Case Report

Using 3D-printed duplicate dentures as an impression method in a patient with severely limited mouth opening after tumor excision and graft repair: A clinical report

Fu-Chuan Tsai, DDS[a], Chia-Yuan Hu, DDS, MS[b], Tong-Mei Wang, DDS, PhD[c], Tsung-Chieh Yang, DDS, PhD[d]

[a]Graduate Student, Graduate Institute of Clinical Dentistry, School of Dentistry, National Taiwan University and National Taiwan University Hospital, Taipei, Taiwan

[b]Attending Staff, Department of Dentistry, National Taiwan University Hospital, Taipei, Taiwan

[c]Assistant Professor, School of Dentistry, National Taiwan University and National Taiwan University Hospital, Taipei, Taiwan

[d]Associate Professor, School of Dentistry, National Taiwan University and National Taiwan University Hospital, Taipei, Taiwan

Running title: 3D printed duplicate denture as impression tray

Corresponding author:
Tsung-Chieh Yang
National Taiwan University, School of Dentistry, No 1, Chang-Te street, Taipei 100, Taiwan
E-mail: yangtc@ntu.edu.tw
Tel: +882-2-23123456 ext. 67718

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Abstract

Prosthetic management of edentulism can be challenging with the presence of severely limited mouth opening and oral movement, especially in patient with tumor excision and graft repair. Adjusting the current denture and then duplicating it for closed-mouth impressions is one method to effectively record the tissue and polished surfaces, and the vertical dimension. This clinical report describes a method for using 3-D printed duplicate interim dentures as impression trays to reproduce the denture space, including polished surfaces and vertical dimension, in patients with limited oral movement after extensive surgical procedures. Interim complete dentures were placed in the edentulous maxilla and mandible with multiple extensions of the denture base and adjustments of the polished surfaces. After the oral function improved, the interim dentures were duplicated and designed as impression trays to record the form as adapted by the patient during daily use. This method, together with computer-aided design and manufacturing, provides a more efficient method of fabricating removable prostheses. During the 2-year follow-up period, the patient's masticatory function and physical appearance improved.

Key words: Limited mouth opening, 3D printed duplicate denture, close mouth impression

Introduction

Prosthetic management of patients with extensive surgical procedures can be challenging due to the presence of severely limited mouth opening and interocclusal space[1,2]. For the dentist involved in prosthodontic treatment of such patient, restricted maximal opening commonly leads to compromised impressions and prostheses, especially in removable dental prostheses[3]. The conventional fabrication of complete dentures is founded on several anatomical landmarks and reference planes[4,5]. The loaded impression tray is the largest item requiring intraoral placement in this process. However, it is difficulty in patient with restricted opening ability to record the morphology of edentulous ridge properly[2]. To overcome the challenge of clinical variations in edentulous ridges, a method has developed by using the current denture as an impression tray after morphological adjustments to record the tissue and polished surfaces in a duplicate denture[6-8]. The key factor for this method is adjusting the current dentures

till it had been adapted physically and then duplicating accurately. With the development of digital approaches, such as optical scanners and computer-aided design and manufacturing, had led to be more precise and easier duplication process [9]. This clinical report describes and evaluates a digital process to duplicate interim dentures for fabrication of the final prostheses in a patient with severely limited mouth opening after extensive surgical procedures.

Case report

A 65-year-old man presented at our department requesting prostheses to improve masticatory function. He had undergone a tumor excision combined with radical neck dissection and graft repair 8 years previously to treat bilateral buccal mucosa and left lateral tongue verrucous carcinoma. Clinical and radiographic evaluations revealed poor oral hygiene, multiple retained roots, and ill-fitting fixed prostheses with marginal dental caries (Figs 1 and 2). The range of tongue movement and mouth opening was limited (maximum mouth opening 10 mm between maxillary and mandibular incisal edges), and the lingual vestibule was shallow due to scar formation and submucosa fibrosis after surgical processes. These factors made it difficult to maintain oral hygiene and even insert an impression tray during prosthetic treatment. After discussion, irreparable teeth were extracted and complete dentures were fabricated during the interim phase (Figs 3 and 4).

Prosthetic treatment began with plastic stock trays (COE space tray; GC Corp, Tokyo Japan) were adjusted to be able to place in the mouth and cover the edentulous ridges as much as possible. And preliminary impressions were taken by alginate impression material (Jeltrate; Dentsply Sirona, York, US). Then border molding and functional impressions of the maxilla and mandible within the available range of motion using standardized portion of low viscosity polyvinyl siloxane impression material (Panasil Initial Contact Light; Kettenbach GmbH & Co KG, Eschenburg, Germany). The vertical dimension and interocclusal record were transferred to a semi-adjustable articulator (Artex CPR; Koblach, Austria). Anterior resin teeth were placed in the wax rim, with adequate horizontal and

Figure 1. Frontal view of the patient.

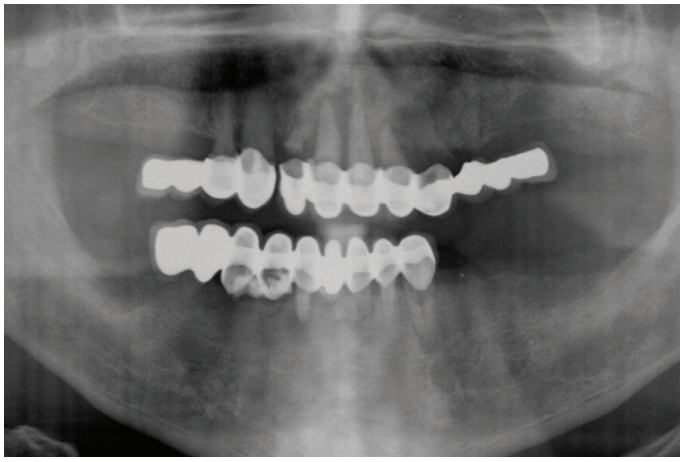

Figure 2. Panoramic radiograph of the patient.

Figure 3. Occlusal view of the maxillary arch after irreparable teeth were extracted.

Figure 4. Occlusal view of the Mandibular arch after irreparable teeth were extracted.

Figure 5. Interim dentures with extension of the denture bases and adjustment of the polished surfaces.

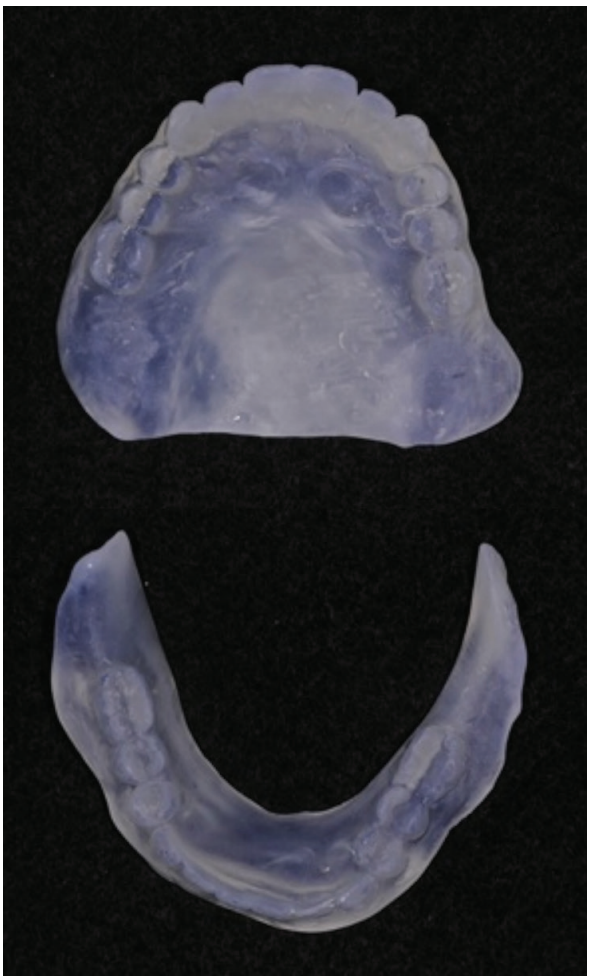

Figure 6. 3D printed duplicate dentures.

vertical overlap and the central fossa of the posterior teeth placed on the crest of the alveolar ridge. The occlusal contacts were adjusted for maximal intercuspation and group function on the working side with balanced contacts on non-working side to improve the stability of prostheses[10]. Due to the limited mouth opening, the morphology of the polished surfaces and extensions of the denture base were evaluated by applying tissue conditioner (Tissue Conditioner II; Shofu Inc, Kyoto, Japan) and self-curing polymethyl methacrylate (PMMA) resin (Unifast II; GC Corp, Tokyo, Japan) several times (Fig 5) After 2 months of regular maintenance, masticatory function was improved.

Regarding the process of definitive prostheses, the interim dentures were scanned with an optical scanner (E3 scanner; 3Shape, Copenhagen, Denmark) and processed with Meshmixer software (Autodesk Inc, California, US). The duplications were printed from NextDent Ortho Clear printable resin (NextDent BV, Soesterberg, Netherlands) using a digital light processing (DLP)-based printer (NextDent 5100; NextDent BV) (Fig 6), serving as a tray for closed-mouth impressions and bite registration (Fig 7). For fabrication of the definitive prostheses, the tooth shape, incisal display, and occlusal plane for tooth arrangement were based on the morphology of the duplication. After trial of the wax dentures, dentures were fabricated by packing with heat-polymerized PMMA resin (Lucitone 199; Dentsply Sirona, Charlotte, US), laboratory remounting, and polishing. Finally, the tissue, occlusal and polished surfaces of the dentures were adjusted several times to maximize oral function (Figs 8,9 and 10). The patient was satisfied with the prostheses and returned for regular 3-monthly follow-ups. No complications occurred during the 2-year follow-up period.

Discussion

Restricted mouth opening ability, oral movement and limited interocclusal space are often encountered in patients who have extensive surgical procedures[1,2]. This situation is a challenge for clinicians due to difficulty in impression during prosthetic treatment. Additionally, poor stability of

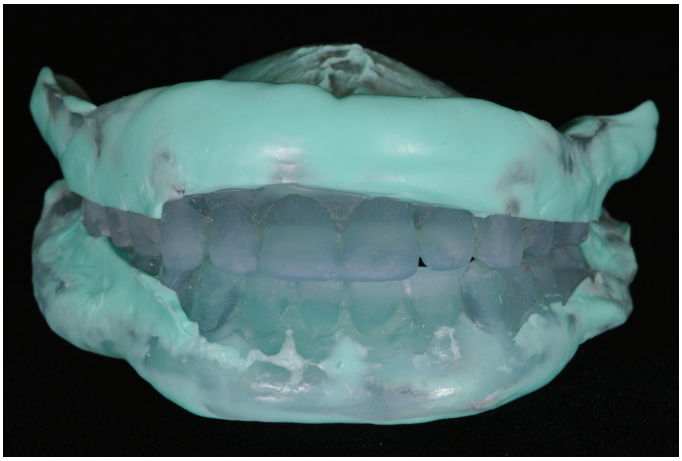

Figure 7. Duplicate dentures as trays for the final impressions and jaw registration.

Figure 8. Frontal view of the patient with final prostheses.

Figure 9. Maxillary view of the patient with final prostheses.

Figure 10. Mandibular view of the patient with final prostheses.

removable dental prosthesis is generally associated with restricted oral movement. Soft tissues form the internal and external boundaries of the denture space, and dentures are more likely to be stable when they are located in a space in which the forces exerted by muscles tend to stabilize the denture[4,5,10,11]. Adjusting the current denture of tissue and polished surfaces till it became stable in the oral cavity, and then duplicating it for closed-mouth impressions is one method to effectively record the tissue and polished surfaces and the vertical dimension[6-8]. In this clinical report with limited mouth opening and oral movement, replicating the interim dentures as impression trays preserves valuable information for fabrication of new prostheses on tooth position, polished surfaces and vertical dimension, as a result of such economized clinical time during fabrication of complete denture was applied. However, the quality of the interim prosthesis influenced the clinical outcome using close mouth impression process with replicated interim denture. If the tooth position, occlusal plane or vertical dimension is obviously inadequate, the conventional process with custom tray to take function impression and occlusal rim to register the jaw relation is more effective.

The duplicate denture technique is not a single technique but a variety of concepts designed to replicate the complete denture. With advances in digital technology, effective and accurate duplications can be achieved with an optical scanner to recode the form, design software to adjust the configuration, and 3D printing technique to produce the shape in minimal time. About different fabrication techniques, Hsu et al[12] compared the adaption of denture bases fabricated by CAD-CAM milled, 3D printed, injection molded and compression molded techniques, and reported the divergent results in 3D printed denture bases both at maxillary and mandibular arches. Additionally, 3D printed denture bases were found to have higher flexibility under loading in this in vitro study[12]. Therefore, the accuracy of 3D printed technique and dimension stability of the materials need to be evaluated furtherly in the future study.

In this clinical report, duplicating the denture space by digital process not only reduced the clinical treatment time, but also provided important information for the fabrication of the definitive prostheses.

Summary

This clinical report describes the use of 3D printing technique to duplicate interim denture as trays for closed-mouth impressions. In this case with limited mouth opening and oral movement after surgery, definitive prostheses were fabricated effectively according to the form that had been adapted physically using a digital approach.

Acknowledgements

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