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Case Report

Virtual yet veritable – Digital dentures

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ABSTRACT

Digitally produced complete dentures has become a popular option due to their added advantages in fabrication of higher quality of dentures and ease. Additive and subtractive technologies of digital systems are one of the upcoming techniques in dentistry. However, both these technologies have similar steps and time frames for their processes, additive technique holds an upper hand in conservation of milling block materials. The production of maxillary and mandibular complete denture prothesis also involves similar steps and techniques. The aim of this case report is to throw light on the upcoming technology in reducing the time constraints while fabricating complete dentures in geriatric patients.

1. Introduction

Teeth loss is more common in old age. Edentulism along with longer life expectancy efficiently results in an increasing demand for partial and complete dentures (CDs).[1,2] Traditional techniques for fabrication for complete dentures have not changed for a long time and include several appointments for the patient, complex steps for the clinician and laborious procedures for the dental technician.[3]

Since its introduction in the 1980s, digital dentistry, has taken a revolution in digital technology and robotics, has changed many aspects of the dental practice. Treating edentulous jaws with CDs is no exception. Computer-aided design and computer-aided manufacturing (CAD/CAM) methods for complete denture (CD) fabrication are on recent trend.[3,4]

Nowadays, the fabrication of CDs using CAD/CAM methods has attracted a lot of attention from the industry, resulting in breakthroughs in both the design and in the manufacturing sectors.[5–9] This new technology is promising and a better tool for prosthodontic rehabilitations.[10]

2. Digitally Produced Dentures

These systems mainly work on the commercially available CAD software tools, which aid in designing dentures for maxillary or mandibular or for both the arches. Clinical recording methods for scanning the tissue surface of the denture are still upcoming and are highly reliable on the used systems.

There are two methods to obtain a successful tissue record. They can either directly scan the underlying tissues using an intraoral scanner or by scanning the stone cast or the impression using a desktop or intraoral scanner. In spite of these above mentioned advantages of collection and merging of intraoral scans to transferring the records to the virtual articulators, this technology still lacks in the sector of registering maxillomandibular relationships.

These digitally produced CDs also requires the construction of denture bases with wax rims for fabrication

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of digitally produced CDs. Records obtained using these denture bases and rims can be scanned and files are analyzed by digital systems and properly aligned with underlying tissues for supporting the dentures.[11] Post scanning of the casts and obtained maxillomandibular relations they are imported to the corresponding CAD software, where the surface of the denture is designed. The jaw movement and relation between the maxilla and mandible can be reproduced by the computer software, which are generally available in the CAD software which are currently in use.[12]

These software programs are known as virtual articulators. The CAD software also allows tooth selection, arrangement of artificial teeth, thereby bringing the occlusion in the virtual articulator. Above all of these advantages, the digital systems also possess drawbacks which needs to be improved in the upcoming years of practice. The CAM part of the digital fabrication of CDs, there are two principal methods for manufacturing them namely, additive and subtractive. Nonetheless, both require the appropriate three-dimensional (3D) denture design CAD files.[13]

2.1. Additive method

The additive method (also called rapid prototyping) was introduced in 1981 and can be called as 3D printing.,[14] this included a combination of techniques, which fabricates a object by adding layer by layer based method based on the corresponding CAD software. Briefly, digitally produced dentures using 3D printing technology comprises of manufacturing denture base in pink colored materials, whereas, the denture teeth are either printed individually or in complete arches using tooth shade materials. Later printed teeth are luted to the denture bases with liquid material from the printer tank and light cured for polymerization. These dentures are of high details and smooth surfaces.

2.2. Subtractive method

This methods includes milling techniques using red pigmented resin discs for denture bases and teeth are milled using customized or preformed series and bonded to the denture bases.[15] Though there are a lot of commercially available CAM systems, these software should be compatible with the milling discs for fabrication of CDs.

3. Case Report

A 66-year-old female patient was presented to the Department of Prosthodontics, for the replacement of completely missing upper and lower teeth in the front and back teeth region (Figure 1). Her medical history was noncontributory and revealed excellent mental clarity, good general health in the absence of general diseases. The clinical examination revealed completely edentulous maxillary and mandibular arch.

The patient was informed about the treatment plan of fabrication of upper and lower complete denture prosthesis using digital technique. Considering the main complaint of the geriatric patient, execution of the treatment plan was initiated with fabrication of a new upper and lower complete dentures, which was accepted by the patient. The combined workflow of traditional and digital protocols for the fabrication of both maxillary and mandibular CDs comprising of various clinical and laboratory steps are listed in this report. This case was designed using CAD program: the Dental System 2019 program (3Shape A/S, Copenhagen, Denmark).

3.1. Clinical session – Impression making

In the first appointment, preliminary impressions were taken with impression compound using stock impression trays and casts were obtained by pouring in dental plaster. (Figure 2A-B) Custom trays were fabricated, border molding was done, and secondary impressions were made in light body elastomeric impression material (Aquasil Ultra LV Dentsply Caulk). The impression were beaded and boxed using modeling wax and master casts were obtained using (type IV) dental stone (Figure 3A-B).

In the next clinical appointment, occlusion rims were fabricated using modelling wax and jaw relation was recorded. Maxillomandibular relationship (MMR) was registered with a bite registration material (Jet bite; Coltène). (Figure 4)

3.2. Laboratory step

3.2.1. Scanning of the Maxillomandibular relation

Casts and established MMR were scanned separately with an 3S lab scanner. MMR was scanned for the digital design of teeth and gingival tissues. (Figure 6A-D) The scanned digital files were imported into the CAD software for processing. The casts were aligned by selecting the reference points.

The occlusal plane was determined by the digitized wax rim in the Dental System 2019 program (3Shape™ A/S, Copenhagen, Denmark). The functional borders of the denture were selected and designed. The marking of the appropriate reference points on the alveolar ridge (canines, incisive papilla and maxillary tuberosity) followed for tooth set-up (Figure 7A-B). After the initial selection of size and shape, teeth were further individualized for the needs of the occlusion in this case. Post completion of teeth arrangement, denture base was designed and tissue surface was printed. An important factor is denture base fabrication is the thickness of the palatal part of the upper denture, which was chosen to be 1.5mm in this case. Finally, a monolithic trial denture was manufactured utilizing a 3D

printer (Asiga Max UV™, Sydney, Australia) designated for rapid prototypes

3.2.2. Clinical session- Try in

The try – in was evaluated and approved in the following clinical visit (Figure7A-C) and was allowed to stay in patient's mouth for 30 mins to allow recording the functional movements of tongue and to check for retention, stability, and speech. (Figure 9)

3.2.3. Laboratory steps – Digital fabrication technique

Denture base and artificial teeth were printed individually using 3D printer (Next dent 5100). Denture base was milled in a 30 mm PMMA pink puck (IvoBase™ CAD, Ivoclar Vivadent® AG, Schaan, Liechtenstein), while teeth were milled in a 20 mm tooth-colored multilayered resin puck (SR Vivodent® CAD Multi, Ivoclar Vivadent® AG, Liechtenstein). Teeth were temporarily mounted with hard wax to check for occlusion (Figure 10).

Once checked and verified, hard wax is removed. The teeth sockets and the cervical part of teeth were abraded with 50 μm aluminum oxide sand blasting, thoroughly cleaned, chemically activated with methyl-methacrylate monomer and bonded with a specially designed PMMA cold-curing resin for digital denture teeth bonding (IvoBase CAD Bond™, Ivoclar Vivadent® AG, Liechtenstein). Denture teeth and denture base can be stained using coloring agents for characterization, if any.

3.2.4. Clinical session – Insertion of digital complete dentures

In the following clinical session, the 3D printed upper and lower complete dentures are inserted (Figure 11). These inserted dentures were checked intraorally for retention, denture extensions, support and occlusion. Patient was instructed with regular denture maintenance and oral hygiene instructions for better oral health and prosthesis function. Patient was recalled after one week for a regular post-insertion review.

4. Discussion

There are lot of systems for fabrication of complete dentures using digital technology in today's practice. Hence, all these systems in use should be mastered by the clinicians and technicians for their ease.[16] The advantages of digital techniques possess higher mechanical properties, which are fabricated using pre-polymerized polymethyl methacrylate blocks. They have also proved to have improved fit when compared with conventional dentures.[17]

The main ideology behind this new technology is the reduction of chairside time for both the clinicians and patients, where the time can be invested in more urgent or profitable treatments.[9] The goal is to shorten the denture-making technique and to improve the final product.[18]

Fig. 1: Pre op extraoral

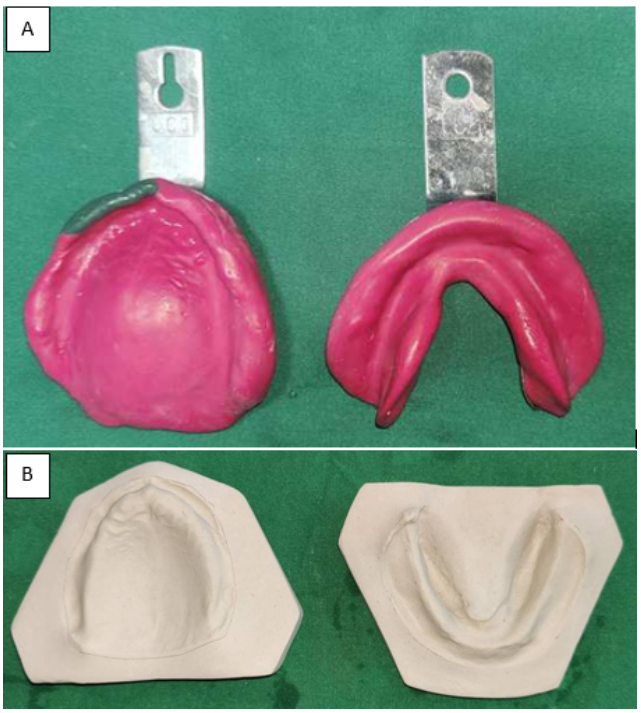

Fig. 2: A: Primary impressions; **B:** Primary maxillary & mandibular casts

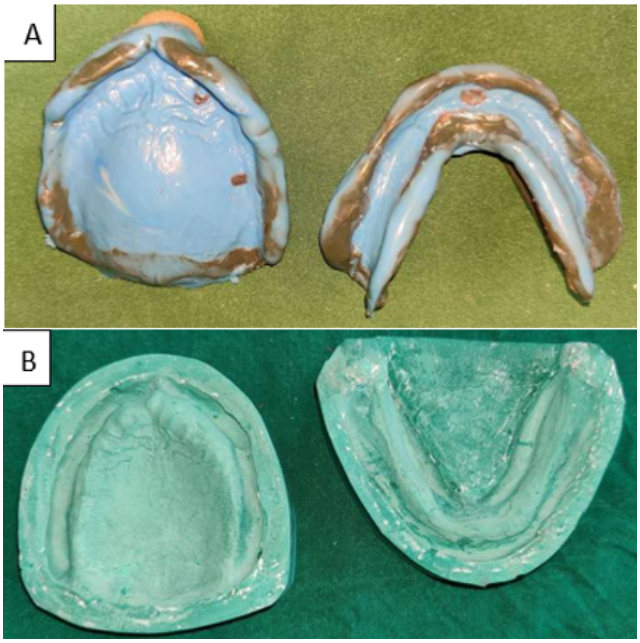

Fig. 3: A: Secondary impressions; **B:** Master casts

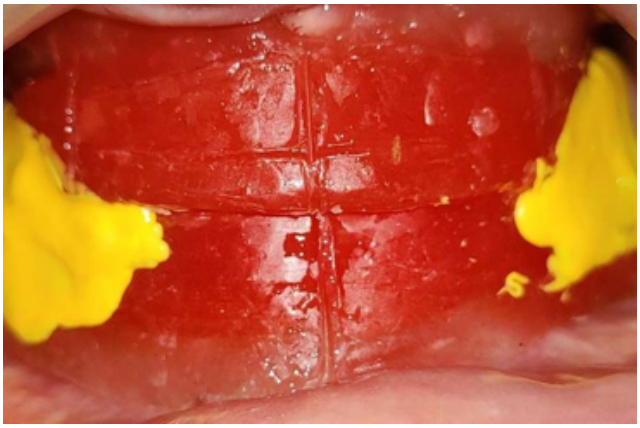

Fig. 4: Maxillomandibular record

Fig. 5: Scanning of maxillomandibular record

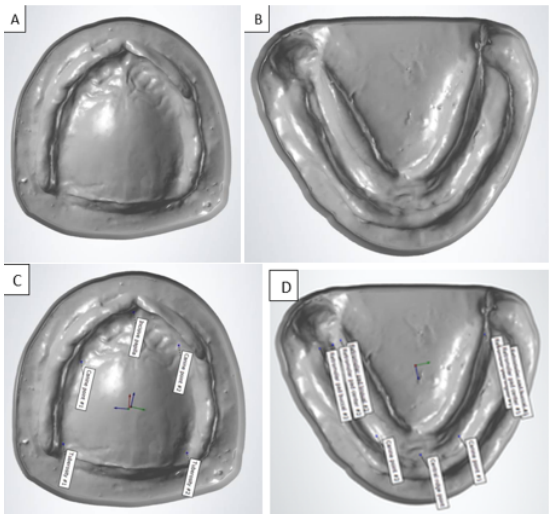

Fig. 6: A: Scanned maxillary master cast; **B:** Scanned mandibular master cast; **C:** Maxillary master cast – anatomical landmarks; **D:** Mandibular master cast – anatomical landmarks

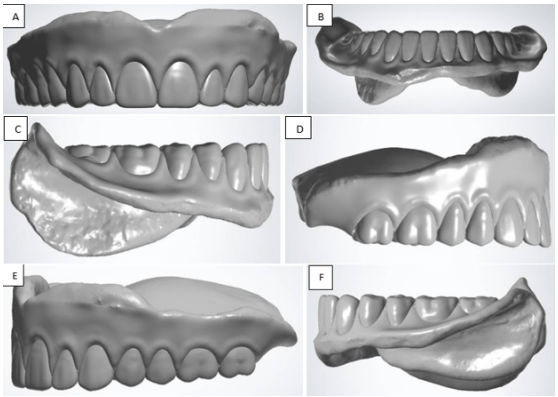

Fig. 7: A: Maxillary teeth arrangement – frontal view; **B:** Mandibular teeth arrangement – frontal view; **C:** Mandibular teeth arrangement – right lateral view; **D:** Maxillary teeth arrangement – right lateral view; **E:** Maxillary teeth arrangement – left lateral view; **F:** Mandibular teeth arrangement – left lateral view.

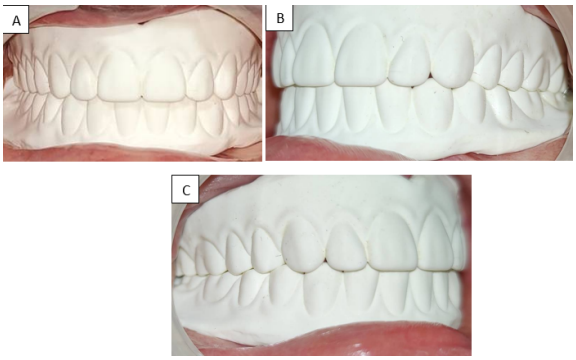

Fig. 8: A: Try in – frontal view; **B:** Try in – left lateral view; **C:** Try in – right lateral view

Fig. 9: Post op extraoral

Fig. 10: Processed & finished maxillary and mandibular dentures – lateral view

Fig. 11: Finished maxillary and mandibular dentures – occlusal view

However it is unclear, whether the digital techniques are leading to faster fabrication of cases, which likely to be stated by the system's protocol.[19]

The added advantages with this digital era includes that the conventional dentures require professional skills that develop in overall practice and experience, where the outcome is technique sensitive and processing errors will lead to repetition of numerous steps. Moreover the patient records are difficult to save and store in conventional techniques, which can easily accessed using digital technology for the later years.[4]

Combinations of conventional and digital approach can be applied in the upcoming years for a better ease of fabrication. By the knowledge of the currently used software, students and dentists can efficiently include digital technology in their day-to-day practice especially during the COVID-19.

Additionally, a large number of combinations between the classic treatment procedure and the digital approach can be applied. With the appropriate software, students can even follow up the production steps remotely or in asynchronous distance learning set-ups, the value of which is easily recognizable, especially nowadays, during the COVID-19 pandemic.

5. Conclusion

Digitally produced complete dentures are well adaptable, enabling the combination of conventional technique in clinical practice with the latest CAD/CAM advances in the laboratory setting. This new technology provides both the clinician and patients with promising better results, thereby promoting the profession to a higher level. Nevertheless, this track should not be taken without consideration and careful treatment planning.

6. Conflict of Interest

The authors declare that there is no conflict of interest.

7. Source of Funding

None.

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