

## Case Report

# Prosthetic rehabilitation of untailed defects using patient-specific implants

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## ABSTRACT

The restoration of speech, deglutition, mastication, and respiration in patients with bimaxillary resection involving the maxillae, hard and soft palates, and paranasal sinuses poses a significant challenge. This clinical report describes the prosthodontic management of a patient with bilateral maxillectomy caused due to post-COVID-19 mucormycosis. A patient-specific implants (PSI) that matched the remnants of the zygoma complex was designed to improve the patient's severely impaired speech and swallowing. The patient's postsurgical anatomy was first visualized using three-dimensional computed tomography data. Following that, a customized zygoma-supported titanium framework was designed to support the prosthesis based on the data. Two weeks after the framework was installed, an open-tray impression was made and the prosthesis was fabricated. These findings suggest that PSI-retained prosthesis can be considered in cases with severely compromised maxillary bone anatomy, impaired oral functioning, and no viable conventional reconstruction options.

**Key Words:** Implants and prostheses, mouth rehabilitations, Mucorales infection, subperiosteal implant therapy, three-dimensional printing

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## INTRODUCTION

The prevalence of opportunistic infections has increased predominantly during the outbreak of SARS-COV-2 infection. These opportunistic infections are by different kinds of bacterial, fungal, and virus species, which includes Mucorales, *Aspergillus*, *Candida*, *Cryptococcus neoformans*, *Pneumocystis jiroveci (carinii)*, cytomegalovirus, herpes simplex virus, *Strongyloides stercoralis*, *Mycobacterium tuberculosis*, and *Toxoplasma gondii* species.<sup>[1]</sup> Of these, invasive fungal infection by mucormycosis (most commonly referred to as black fungus) is found to be fatal sequelae increasing the morbidity in the post-COVID individuals.<sup>[2]</sup> The most common

etiological factors for the COVID patient to infect with *Rhizopus oryzae* are excessive use of corticosteroids, uncontrolled diabetes, long-term stays in the intensive care unit, malignant hematologic organ or marrow transplantation, disorders, and deferoxamine therapy in patients receiving hemodialysis, neutropenia, trauma, and burns.<sup>[3-6]</sup> The oral manifestations of the mucormycosis include massive tissue destruction, followed by nonhealing ulcers, osseous destruction, and the formation of oroantral communications.<sup>[7]</sup> The different types of mucormycosis include rhinocerebral variant affecting the sinus and brain, pulmonary affecting the lung, gastrointestinal affecting the

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tract, cutaneous affecting the skin, and disseminated mucormycosis which spreads through the bloodstream. Of these, the rhinocerebral type is the most common affecting the brain and sinuses, which begins in the nose by inhaling the fungal spores leading to vascular thrombosis and necrosis of the tissues.<sup>[7,8]</sup> Literature suggests that the surgical debridement in and around the tissue affected along with the amphotericin B liposomal 3.0 mg/kg has proved to give better postoperative outcomes.<sup>[9]</sup>

Surgical defects can be simple or complex based on tissue loss. Simple defects can be restored with removable prostheses using conventional maxillofacial implants, attachments, adhesives, and spectacles as retentive aids. Prosthetic rehabilitation of untailed defects is an arduous procedure due to the massive loss of soft and hard structures in a disproportionate manner. For such defects, customized implants that anchor the local residual zygomatic, pterygoid, nasal, and orbital floors provide better results than conventional implants.<sup>[10]</sup>

## CASE REPORT

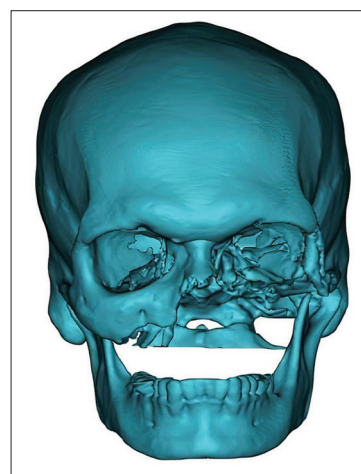
A 40-year-old male patient approached the Department of Prosthodontics, Lenora Institute of Dental Sciences Rajahmundry, Andhra Pradesh, India, with the chief complaint of difficulty in taking food and hypernasal speech discrepancies. A detailed medical history was recorded, inferring that the patient has been known as diabetic for 4 years and is on medication. He had a history of COVID-19 and was screened on April 19, 2020. He was hospitalized for 6 days and was on medication and ventilator support. After 2 days of discharge from the hospital had a unilateral swelling (post-COVID) of the left side of the face for 2 weeks and also complained about the loosening of teeth and was diagnosed with mucormycosis. Surgical debridement was done along with the amphotericin B drug therapy to decrease the spread and effect of the fungal infection. After the surgery, he was presented with oroantral and oronasal communication with mastication difficulties and nasal regurgitations.

The extraoral and intraoral examination revealed the absence of the left orbit and total maxilla [Figure 1]. This led to a concave profile that obliterated the nasolabial fold, the corners of his mouth drooped, and he had insufficient upper lip support. Examination of the lower arch revealed a full complement of teeth with the porcelain-fused

ceramic full-veneer crown on the right molar tooth and slightly supraerupted malaligned anterior teeth. The tongue was normal with no obstruction in its movements, and the temporomandibular joint movement was normal without any deviation or deflection. Postsurgical three-dimensional (3D) facial computed tomography (CT) revealed left total maxillectomy and right subtotal maxillectomy and left orbital decompression along with the resection of the left zygomatic arch and rim [Figure 2]. The main goal in this type of defect, where there is loss of both soft-tissue structures and alveolus along with the zygomatic bones is to restore the facial profile and function. After reviewing intraoral and extraoral soft-tissue and hard-tissue (bone) status; the psychological and economic condition of the patient; the need for oral hygiene protocol to reduce secondary infections and to assess the prosthesis longevity and stress transfer mechanism on to the cortical bone; the best treatment plan selected was an implant-supported removable prosthesis. The implants will provide the majority of the retention in this case,



**Figure 1:** Preoperative intraoral image.



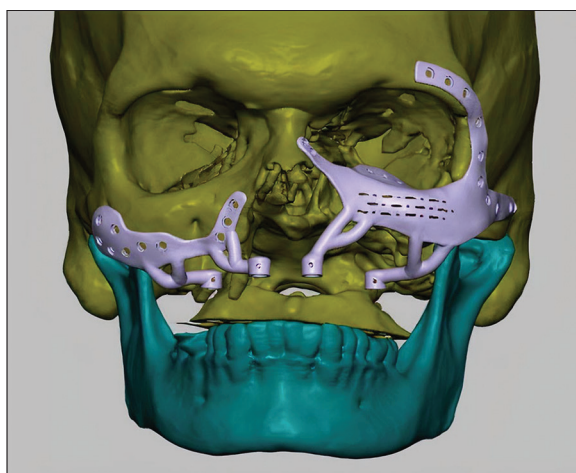
**Figure 2:** Three-dimensional cone-beam computed tomography depicting the loss of zygomatic and orbital floor on the left side and subtotal maxillectomy on the right side of the face.

whereas the intaglio surface of the acrylic prostheses will provide support and stability.

The surgical procedure was planned under general anesthesia. The custom-made subperiosteal zygomatic implants were milled with titanium as designed following the anatomical contour of the residual bone [Figure 3]. The milled structures were planned and designed such that the multiunit abutments projecting from the implants were parallelly aligned. The surgical procedure was conducted meticulously, and the abutments were positioned near optimum to align with the mandibular teeth [Figure 4]. Thus, the abutments were in the polygon to decrease the offset loads and distribute the leverage forces evenly.

The oral rehabilitation procedure was started after 15 days of healing with the impression-making process. The open-tray impression copings were stabilized with the dental floss and pattern resin, then made an impression using polyvinyl siloxane impression material [Figure 5]. Inter arch records were made using the aluminum-coated wax and a titanium metal bar was fabricated and tried in [Figure 6]. After

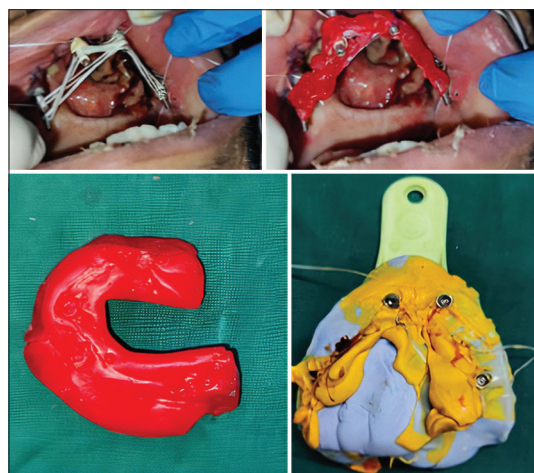
that, the obturator was fabricated on the definitive cast with acrylic resin material. The prosthesis was inserted, and postinsertion instructions (denture and oral hygiene instructions) were given. The prosthesis was fabricated with heat-cured acrylic resin reinforced with metal mesh. The occlusion chosen was bilateral balance occlusion using semianatomic teeth to increase the stability of the prosthesis. The materials used in the fabrication process of the prosthesis were polyvinyl siloxane impression materials for impressions to record the fine details with dimensional accuracy without distortion. They may be used for multiple pouring of the casts during the duplication for laboratory purposes. The metal framework work was made of titanium, which is the best material due to its biocompatibility and compressive strength to distribute the stresses among the abutments. The aluminum-reinforced wax was used in recording the interocclusal records to decrease the distortion that was common in regular waxes. Because the



**Figure 3:** Virtual designing of the patient-specific implants.



**Figure 4:** Orthopantomogram inferring the position of the abutments.



**Figure 5:** Stabilization of open-tray copings with dental floss and pattern resin, bite registration, and impression.



**Figure 6:** Postoperative image figure.



prosthesis was in opposition to the natural dentition, the wear properties of the acrylics were reduced using heat-cured acrylic and reinforcing the acrylic component with metal mesh. On the other hand, the opposition of the maxillary and mandibular teeth was set in bilateral balanced occlusion with a minimum number of interferences to increase the stability of the prosthesis. During the first follow-up visit after 1 week, the immediate complication was lacking the seal on the left posterior tooth region, which was relined using soft relining material. The follow-up visits were after 15 days, 30 days, 45 days, 60 days, and 90 days. The occlusal refinements, speech quality, and peripheral seal were evaluated during the follow-up visits. After the last follow-up period, the patient was satisfied with the routine usage of the prosthesis.

## DISCUSSION

The resection of tumors or any infection in the oral and maxillofacial region has a profound impact on the social, psychological, and mental health of the patient. Spiro *et al.*,<sup>[11]</sup> in 1997, classified and gave the terminology based on the portion removed into limited, subtotal, and total maxillectomy. The fabrication of prostheses in these clinical conditions is cumbersome. The retention, stability, adaptability, decreased interarch distance, scar tissue formation, decreased keratinized tissue, lack of anatomical undercuts, and decreased mouth opening pose major difficulties in prosthesis construction.<sup>[12,13]</sup>

In this current case report, the patient underwent right subtotal maxillectomy, left total maxillectomy, and orbital decompression due to post-COVID sepsis by mucormycosis for which customized implants and its supported prosthesis were planned as a treatment option. In this report, a titanium bar was screwed to the implant abutment, and this bar-retained prosthesis was fabricated. The prosthesis was retained to the bar with an O-ring attachment system. The custom-designed subperiosteal zygomatic implants were fixed to the residual bone from which the abutments were projected intraorally. The metal bar attached to this was able to distribute the forces evenly to all the abutments, thus reducing the concentration of impact on the residual bone. This technique of using a removable prosthesis on the metal bar provided good retention as well as provides ease in the maintenance of the prosthesis. The teeth were arranged in a bilaterally balanced occlusion. The introduction

of improved investigative technologies such as 3D CT and improved artificial intelligence and additive manufacturing technologies such as 3D printing in the medical field has been a boon in the development and use of patient-specific implants. Compared to prebent or premade implants, the use of PSI provides greater accuracy in details, better site adaptation, and a shorter operating time. As we selected acrylic prosthesis over titanium framework, the main drawbacks include the attrition of the acrylic teeth, the wear of the acrylic, and the fracture of the components. The chances of secondary infections and recurrence of mucormycosis may be present in the malunion and nonhealing areas around the implants. The possible solutions for these kinds of problems were the use of heat-cured acrylic resins reinforced with metal inserts and better occlusal schemes for the clinical situation to dissipate the stresses on the implants. Better oral hygiene measures should be added. Improvements in meticulously and better union between the implant and bone junction can be achieved by achieving initial stability, oral hygiene measures, and reducing the stress concentrators in the occlusion. Gerbino *et al.*,<sup>[14]</sup> in their study, mentioned that the PSI is more stable compared with a manually bent titanium implant in rehabilitating the maxillofacial defects. Moreover, the stiffness of the PSI prevents implant deformation during placement. Customized subperiosteal zygomatic implant-supported prosthesis provided better results in terms of patient adaptation, speech improvement, mastication, and patient satisfaction. Limitations of the present study include the weight of the definitive prosthesis was increased due to the selection of the titanium framework. As the reconstruction material was not autografted, the chances of rejection were high. The recommendations for future studies include incorporating lightweight materials for framework construction, and innovations in increasing the acceptance of the framework design are necessary.

## CONCLUSION

Mucormycosis causing facial deformities may affect the social life of the patient. Titanium-based 3D patient-specific implants (PSI) provide an innovative solution to ensure the facial deformity does not leave a deep scar on the patient's dignity and self-confidence.

### 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.

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Nil.

### Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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