Vol. 12 No. 2, December 2020
The Journal of Korean Academy of Osseointegration 2020, 12(2) 43-47

Customized fabrication of implant-supported fixed dental prosthesis using CAD-CAM provisional and zirconia prostheses

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Implant-supported fixed prostheses have become a treatment option for completely edentulous patients. Provisional prostheses during implant therapy are used to evaluate esthetic, phonetic, and occlusal function before delivery of the final prostheses. The conventional workflow is based on manual and time-consuming processes. With the development of digital technologies in dentistry, the predictability and practicality of clinical and laboratory procedures have been significantly enhanced. By using digital scanning, the patient-specific information can be reflected in an interim restoration and adapted to the definitive restoration. This clinical report describes a complete maxillary rehabilitation with digital scanning, CAD/CAM-fabricated provisional prostheses, and a monolithic zirconia prosthesis. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2020;12(2):43-47)**

Key words: Implant-supported fixed prosthesis, Provisional, Digital scanning, Monolithic, Zirconia, CAD-CAM

INTRODUCTION

Implant-supported fixed prostheses have become an option in prosthodontic treatment planning for completely edentulous patients. In patients with extensive tooth loss, it is challenging to restore the mastication, esthetics, and speech functions[1]. The long-term use of provisional prostheses has been recommended in implant prosthetic treatments[2]. The provisional prostheses can be used to predict the longevity of definitive prostheses and improve perioral conditions. They are also useful for communication between clinicians, laboratory technicians, and the patient[3]. The conventional workflow for fabricating provisional acrylic prostheses is based on manual works, time-consuming, and sometimes tedious. With the development of digital technologies in dentistry, the predictability and practicality of clinical and laboratory procedures have been significantly enhanced[4,5]. Digital scanning enables the scan data to be electronically transmitted to a corresponding production part, and prostheses can be fabricated with computer-aided designing and computer-aided manufacturing (CAD-CAM)[4,6]. Nowadays, modeless fabrication protocols are realized by using the digitally articulated virtual definitive casts[7]. Various restorative materials, including metal alloys, ceramics, and composite resins, also have been proposed for the subsequent CAM production of provisional and definitive prostheses[8].

The digital methods are more advantageous when comprehensive rehabilitation is needed. The patient-specific information provided by digital scanning can be reflected in an interim restoration and adapted to the definitive restoration[9]. Accordingly, the customized definitive prosthesis can be fabricated using CAD-CAM technologies. This clinical report describes a complete maxillary rehabilitation with digital scanning, CAD/CAM-fabricated provisional prostheses, and a monolithic zirconia prosthesis.

CASE REPORT

A 53-year-old male patient with an edentulous maxillary arch presented dissatisfaction with his existing maxillary implant-supported fixed complete prosthesis (Figure 1). The patient also encountered speech problems related to the lack of space for the tongue movement. Radiographic examination showed six implants that had been placed in the maxilla. The occlusal plane was considered preserved, and no temporoman-

Received October 14, 2020, **Revised** November 15, 2020, **Accepted** December 5, 2020

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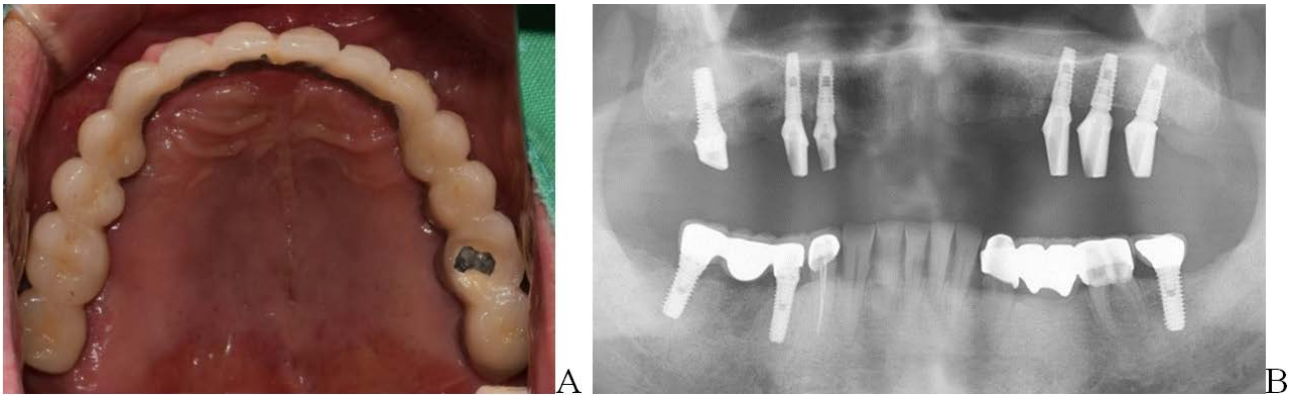

Figure 1. (A) Initial occlusal photo. (B) Initial panoramic radiograph.

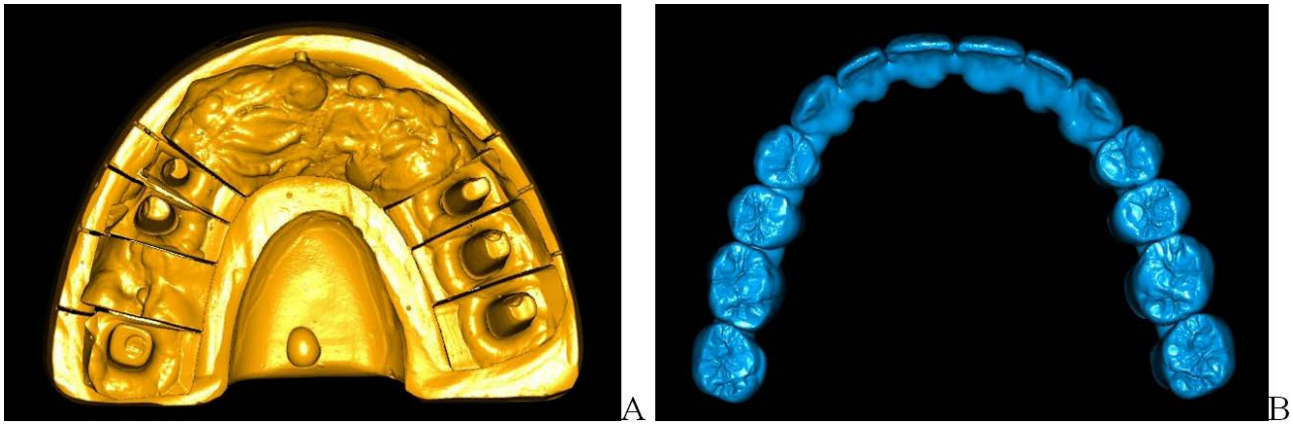

Figure 2. (A) Digital scan of maxillary stone cast. (B) Design of the first provisional prosthesis.

dibular joint disorder was found.

The patient agreed to replace his previous fixed prosthesis with new monolithic zirconia in the maxilla, refusing removable dentures. The prior implants were considered in good condition.

The maxillary impression was taken with an additional type silicone impression material (Virtual; Ivoclar Vivadent, Schaan, Liechtenstein) and a stone cast (Esthetic-rock; dentona AG, Wipperfurth, Germany) was made (Figure 2). The master cast was then digitized using a desktop scanner (IDC S1, Amann Girrbach, Koblach, Germany).

A provisional complete-arch fixed implant supported prosthesis was fabricated based on the digitized data using a CAD software program (IDC D1; Amann Girrbach, Koblach, Austria), a five-axis milling machine (IDC MILL 5X; Amann Girrbach, Koblach, Austria) with a polymethyl methacrylate resin block (Vipi Block Trilux; VIPI, Pirassununga, Brazil) (Figure 3). The provisional restoration afterward was delivered to the oral cavity with a temporary cement.

Dental implants (AnyOne, MegaGen, Daegu, Korea; Ø4.0 × 10 mm) were additionally placed in the anterior edentulous area to reinforce the support of prosthesis. In the follow-up period, the provisional prosthesis was modified based on the patient's request. The thickness of the prosthesis was reduced and the line angles were rounded.

The second provisional prosthesis was fabricated after 3 months of the first provisional delivery. An intraoral digital scanner was used to copy the modified shape of the first prosthesis (Figure 4), and the scan image was transferred to the CAD software where the scan was a template for designing the second provisional (refitting). The second design was converted to acrylic prosthesis using the milling process (Figure 5). In the second provisional, palatal surfaces of incisors and canines became more concave, and the height and volume of cusps in molars were reduced and rounded up. Figure 6 shows the difference between designs of first and second provisional prostheses.

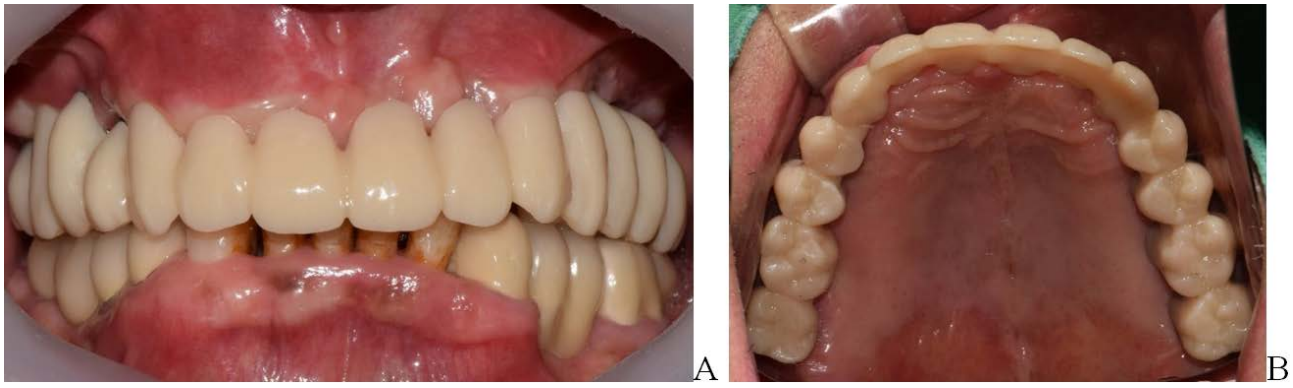

Figure 3. The first provisional prosthesis. (A) Frontal view. (B) Occlusal view.

Figure 4. Direct digital scanning of clinically modified provisional prosthesis to use it as a template for designing the second provisional prosthesis.

Figure 5. The second provisional prosthesis.

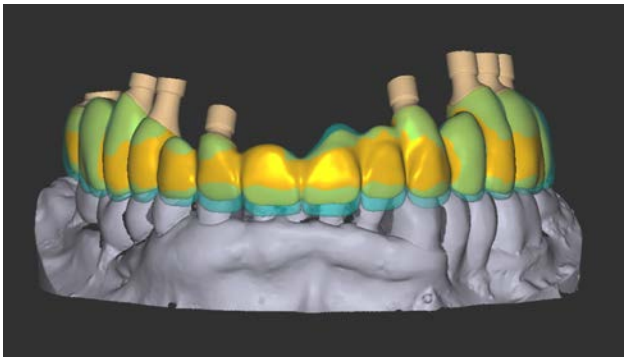

Figure 6. Superimposing the designs of first (green) and second (yellow) provisional prostheses.

Figure 7. Definitive implant-supported monolithic zirconia prosthesis. (A) Frontal view. (B) Occlusal view.

The definitive prosthesis design was acquired by digital scanning the second provisional that was also modified based on the patient's demands in the follow-up period. A monolithic zirconia block (Zolid fx white; Amann Girrbach, Koblach, Germany) was chosen as the material for the final prosthesis. The definitive zirconia prosthesis was placed on the customized abutments using a resin cement (RelyX Unicem Clicker; 3M ESPE AG, Seefeld, Germany) (Figure 7). The patient was satisfied with the predictability of treatment workflow, and esthetics and function of the prosthesis.

DISCUSSION

The fabrication of properly contoured and adequately-fitting provisional prostheses is a prerequisite for the success of the overall prosthetic treatments[10]. Once the provisional prosthesis is approved by the patient, the contour can be subsequently duplicated in the definitive prostheses. Nowadays, the CAD-CAM technologies offer the possibility to produce dental prostheses with many benefits including access to almost defect-free, industrially prefabricated, and controlled materials. Moreover, commensurate data storage in a standardized chain for communication results in an improvement of precision for planning treatment, as well as an increase in efficiency[11]. As for technique, the conventional fabrication of provisional prostheses is associated with some shortcomings affecting the mechanical strength such as mixing procedures and filling the over-impression leading to errors like the incorporation of voids that compromises the mechanical strength. Some human errors, such as voids in stone casts or deformation of impressions are eliminated in CAD-CAM technologies and thus digital prostheses produce superior results[12]. Furthermore, the CAD-CAM process can be employed for the fabrication of permanent prostheses, as well as temporary prostheses to be milled from industrially produced blocks[13].

Various materials have been used in the fabrication of provisional prostheses. Clinically, the mainstay of materials is still autopolymerizing polymethyl methacrylates (PMMA). The selection of the appropriate provisional material and technique for fabrication should be based on the inherent strengths and weaknesses of the material itself, coupled with the specific goals for that phase of treatment[14]. In the cases involving complex treatment over a prolonged period, these provisional prostheses must maintain their structural integrity throughout the diagnostic and restorative phases. To ensure these objectives, the material used to fabricate the interim prosthesis ideally should have a low polymerization shrinkage to satisfy biologic and esthetic needs as well as mechanical requirements, such as resistance to functional loads. Hence, the treatment in this clinical report, the cross-linked PMMA blocks which have been previously polymerized are milled to produce the provisional prostheses of better strength as well as homogeneity. In this treatment of a complete maxillary edentulous patient with a long-term provisional restoration toward the goal of a monolithic zirconia definitive restoration, the virtual design drawn by the computer software program can be used for both the provisional and definitive prostheses. Accordingly, the CAD-CAM provisional restoration becomes the direct reference for estimating the prognosis of the definitive restoration. Moreover, the initial design can be shaped to accommodate the clinical requirements and patient satisfaction collected during the provisional restoration use[6]. In the current clinical report, image superimposition, and computer de-

signing tools have been used to modify from time to time the provisional prosthesis directly based on patient's feedback; furthermore, the double- scan images and superimposing of the interim images allowed clinicians to quickly analyze and recreate a new restoration based on existing one without committing the previous omission. With this digital workflow, different scans were superimposed to obtain a single file containing essential information. Parameters including esthetic qualities, functional vertical dimension, occlusal relationships were digitally transferred from the original dentition to the virtual arches[15].

The drawback of this clinical case is that this zirconia approach is not appropriate for patients with a severe loss of vertical dimension, inadequate occlusal scheme, or abnormal occlusal or incisal planes. Although a reduction of the number of appointments and increased quality of esthetics are the main advantages, the expenditure of the whole procedure is still a limitation. The associated cost to virtual designing and planning software, the system-specific training for this software may increase overall procedure cost for both clinicians and dental technicians.

CONCLUSION

Digital techniques incorporating digital scanning, design refitting, machine processing of provisional prosthesis could be effective tools in customizing the definitive prosthesis in the cases with comprehensive tooth loss.

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