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Review Article **Prosthodontics**

"Reconstruction and Rehabilitation of Maxillary Defects Secondary to Mucormycosis"

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Abstract

Maxillary defects can occur due to certain bacterial, fungal and viral infections. But in recent time mucormycosis has become prevalent secondary to covid-19 infection. Mucormycosis is an opportunistic fungal infection, which primarily affects diabetic and immunocompromised patients. Surgical excision and debridement of the affected areas can result in significant defects. Reconstruction and rehabilitation of these defects remains a significant challenge for the clinicians because 3-D anatomy of the maxilla serves speech, swallowing and aesthetic roles. This review article discusses the reconstructive and rehabilitative methods of mucormycosis maxillary defects.

Keywords: Maxillectomy, Mucormycosis, Prosthesis, Reconstruction, Rehabilitation.

INTRODUCTION

Mucormycosis is a rapidly progressive, fulminant and life-threatening infection. Paltauf was the first to describe it in 1885. After candidiasis and aspergillosis, it is the third most prevalent opportunistic fungal infection. Mucormycosis, also known as black fungus, caused havoc in India during the catastrophic COVID-19 epidemic's second wave (between April and June 2021) by a rapid and deadly surge with up to a 50% fatality rate. While the actual reason for its sharp rise during the second wave is still unknown, it has been discovered that diabetics and immunocompromised patients who have recovered from COVID-19 infection are more susceptible to mucormycosis. The disease is clinically characterized by a partial loss of neurological function and a gradual necrosis due to the invasion of the organisms into the blood vessels resulting in thrombosis and tissue infarction/necrosis. The disease may progress to involve the cranium thereby increasing the fatality rate [1].

Based on clinical presentation and involvement of a particular anatomic site mucormycosis is divided into six types: (i) rhinocerebral, (ii) pulmonary, (iii) cutaneous, (iv) gastrointestinal, (v) disseminated, and (iv) miscellaneous. Rhinocerebral type is the most common form of the disease. Eye or facial pain and numbness are the first signs of rhinocerebral mucormycosis, followed by conjunctival suffusion, hazy vision, and soft tissue swelling. If left untreated, the infection progresses into the sinuses and oral cavity and produce painful, necrotic ulcerations of the hard palate [2].

Immunosuppressive therapy is one of the treatment options for COVID-19 patients. However, it is well known that immunosuppressive agents (*e.g.*, corticosteroids and cytokine blockers) increase the risk of opportunistic infections. Several opportunistic infections were reported in COVID 19 patients, such as Aspergillus spp., Cryptococcus neoformans,

Pneumocystis jiroveci, Mucormycosis and Mycobacterium tuberculosis. Mucormycosis was most prevalent in India. Treatment includes local or systematic antifungal medications and surgical debridement. Surgical excision and debridement of the affected areas results in defects of varied sizes which affects the functions, esthetics, morbidity and quality of life.

As India is a country of varied population it is important to discuss various reconstructive and rehabilitative procedures which suffice a particular patient need. Most patients are coming in the age groups of 21-40 and are willing for full reconstructions instead of just a simple closure. So it is necessary to discuss and understand the current trends for the reconstruction techniques present and prosthetic rehabilitative procedures associated with it.

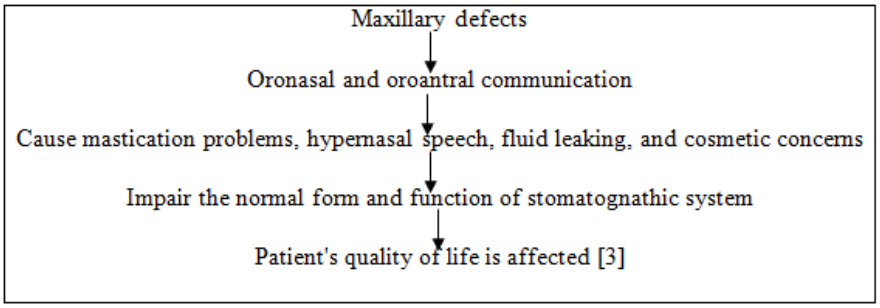


Fig-1: Sequeale of Maxillary defects

Prosthodontic rehabilitation or surgical correction of the defect is used to treat maxillectomy defects. The decision to use either of the options is determined by the site, size, etiology, severity, age and the patient's wishes. However, the success of the Prosthodontic rehabilitation depends upon the team approach of the Surgeon, Prosthodontists and the patient. The separation of the oral and nasal cavities to allow adequate swallowing and speech, support for the orbital contents to prevent enophthalmos and diplopia, support of the soft-tissue to restore the midfacial contour and aesthetic, are all part of the prosthodontic rehabilitation of total or partial maxillectomy in patients [4].

RECONSTRUCTION METHODS

Soft tissue Reconstruction	
Temporalis muscle flap	Small- and medium-sized palate defects.
Radial forearm free flap	Maxillary reconstruction of small defects
Rectus abdominus, latissimus dorsi, or vastus lateralis flap	Large-volume defects
Microvascular repair	Large-volume maxillectomy defects with or without ocular exenteration
Hard tissue reconstruction	
Osteocutaneous Radial Forearm (OCRF)	The bone may be placed horizontally for arch reconstruction, obliquely for zygomaticomaxillary restoration, or osteotomized for inferior orbital rim repair.
Iliac crest free flap	Complete maxillary reconstruction, restore the alveolus, zygomatic prominence, infraorbital rim and the muscle is used for sinus obliteration, oronasal separation, and intranasal lining
Subscapular flap	Total maxillectomy with orbital preservation
Fibula flap	Inferior maxillectomy that does not compromise the inferior orbital rim, extend across the midline, and necessitates osteointegrated dental implants for oral rehabilitation.

Fig-2: Methods of reconstruction

The type of flap is decided by the amount, location, and quality of residual bone of the midface and dentition. Local, regional, or distant free flaps all can result in acceptable aesthetics and functions, mainly in larger defects. Although free flaps are more commonly used, a temporalis muscle flap may be utilized for small- and medium-sized palate defects. Intraorally, the fascial surface is allowed to mucosalize, resulting in a more natural intraoral lining than skin flaps. Reconstruction with radial forearm fasciocutaneous flaps results in good appearance, chewing, taste, speech, comfort and convenience [5].

The vascular status of the donor site, flap surface to volume ratio, tissue pliability, and pedicle size and length all influence autologous tissue selection. The radial forearm free flap is mainly used for maxillary reconstruction of small defects as it satisfies all the above criteria. Other donor sites, such as the rectus abdominus, lateral arm, and serratus anterior

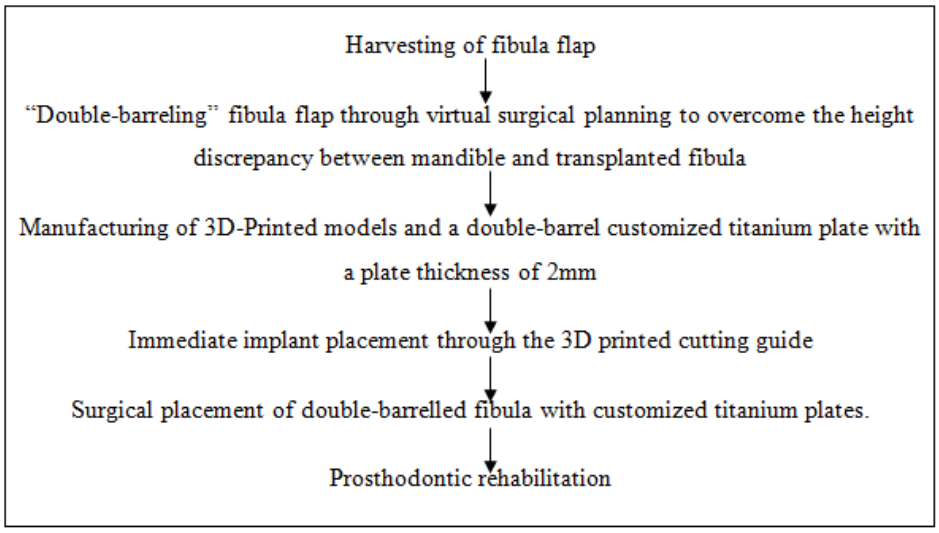
muscle, have been used to effectively restore similar defects [6, 7]. Microvascular repair is usually required for large-volume maxillectomy defects with or without ocular exenteration.

In short, reconstruction with soft-tissue flaps is indicated in 2 conditions: small to medium sized maxillectomy defects with firm dentition to support prosthesis or larger defects in patients with poor oncologic prognosis.

Large defects can be reconstructed by nonvascularized bone grafts, vascularized bone grafts, and tissue engineering approaches. The fibula flap is regarded as the gold standard for mandibular reconstruction due to several advantages: great length of bone which allows reconstructions of defects longer than 10 cm, medullary and periosteal vascular supply, large skin paddle for soft tissue reconstruction, a anatomically constant vascular pedicle based on peroneal artery, bicortical bone which makes dental rehabilitation with implant-supported or implant retained prostheses feasible [8].

Double-barrel fibula flap enable enhanced aesthetic and functional results, as well as immediate one-stage osseointegrated dental implantation. "Double-barreling" of the fibula is done to overcome the height discrepancy between mandible and transplanted fibula. This technique involves osteotomies and folding of the fibula graft to create equal struts, while preserving the blood supply throughout the graft [8] [Fig 3].

Fig-3: Double barrel reconstruction of mandible



The computer assisted techniques (CAD-CAM) used for maxillary reconstruction mainly include [9] (Fig 4):

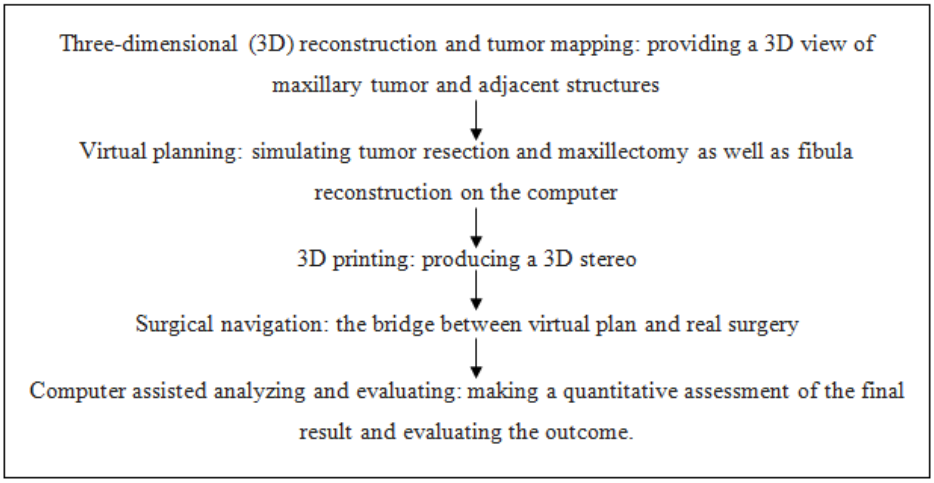


Fig-4:CAD-CAM reconstruction of maxilla

Fig-5: 3D Reconstructed maxillary defect

Prosthetic Rehabilitation

Prosthetic rehabilitation has been advised for the rehabilitation of defects of the hard and soft palate. There are maxillary obturators for hard palate defects, pharyngeal obturators for soft palate defects, and maxilla-pharyngeal obturators for defects that include both structures. In general, prosthetic intervention leads to a rehabilitation of dentition, reduction of hypernasality and subsequent restoration of speech and also limit nasal leakage of liquids and food [10].

Prosthetic rehabilitation with obturator prosthesis restores functional capabilities such as speech, oral food intake, and deglutition by re-creating an anatomic barrier between the oral and nasal cavities. Depending on how long it has been since the maxilla was surgically resected, obturators can be classed as immediate surgical obturators (feeding plates), temporary or interim obturators, or definitive obturators.

Immediate surgical obturator

An immediate surgical obturator is placed just after the surgery and is mainly used to minimize post-operative complications. It protects the surgical site from food debris contamination, supports soft tissue, reduces scar contracture and disfigurement, reproduces the anatomy of the palate and promotes post-operative oral hygiene. It also allows the patient to resume a normal diet, protect the surgical site from trauma and also maintain pressure. Furthermore, it restores normal speech and eliminates the need for nasal gastric tubes. They can also be used to correct contour of lip and cheek and limit the flow of exudates into the mouth [10, 11] [Fig 6].

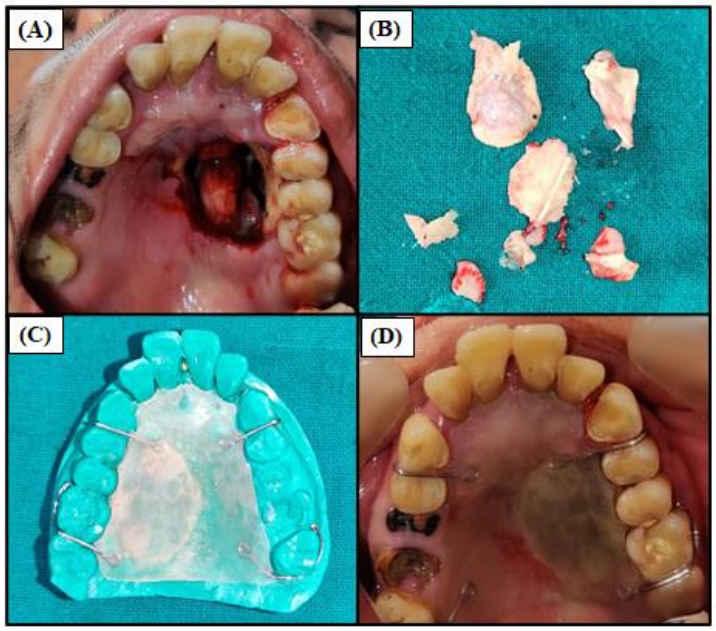


Fig-6: Immediate surgical Obturator
(A) Maxillary defect, (B) Debridement of necrosed tissue, (C) Fabrication of obturator (D) Post rehabilitative view

Interim obturator

The interim obturator or temporary is made from a post-surgical impression cast, which has a false palate and ridge without teeth [11]. The bulb part of the obturator extends into the defect and accommodates it which provides a hermetic seal [Fig 7].

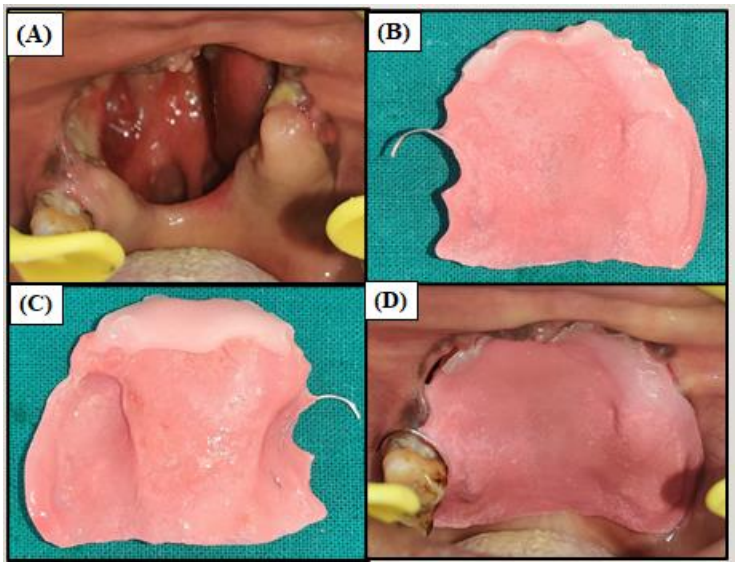


Fig-7: Interim Obturator
(A) Maxillary defect, (B, C) Relining of prosthesis, (D) Post rehabilitative view

Definitive obturator

The definitive obturator is fabricated from a post-surgical maxillary cast about 6 months after surgery, when the surgical site has healed completely and dimensional alterations are unlikely. This obturator has a metal frame work, which acts as the palate and supports the teeth and a closed or open hollow bulb [12].

Hollow bulb obturators

The extent to which the obturator extends into the defect part depends on factors such as configuration of defect, character of lining tissue and functional requirements for prosthesis retention, support, and stability. In larger surgical defects, obturator is extended vertically to engage the surgical defect and horizontally to engage the bony or soft tissue undercuts at the expense of its shape, size and weight. The obturator's increased weight makes it uncomfortable and non-retentive for the patient, jeopardizing its function. Hollow bulb obturators are fabricated to decrease the weight of the prosthesis [12]. According to Wu and Schaaf studies, hollow obturator significantly reduces prosthesis weight from 6.55% to 33.06% depending on the size of the defect [13, 14][Fig 8].

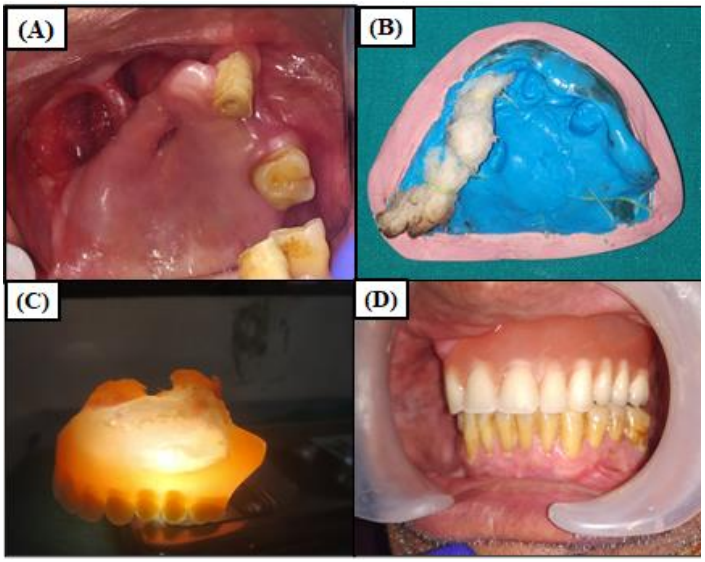


Fig-8: Hollow Denture
(A) Maxillary defect, (B) Impression, (C) Hollow Obturator, (D) Post rehabilitative view

Inflatable obturator

Hollow obturators can be open or closed. According to Oral *et al*. study open-hollow design has lighter weight, easily cleansable, adjustable and produces better articulation as compared to closed design. Hollow obturators have significantly reduced weight but it is problematic in patients with limited mouth opening. So, in such scenarios the inflatable obturator is the preferred and the suitable treatment option [15].

Two-part prosthesis

In extensive bilateral midfacial defects and total or partial maxillectomy cases prosthetic rehabilitation is achieved using two-part prosthesis i.e. antral and oral part. Retention of antral part is achieved by engaging soft and hard tissue undercuts or with the help of resilient liners and oral part is attached to antral part by different types of attachments.

Cast partial prosthesis

In hemi-maxillectomy cases or in cases with firm, retained teeth prosthesis with metal framework or cast partial prosthesis serve as the best treatment modality. Cast framework partial dentures are more comfortable, durable, and biocompatible and has enhanced longevity, stability and esthetics as compared to resin-based prosthesis [16].

CAD-CAM and SLS technology

The computer-aided design and computer-aided manufacturing (CAD-CAM) technology and selective laser sintering (SLS) technology are also used in the fabrication of prosthesis for maxillofacial defects. SLS technique has advantages of improved mechanical properties, higher patient satisfaction in terms of prosthesis cleaning, speaking, mastication and comfort, reduced laboratory time, and availability of saved data for future prosthesis reproduction [17].

Zygomatic Implants

In bilateral hemi-maxillectomy cases zygomatic implants can be a solution to the lack of maxillary bony support for prosthetic rehabilitation. Zygomatic implant retained prosthetic rehabilitation is indicated in benign and malignant pathologic ablation (ameloblastoma, squamous cell carcinoma), infectious debridement (mucormycosis), avulsive trauma (gunshot wounds) and failed reconstructions. Zygoma implant reconstruction of acquired maxillary defects is a safe, predictable, and cost-effective treatment modality [17]. Disadvantages associated with prosthodontic rehabilitation include the need for periodic recalls and replacement, problems with prosthesis retention, and the sense that the prosthesis is not a “natural” part of one’s body [18].

CONCLUSION

Maxillary reconstruction of mucormycosis defect is a significant challenge for the clinicians as maxillary bone separates the oral and orbital cavities and also provides skeletal support to the orbital contents. Decisions regarding the extent of the maxillectomy defect and structures to be preserved is paramount for treatment success. A team approach between the surgeon and the maxillofacial prosthodontist is essential for restoring speech, swallowing, mastication and esthetics. Thus, the need of the hour is to have knowledge about different methods of rehabilitating such defects which can aid in providing improved quality of life.

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