Use of ceria-stabilized zirconia/alumina nanocomposite for fabricating the frameworks of removable dental prostheses: A clinical report

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ABSTRACT
Ceria-stabilized zirconia/alumina nanocomposite (Ce-TZP/A) exhibits an elasticity equivalent to that of cobalt–chromium alloy and a flexural property that is superior to that of yttria-tetragonal zirconia polycrystal. Therefore, the use of Ce-TZP/A for the fabrication of removable dental prosthesis frameworks is being studied. However, the current English literature does not include any clinical report on the use of Ce-TZP/A for the fabrication of the entire framework. This clinical report describes the process and outcomes of fabricating a mandibular implant-supported overdenture and a maxillary complete denture with Ce-TZP/A as the framework material. (J Prosthet Dent 2016;116:166-171)
knowledge, only 1 study has reported an actual clinical application.27 As an RDP framework, Ce-TZP/A exhibits an elasticity equivalent to that of Co–Cr and a flexural property superior to that of yttria-tetragonal zirconia polycrystal (Y-TZP). Therefore, its use in the fabrication of clasps included in the framework of partial removable dental prostheses is being studied.21 This clinical report describes the process and outcomes of fabricating a mandibular IOD and a maxillary CD using Ce-TZP/A as the material for the base frameworks.

CLINICAL REPORT

A 65-year-old, completely edentulous Asian woman presented at Nihon University Dental Hospital. The patient’s medical history was unremarkable. On the basis of clinical and radiographic examinations and the patient’s expectations, a treatment plan was developed to fabricate an IOD supported by 4 implants for the mandible and a CD for the maxilla. For implant placement in the mandible, a surgical guide was fabricated, followed by the placement of 4 threaded, 4×10-mm implants (Osseotite; OSS 410; Biomet 3i). After 3 months, the implants were uncovered and healing abutments (One-piece Healing Abutment; Biomet 3i) were seated (Fig. 1).

The maxillary custom impression tray was border molded with modeling plastic impression compound (Impression compound type I; Kerr Corp) and an impression made with polyvinyl siloxane impression material (Take 1; Kerr Corp). The impression was poured with Type IV dental stone (New Fujirock; GC Corp). Subsequently, wax occlusion rims were fabricated for both jaws, and the lip support and facial profile were evaluated. The occlusal vertical dimension (OVD) was determined on the basis of the OVD in the patient’s existing prostheses. The casts were mounted in a semiadjustable articulator (Denar Mark II Articulator; Whip Mix Corp) in a centric relation record. Artificial teeth were selected according to the patient’s existing CD (Duradent; GC Corp) and arranged on the occlusion rims used for registration, which were then evaluated in the oral cavity for pronunciation, appearance, and occlusion. Before the design and fabrication of the Ce-TZP/A framework, the definitive denture forms were determined using the wax trial dentures. This allowed an estimate of the denture space while designing the Ce-TZP/A framework and created an appropriate framework.

The maxillary definitive cast and wax trial denture were scanned with a laser scanner (Noritake Dental Scanner SC-3; Kuraray Noritake Dental Inc), and the scanned data were overlaid on a personal computer (PC) screen using CAD software (Katana; Kuraray Noritake Dental Inc). An IOD using stud-type attachments was fabricated for the mandible. Locator attachments (Locator implant attachment; Zest Anchors) were mounted on the definitive cast and read by a dental scanner. The scanned data for the mandibular definitive cast and wax trial denture were overlaid on a PC screen using CAD software (Katana; Kuraray Noritake Dental Inc). The Ce-TZP/A framework was designed using CAD software (Katana; Kuraray Noritake Dental Inc), with focus on the following considerations: the design of the maxillary framework was similar to that of conventional Ti and Co–Cr frameworks; holes were included for the Locator attachments (Zest Anchors) in the mandibular framework to facilitate the use of the direct technique, wherein the retaining caps (Denture cap; Zest Anchors) are assembled inside the oral cavity at the time of delivery.

![Figure 1. A, Occlusal view of maxillary arch. B, Occlusal view of mandibular arch with healing abutments.](image-url)
of the definitive IOD, and tissue stops were included on the mucosal side of each framework (Fig. 2).

For the fabrication of the Ce-TZP/A framework, special CAM software (WorkNC Dental; Vero) was used. Milling operations were performed after determining details such as the positions and heights inside the disk, sizes, and lengths of the support pins, and the size of the stabilizer using a special template for the framework. The ceramic material was milled (C-Pro Nano-zirconia; Panasonic Healthcare) using a dedicated milling machine for Ce-TZP/A (imes-icore 250i 5-axis CAD-CAM milling machine; imes-icore GmbH). Then, the material was sintered for 15 hours in a dedicated sintering furnace (Austromat μSiC; Dekema), and the bases were cut from the ceramic disks for dental milling and fitted to the definitive casts (Fig. 3). Wax trial dentures were fabricated, again using an index on the completed Ce-TZP/A framework, followed by the final trial fitting in the oral cavity. The wax trial dentures were invested in special flasks (Palajet duoflask; Heraeus Kulzer GmbH).

As a preparation for resin packing and polymerization after wax elimination, the following pretreatments were performed for the mesh-type retention area for the resin denture base on the Ce-TZP/A framework. This area was airborne-abraded with 0.11-mm particles (Rocatec Plus; 3M ESPE). A bonding agent (Ceraresin Bond; Shofu Inc) was applied after primer (AZ Primer; Shofu Inc) application and photopolymerized. Finally, opaque material (Ceramage Pre-Opaque; Shofu Inc) was used for the mesh-type retention area.

The pretreated Ce-TZP/A frameworks were returned to the definitive casts, and resin packed by mixing a pour-type autopolymerizing resin at room temperature (PalaXpress vario; Heraeus-Kulzer GmbH) and pouring it into flasks using a compressed air injection unit (Palajet; Heraeus-Kulzer GmbH) at a pressure of 414 kPa, which was held for 10 minutes. Subsequently, the resin was polymerized using a multimode-type pressure polymerization unit (Palamat Elite; Heraeus-Kulzer GmbH) under a pressure of 200 kPa and at a constant temperature of 55°C. The dentures were removed from the casts, finished, and polished (Fig. 4).

The definitive CD was delivered after clinical remounting and occlusal equilibration. The definitive IOD was inserted, and the healing abutments were replaced by
Locator attachments (Zest Anchors) exhibiting a cuff height of 4 mm. The male components (Denture caps; Zest Anchors) were incorporated into the IOD using the direct technique with an autopolymerizing resin (Pattern resin; GC Corp). The red plastic nylon insert (Extended Range Male; Zest Anchors) was inserted into the matrix housing. The overdenture was polished and delivered after making minimal occlusal and fit adjustments (Fig. 5).

The patient was given oral hygiene and prosthetic maintenance instructions and was recalled at 24 hours.

Figure 3. A, Complete CAD-CAM-fabricated Ce-TZP/A framework seated on maxillary definitive cast. B, Complete CAD-CAM-fabricated Ce-TZP/A framework seated on mandibular definitive cast. Four holes placed for Locator attachments.

Figure 4. A, Occlusal view of definitive prostheses with Ce-TZP/A framework. B, Intaglio surface view of definitive prostheses with Ce-TZP/A framework.
week, and 3 weeks. Each appointment involved the evaluation of occlusion, masticatory efficiency, oral hygiene, and patient satisfaction and comfort. No clinical problems such as loosening or loss of the denture retainers, decreased retention, or loosened screws were encountered. The patient’s satisfaction level and masticatory function were improved by the IOD. The patient has been undergoing regular follow-ups every 4 months for 3 years and has not complained of the metallic taste that is common with Co–Cr metal bases (Fig. 6). However, dark stains appeared on the palatal portion of the white Ce-TZP/A framework over time, which were probably caused by consuming approximately 3 cups of coffee each day, considering she was a nonsmoker. These stains were easily removed by chairside polishing.

DISCUSSION

Ti and Co–Cr are commonly used for metal RDP frameworks, and the fabrication of frameworks using these materials by milling procedures instead of conventional casting procedures has become possible through the advancement of CAD-CAM technologies. For this patient, Ce-TZP/A was used, which is not a conventional metal framework material. Ce-TZP/A exhibits higher strength and fracture toughness than Y-TZP, which is widely used for the fabrication of FDPs and crowns. However, this material has almost never been used for RDP frameworks, including IOD.

However, although Ce-TZP/A has better physical properties than Y-TZP, its applicability is limited because of its color. Nevertheless, it can be useful for the fabrication of RDP frameworks because of excellent biocompatibility, resistance to low-temperature degradation, a density lower than that of Co–Cr, ability to accommodate a base thickness decrease of up to 0.55 mm, minimal impact on the sensitivity to temperature inside the oral cavity, and the same fabrication process using CAD-CAM, as that for Ti and Co–Cr frameworks.

In this clinical report, the Ce-TZP/A framework for the maxillary CD and the mandibular IOD was fabricated using the same clinical and technical procedures used for Ti and Co–Cr frameworks.

SUMMARY

This clinical report introduces the use of Ce-TZP/A for the fabrication of CD and IOD frameworks. Both the maxillary CD and mandibular IOD are following an unremarkable course without significant clinical problems; furthermore, the degree of patient satisfaction was high. However, the use of Ce-TZP/A as an RDP framework material is relatively new; therefore, further studies evaluating the responses to various issues are necessary.

REFERENCES


Figure 5. A, Occlusal surface view of mandibular arch with attachments (Locator; Zest Anchors). B, Intraoral facial view of definitive prostheses.

Figure 6. Intraoral facial view of definitive prostheses at 3-year follow-up visit.

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