

Monolithic Zirconia FPD on Modified Titanium Bonding Bases in Limited Interocclusal Distance: A Case Report

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A 62-year-old male patient sought treatment for missing maxillary teeth. A diagnostic cast demonstrated that the interocclusal distance was insufficient. A 5-unit screw-retained implant-supported fixed partial denture (FPD) was used to restore missing maxillary teeth. The restoration of multiple missing teeth using an implant-supported FPD is challenging when the interocclusal distance is limited due to lack of retention and inadequate esthetics. In this case, a hexagonal, screw-retained, and subgingivally located titanium-based zirconia implant-supported FPD with a conical abutment base was used for restoration to overcome the limited interocclusal distance. This implant-supported FPD, consisting of CAD/CAM-designed monolithic zirconia cemented to a titanium bonding base in the laboratory, is expected to facilitate predictable retention and adequate esthetics as well as provide ease of retrieval.

Key Words: titanium bonding base, monolithic zirconia, limited interocclusal distance, screw-retained implant-supported FPD, digital flow CAD/CAM

INTRODUCTION

Over the past four decades, the proven long- and short-term success of implant-supported fixed dental prostheses has led to the routine use of dental implants for the oral rehabilitation of fully or partially edentulous patients.^{1,2} However, in restorations where the interocclusal distance is insufficient, there are problems associated with retrievability, retention, and esthetics with implant-supported fixed partial dentures (FPDs).^{3,4} The materials used for the construction and retention of the prosthesis and abutment are therefore key considerations to achieve the optimal outcome during this procedure.

Originally, screw-retained implant-supported prostheses mainly followed the Brånemark protocol.⁵ Later, cement retention became more popular for compensation of mispositioned implants as it allowed clinicians to utilize a procedure similar to that for restoring natural teeth.^{6,7} However, a screw-retained prosthesis has several advantages over a cemented one, including reduced risk of biologic complications (peri-implantitis and peri-implant mucositis) and predictable retrievability.^{8,9} It is particularly important to use screws to achieve proper retention and esthetics when the interocclusal distance is limited.³

Because of growing esthetic demands, zirconia in conjunction with CAD/CAM has become increasingly popular due to cost, esthetics, and time-saving fabrication workflows. The

microstructural and mechanical properties of zirconia, as well as its excellent biocompatibility, have been well documented.^{10,11} However, common limitations of zirconia-based restorations are cracking, chipping, and wear of antagonistic teeth due to porcelain veneering on the framework.^{12,13} These drawbacks may be overcome using monolithic zirconia. In any event, abutments are required to connect these monolithic reconstructions to the implant. Being located below the level of the gingiva, they are the key to ensuring soft-tissue adaptation in the absence of inflammation. Therefore, titanium bonding bases for crowns can be selected as an alternative to achieve more predictable clinical results.¹⁴ Specifically, a modified titanium bonding base with a conical interface can compensate for minor divergences between implants and discrepancies arising from the seating of multiple-unit restorations. Moreover, a titanium base with a hexagonally parallel bonding surface may lead to increased retention, particularly in cases where the interocclusal distance is limited.

The purpose of this clinical report is to describe a screw-retained and titanium-based maxillary monolithic zirconia FPD, which was produced by CAD/CAM and used to treat a patient where the interocclusal distance was limited.

CLINICAL PRESENTATION

A 62-year-old man with no significant medical history presented to the dental clinic in the Department of Prosthodontics with the chief complaint of missing maxillary anterior teeth.

When the patient's previous dental history was reviewed, it was revealed that the anterior teeth had increasing mobility over the past year, and teeth no. 8, 9, 10, 11, and 12 had been

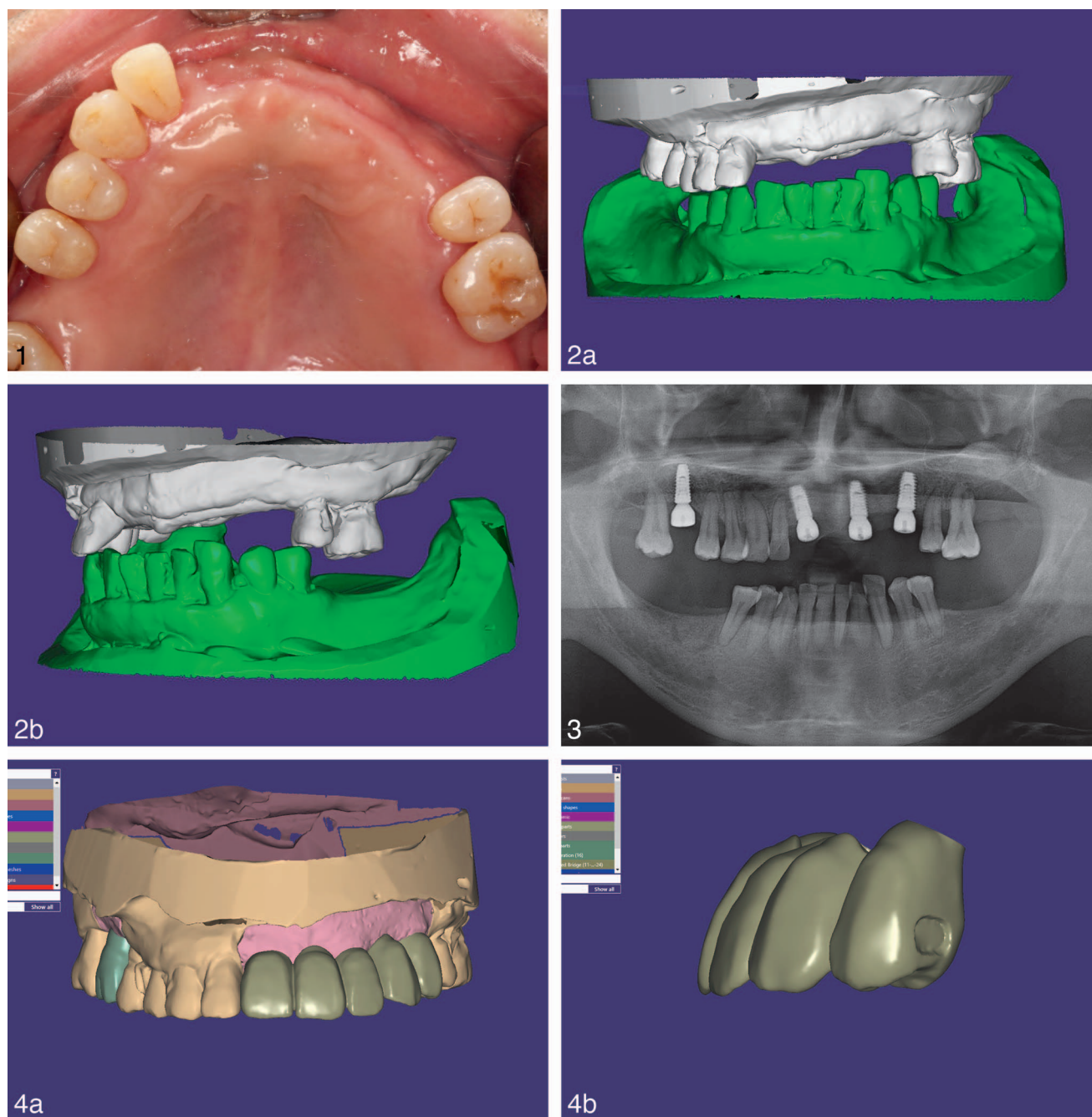
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FIGURES 1–4. **FIGURE 1.** Intraoral occlusal view of patient's pretreatment condition. **FIGURE 2.** (a) Virtual cast using software (Exocad v 5541/64) to confirm obtained maxillomandibular relationship. (b) Virtual lateral view. **FIGURE 3.** Panoramic radiograph after implant placement. **FIGURE 4.** Design of computer-aided design/computer-aided manufacturing maxillary implant-supported fixed partial denture (FPD). (a) Frontal view. (b) Proximal box was designed on the distal side of the FPD.

extracted in the last year. Partial edentulism and generalized chronic periodontitis on the remaining teeth were diagnosed (Figure 1). A diagnostic cast was made and scanned using a dental laboratory scanner (Identica, Medit Corp, Seoul, South Korea). On the virtual cast, the approximate interocclusal distance was measured as 5 mm, which was judged as insufficient (Figure 2a and b). A surgical template was designed using specialist software (Exocad v5541/64, Exocad GmbH, Darmstadt, Germany) and fabricated using a three-dimensional

3D printer (Zenith D, Dentis Co, Ltd, Daegu, Korea) to place implants as parallel as possible. A 5-unit screw-retained implant-supported FPD was used to restore missing teeth in the maxilla. Three implant fixtures (SuperLine, Dentium, Seoul, Korea) were placed on the sites of tooth no. 8 (right maxillary first incisor; SuperLine implant 4.0×10 mm, Dentium), tooth no. 10 (left maxillary second incisor) (SuperLine implant 4.0×10 mm, Dentium), and tooth no. 12 (left maxillary first premolar) (SuperLine implant 4.5×10.0 mm, Dentium). A panoramic

radiograph was taken after implant placement (Figure 3). An interim restoration was designed using specialist software (Exocad v 5541/64; Exocad GmbH) and fabricated with polymethyl methacrylate (PMMA) using a milling unit (M4 wet heavy metal milling unit, Zirconszahn GmbH, Gais, Italy). This was delivered to the patient after implant surgery.

After a trial period of 3 months, the patient reported no discomfort and was therefore recalled for the definitive prosthesis. Impression copings were engaged to the implant fixtures, and a pick-up impression was made with a customized tray using polyether impression material (Impregum Penta, 3M ESPE, Irvine, Calif). An interocclusal record was made with VPS bite registration material (O-Bite, DMG, Ridgefield Park, NJ). A definitive cast was poured in type IV dental stone (Snowrock, DK Mungyo, Gyeongnam, Korea) and mounted in a semi-adjustable articulator (Artex, Aman Gierbach AG, Austria). Three sandblasted titanium bonding bases (Heri link abutment; Heri Co, Ltd, Seoul, Korea) were connected to the maxillary working cast. The maxillary working cast, mandibular cast, and a copy of the interim restoration were scanned with a model scanner (Identica, Medit Corp, Seoul, Korea). Definitive restoration was digitally designed using the interim restoration as a reference with the software (Exocad v 5541/64, Exocad GmbH; Figure 4a). A small inverted trapezoid retentive box was designed on the distal proximal area of the FPD to adjust the contact area in case of progressive loosening (Figure 4b).

The FPD was fabricated out of a monolithic zirconia disc (Katana zirconia, Kuraray Noritake Dental Inc, Aichi, Japan). Milled pre-sintered zirconia was colored using coloring liquid, dried under an infrared lamp, and sintered (Nabertherm LHT 02/17 LB Speed Sintering Furnace, Nabertherm GmbH, Lilienthal, Germany; Figure 5). Sandblasting, staining, and glazing were performed on the FPD except for the occlusal table, which was polished. Next, the monolithic zirconia FPD was fixed on the titanium bases (Heri link abutment, Heri; Figure 6) using resin cement (Multilink N; Ivoclar Vivadent AG, Schaan, Liechtenstein) to form a one-piece screw-type implant-supported FPD. Next, porcelain etching (Porcelain Etch, Ultradent Products, Inc, USA) and primer (Universal primer A, B, Tokuyama, Japan) were then applied to the proximal box. The bonding agent was applied to the box and was light cured. The proximal box was filled with composite resin (Filtec Z250 Universal Restorative, 3M ESPE) and light cured for 20 seconds. Then, the implant-supported FPD and the proximal area were adjusted onto the working cast using articulating paper (Articulating Paper, Bausch GMBH, Germany).

The definitive monolithic zirconia implant-supported FPD was delivered to the patient (Figure 7a and b). Screw access openings were filled with polytetrafluoroethylene (Teflon; Traxco, SA), and the composite resin was light cured (Filtec Z250 Universal Restorative, 3M ESPE). Seating was confirmed from periapical radiographs and the panoramic radiograph (Figure 8). The patient, who was satisfied with the clinical outcomes in terms of function and esthetics, was given detailed post-insertion and hygiene instructions. Recall visits were made to verify hygiene and occlusion. The present case has been followed for 8 months since the surgical procedures were performed. Restoration of the remaining mandibular edentulous sites with implant-supported FPD were planned in recall visits.

DISCUSSION

A distinctive feature of the titanium bonding base used in this clinical report is a sleeve that is 0.8 mm in height, allowing the zirconia to extend more subgingivally, thus hiding any metal in a shallow sulcus and reducing the possibility of metal exposure due to any future gingival recession. The subgingival placement of the restoration not only improves esthetics but also helps in cases with deep gums, where it provides the benefits of cementing the zirconia to the base without the need for intra-oral cementation.¹⁵ In addition, the use of a conical titanium bonding base may be a favorable solution applicable for the multiple-unit FPD when implant divergences need to be compensated.¹⁶ It achieves a passive fit that makes seating easier.

In an attempt to reduce the risk of contact loosening complications, the proximal area of the implant-supported FPD was designed to accommodate future enlargement by adding composite resin on the chair side. The buccal, lingual, and gingival sides of the proximal box were designed with minimal undercut. The occlusal edge of the box has no undercut and gradually inclines toward the occlusal surface to prevent thinning of the porcelain and provide mechanical retention for the resin, which is more resistant to possible complications.

The titanium base bonding surface is hexagonally parallel where it connects to the monolithic zirconia. This makes the crown more resistant to dislodgement than cylindrical or rectangular geometries when the interocclusal distance is inadequate. Stable adhesion between the zirconia and the titanium bonding base was achieved by fixing them with dual-curing resin cement after the bonding surfaces of titanium bases were air abraded with aluminum oxide. Moreover, the use of opaque resin cement, together with airborne particle abrasion, may hide the grey and black substrates of the titanium bonding base.^{17,18} However, bonding strength between the implant crown and titanium bonding base requires further extensive studies. The concept of titanium bonding bases supported fixed implant reconstructions has demonstrated very promising results when applied to single-unit reconstruction.^{14,19,20} Further studies with long-term follow up observations are necessary to investigate the clinical performance of treatment with prefabricated titanium bonding bases for multi-unit implant FPD.

CONCLUSION

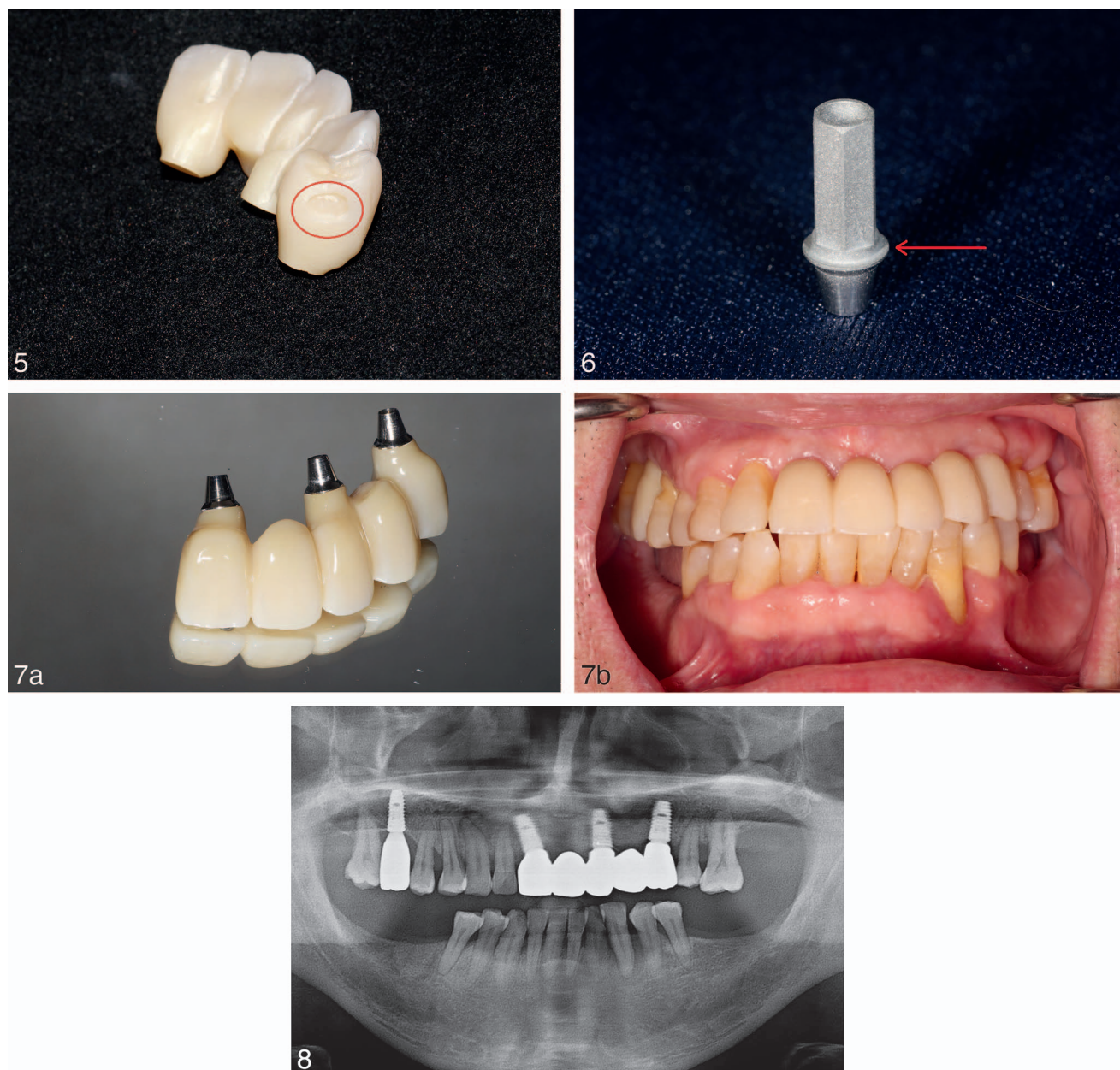
A modified titanium bonding base design incorporating a monolithic zirconia screw-type implant-supported FPD may benefit patients with insufficient interocclusal distance by providing predictable retention and a maintainable retrieval system. Further, the conical-shaped abutment base may make seating easier in case of multiple implants placed with some degree of divergence.

ABBREVIATIONS

3D: three-dimensional

CAD/CAM: computer-aided design/computer-aided manufacturing

FPD: fixed partial denture



FIGURES 5–8. **FIGURE 5.** Monolithic zirconia fixed partial denture (FPD) after sintering procedure. The proximal box is shown by a red circle. **FIGURE 6.** Sandblasted titanium bonding base. The sleeve of titanium bonding base is shown by an arrow. **FIGURE 7.** (a) Frontal view of definitive implant-supported FPD. Conical interface of titanium bonding base provides easier seating of multi-unit implant supported FPD. (b) Intraoral frontal view of definitive prosthesis in place. **FIGURE 8.** Panoramic radiograph of definitive prosthesis in place.

PMMA: polymethyl methacrylate
VPS: vinyl polysiloxane

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NOTE

The authors declare no conflicts of interest.

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