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Case Report

Image Guided Palatal Obturator Design and Fabrication for Maxillectomy Defect in the Case of Acute Invasive Fungal Sinusitis

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Abstract: Acute invasive fungal sinusitis requires a high clinical suspicion and rapid diagnosis for initiation of surgical and medical treatment. Due to necessity of expedited surgical treatment, evaluation and impression making by a maxillofacial prosthodontist is rarely possible prior to debridement. Surgical debridement often results in maxillary defects, which can negatively impact speech, deglutition, and respiration. A surgical obturator occludes the palatal defect resulting in improved speech, swallowing and prevention of wound contamination with food particulate. This article focuses on utilizing medical imaging, usually acquired for diagnosis and surgical planning, to fabricate a well-fitting surgical obturator without conventional or digital intraoral dental impression making.

Keywords: Maxillofacial prosthodontics, obturator, removable prosthodontics, digital, medical imagining.

INTRODUCTION

Acute invasive fungal sinusitis (IFS) is a rare but aggressive type of rhinosinusitis. Mortality rates have been cited around 50-80% [1, 2]. As its name states, IFS differs from noninvasive fungal sinusitis in that the fungal species invades neurovascular structures within the face resulting in thrombosis, ischemia, and necrosis. The species can then invade adjacent soft tissue and bone beyond the sinuses. Uncontrolled diabetics are particularly susceptible to mucormyces/zygomyecetes whereas immunosuppressed patients are largely susceptible to *Aspergillus* species [3]. Regardless of the pathogen, IFS requires a high clinical suspicion and rapid diagnosis for initiation of surgical and medical treatment. Surgical debridement often results in maxillary defects which can negatively impact speech, deglutition, and respiration. A surgical obturator occludes the palatal defect resulting in improved speech, deglutition, and prevention of wound contamination with food particulate. Traditionally, these surgical obturators have been manufactured by a maxillofacial prosthodontist through the acquisition of dental impressions. A maxillofacial prosthodontist may not be

available to perform this task concurrently with an emergent surgery. Additionally, intraoral impressions made during surgical resection can be compromised by residual debris and bodily fluid from the surgical field. Although materials such as alginate and reversible hydrocolloid are considered acceptable for surgical sites, their unstable nature makes them challenging during an emergent surgery, as they must be poured into stone immediately after impressing. This case report presents an alternative to conventional intraoral impressions by modeling a surgical site using computed tomography (CT) data and fabricating a surgical obturator with a hybrid digital-analog workflow.

CASE PRESENTATION

Patient WS is a 60-year-old male with uncontrolled diabetes who presented with right-sided facial hypesthesia and acute right sided vision loss. Physical exam demonstrated right upper lid ptosis, reduced right extraocular movement, palatal necrosis, and blanched right inferior and middle turbinates. The frozen pathology from the biopsied inferior turbinate was consistent with IFS. Medical-grade CT and MRI imaging confirmed the diagnosis (Figs 1 and 2). He was diagnosed with orbital apex syndrome secondary to IFS, was started on antifungal therapy, and underwent aggressive surgical debridement (Figure 3). In the ensuing days, serial endoscopic exams demonstrated stability of the sinonasal cavity and maxillofacial prosthodontists were consulted for surgical obturator fabrication. The patient was struggling with oral intake secondary to large palatal defect. To avoid percutaneous endoscopic gastrostomy (PEG) tube placement, an obturator to facilitate oral intake was fashioned. Since treatment and delivery of the obturator the patient is doing well and has recovered from the IFS.

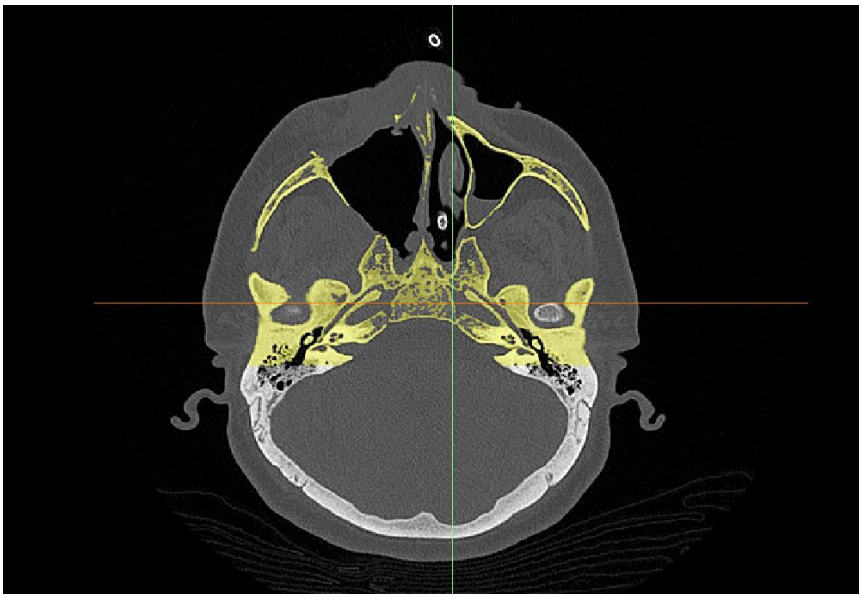

Figure 1: Pre-operative imaging

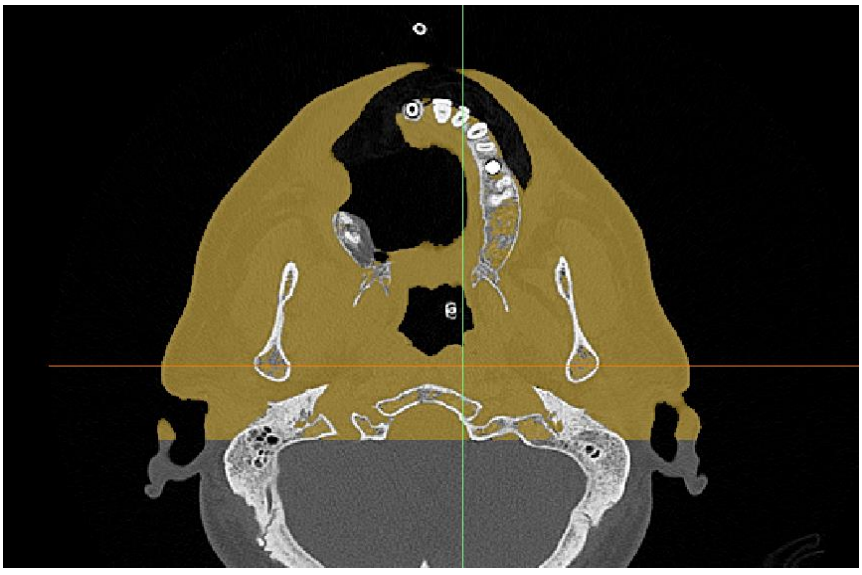

Figure 2: Pre-operative imaging

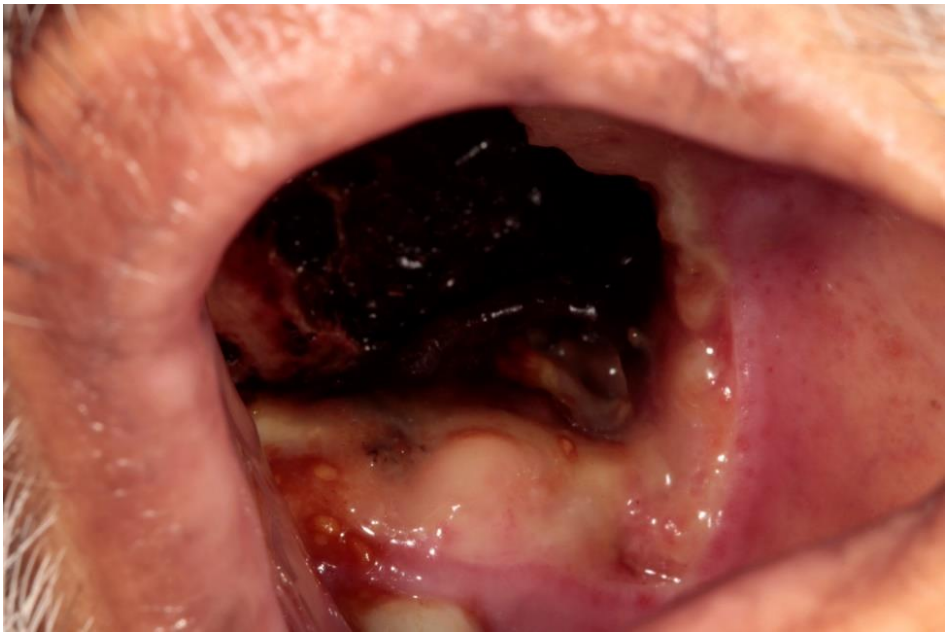

Figure 3: Post surgical defects status post debridements with healthy margins

TECHNIQUE

A "thin slice" (0.2 mm voxel) medical grade CT was acquired postoperatively after physicians determined that the patient was stable and required no further debridement's. The soft tissue and dentition were separated from each other with gauze and a flat arch-shaped 3mm mouthguard material. Separating the tongue from the palate and the teeth from mucosa during the CT scan made it possible to digitally generate a 3-D model of the patient's current dentition and remaining palate (Figs 4 and 5. The digital model was printed in photopolymer model resin (Model V2, Formlabs, MA, USA) using stereolithography technology (Formlabs and 3-D Systems, SC, USA) (Figure 6). The quality of the CT image and subsequent model permitted for accurate rendering of all intraoral anatomy, including soft tissue, and identification of the defect. A surgical obturator was fabricated using ProBase (Ivoclar, Schaan, Liechtenstein) clear acrylic with the addition of retention clasps (Figure 7). Once contouring and polishing were finalized, a soft reline was performed with Tokuyama Sofreliner (Metelen, Germany) (Figure 8). The reline was trimmed to provide an appropriate seal along the dentition and maxillary defect. There were no complications during delivery, which was supported by the physician's endoscopic evaluation and the patient eating and drinking without regurgitation (Figure 9).

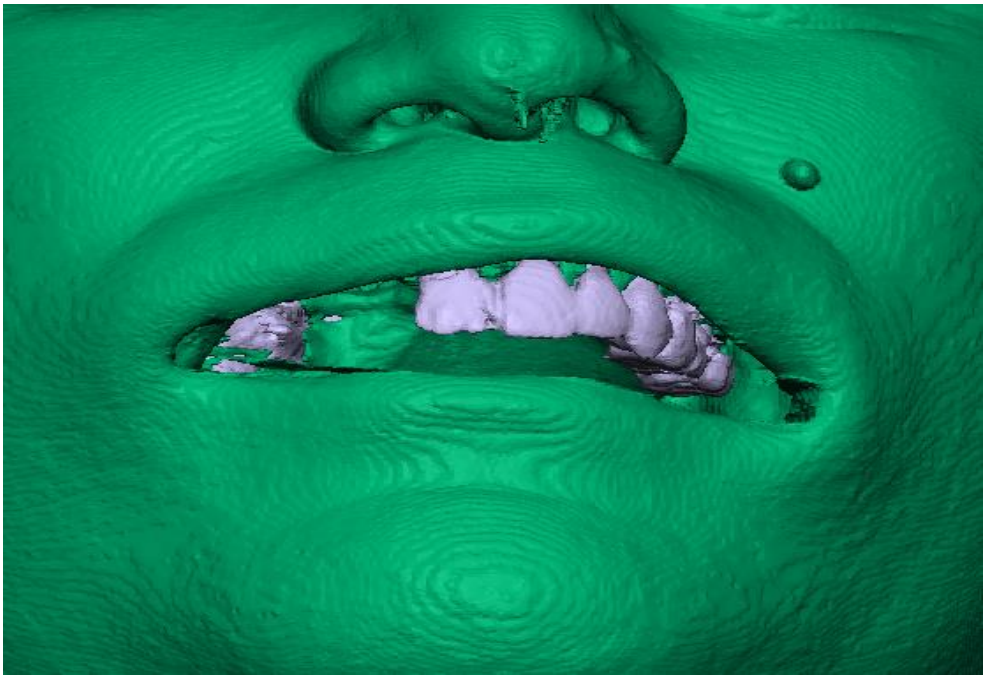

Figure 4: 3-D model of the patient's oral cavity

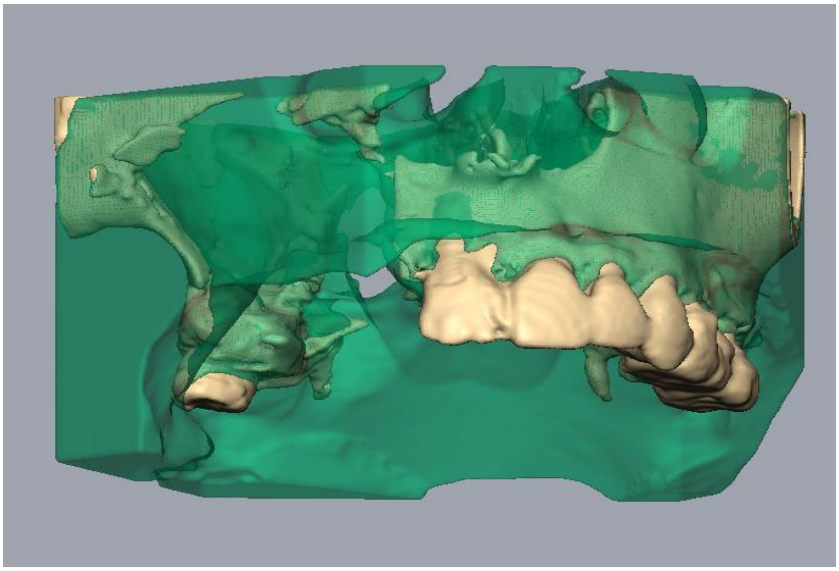

Figure 5: 3-D model of the patient's post-operative dentition and remaining palate

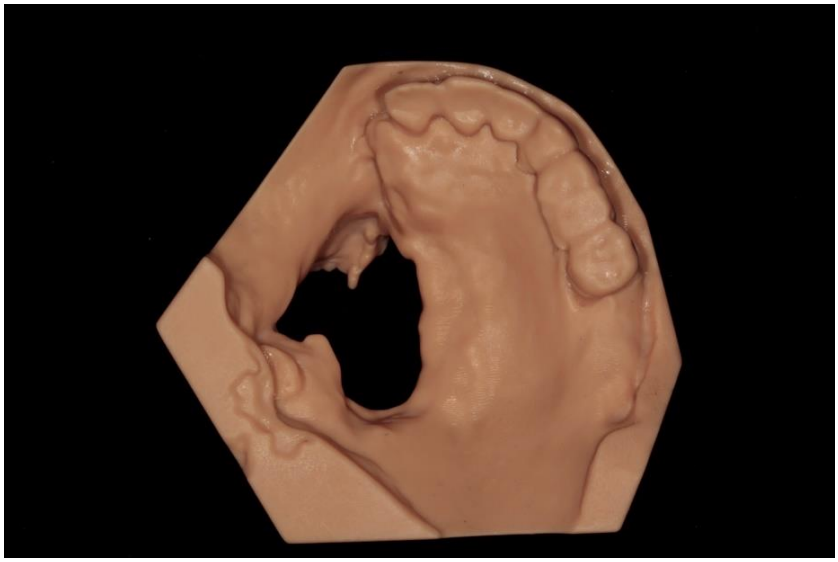

Figure 6: Digitally printed anatomical 3-D model acquired from patient's medical grade CT

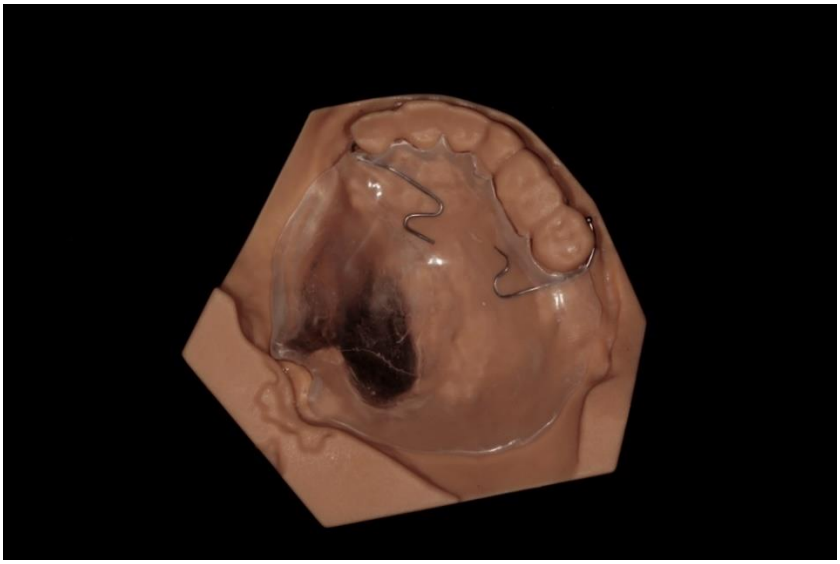

Figure 7: Surgical obturator fabricated using Probase clear acrylic

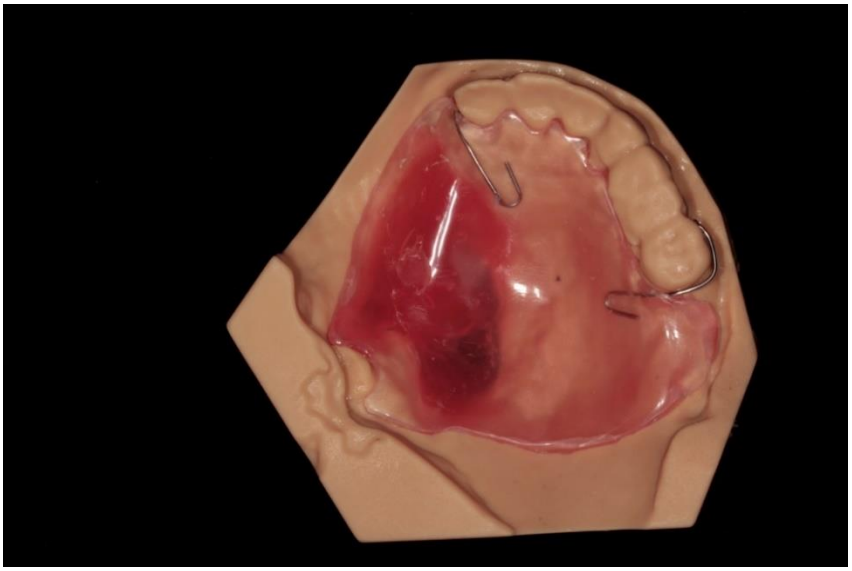

Figure 8: Surgical obturator fabricated using Probase clear acrylic and relined with Tokyama Sofreliner

Figure 9: Patient with surgical obturator inserted

DISCUSSION

Computer aided design and rapid prototyping has been described primarily in the prosthodontic literature in reference to oncologic defects [4-6]. This method has application for the design and fabrication of a palatal obturator using CT data prior to a planned oncologic resection as described by Rodney *et al*., allowing for implantation of the obturator concurrently with the oncologic resection [7, 8]. Ekstrand *et al*., showed similar results in their application of this workflow designing an obturator to be implanted immediately after tumor extirpation such that a patient could wake up functionally restored [9]. Ye *et al*., demonstrated that digital casts made from CT scans of patients with maxillectomy defects closely matched traditional impression casts without significant differences in anatomic landmark measurements demonstrating accuracy and suitability for clinical usage [10]. Our case report extends this technique beyond the existing body of knowledge on maxillectomy defects and computer aided obturator design from the oncologic sphere to a rhinologic practice in the case of IFS.

The case report also aims to increases awareness of this uncommon but insidious disease process and highlights the multidisciplinary approach to managing IFS. An alternative approach to fabricating the surgical obturator using CT data acquisition was pursued because conventional impressions posed a risk to the healing process at the time the surgical obturator was requested, and digital intraoral impressions were unavailable for inpatient use. Conventional impressions have several disadvantages associated with them including: significant time and cost associated with the impression taking, model fabrication and storage [11]. According to Punja *et al*., in 2017 conventional impression techniques also show inaccuracies due to distortion of the impression and casts which could leave to an inaccurate model [12]. In order to take a

impression immediately after surgical resection surgical packs must be packed and nasogastric tube must be used [13]. Conventional impressions techniques pose the risk of leaving impression material in the resected defect which could later become infected or become displaced into the sinus and result in chronic sinusitis [14]. This obturator was provided to the patient while inpatient and enabled a quicker recovery with a return to oral nutritional intake and functional, intelligible speech prior to discharge. This technique offers practicality and efficiency for the prosthodontist, the surgeon, and the patient in a hospital environment where dental resources may be limited.

CONCLUSION

Surgical obturators have been shown to decrease psychological impact of surgical defects, provide protection of surgical wounds, and allow the patient to return to a more normal quality of life. The case presented and technique described provides an efficient, reliable method for producing a surgical obturator in the absence of dental impressions that benefits the patient, surgeons, and dental providers.

DISCLAIMER

The views expressed in this manuscript are those of the authors and do not necessarily reflect the official policy of the United States Government, the Department of Defense, the Defense Health Agency, the Department of the Army, the United States Army Medical Department, or Uniformed Services University.

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Declarations of Interest: None

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