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Case Report

Digital oral rehabilitation with cast partial denture: A clinical report

Ambika K. Narayanan[1], Poonam Prakash[1]

[1]Department of Dental Surgery and Oral Health Sciences, Armed Forces Medical College, Pune, Maharashtra, India.

***Corresponding author:**
Poonam Prakash,
Department of Dental Surgery and Oral Health Sciences,
Armed Forces Medical College,
Pune, Maharashtra, India.

pnmprakash@yahoo.co.in

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ABSTRACT

Digitization has slowly become the new conventional technique today offering multiple advantages, its application in the field of implantology and fixed prosthodontics has been time tested, and its gradually being utilized in removable prosthodontics also. Digitization allows digital surveying, designing the framework with components, and obtaining a 3D printed resin framework, which can be tried intraorally and cast using conventional techniques. This technology is time-saving, highly accurate, also allows digital archiving of casts. This case report presents rehabilitation of a partially edentulous mandibular arch opposing completely edentulous maxillary arch using digital technology and casting using conventional technique.

Keywords: Digitization, 3D printed resin framework, Cast partial denture

INTRODUCTION

Removable partial dentures are one of the conservative and cost-effective treatment options for rehabilitation of partially edentulous arches, resulting in an overall improvement in quality of life.[1,2] However, the laboratory procedures involved in its fabrication are complex, time-consuming, and require manual dexterity. The advent of digital technologies has revolutionized the procedure by effectively reducing the overall duration of prosthesis fabrication; eliminating chances of human errors, thus optimizing functional and esthetic outcomes.[3] Digitization in RPD framework construction is based on two different processes: subtractive or additive techniques. Subtractive manufacturing involves milling the framework from a metal block by a computer numerical control machine. The subtractive procedures are greatly suited to the fixed prosthesis. Their implementation is more difficult to produce RPD framework, due to increased manufacturing time, the complexity of the framework, material cost, and wear.[4] Rapid prototyping (RP), also known as additive manufacturing, is an umbrella term for various processing technologies that fabricate precise three-dimensional (3D) models directly from computerized 3D data in a short time using layer-by-layer building technique.[4,5]

Presented herein is a case report of a patient where a partially edentulous mandibular arch opposing completely edentulous maxillary arch, was rehabilitated using combined digital and conventional techniques.

CASE REPORT

A 65-year-old female presented with completely edentulous maxillary and Kennedy's Class 1 mandibular arches. The patient had no contributory medical history and displayed a philosophical attitude. Intraoral examination revealed a residual dentition (34, 33, 32, 31, 41, 42, 43, 44, and 45); which were periodontally stable [Figure 1]. Routine hematological and radiological investigations were within normal limits. Diagnostic impressions were made with irreversible hydrocolloid impression material (ZhermackTropicalgin) for the mandibular arch. A primary impression made using a high fusing impression compound (DPI Pinnacle) was made for the maxillary arch. Maxillomandibular relations were recorded and diagnostic mounting was done on a semi-adjustable articulator to evaluate the inter-arch space. Based on clinical and radiographic examination which confirmed the provisional diagnosis and a comprehensive prosthetic treatment plan was devised and explained. However, an implant-supported prosthesis was ruled out, due to the patient's unwillingness to undergo surgery and the cost involved. Hence, after obtaining written informed consent of the patient a complete cast metal denture base for the maxillary arch opposing a cast partial denture for the mandibular arch was planned.

Pre-prosthetic phase

Before starting prosthetic treatment patient underwent motivation, education and scaling and root planing.

Prosthetic phase

Mouth preparation for mandibular teeth - Guide planes were made on the distal terminal abutments and the rest seat preparation was done on 34, 35, 43, and 44. Final impressions were made both for the maxillary and mandibular arches and the master cast was surveyed.

Digitization

Designing of framework components using ExoCad and fabrication of 3D castable resin framework.[5]

A digital and conventional method of fabrication of the partial denture framework was decided. Digital designing of the framework was done using specialized software (ExoCad) through a series of digital steps that simulate conventional laboratory procedures. First, a digital surveying tool automatically determines the path of insertion. The software rotates the casts three-dimensionally to achieve the best tilt for the path of insertion, measuring the depth of undercuts and parallelism [Figure 2]. The survey line is created automatically, based on these calculations. In comparison to the conventional manual procedure, this virtual step saves time and labor. The undesirable undercuts are blocked digitally after establishing survey lines [Figure 2]. The area for placement of direct retainers and the retentive terminals are decided. Thin layers of virtual wax are added on relief areas, after which various components - includingl linguoplate major connector with a step back design, occlusal rests on 34,

Figure 1: Pre-treatment.

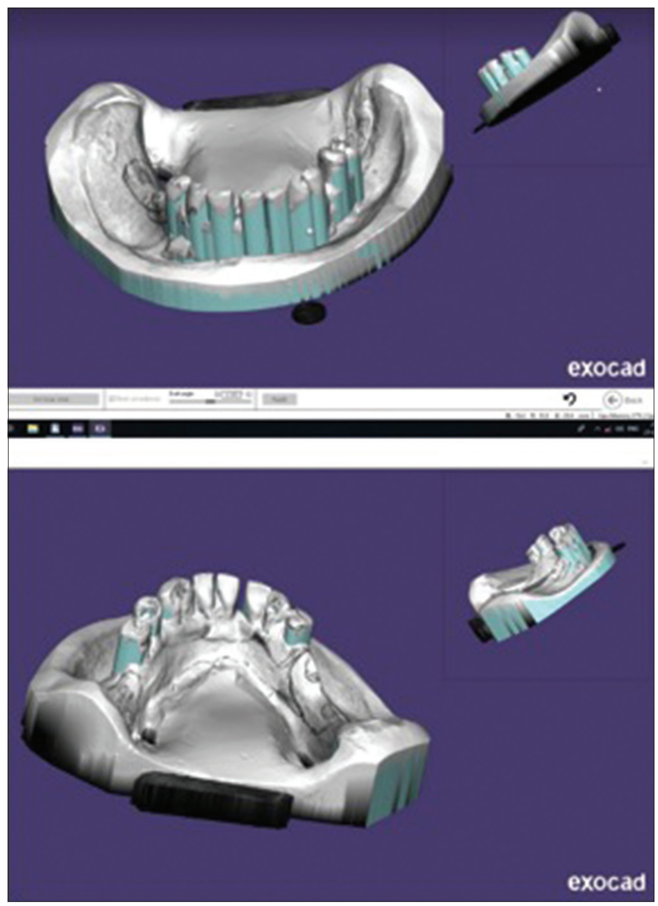

Figure 2: Virtual determination of path of insertion and virtual block out of undesirable undercuts.

35, 44; cingulum rest on 43; embrasure clasps on 34, 35; I-bar clasp on 44; proximal plates on distal surfaces of 35, 44; and minor connectors were added [Figure 3] and [Figure 4].

The clasp systems were drawn three dimensionally. After complete adjustment of the framework, rests, finish lines,

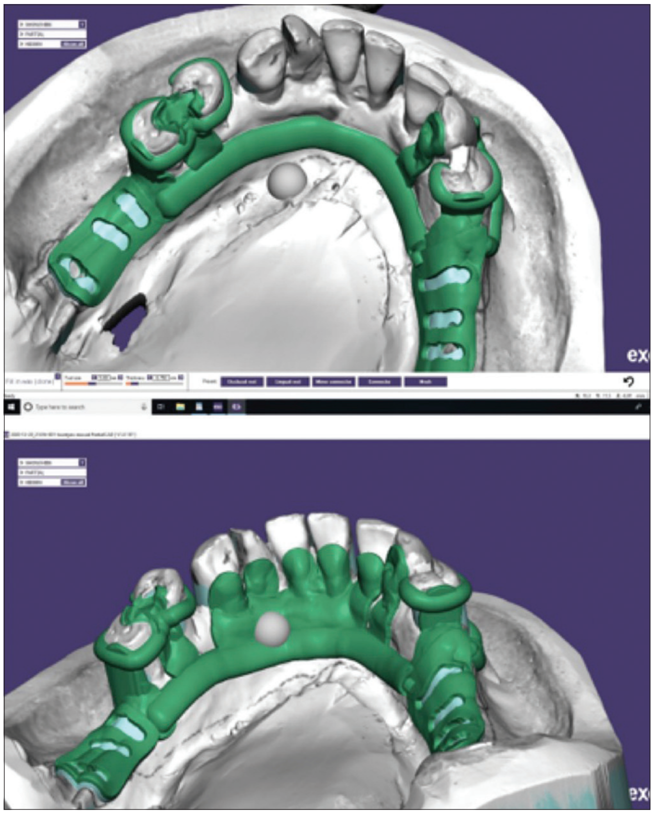

Figure 3: Designing the Linguoplate major connector and rests.

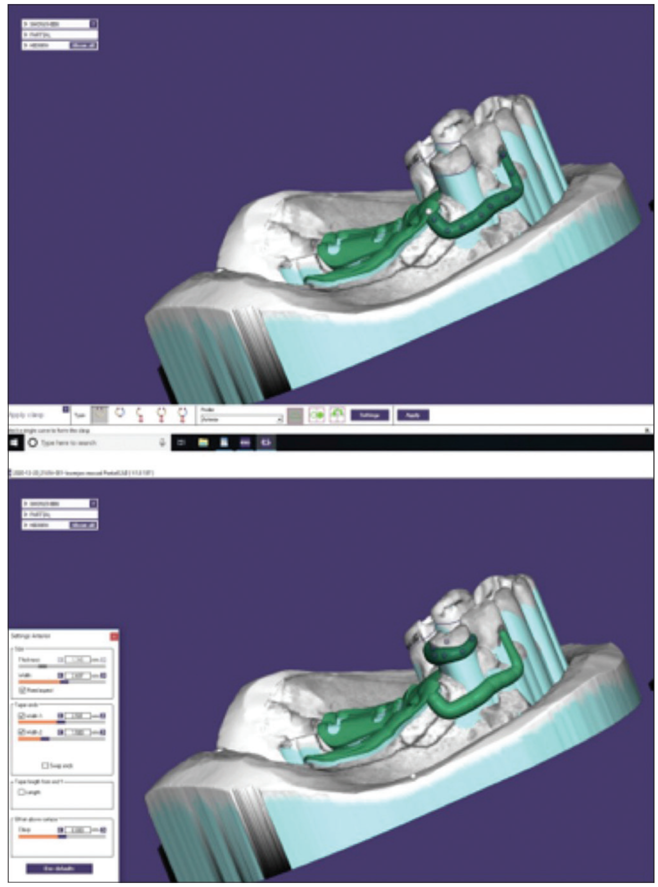

Figure 4: Virtual designing of clasp arms.

and connectors were drawn with customized tools of software [Figure 5]. For the maxillary arch, a complete palate major connector with a mesh pattern as a minor connector was designed [Figures 6 and 7]. Supports were added to hold the framework in position. The entire designing procedure required about 40 min per framework. A standard triangulation language (STL) file of the framework was created [Figure 8]. The STL file of the designed framework was then transferred to a 3D printer. This professional 3D printer uses a digital light processing (DLP) technology, a process like stereolithography (SLA). An HD resolution DLP projector, using a LED light source to photo cure liquid resin (MAZIC[R] D CAST), layer by layer to build a 3D resin framework pattern of the RPD. After the printing was finished, the building platform was removed from the machine.

Post-processing curing: The printed jobs were rinsed with ethanol and ultrasonicated for 5 min in isopropyl alcohol to remove any excess material, using ultrasonic baths. The printed job was dried to free alcohol residue. The 3D printed materials were post-cured in a UV curing unit (Vericom MAZIC[R] D Oven) by UV light treatment for final polymerization. The support structures were removed using conventional finishing burs. The 3D printed resin framework was tried intra-orally and evaluated to confirm the fit, accuracy, and extensions [Figure 9]. Care was done to store the printed job under dry and dark conditions. The printed resin pattern of the digital RPD was then invested and cast in cobalt-chromium (Co-Cr) (BegoWironit) using the conventional casting technique. Metal try-in of the framework was performed to check the fit and accuracy [Figure 10]. Maxillomandibular relations were recorded, teeth arrangement (Dentsply Sirona Cosmo HXL) with bilateral balanced occlusion was done and after the trial of the waxed-up denture, the processing of RPD was done in the usual manner. The prosthesis was then inserted [Figure 11].

Maintenance phase

The patient was instructed to carefully perform oral hygiene measures. The patient was kept on regular follow visits to check the fit and function of the prosthesis.

DISCUSSION

RP technologies include SLA, selective laser melting (SLM), selective laser sintering, selective deposition modeling, fused deposition molding, 3D printing, and direct inkjet printing.[4,5]

Eggbeer *et al*. are documented as the first to build resin RPD frameworks with a SLA apparatus (SLA-250) machine which

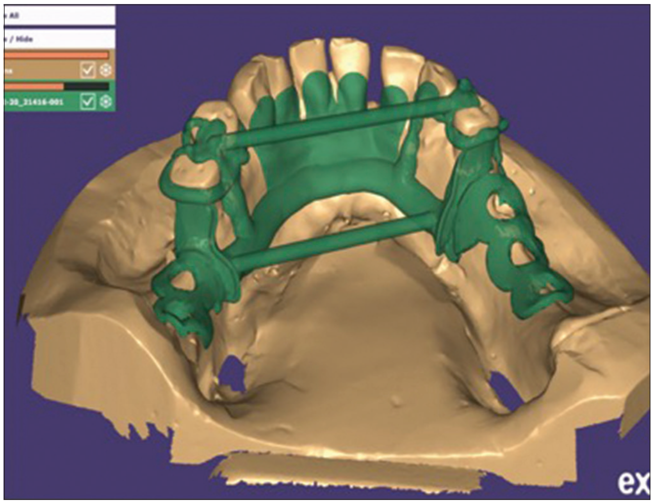

Figure 5: Virtual drawing of the finish line and adjustments.

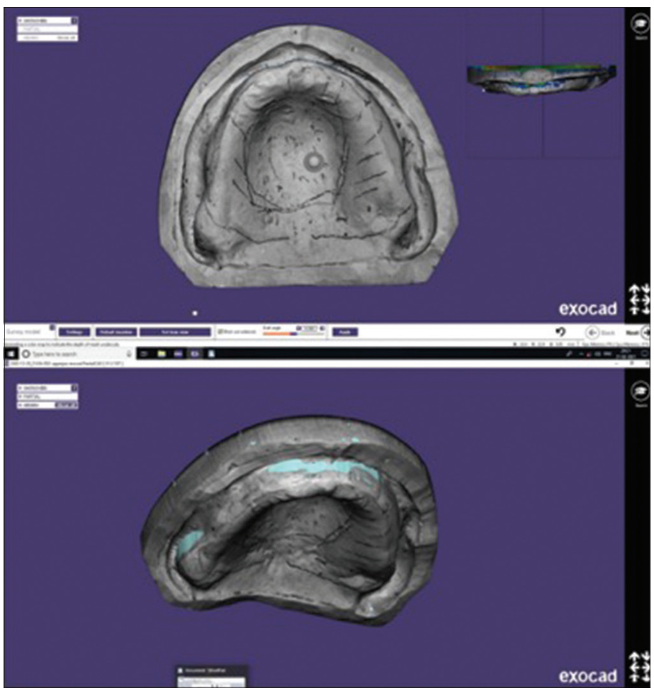

Figure 6: Virtual determination of path of insertion, digital surveying, and block out.

was popular at that time.[6] These frameworks were then cast in a Co-Cr alloy using conventional methods. The first Co-Cr RPD framework manufactured directly by SLM for a patient is credited to Williams *et al*.[7]

The main benefits of introducing CAD/CAM in the fabrication of the RPD framework involve automatic determination of a proposed path of insertion, the immediate removal of undesirable undercuts, and the rapid identification of desirable undercuts. Not only is it a time-saver, but also the CAD/CAM technology delivers inherent repeatability, which may assist in decreasing human errors

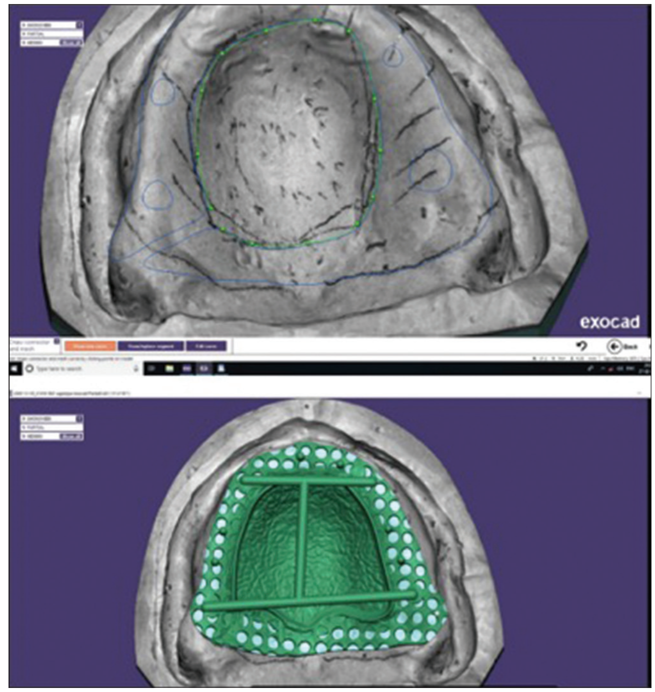

Figure 7: Marking extensions for major connector and designing.

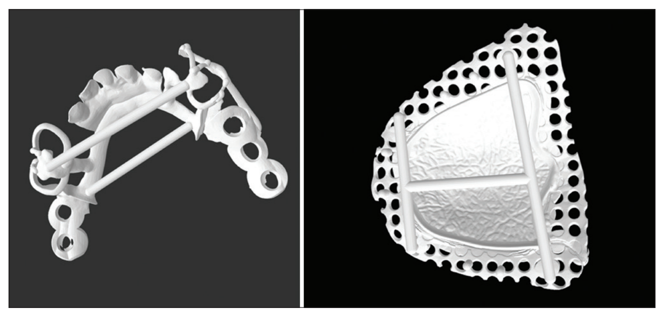

Figure 8: STL file generated.

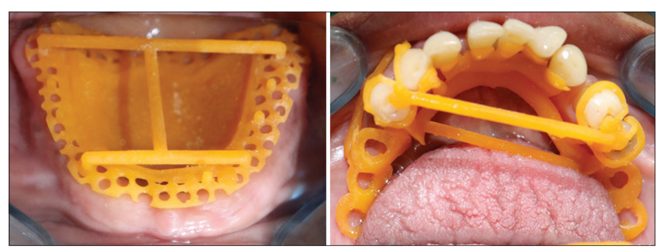

Figure 9: 3D printed resin framework trial.

and enhance quality control in the dental laboratory.[7] The advantage of this digital-conventional method lies in the fact that due to the fabrication of a 3D printed resin model, the dexterity of lab procedures of cast block out, duplication, wax pattern fabrication was avoided, thus saving the valuable laboratory and patient's time. The master cast could be saved. The digital designing on a 3D E-model helped in assessing and surveying the cast, blocking out undercuts,

Figure 10: trial of finished metal framework.

Figure 11: Final prosthesis insertion and post-treatment.

and accurate designing of the framework.[5] The trial of the resin framework could be done, which is not possible with a conventional wax pattern; which helped in the evaluation of the framework. Conventional wax pattern adaptation requires human intervention and materials manipulation that may inherently induce processing shrinkage and/or expansion. This may lead to increased processing errors and inaccuracies which may explain the decreased retention values of conventional dentures in comparison to those of digital dentures.[8,9] Furthermore, the cost incurred in designing the 3D resin model is much lesser than the cost of milling of a metal framework, since the conventional procedure of casting the metal framework is carried out.[10] The fit and accuracy of the cast metal frameworks and the patient satisfaction with the prosthesis were excellent.

CONCLUSION

Digitization in cast partial denture construction offers rapid production and reduced manual errors. The 3D printed resin frameworks although require further processing in the form of casting; it provides a cost-effective alternative for the expensive milled cobalt-chrome frameworks. It is also possible to invest multiple frameworks to reduce time and material expense. This technique in addition to lessening the laboratory steps, helps to achieve a better reproducibility and adaptation of the prosthesis. Hence, this technique carries the potential to be a mainstay procedure in the future.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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