

# Dual Jaw Treatment of Edentulism Using Implant-Supported Monolithic Zirconia Fixed Prostheses

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## ABSTRACT

This case report describes restoration of the edentulous maxilla and mandible with implant supported fixed prostheses using monolithic zirconia, where the incisal edges and occluding surfaces were made of monolithic zirconia. Edentulism is a debilitating condition that can be treated with either a removable or fixed dental prosthesis. The most common type of implant-supported fixed prosthesis is the metal acrylic (hybrid), with ceramo-metal prostheses being used less commonly in complete edentulism. However, both of these prostheses designs are associated with reported complications of screw loosening or fracture and chipping of acrylic resin and porcelain. Monolithic zirconia implant-supported fixed prostheses have the potential for reduction of such complications. In this case, the CAD/CAM concept was utilized in fabrication of maxillary and mandibular screw-retained implant-supported fixed prostheses using monolithic zirconia. Proper treatment planning and execution coupled with utilizing advanced technologies contributes to highly esthetic results. However, long-term studies are required to guarantee a satisfactory long-term outcome of this modality of treatment.

## CLINICAL SIGNIFICANCE

This case report describes the clinical and technical procedures involved in fabrication of maxillary and mandibular implant-supported fixed prostheses using monolithic zirconia as a treatment of edentulism, and proposes the possible advantages associated with using monolithic zirconia in eliminating dissimilar interfaces in such prostheses that are accountable for the most commonly occurring technical complication for these prostheses being chipping and fracture of the veneering material.

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## INTRODUCTION

Edentulism is associated with self-reported reduction in quality of life.<sup>1–3</sup> Among the adult population in the United States, tens of millions of individuals are or will be edentulous by 2020.<sup>4,5</sup> Consequently, successful management of edentulism remains an issue of concern for the edentulous patient and the clinical team. There

exist persistent efforts to improve upon the treatment modalities that may be offered to the edentulous patient.

For decades, conventional denture therapy represented the only mainstream treatment available for restoring esthetics and to a certain degree function, as well as the self-esteem or social well-being of the edentulous

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patient. However, wearing of conventional dentures is accompanied by potential complications such as traumatic ulcers, gagging, denture stomatitis, and residual ridge resorption. In addition, a certain percentage of patients remain maladaptive to complete dentures regardless of the patients' or clinicians' efforts to adapt to or modify the prostheses.<sup>6</sup>

Implant supported or retained removable prostheses revolutionized the opportunity for rehabilitation of the edentulous patient, and in spite of the increased cost associated with implant therapy, there has been a common consensus that patients who receive mandibular overdenture therapy benefit from improved masticatory function, nutrition, and satisfaction.<sup>5,7,8</sup> Despite the highly successful outcomes for implant supported overdentures, there remain edentulous patients who reject the notion of any type of removable prostheses.

Fixed options for implant-based rehabilitation of the edentulous patient have been documented for both maxillary and mandibular arches,<sup>9,10</sup> with a variety of opinions impacting the implant number, position, and distribution within each arch. These prostheses can be implant-supported fixed denture prosthesis (ISFDP) or hybrid prostheses (with metal frame work and resin),<sup>11</sup> multi-unit ceramo-metal restorations,<sup>12</sup> CAD/CAM-based restorations with metal or zirconia frameworks,<sup>13–15</sup> or monolithic zirconia implant-supported fixed prostheses.<sup>16,17</sup>

The aim of this case report is to describe the clinical and technical procedures involved in fabrication of maxillary and mandibular implant-supported fixed prostheses using monolithic zirconia (ZirkonZahn GmbH, Gais, Italy), where the occlusal surfaces and incisal edges were kept in monolithic zirconia, and veneering porcelain was applied only on the facial surfaces.

## CASE REPORT

A 62-year-old woman presented to the Graduate Prosthodontic Clinic at the University of North

Carolina seeking treatment with the following chief complaint: "I would like to have my dentures replaced with something that doesn't come out." A review of patient's medical history revealed Type II diabetes mellitus, hypertension, and high cholesterol, all of which were controlled by medications.

The patient's dental history revealed her teeth were extracted due to caries and that she has been edentulous for 2 years (Figure 1). During this period, she was provided with immediate complete dentures, but she used the maxillary denture only, as she couldn't tolerate the mandibular denture. The maxillary denture was fabricated in a horse shoe design as the patient had severe gag reflex upon using full palatal coverage design. Upon clinical examination, her maximum mouth opening was 45 mm. Further examination of TMJs revealed no clicking or crepitus, and there was no tenderness to palpation in the muscles of mastication. Intraorally, the maxillary residual ridge demonstrated moderate resorption, and pin point hyperemia underneath the covered part of the palate was evident, suggesting type I denture stomatitis. The mandibular ridge was severely resorbed. Upon reviewing radiographs, pneumatization of maxillary sinuses was evident, as well as mandibular arch resorption.

Several treatment options were discussed with the patient including: conventional complete denture therapy, implant retained complete overdentures, and implant supported fixed prostheses (hybrid prostheses, multiunit PFM (porcelain fused to metal) prostheses,



**FIGURE 1.** Edentulous arches at presentation. Frontal view of maxillary and mandibular arches.

and zirconia-based prostheses). Options of cement versus screw retained prostheses as well as one piece or segmented restorations were all discussed in detail as well as number and distribution of implants and procedures associated with each of the options, along with advantages and disadvantages of each treatment option.

### Treatment Plan

A definitive treatment plan was agreed upon based on the discussion of all of the above-mentioned options, and it was executed as following:

- (1) Tissue conditioning and fabrication of new interim dentures
- (2) Bone augmentation (bilateral maxillary sinus augmentation and canine area)
- (3) Fabrication of radiographic templates and obtaining a 3D radiograph for evaluation of bone augmentation outcome and planning for implant placement
- (4) Placement of six maxillary and four mandibular implants in the following positions: 3, 4, 5, 12, 13, 14, 21, 23, 26, and 28
- (5) Restoration with screw-retained monolithic zirconia prostheses

### Treatment Phases

Maxillary denture-associated stomatitis was treated by using tissue conditioner that was changed weekly, as well as prescription of a topical antifungal. That was followed by fabrication of new interim dentures.

### Surgical Phase

Bilateral maxillary sinus grafting was performed through a lateral window sinus lift technique. Maxillary sinus grafting has become an important aid to enable implant placement in the posterior maxillary region, as enhanced bone volume in this region permits distal location of implants that are associated with high survival rates, and this can be achieved through the use of autogenous bone or allografts or a mixture of both through different technique.<sup>18,19</sup> In this case, sinus

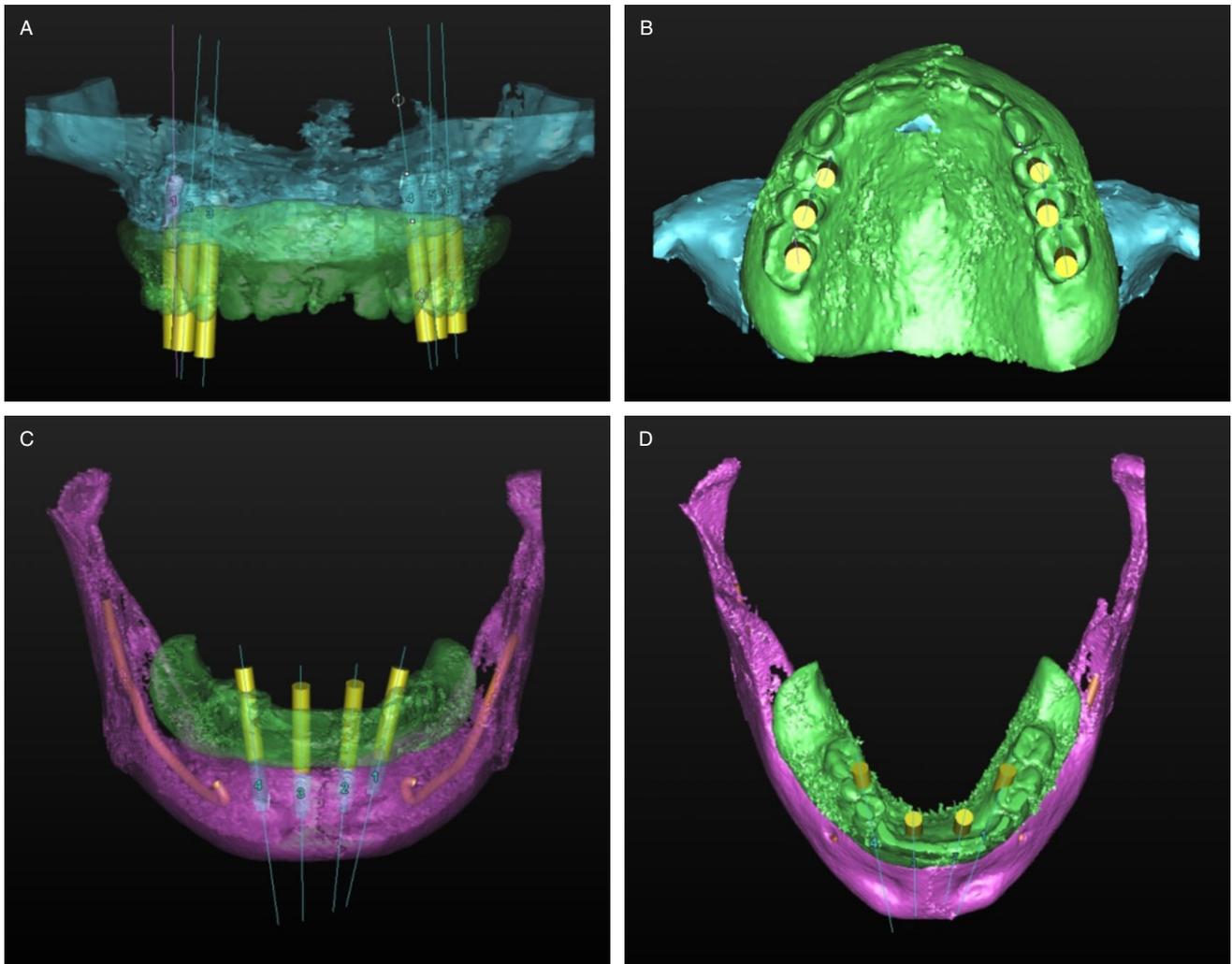
grafting and augmentation facially bilaterally in the canine area was achieved using autogenous bone (left lateral tibia) mixed with PRP (platelet rich plasma) and Bio-Oss (Geistlich Pharma AG) and covered using a BioGide (Geistlich Pharma North America, NJ, USA) membrane. Healing occurred uneventfully, with the use of conventional interim dentures for a period of 9 months.

Subsequently, planning for implant placement using CBCT (cone beam computed tomography) was performed. The interim dentures were checked again for satisfaction in terms of midline position, occlusal plane orientation, proper teeth size and positions, and accurate centric relation. The dentures were then duplicated into resin templates using Biocryl X radiopaque acrylic resin (Great Lakes Orthodontics, NY, USA) and CBCT was performed using Sirona Galileos CBCT Scanner (Sirona Dental Systems, Inc. NY, USA) (Figure 2). Virtual planning was done using the Facilitate software (Materialise Dental, Belgium) with maxillary and mandibular arches being segmented from the scanned prostheses. In planning, special attention was given for screw hole access positions through the teeth, implants angulation on the mandible and AP-spread (antero-posterior) (Figure 3A–D).

According to the treatment plan, the radiographic guides were converted to surgical guides, and the following implants were placed using these analog guides to direct implant orientation in each of the corresponding sites: maxillary implants: #3 (AstraTech 4.5 × 9 mm), #4, 13, 14: AstraTech 4.0 S × 8 mm, #5,12: AstraTech 3.5 × 8mm; mandibular implants: #21:



**FIGURE 2.** Panoramic view reconstructed from a 3D volume demonstrating the denture duplicates that were used as the scan prostheses. Maxillary sinus grafts noticeable.



**FIGURE 3.** Virtual planning in facilitate software. A, Frontal section for a panoramic reconstructed view showing implants positions in the maxilla. B, Occlusal view of maxillary arch proposed implants sites. All screw holes planned to be on the lingual side. C, Frontal section for a panoramic reconstructed view showing implants positions in the mandible, distal angulation of the distal implants planned to achieve an appropriate AP spread. D, Occlusal view of mandibular arch proposed implants sites.

AstraTech 4.0 S × 8 mm, #23, 26, 28; AstraTech.4.0 S × 11 mm. Cover screws were placed on the maxillary implants (two-stage surgery), whereas the mandibular ones received healing abutments (one-stage surgery). The interim dentures were generously relieved and placed following relining with soft reline material for the healing period.

**Restorative Phase**

Three months after implant placement surgery, second-stage surgery was done for the maxillary implants and healing abutments placed. A week later,

healing abutments were removed and 20 degree Uni Abutments (Astra Tech, DENTSPLY Implants, MA, USA) were selected and impressed at the abutment level. At this stage, both maxillary and mandibular dentures were converted into fixed temporary prostheses (Figure 4). In order to verify the accuracy of the impression derived master casts prior to proceeding with framework fabrication, verification jigs were fabricated on the poured models and verified intraorally. Maxillomandibular records (facebow, VDO, CR) were obtained using the existing temporary conversion prostheses. After making the facebow record (Denar slidematic facebow, Whip Mix Corp,



**FIGURE 4.** Maxillary and mandibular dentures converted into screw-retained fixed provisional prostheses.

KY, USA), the master casts were mounted on a Hanau modular semi-adjustable articulator (Whip Mix Corp) using mounting plaster (Mounting Plaster, Whip Mix Corp) with the aid of a vinylpolysiloxane record of the maxillomandibular relation in CR. An index of the temporary prostheses was made using a lab putty material, and this was used for communication with the lab in relation to definitive restorations fabrication (Figure 5). The laboratory produced a polymethylmethacrylate mock-up of the designed prosthesis, and these were tried intraorally to verify the fit as well as lip support, midline position, incisal edge position and teeth display, occlusal plane orientation, centric relation, phonetics and esthetics to patient's satisfaction (Figure 6).

The mock-up of tooth position was then scanned, milled from monolithic zirconia (Prettau Zirconia, Zirkozahn GmbH, Gais, Italy), and then sintered, colored, and glazed. The completed restorations were placed intraorally and passive fit verified once again. Subsequently, the attainment of precise and well distributed posterior bilateral stable contacts in CR with no contacts on protrusive and lateral excursions was achieved by minor selective modifications. Finally, the esthetics and phonetics were verified (Figure 7A–D). A panoramic radiograph was then obtained to verify fit and as a baseline for future follow-up (Figure 8).

These prostheses are large and contact near or with the residual alveolar ridges. This is essential for proper



**FIGURE 5.** Wax-up made as a copy from the provisional prostheses for the use in the lab for fabrication of polymethylmethacrylate mock-up of the definitive prostheses to be tried intraorally.



**FIGURE 6.** Polymethacrylate mock up of the definitive prostheses tried intraorally to confirm fit, function, and esthetics.

maxillary esthetics and phonetics. Therefore, the final step in delivery of such an implant-supported prosthesis is the proper prescription of oral hygiene instructions. The patient must demonstrate their ability to perform these procedures to reinforce and assure the cleansability. Finally, the patient was advised on the importance of regular follow-up and was placed on a 6-month recall regimen.

## DISCUSSION

Tooth replacement must be esthetic and functional, including proper masticatory and phonetic attributes.



**FIGURE 7.** Definitive monolithic zirconia maxillary and mandibular implant supported fixed prostheses 6 months post-delivery. A, Frontal view of the prostheses in MIP (maximum intercuspation position). B, Maxillary occlusal view. Screw access holes appear in the positions that were planned for as in Figure 3. Screw access holes were covered with composite material. C, Mandibular occlusal view. D, Frontal view of the smile with the definitive prostheses.



**FIGURE 8.** Panoramic view with the definitive prostheses in place.

For fixed implant prostheses, replacement of the alveolus and related soft tissue architecture is essential and must be coordinated with phonetics, esthetics, as well as hygienic necessity. In cases where a denture would be utilized, denture flanges would certainly offer

the opportunity of restoring support as well as soft tissue contours to both patient and dentist's satisfaction. Yet, if the situation demands a fixed solution, then predictable restoration of gingival contours becomes more challenging.<sup>20</sup> One resolution to that is augmentation of hard and soft tissues prior to implant placement. However, when augmentation is not selected, not feasible, or if the outcome is less than ideal, then the clinical challenge of replacing alveolar form remains.

The proper planning of fixed implant prostheses for edentulism requires consideration of the durability, hygiene, and esthetic features of the prosthesis. ISFDP have demonstrated high survival rates of 97% at 10 years in the mandible, and 95% at 5 years in the maxilla.<sup>21</sup> Even when both maxillary and mandibular

arches are restored with ISFDP, they still demonstrate success rates well above 90%.<sup>22,23</sup> Reviewing biologic complications associated with metal resin and metal ceramic ISFDP in edentulous patients showed that it can be expected that two of 1,000 implants will be lost after 10 years.<sup>21</sup> On the other hand, prosthesis-related technical complications are found to be frequent, including screw loosening/fracture, veneering material chipping/fracture, wear and/or total replacement of acrylic resin teeth, framework fracture, loss of screw access filling material, fracture of the opposing restoration, and lack of biologic color especially at the prosthetic gingival architecture.<sup>15,21,24–26</sup>

Chipping or fracture of the veneering material was reported to be the most commonly occurring prosthesis-related complication.<sup>13,25</sup> Thus, the use of alternative materials that demonstrate durability as well as overcome the complications associated with traditional hybrid and ceramo-metal prostheses is important to investigate. Such alternatives include using CAD/CAM fabricated titanium frameworks and cemented individual crowns,<sup>13</sup> and using CAD/CAM fabricated cross-arch zirconia frameworks.<sup>27</sup> However, the complications using alternatives to hybrids include fracture of crowns, fractures of frameworks and chipping at a high rate.<sup>28</sup> More recent developments in prosthetic rehabilitation of endosseous implants include the use of CAD/CAM for planning and manufacture of monolithic zirconia prostheses.<sup>14–17</sup> High strength of monolithic zirconia combined with the lack of dissimilar interfaces through which chipping might occur seems promising in overcoming this frequently occurring complication as well as in reducing the costs associated with frequent maintenance visits needed as a result of these technical complications.<sup>16</sup> However, the longevity of treatment modalities based on monolithic zirconia prostheses is yet to be recognized.

## CONCLUSION

With careful interdisciplinary planning and employing CAD/CAM concepts to fabricate milled monolithic zirconia prostheses, it is possible to create retrievable yet highly esthetic screw-retained restorations with

passive and precise fit in addition to the possible improvement in function over other materials used for fabrication of implant-supported fixed prostheses in an attempt to provide excellence in esthetics, design, and hygiene. Yet, the longevity remains to be defined through long-term clinical trials.

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