Case Report

Rehabilitation of a maxillectomy patient using intraoral scanning impression technology and a computer-aided design/computer-aided manufacturing fabricated obturator prosthesis: A clinical report

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Abstract

Rehabilitation of a partially dentate postmaxillectomy patient using a novel approach is presented in this report. The patient was referred to our practice by the oral and maxillofacial surgery department of the local general hospital for the evaluation and prosthetic treatment planning. He had undergone biopsy for a lesion located in the right quadrant of his maxilla and was scheduled for a hemimaxillectomy for removal of a squamous cell carcinoma. A surgical obturator was prepared for placement at the time of ablative surgery. Following completion of adjuvant radiotherapy and chemotherapy, a digital intraoral impression of the remaining maxilla and mandible was obtained, and a computer-aided design/computer-aided manufacturing obturator removable partial denture utilizing a selective laser melting -produced metal framework was fabricated and delivered to the patient to restore function and esthetics. The need for conventional impression was eliminated leading to a reduction of necessary appointments and more comfort to the patient.

Keywords: Digital impression, intraoral scanning, obturator, selective laser melting

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Received: 14th January, 2018, **Accepted:** 28th May, 2018

INTRODUCTION

Rehabilitation of oral function in maxillectomy patients using an implant-retained and/or supported obturator prosthesis is a well-established treatment modality. The overall improvement in the quality of life (QOL) index in this patient cohort has been shown to be significant although still inferior to presurgical status.[1-3] Wang *et al.*[4] in a recent publication supported that there is no significant difference in the QOL between maxillectomy patients that had been restored with dental implants and an obturator compared to maxillectomy patients restored with a free vascularized flap and a fixed, implant-supported prosthesis.

Trismus, xerostomia, and mucositis are well-known side effects of surgery, radiotherapy, and chemotherapy of the

Access this article online	
Quick Response Code:	Website: www.j-ips.org
	DOI: 10.4103/jips.jips_14_18

How to cite this article: Michelinakis G, Pavlakis M, Igoumenakis D. Rehabilitation of a maxillectomy patient using intraoral scanning impression technology and a computer-aided design/computer-aided manufacturing fabricated obturator prosthesis: A clinical report. J Indian Prosthodont Soc 2018;18:282-7.

oral cavity.[5-7] Fibrosis of the masseter and lateral pterygoid muscles can lead to a severe limitation in mouth opening, thus making prosthodontic procedures such as not only impression taking is challenging for the dentist but also the insertion of the obturator extremely difficult for the patient.[8] Kinesiotherapy must be prescribed to the patient before the onset of trismus, and it should continue even after the completion of radiotherapy to prevent the late onset of trismus.

In cases of reduced mouth opening, it is advantageous to complete the impression-taking procedures with as little discomfort to the patient as possible. Various techniques have been described in the literature to help overcome the limitation in mouth opening including multiple impression stages, sectional, and flexible impression trays.[9,10]

In recent years, the shift from analog to digital impression taking has also been implemented into maxillofacial rehabilitation of oncology patients.[11-13] The combined use of cone beam computed tomography and three-dimensional (3D) printing has led to a reduction in the number of impression appointments needed for the construction of an obturator prosthesis.[11] The accuracy of this technique compared to traditional impression procedures has been investigated with favorable results.[12] Intraoral digital impression techniques have gained in popularity, and their use in fixed and removable prosthodontics has increased. Intraoral scanning (IOS) is a clinically acceptable alternative to conventional impression methods in fabrication of crowns and short fixed dental prostheses (FDPs). For fabrication of implant-supported crowns and FDPs, digital impression systems also result in clinically acceptable fit. Digital impression techniques are faster and can shorten the operation time; however, the conventional impression technique is still recommended for full-arch impressions.[14] Unfortunately, there are no such recommendations for the use of the IOS procedures in the field of maxillofacial prosthodontics.

Conventionally, metal frameworks for removable partial denture (RPD) prostheses are manufactured using cobalt-chromium (Co-Cr) alloys and investment/casting techniques due to their ease of manufacture and lower cost compared to titanium and gold-based alloys, respectively.[15] Recently, introduced additive manufacturing technologies have opened up new horizons in the prosthodontic rehabilitation of patients.[16,17] The introduction of selective laser melting (SLM) led to the production of computer-aided design/computer-aided manufacturing (CAD/CAM) Co-Cr RPD frameworks that exhibit adequate mechanical and clinical properties for use.[18-20]

In this case report, we present the clinical and laboratory procedures for rehabilitation of a posthemimaxillectomy patient using both IOS impression and a CAD-CAM produced RPD obturator prosthesis.

CASE REPORT

A 39-year-old male patient was referred to our practice for the evaluation and prosthodontic treatment planning. The patient was diagnosed with squamous cell carcinoma (SCC) of his right premaxilla and nasal cavity following a biopsy a few days before his referral [Figure 1]. A computed tomography scan of the region revealed that the tumor extended toward the nasal septum and the floor of the right sinus cavity. Initial treatment planning included the resection of the lesion, fitting of an immediate obturator prosthesis, and placement of two dental implants in the position of the upper left first premolar and upper left first molar to assist in the retention of the final obturator prosthesis.

Surgery to remove the carcinoma was carried out 2 weeks later, and the patient exited the hospital wearing the immediate obturator prosthesis relined with a soft denture temporary reline material (Viscogel, Dentsply USA) [Figure 2]. Two straumann tissue level implants (Straumann, Switzerland) were placed as scheduled, and 6 weeks later, the patient proceeded to receive adjuvant radiotherapy (54 Gy in 30 sessions, 1, 8 Gy per session) and chemotherapy (Cisplatin 20 mg). Mild xerostomia and trismus developed as side effects of radiation and chemotherapy. Saliva substitute and physiotherapy were, thus, prescribed to the patient.

Six months after the ablative surgery, the patient's maxilla, mandible, and bite were scanned using an

Figure 1: Initial situation

intraoral scanner (TRIOS, 3 shape, Copenhagen) following the official scan strategy suggested by the manufacturer [Figures 3a and b]. The total number of 3D images was kept below the critical number of 1500 for each jaw, a threshold set by the software. The STL data were inserted into CAD software (Dental Wings Productivity Package, Dental Wings) and the obturator and RPD framework were designed [Figures 4a and b]. The STL data of the upper and lower jaw were also sent to an stereolithography printer (Projet 6000, 3D Systems) and a resin model of the resected maxilla and intact mandible were 3D printed with a dedicated resin (Visijet SL e-Stone, 3D Systems) [Figures 5a and b]. The metal framework for the RPD was constructed with SLM technique using a SLM machine (PRO100 DMP, 3D System) and a Co-Cr alloy (BioSint 16, Stroumpos H and e-Dental), and the trial obturator portion of the RPD was milled using a resin blank (Copra wax PMMA Disc, Whitepeaks). The two were assembled on the maxillary resin master cast and tested for accuracy of fit intraorally [Figures 6a and b]. The metal framework exhibited excellent fit, retention, and stability to finger pressure, and the closure of the oronasal communication by the obturator was verified with water intake by the patient. Once the clinical fit was verified, the permanent obturator part was milled from a pink resin blank (CAD, Ivoclar Vivadent) using a milling machine (Coritec 250i imes, Icore) and incorporated

Figure 2: Immediate obturator relined with Viscogel

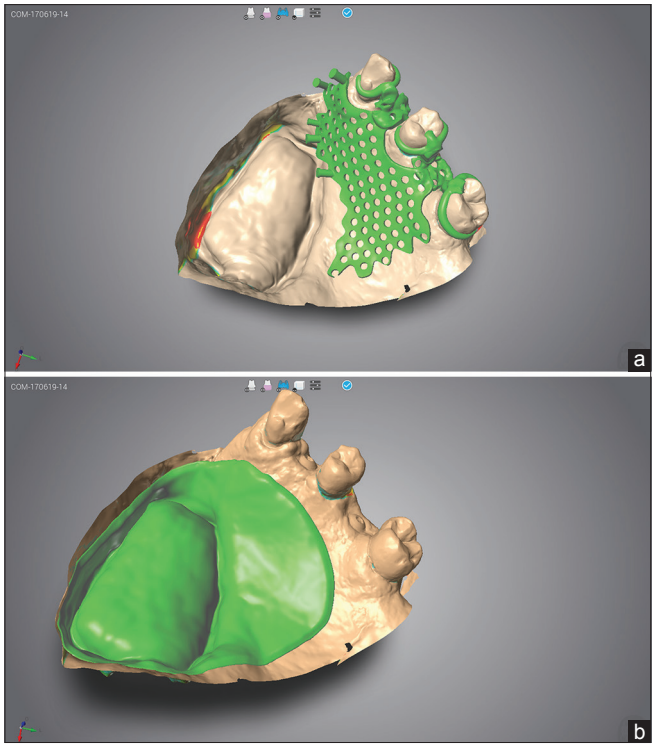

Figure 4: (a) Computer-aided design of the removable partial denture framework. (b) Computer-aided design of the obturator and denture base

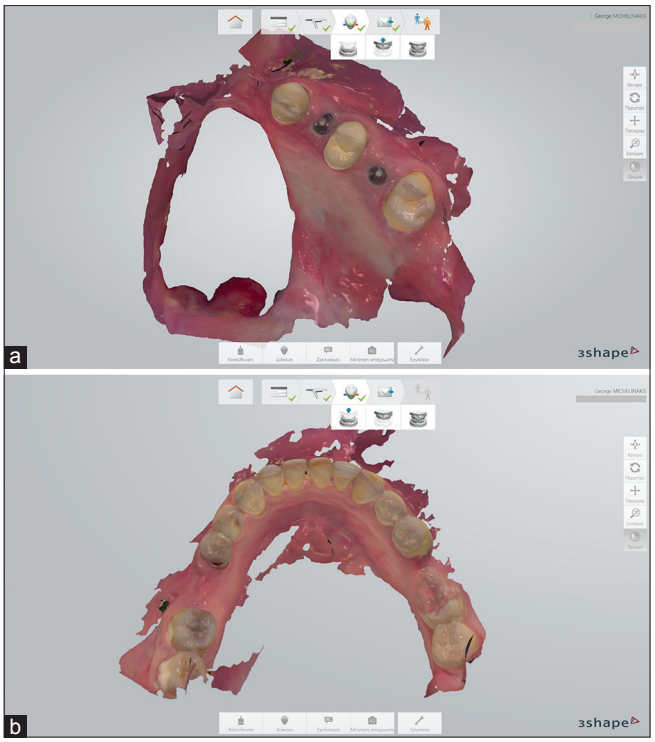

Figure 3: (a) Intraoral scan of the maxilla and defect. (b) Intraoral scan of the mandible

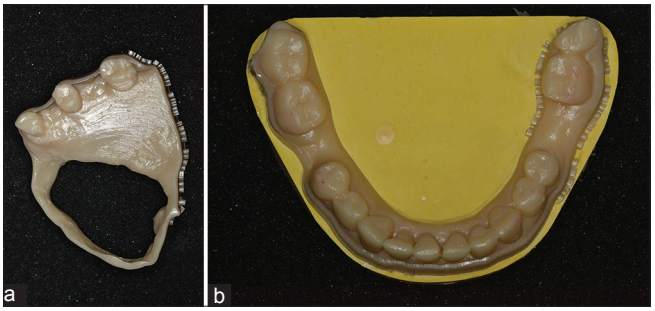

Figure 5: (a) Three dimensional printed maxillary cast. (b) Three-dimensional printed mandibular cast

into the denture base [Figures 7a and b]. Denture teeth (SPE, Ivoclar Vivadent) were set on the wax base plate and assessed clinically for esthetics and phonetics. Locator attachments (Zest Anchors, Carlsbad USA) were torqued onto the implants, and their respective female caps were picked up in the framework using an appropriate resin (Kallocryl, Speiko Germany) to accurately establish the implants' position [Figure 8] before final denture processing. For the denture base, a heat-polymerized resin was used (Weropress, Merz Dental). The obturator prosthesis was delivered to the patient 8 months following the tumor resection surgery [Figures 9a and b].

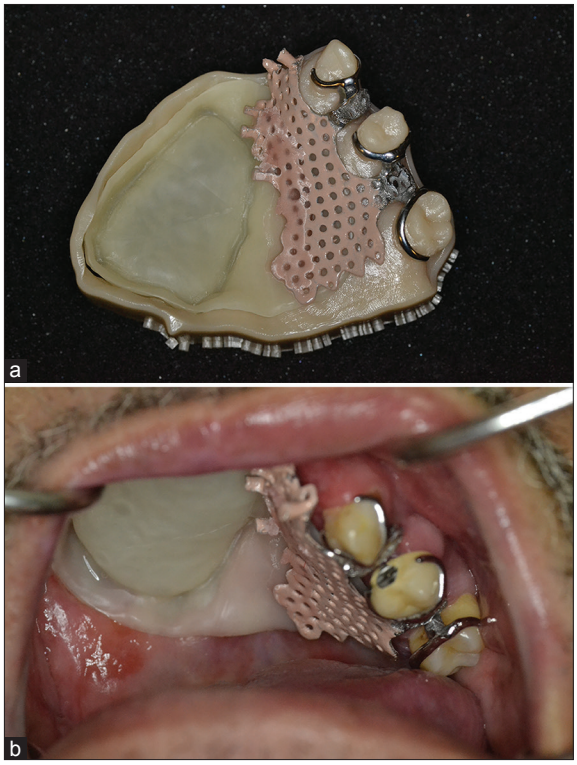

Figure 6: (a) Computer-aided design-computer-aided manufacturing removable partial denture framework and trial obturator assembled on master cast. (b) Assembly tested intraorally for fit

Figure 8: Intraoral pick-up of the locator matrix attachment to establish accurate implant position

DISCUSSION

IOS of a partially edentulous jaw to produce a 3D-printed RPD framework has been reported in the literature with acceptable results regarding the accuracy of fit and clinical outcomes.[21-23] Wu *et al*.[23] reported that correct scanning strategy and adequate digital impression of the supporting hard and soft tissue in the maxilla is a prerequisite for an accurate fit. Hu *et al*.[22] state that when scanning teeth or attached firm palatal or lingual mucosa, this technique is advantageous, but for moveable soft tissue a conventional technique utilizing border molding should be prefered. Kattadiyil *et al*.[21] also suggest that inexpensive pattern resin frameworks of the proposed design can be produced to verify the fit of the 3D-printed casts before proceeding with the fabrication of the definitive metal framework.

Using the SLM technique to produce a CAD/CAM RPD framework made either from titanium[22-24] or Co-Cr alloy[25-27] is an established technique that compares favorably regarding precision of fit, retention, and stability to RPD frameworks that are produced using traditional investing/casting techniques. Nevertheless, owing to the complexity of design, structure, and component materials, evaluation of CAD/CAM RPD framework fit has employed more qualitative than quantitative criteria.[20] CAD/CAM RPD frameworks produced from milling of PEEK blanks have shown the improved accuracy of fit and could be considered as a replacement of metal for RPD framework production.[26]

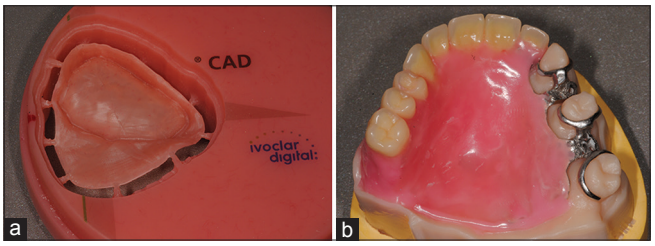

Figure 7: (a) Obturator and denture base milled from Ivoclar computer-aided design pink resin blank (b) Teeth trial set-up

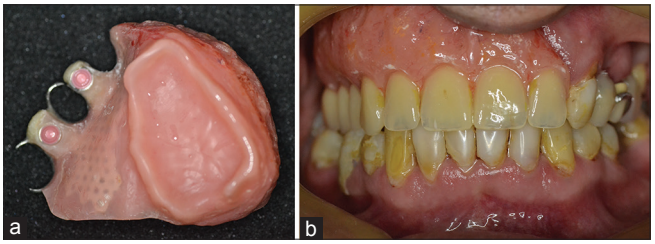

Figure 9: (a) Intaglio surface of obturator removable partial denture prosthesis. (b) Final view of the obturator *in situ*

IOS of a hemimaxillectomy patient with simultaneous advocation of a CAD/CAM protocol for final obturator prosthesis fabrication has never been described in the literature. Londono *et al*.[28] reported on a case that a combination of digital and analog impression procedure was implemented to produce a final cast for a maxillectomy patient suffering from exaggerated gag reflex. The digital maxillary impression did not include the defect area, and therefore, additional laboratory steps were required to produce the obturator. Our patient was suffering from mild trismus at the time of the scanning procedure; however, the TRIOS scanner was successful in obtaining a digital impression of both the remaining maxilla and teeth and also the periphery and borders of the oncology defect. One advantage of the digital impression technique is that it does not have to be completed in one scan, making the procedure much more comfortable for a patient suffering from trismus or xerostomia. Severe mouth opening limitation and a larger scanner tip would have prohibited the implementation of this protocol. In the case presented here, physical impression stages for both the maxilla and mandible using conventional impression materials were eliminated, and the patient underwent only one digital impression procedure for both the upper and lower arches. This led to minimal discomfort from the irradiated oral tissues exhibiting the merits of the technique.

Fabrication of the obturator prosthesis required only three clinical appointments (digital impression, fit verification, and teeth try-in) as compared to five or more appointments which are the norm in these cases. In the field of computer-engineered complete dentures, the reduction in the number of necessary visits and electronic archiving are considered advantages; however, the patients' dissatisfaction with the final result has been reported, which may be due to the lack of a trial placement appointment.[29] In our case, the teeth try-in appointment was not omitted, thus ensuring patient acceptance of the final esthetic outcome.

Electronic archiving is another advantage of this protocol as it facilitates the remake of the prosthesis in case of loss or damage. Elbashti *et al*.[30] have recently published a technique for extraoral scanning of an existing obturator for emergency purposes using a chairside intraoral scanner (Lava COS; 3D Espe, USA). The scanned obturator was 3D printed and checked for accuracy against the original prosthesis using a dedicated software, and the authors reported acceptable results.

CONCLUSION

The IOS of a hemimaxillectomy patient and the implementation of CAD/CAM techniques for obturator fabrication are a viable option for less tissue irritation and more patient comfort.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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