view, represents an additional therapeutic option for the dental practitioner.

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