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DENTAL TECHNIQUE

Fabrication of a 3D-printed interim obturator prosthesis: A contemporary approach

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ABSTRACT

This report describes the combination of analog and digital techniques for the fabrication of a 2-piece hollow bulb maxillary obturator. The procedure described provides an accurate representation of the surgical defect while avoiding the discomfort associated with analog impressions. The manipulation of a routine postoperative computed tomography (CT) scanner in conjunction with a 3D printer allowed for the fabrication of a 3D-printed anatomic cast from which the 2-piece hollow bulb obturator was fabricated. The clinical and laboratory steps involved are described in this article. (J Prosthet Dent 2019;121:960-3)

The fabrication of complete dentures consists of many individual clinical and laboratory procedures. Accurate preliminary and definitive impressions are essential.[1] In situations where a completely edentulous patient requires an obturator, the process of impression making is more difficult and arguably more important for the success of the prosthesis.

A maxillary obturator is the prosthesis used to close a congenital or acquired tissue defect, primarily of the hard palate and/or contiguous alveolar/soft-tissue structures.[2] The process from tumor ablation surgery to delivery of the definitive obturator is lengthy. The patient typically receives 3 obturators during the recovery: a surgical obturator, an interim obturator, and a definitive obturator.

The interim obturator is typically fabricated from the presurgical diagnostic cast. However, the use of the presurgical cast lacks accuracy.[3] Although a postsurgical impression is desirable, it is not always practical. Postsurgical edema, trismus, soreness, and emotional state complicate the impression-making process. A precise impression is essential for fabricating an obturator. The precision is related to soft-tissue elasticity, anatomic undercuts, and material distortion while capturing the impression.[4]

The advent of digital technology has made it possible to record oral morphology without the use of traditional impression materials and methods. Three-dimensional modeling has made it possible to combine digital scans with traditional laboratory processes for the fabrication of complex prostheses. Computed tomography (CT) and cone beam computed tomography (CBCT) provide volumetric data that can be used immediately and in an accurate way.[5,6] CT files can be converted to standard tessellation language (STL) files and used for rapid prototyping procedures such as stereolithography (SLA) 3D printing.[7] SLA can use a variety of materials to create prosthetic devices and/or models of anatomic structures. With the CT data, accurate anatomic casts can be easily obtained.[8-10] This technology has revolutionized the dental field and has exciting implications in the field of maxillofacial prosthetics.

DENTAL TECHNIQUE

A 63-year-old man presented for a preoperative consultation with a recent diagnosis of adenoid cystic carcinoma of the right maxillary sinus (Fig. 1). The patient was

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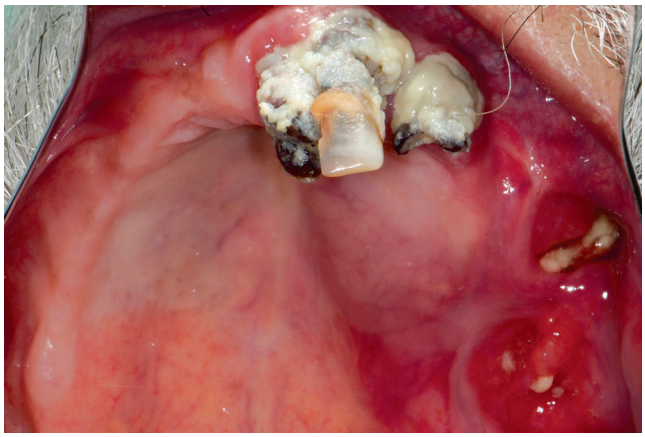

Figure 1. Preoperative maxilla. Occlusal view.

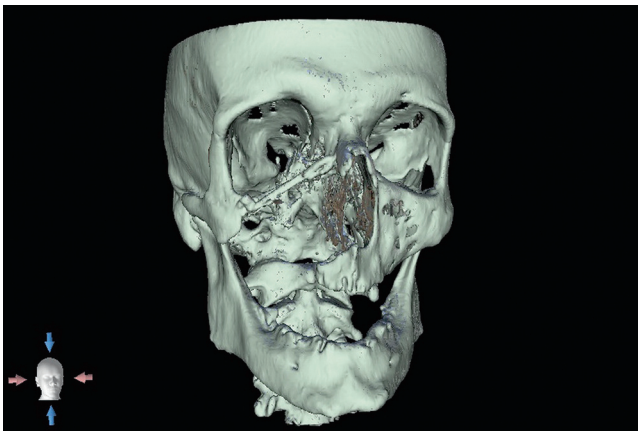

Figure 2. Postoperative computed tomography scan. Three-dimensional view.

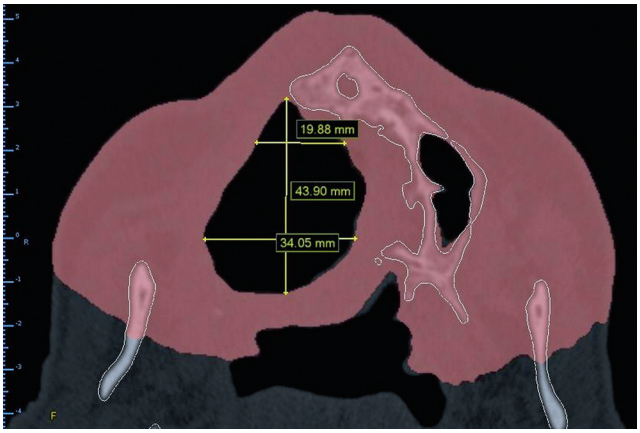

Figure 3. Postoperative computed tomography scan. Coronal view.

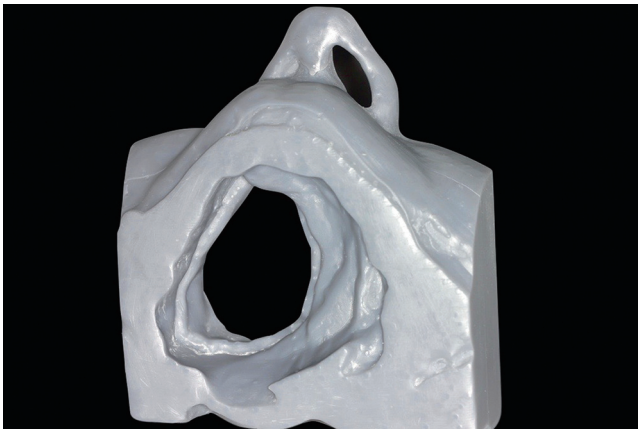

Figure 4. Printed anatomic cast.

planned for surgical intervention with a maxillary resection. The following technique provided a straightforward protocol for fabricating an edentulous maxillary obturator with a combination of conventional and digital techniques.

1. Make a CT scan 3 months after the operation (Figs. 2, 3) and upload the Digital Imaging and Communication in Medicine (DICOM) data from the CT into an advanced 3D treatment-planning software program for computer-guided surgery (Blu Sky planner; Blue Sky Bio LLC). The Digital Imaging and Communication in Medicine files are converted into a relevant STL file of the maxillary defect. The STL file is imported into an open-source software program for advanced processing and editing (Meshmixer; Autodesk Inc) and is edited using plane cuts to keep the portion of the model that was required for printing.
2. Inflate (extrude by 3 mm) the inner borders of the defect on the lateral side of the right nasal cavity and the wall of the cranial orbit to avoid irritation of the tissues by the obturator. This is performed without any change to the external palatal borders.
3. Use an SLA desktop 3D printer (Form 2; Formlabs, Inc) to fabricate a precise anatomic cast representing the soft tissues within the accurate borders of the defect. After segmentation, print the STL file in gray resin (V1; Formlabs, Inc) at a resolution of 50 μm (Fig. 4). Postprocessing of the cast involves a 92% isopropyl alcohol rinse, removal of the printing supports, and a postpolymerization cycle at 405 nm (EyeVolution; Dreve Dentamid GmbH) to increase the strength of the model.
4. Fabricate a wax pattern for the hollow bulb of the obturator using the anatomic cast. Gradually place wax (Modeling wax, Anutex; Kemdent) adding to a thickness of 2 to 3 mm in the horizontal plane and then in the vertical plane at the borders of the defect. Make a ledge at the inner rim of the defect to create an index for the acrylic resin portion of the obturator to engage (Fig. 5).

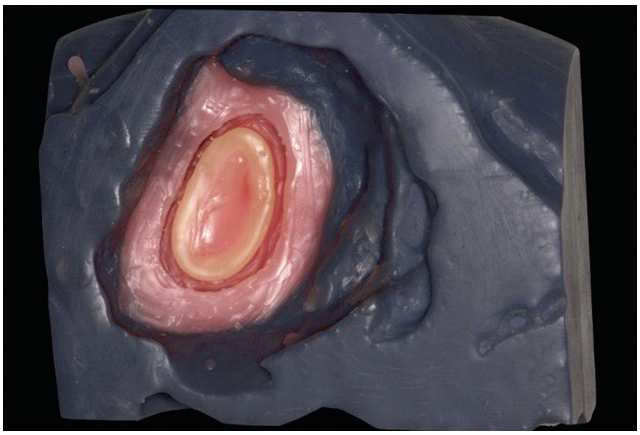

Figure 5. Waxing of hollow bulb for definitive obturator.

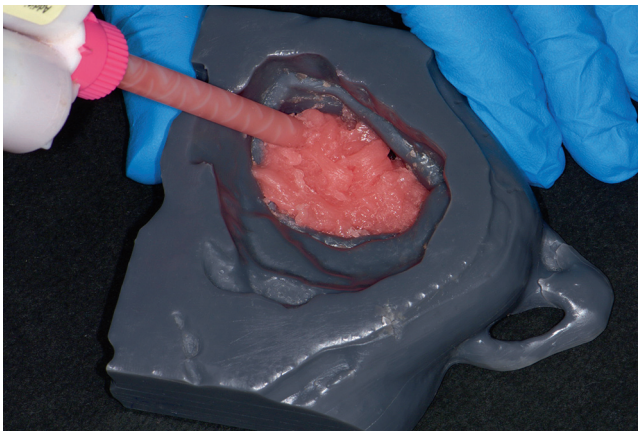

Figure 6. Direct application of silicone denture soft lining material into anatomic model.

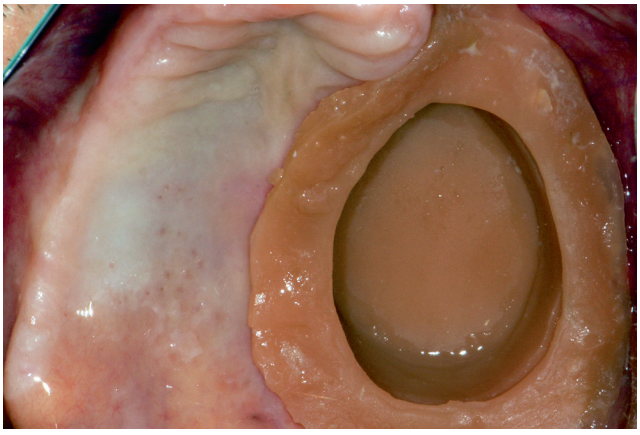

Figure 7. Hollow bulb seated in patient's mouth.

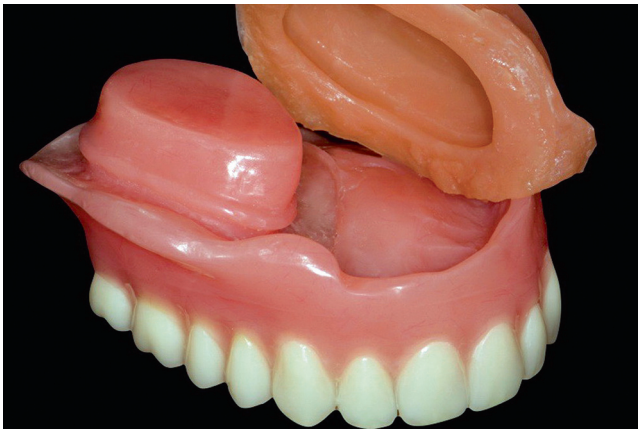

Figure 8. Definitive prosthesis.

5. Invest the printed 3D cast and wax pattern for the hollow bulb in a postreline jig (ReFlex Reline Jig; Lang Dental Manufacturing Co, Inc) using Type IV dental stone (Fujirock EP; GC Europe N.V.).
6. Complete the drag portion of the investment using laboratory condensation vulcanizing modeling silicone (Laborsil 90; Dreve Dentamid GmbH) to reproduce the intaglio of the hollow bulb in detail. Further invest and attach the condensation silicone to the upper member of the jig with plaster.
7. After wax elimination, inject long-term, room temperature, vulcanizing silicone denture soft lining material (Multisil; Bredent GmbH & Co KG) into the printed cast and the upper portion of the reline jig (Fig. 6).
8. Polymerize in a 25°C water bath for 5 minutes under 0.4 MPa, open the reline jig, remove the hollow bulb portion of the obturator, and insert it into the patient's mouth (Fig. 7).
9. Verify adequate seal by having the patient speak and swallow water. The lack of nasal regurgitation and vocal nasality indicates that the bulb portion of the prosthesis provides successful obturation.
10. Make a pick-up transfer impression with the silicone obturator in situ. Use traditional denture fabrication techniques for the remainder of the clinical and laboratory processes (Fig. 8).
11. Schedule monthly recalls to evaluate and adjust the prosthesis. Make adjustments in the traditional manner with pressure-indicating paste and burs.
12. Continue monthly follow-ups until the fabrication of the definitive maxillary obturator begins at 6 months.

DISCUSSION

Fabrication of maxillary obturators for the completely edentulous, resected maxilla is challenging in many ways. It is essential that an accurate impression be made of the surgical defect and the remaining maxilla. With elastomeric impression materials, there is a risk of dislodging a portion of the impression material into the surgical site. Opposing undercuts in the surgical site and the

remaining maxilla are a cause for caution. The described technique avoids the potential for this complication and provides the patient with a more comfortable procedure for prosthesis fabrication.

In place of traditional impression techniques, the impression of the patient's surgical site was made from a 3D-printed cast obtained from the 3-month postoperative CT scan. Making a CT scan at the 3-month postoperative visit is a routine procedure. It aids in the surveillance of recurrent tumors and offers the opportunity to assess postoperative healing.[11] In this patient, an open-source software program and a 3D printer were used to fabricate an anatomically accurate cast.

For removable prostheses, support, stability, and retention are implicit in prosthetic success. For maxillary obturators, these aspects are essential to adequately seal the bulb portion of the obturator. Without an accurate definitive impression, these parameters are further impaired, resulting in a leaky prosthesis. A poor seal results in poor acceptance of the prosthesis by the patient. The high level of satisfaction and lack of air and water leakage in this patient indicated the success of the combined 3D-analog technique.

The use of an open-source 3D software program for advanced processing and editing provided a direct and straightforward method of fabricating a precise soft-tissue cast of the surgical site. Patients with severe trismus may be able to receive prostheses, which was previously impossible with traditional impression techniques. In this patient, the use of computer-aided design resulted in the ability to avoid the inner border of the lateral aspect of the right nasal cavity, effectively avoiding irritation of the nasal mucosa. With the ability to digitally inflate the anatomic borders by 3 mm, the resulting cast provided relief for sensitive tissues.

A limitation to the use of this technique is that the in-office availability of the equipment is necessary, although digital dental technologies are becoming commonplace. In addition, the practitioner must have some knowledge and experience related to the software required to use these technologies. A dental laboratory may be used to print the cast, but this would eliminate some of the convenience of the technique.

SUMMARY

The 3D-printing technology was used to fabricate an interim maxillary obturator prosthesis. This contemporary technique eliminated the need for conventional uncomfortable impression techniques, facilitating and shortening dental treatment for maxillofacial patients.

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