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Corresponding Author
Dipti Wadhwani,
Department of Dentistry, Vilasrao Deshmukh Government Medical College, Latur, India
diptitharani@gmail.com

Author Designation
[1]Professor
[2]Assistant Professor

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Prosthetic Rehabilitation of Post-COVID-19 Mucormycosis Patients Treated with Maxillectomy: A Case Series

[1]Ritesh Wadhwani and [2]Dipti Wadhwani
[1,2]Department of Dentistry, Vilasrao Deshmukh Government Medical College, Latur, India

ABSTRACT
The surge in cases of COVID-19 in India during the second wave of the pandemic was associated with increased reporting of invasive mucormycosis post COVID-19, especially among critically ill patients treated with steroids. The most common type of the disease observed was rhino-orbito-cerebral mucormycosis, with many cases showing involvement of palate and maxillary alveolar process. Management included systemic antifungal therapy and aggressive surgical debridement with maxillectomy performed in many patients. Such treatment adversely affects facial appearance, and functions such as mastication, speech and deglutition. Prosthetic rehabilitation after surgical treatment of mucormycosis is essential for the early restoration of oral function and facial esthetics. Maxillectomy often leads to oro-antral communication and lack of supporting basal tissues, which pose difficulty in making a prosthesis. This article presents prosthetic rehabilitation of fourteen cases of post-COVID-19 mucormycosis treated with maxillectomy. Clinical presentation, computed tomography findings, histopathological findings and treatment received by the patients is presented. Method of fabrication of prosthesis is described. Obturator complete/partial removable dentures were fabricated for these patients with modifications of the conventional prosthetic methods to deliver a functionally stable prosthesis.

INTRODUCTION

The infection of COVID-19 emerged in 2019 and was declared a global pandemic in March 2020 by WHO[1]. The world witnessed several waves of this pandemic. The clinical presentation of the disease in all these waves remained more or less similar, with differences in the severity of infection, the second wave that peaked in India in April-May 2021, being the most severe[2]. The increased severity of symptoms in the second wave led to the rise in usage of systemic steroids to suppress the inflammation. This was followed by sudden surge in opportunistic infections, the most prominent of which was mucormycosis.

The most common and distinct presentation of mucormycosis is rhino-orbital-cerebral infection, which typically occurs when fungal spores are inhaled into the sinuses. From there, the infection can remain localized, with symptoms consistent with acute sinusitis. In vulnerable hosts however, progression of the infection with invasion of the orbit and palate and further extension to the brain may occur[3]. Management of mucormycosis involves systemic anti-fungal therapy and surgical debridement. Surgical debridement is instrumental in the treatment of this disease and has been shown to improve survival[3]. Thus, aggressive debridement of all necrotic tissue should be carried out expeditiously. Frequently, repeated debridement are required to effectively remove all necrotic tissue to get a clean and viable surgical margin, increasing the effectiveness of antifungal therapy[4].

Many patients of rhino-orbito-cerebral mucormycosis require maxillectomy, which may lead to oro-antral communications. Maxillectomy alters facial appearance, functions and an individual's overall quality of life[5]. Maxillectomy can be reconstructed with soft tissue flaps or a prosthetic obturator[6]. Obturator function and quality of life have a strong correlation. Some of the problems associated with rehabilitating extensive intraoral defects make it extremely challenging for a dentist to fabricate a prosthesis[7]. Here we report a case series on prosthetic rehabilitation of fourteen patients with post-COVID-19 mucormycosis treated by maxillectomy treated at a Government Medical College Hospital in Maharashtra, India. The surgical treatment of the patients was carried out in the Department of Otolaryngology. Prosthetic rehabilitation of the patients was carried out in the Department of Dentistry. The expected outcome is an improvement in the overall function and esthetics after the delivery of prostheses. An informed written consent was obtained from all the patients for publication.

Case Series

Case No. 1: A 37 year old male patient reported with headache and pain over right side of face in cheek and periorbital region since 10-12 days. He also complained of swelling over upper gums. There was history of fever and cough around one month ago, for which patient took medications prescribed by a general medical practitioner. There was no history of any systemic disease. Physical examination revealed extraoral swelling in right infra-orbital and cheek region. Intra-oral examination revealed multiple gingival abscesses over labial and buccal gingiva in bilateral maxillary arch. Computed tomography (CT) scan of paranasal sinuses (PNS) showed mucosal thickening in all paranasal sinuses, erosion of hard palate and superior alveolar margin bilaterally, suggestive of fungal sinusitis. Haematological investigations showed raised blood sugar level. Patients KOH mount of sample collected from nasal cavity was positive for fungal element, suggestive of mucormycosis. The treatment was started with injection Liposomal Amphotericin B. The patient underwent surgical treatment in the form of Functional Endoscopic Sinus Surgery (FESS) along with bilateral maxillectomy. Patient was kept on follow up anti-fungal therapy (Pasoconazole) and discharged. After three months of follow-up he was referred to Department of Dentistry for prosthesis. Intra-oral examination revealed edentulous maxillary arch with oro-antral communication present on right side. Maxillary obturator complete denture was fabricated for the patient.

Case No. 2: A 52 year old male patient reported with headache and swelling over face since 8 days. He had history of hospitalization for management of COVID-19 infection, during which he received oxygen therapy, injection glucocoricoid and remdesivir. His haematological investigations revealed raised blood glucose level. After around 15 days of discharge from hospital he developed pain and swelling over left side of face. Based on imaging and histopathological investigations he was diagnosed with mucormycosis. He underwent left sided FESS with orbital decompression at a private hospital. His symptoms did not subside after treatment and he reported with headache and swelling over face to our hospital. Patient underwent clinical and radiological evaluation. Bilateral subtotal maxillectomy along with surgical debridement of paranasal sinuses was performed. After three months patient was referred to Department of Dentistry for prosthesis. Maxillary obturator complete denture was made for him.

Case No. 3 (Fig. 1): A 32 year old male patient presented with pain headache and facial swelling since one week. There was history of hospital admission for management of COVID-19 infection, during which he received oxygen therapy, parenteral glucoroticoid and remdesivir. He was a known case of Diabetes Mellitus,

systemic hypertension and had underwent right kidney transplantation ten years ago. Physical examination showed diffuse extra-oral swelling over right side of face involving supra-orbital, infra-orbital and cheek region which was tender on palpation. Mouth opening was limited. Intraoral examination showed diffuse swelling over right buccal mucosa and buccal vestibule. CT PNS showed soft tissue opacification involving frontal, right ethmoid, bilateral maxillary and sphenoid sinuses, suggestive of fungal sinusitis. Patient was put on systemic antifungal therapy and underwent surgical debridement. Bilateral maxillectomy and FESS was performed. Three months after surgery, he was referred to Department of Dentistry for prosthetic rehabilitation. After healing he presented with oro-antral communication of size 2.5 x 1 cm on right side and 1 x 0.5 cm size on left side. A maxillary obturator complete denture was made for him.

Case No. 4: A 45 year old male patient reported with headache since 15 days. He gave history of hospitalisation for management of COVID-19 infection one month ago. He had received oxygen therapy, systemic glucocorticoid and remdesivir. Haematological investigations showed raised blood glucose level. CT PNS findings were suggestive of fungal sinusitis. He received systemic anti-fungal treatment. Surgical debridement was done through bilateral FESS and partial maxillectomy. After complete healing patient was referred to Department of Dentistry for prosthetic rehabilitation. A maxillary obturator removable partial denture was made for the patient.

Case No. 5: A 42 year old male patient presented with pain in upper front teeth region since one week. He gave history of hospitalisation for management of COVID-19 infection one month ago. He had received oxygen therapy, injectable glucocorticoids and remdesivir. Physical examination showed swelling of size 1 x 0.5 cm on palate in mid-palatine region. Tenderness with teeth 14 15 23 24. Grade II mobility with teeth 11 12 13 14 15 16 21 22. MRI PNS revealed right maxillary and ethmoidal sinusitis with abnormal enhancing soft tissue in premaxillary region, mild bone marrow oedema involving right maxilla and alveolar ridge, suggestive of fungal sinusitis. Systemic anti-fungal therapy was started. Bilateral FESS and right partial maxillectomy was done. After complete healing patient was referred to Department of Dentistry for prosthetic rehabilitation. A maxillary obturator removable partial denture was fabricated for him.

Case No. 6 (Fig. 2): A 58 year old female patient reported with pain in upper front teeth since 3 days. There was history of hospitalisation for management of COVID-19 infection, during which she received oxygen therapy, injectable glucocorticoid and remdesivir. Her haematological investigations showed raised blood glucose level. Few days after discharge from hospital she developed headache and swelling over face. She was diagnosed with post COVID mucormycosis, for which she underwent endoscopic medial maxillectomy at a private hospital. One month later she reported to our hospital with pain in upper front teeth. On physical examination multiple draining sinuses were seen over gingiva in 23 24 region. Swelling of size 1 x 0.8 cm was noted over hard palate in mid-palatine region. There was grade III mobility with teeth 21 22 23 24 25. CT PNS showed soft tissue opacification involving bilateral paranasal sinuses, suggestive of fungal sinusitis. Histopathological examination of samples collected from nasal cavity showed presence of broad aseptate hyphae, consistent with mucormycosis. Bilateral partial maxillectomy was performed for surgical debridement. After healing, patient was referred to our department for prosthesis. Oral examination revealed presence of oro-antral communication of size 2.5 x 1 cm on right side. A maxillary obturator complete denture was made for the patient.

Case No. 7: A 55 year old male patient presented with a complaint of pain and swelling over right cheek region and right periorbital region since 15 days. He gave history of hospitalisation for management of COVID-19 infection. He had received oxygen therapy and systemic corticosteroids. His blood investigations showed hyperglycaemia. Physical examination showed multiple draining sinuses over bilateral maxillary gingiva and mobility of maxillary teeth. CT PNS finding were consistent with pansinusitis with erosion of maxillary alveolar arch. Patient underwent bilateral partial maxillectomy and FESS. After healing he was referred for prosthetic rehabilitation. A maxillary obturator partial denture was made for him.

Case No. 8: A 55 year old female patient presented with complain of pain and sensitivity in upper front teeth since two months. She was a known case of Diabetes Mellitus. She was diagnosed with post COVID-19 mucormycosis and underwent FESS and extraction of maxillary right canine tooth at a private hospital. Her symptoms did not subside after the treatment and she reported to our hospital. Physical examination revealed sessile swelling of size 1 x 1 cm over palate in mid-palatine region, tenderness with teeth 12 and 14, grade II mobility with tooth 12. CT PNS revealed sinusitis involving right maxillary, ethmoid and sphenoid sinuses and erosion of palate and right maxillary alveolar arch. Right partial maxillectomy and FESS was performed for surgical debridement. After three months of follow-up patient

was sent to our department of prosthetic rehabilitation. An obturator removable partial denture was made and given to patient.

Case No. 9: A 37 year old male patient presented with complain of facial pain and mobile upper teeth since 15 days. There was history of hospitalisation for management of COVID-19 infection, during which he received oxygen therapy, systemic glucocorticoid and remdesivir. His blood glucose levels were elevated. Physical examination showed inflamed and oedematous maxillary gingiva and mobility of maxillary premolar teeth. CT PNS findings were suggestive of fungal sinusitis. He received systemic anti-fungal therapy. Surgical debridement was done in the form of bilateral partial maxillectomy and FESS. After complete healing he was referred to our department for prosthesis. A maxillary complete denture was made.

Case No. 10 (Fig. 3): A 58 year old female patient presented with numbness on left side of face, below and around eyes since 8-9 days. She gave history of hospitalization for treatment of COVID-19 infection, during which she received oxygen therapy, injectable glucocorticoid and remdesivir. Medical history revealed that she was a known case of Diabetes mellitus and systemic hypertension. Physical examination revealed draining sinuses over buccal gingiva in relation to tooth 24 25, grade III mobility of teeth 24 25. Haematological investigation showed HbA1C: 14.5% and average blood glucose 369 mg dL^{-1}, suggestive of poor glycaemic control. CT PNS showed mild soft tissue opacification involving left ethmoid, left maxillary and sphenoid sinuses causing mild rarefaction of medial and lateral wall of left maxillary sinus suggestive of changes related to fungal sinusitis. Systemic anti-fungal therapy was started for patient. Left side FESS and partial maxillectomy was performed. Patient was referred to department of Dentistry for maxillary prosthesis after complete healing. Intra-oral examination showed presence of oro-antral communication of size 1 cm on left side. Teeth 21 through 26 were missing. Maxillary obturator partial denture was fabricated for her.

Case No. 11: A 41 year old male patient complained of sensitivity in upper left back teeth since one month. There was history of hospitalisation for management of COVID-19 infection, during which he received systemic glucocorticoids. Physical examination showed restricted mouth opening; small, hard swelling over hard palate on left side of size 0.5 x 0.5 cm. Haematological investigation revealed HbA1C: 9% and average blood glucose 211 mg dL^{-1}, suggestive of unsatisfactory glycaemic control. CT PNS showed moderate mucosal thickening in left frontal, maxillary, ethmoid and sphenoid sinuses and right maxillary sinus suggestive of sinusitis. MRI PNS revealed moderate soft tissue opacification involving all left paranasal sinuses and right maxillary and frontal sinuses suggestive of fungal sinusitis. Histopathological examination showed scattered short, thick and aseptate hyphae, consistent with mucormycosis. Patient underwent left side FESS and left partial maxillectomy. After complete healing patient was referred to our department for prosthesis. A maxillary removable partial denture was fabricated for him.

Case No. 12: A 35 year old male patient reported with pain in upper right teeth since last 2 months. There was history of hospitalisation for management of COVID-19 infection, during which he received oxygen therapy. Physical examination revealed draining sinuses over gingiva in maxillary right premolar region and grade III mobility of maxillary right teeth. CT PNS showed mucosal thickening in all paranasal sinuses on right side, erosion of hard palate and superior alveolar margin on right side, which was suggestive of fungal sinusitis. Histopathological examination of the sample collected from sinus showed sinonasal tissue lined by respiratory epithelium having polypoid configuration with moderate mononuclear inflammation, suggestive of inflamed sinonasal tissue. He was put on systemic anti-fungal therapy. Right partial maxillectomy and FESS was performed for surgical debridement. After complete healing patient was referred to Department of Dentistry for prosthesis. A maxillary obturator denture was made for him.

Case No. 13: A 51 year old male patient presented with loosening of upper right back teeth. There was a history of hospitalisation for management of COVID-19 infection. He had received oxygen therapy, systemic glucocorticoid. He was a known case of Diabetes mellitus. Physical examination revealed multiple draining sinuses in maxillary right canine and premolar region. Radiological findings were suggestive of fungal sinusitis. KOH mount of sample collected from nasal cavity showed presence of aseptate fungal hyphae, suggestive of mucormycosis. He received systemic anti-fungal therapy underwent surgical debridement in the form of bilateral FESS and partial maxillectomy. After healing a maxillary obturator removable partial denture was made in the Department of Dentistry.

Case No. 14: A 55 year old female reported with pain and mobility of teeth since 8 days. There was history of fever and cold around one month ago. She was a known case of Diabetes mellitus. Clinical examination showed non-healing socket with 25 with bleeding on provocation, mobility of tooth 24. Swelling of size 2 x 1 cm on hard palate was seen on left side. Based on CT PNS findings and histopathological examination she was diagnosed with mucormycosis. She underwent

Fig. 1: (Case no. 3): A- Bilateral oro-antral communication along with loss of basal tissues. B- Obturator complete denture with extended flanges that cover the oro-antral communication. The intaglio surface of the denture is trimmed to make it lighter. C- Obturator complete denture in place

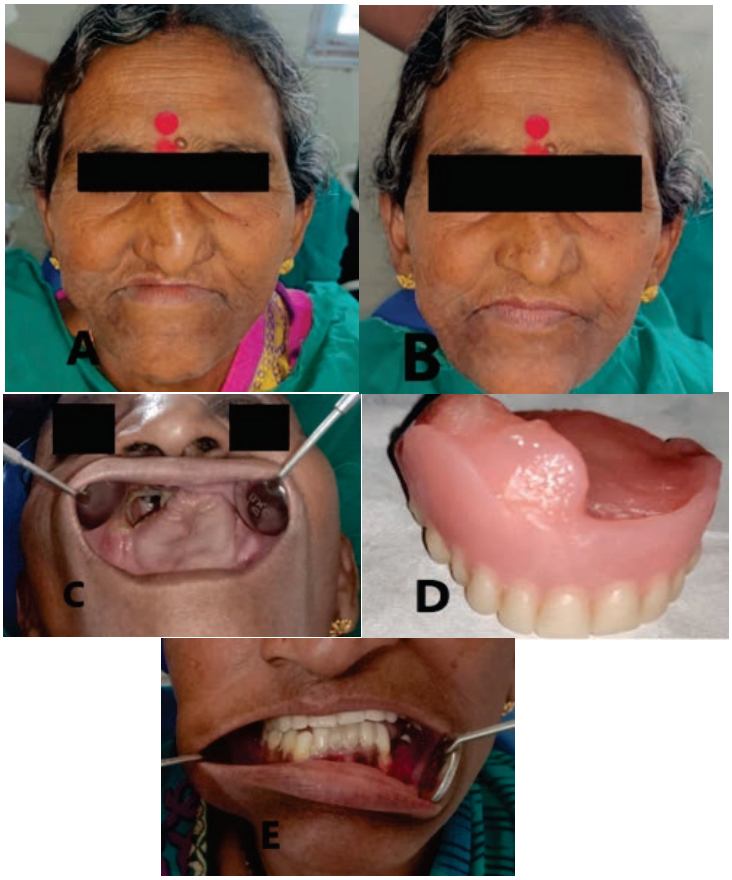

Fig. 2: (Case no. 6): A and B- Improvement in facial appearance before (A) and after (B) delivery of obturator complete denture. C- Oro-antral communication along with loss of basal tissues. D- Obturator complete denture. E- Obturator complete denture in place

Fig. 3: (Case no. 10): A- Facial appearance beore prosthesis. Note the lack of labial fullness on left side as a post-operative effect of left partial maxillectomy. B- Small oro-antral communication present on left side. Missing teeth 21-26. C- Obturator removable partial denture in place. D- Improvement in facial appearance after delivery of obturator prosthesis

FESS and left partial maxillectomy. After complete healing a maxillary obturator removable partial denture was fabricated for her.

Fabrication of Prosthesis: After achieving complete healing in all the above mentioned patients, a maxillary obturator prosthesis with partial or complete denture was made on the basis of existing dentition. The steps for making the obturator prosthesis were similar to those for making a conventional total prosthesis, except some specific care in the prosthesis molding and fitting steps. For taking Primary Impression, a Vaseline embedded gauze was inserted into the cavity in palatal region in order to prevent excess impression material extravasation into the maxillary antrum. The impression tray was chosen according to the patient arch size and the base of the tray was covered with impression compound and the surface of impression compound was covered with Alginate and primary impression was recorded. The impressions were poured with Plaster of Paris and study models were prepared. Customised special trays were fabricated using poly methyl methacrylate. The borders of special trays were trimmed and kept 2 mm short of actual border. The final impressions were recorded on these trays. A Vaseline embedded gauze was packed lightly in the oro-antral communication. The trays were lined with green stick and border moulding was performed. Then impressions were recorded with elastomeric impression material. The impressions were poured with dental stone and master models were prepared. Bite rim blocks were then constructed on master models and intermaxillary relation was recorded and mounted on an articulator. The acrylic denture teeth set were arranged on the wax rims and tried in patient's mouth to verify the occlusion, aesthetic appearance and support for the underlying tissues. Heat cure acrylic resin was used in trial pack technique to prepare final complete denture. The obturator was made hollow to ensure lightness. The retention areas were polished at insertion stages so that prosthesis was not fixed at the communication area. The obturator prostheses were delivered to the patients.

DISCUSSIONS

The case series presents prosthetic rehabilitation of fourteen cases with a history of post-COVID-19 rhino-orbito-cerebral mucormycosis that warranted extensive surgical resection of the maxilla. Such treatment involves loss of basal tissues making the outcome of prosthetic rehabilitation unpredictable. Surgical resection hampers functions like mastication, swallowing, and speech. It leads to sagging of facial tissues and deterioration of patient's esthetics. According to Blair *et al*.[8] maxillary resection has a high level of morbidity with significant functional and psychological implications for the patient.

To re-establish functionality adequate closure of the defect is essential to prevent the passage of air, liquid and food between the nasal and oral cavity.

Rehabilitation of the deficit in the oral cavity and dentition following maxillectomy, can be achieved by using an obturator prosthesis or a vascularised free-flap containing a bone segment. Obturator is an artificial device designed to ensure a tight closure of a bucconasal and/or buccosinusal communication. An obturator prosthesis offers several advantages, which include the possibility to immediately restore dentition without need of further surgery and enables the residual cavity to be kept under control in case of the recurrence of the disease[9]. It improves swallowing and increases masticatory efficiency and speech[10]. Moreover, in wide resections, the obturator supports the facial tissues[8]. It has also been shown that maxillofacial rehabilitation using obturator reduces anxiety levels and severity of depression over a period of time[11]. On the other hand the flap composed of vascularised bone provides permanent closure of the oral-nasal passage with an osteo-integrated implant, but as reported by Cordeiro *et al*.[12] there are systemic complications in 11.7% of the patients and in 9.1% re-exploration is necessary because the vessels of the free flap are compromised with partial necrosis in 1.8%.12 Also, the large size of post-operative defects and the patient's non-acceptance of a more invasive procedure may limit the options for surgical reconstruction, therefore, an obturator prosthesis is ideal for the predictable restoration of oral function and facial esthetics in these patients. In addition, surgical reconstruction is generally considered risky in a patient who has recovered from mucormycosis due to comorbid conditions[13]. For these patients, a prosthesis that can be easily removed is advantageous in checking for the recurrence of infection at the site of surgery, which could help in early diagnosis and treatment before complications develop[14].

After surgical resection, loss of soft and hard tissue, presence of oro-antral communication and lack of vestibular depth as a post-operative complication poses the difficulty for the dentist in prosthetic rehabilitation. There was a need for modification of conventional impression making in the present cases that have been described in this article. Utmost care was taken to prevent intrusion of impression material into the sinus cavity. An accurate impression of the basal tissues and/or adjacent teeth is the first step to make a denture with good retention, stability and support. This also ensures limiting of the denture margins to properly cover the margin of oro-antral communication. The obturator was made of methyl methacrylate. This material has the advantage of being durable in the long term, can be easily cleaned and being perfectly polished. The larger size of obturator prosthesis as compared to conventional denture could lead to increase in its weight. The obturator was made hollow to reduce its weight. In our cases the use of soft tissue liners was avoided. The use of soft liners in an obturator has been advised to reduce pressure on defect areas by providing a cushioning effect between the prosthesis and the defect margins[15]. However, in a patient with a history of mucormycosis the use of soft liners in a prosthesis that contacts the nasal mucosa is not recommended. This is due to their higher risk of fungal contamination compared to acrylic resins[16]. Thus rehabilitation of maxillectomy defects with an obturator prosthesis is a safe, inexpensive and fast alternative with satisfactory outcomes.

CONCLUSION

Post-COVID-19 mucormycosis is a life-threatening fungal infection with high mortality if treated late. The standard proven treatment is surgical debridement that sometimes requires removal of maxillary bone on one or both sides. Maxillectomy cause facial deformity and also hamper mastication, deglutition, phonetics, etc. This causes deterioration in the quality of general and oral health. In spite of the advances in surgical reconstruction techniques, conventional obturator prostheses are still the gold standard to rehabilitate patients with maxillary defects.

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