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REHABILITATION OF MUCORMYCOSIS PATIENTS USING DMLS FABRICATED CAST PARTIAL DENTURE WITH ALTERED CAST IMPRESSION TECHNIQUE—A CASE SERIES

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Abstract

Rehabilitating maxillectomy defects poses significant challenges that require tailored approaches for each individual patient. To achieve successful outcomes, it is crucial to integrate both traditional and modern treatment methods to enhance the prosthesis's retention, stability, aesthetics, and functionality.

Methods: Three patients with post-COVID Mucormycosis who had undergone localized debridement and partial maxillectomy were treated with a definitive rehabilitation plan. For patients with partial maxillectomy, a cast partial denture designed using Direct Metal Laser Sintering (DMLS) and the altered cast technique was employed. The defect areas were kept as hollow cavities (either closed or open) to reduce the prosthesis's weight.

Results and Conclusion: This approach to prosthodontic rehabilitation proves to be a straightforward and cost-effective treatment, significantly enhancing stomatognathic functions and overall quality of life for patients. Major challenges during rehabilitation include achieving retention and stability due to the absence of basal seat and hard tissue support. To address these challenges, a combination of conventional and digital techniques was utilized to ensure precise fitting and accuracy of the prosthesis, thereby minimizing treatment time and the number of patient visits.

Keywords: cast partial denture, mucormycosis, obturator, rehabilitation, altered cast technique

Introduction

Maxillofacial prostheses aim to restore the appearance, function, and structure of facial areas affected by congenital issues, trauma, or cancer. This specialized field requires extensive knowledge of dental materials and technologies to produce long-lasting and effective prostheses.

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Following a maxillectomy, which involves the removal of part of the maxilla, patients face significant challenges such as difficulties with oral function, speech, and appearance, including issues like hyper nasal speech, nasal regurgitation, and problems with chewing[1]. Restoring function with prostheses involves overcoming challenges such as limited mouth opening, undercuts in the defect, and obstruction from the defect's lateral walls. It's crucial to avoid overloading any remaining teeth and to ensure that the prosthesis remains stable and functional[2]. Different obturator designs, including hollow bulbs and two-piece systems, can affect the prosthesis's weight and effectiveness. The process of prosthetic rehabilitation typically involves several stages. Initially, a surgical obturator is used and adjusted to match the changing defect and surrounding tissues. An interim obturator assists with oral functions during the healing phase, until the defect is stable. Once stabilized, a permanent obturator is fitted for long-term use[3]. The prosthesis must create a secure seal to prevent nasal leakage. Proper support, retention, and stability are essential, influenced by factors such as the defect size, the condition of supporting palatal shelves, and the state of remaining teeth, which can act as abutments to improve stability. Effective rehabilitation demands thorough preoperative planning, teamwork between the surgeon and prosthodontist, and advanced impression techniques.[4] Traditional impression methods often struggle with these large defects due to restricted mouth opening and undercuts. The altered cast technique can address these issues, enhancing the fit and functionality of the prosthesis[5]. This case series focuses on the prosthodontic rehabilitation and creation of a hollow bulb obturator for a partially edentulous patient with an acquired defect, employing Direct Metal Laser Sintering (DMLS) and the Altered Cast Technique.

Case Report:1

A 70-year-old male with hypertension and non-insulin-dependent diabetes presented to the Department of Prosthodontics at Government Dental College, Trivandrum, complaining about an ill-fitting acrylic maxillary obturator. The patient reported issues including poor retention, instability, leakage, and food accumulation under the obturator, prompting him to seek a replacement. The patient's medical history revealed that he had undergone a left partial maxillectomy two years ago due to mucormycosis of the maxilla, which followed a COVID-19 infection. Extraoral examination showed facial asymmetry with a collapsed cheek and a pronounced nasolabial fold on the left side. Intraoral examination indicated that the residual maxillary defect had completely healed. There was visible oro-antral and oro-nasal communication on the left side due to the partial maxillectomy. Missing teeth included 21, 22, 23, 24, 25, 26, and 27, and the alveolar ridge was absent with obliteration of the labial and buccal vestibule on that side. The defect was classified according to Aramany's class 1 system. In the mandible, all teeth were vital but showed generalized physiological attrition.

Case Report 2:

A 38-year-old male patient was referred from the Regional Cancer Centre, Thiruvananthapuram, to the Department of Prosthodontics, Government Dental College, Trivandrum, for prosthetic rehabilitation of a maxillectomy defect. The patient had undergone surgical maxillectomy 8 months back for the treatment of mucormycosis. The chief complaints reported by the patient were nasal regurgitation of food and fluids while eating along with difficulty in speaking. An extraoral examination revealed facial asymmetry, with a lack of support for the

lips and cheek on the left side. Mouth opening of the patient appeared normal, with defective hypernasal speech. The patient was wearing an ill fitting interim acrylic obturator that required to be changed. Examination of the interim obturator found it to be grossly under sized compared to the defect itself. Intraoral examination revealed an Aramany type III palatal defect involving the left side of the arch crossing the midline. Intraoral examination revealed the presence of the remaining natural teeth (13,14,16,17,18) in the maxilla. In the mandible posterior teeth were missing and maxillary molar was root canal treated and capped. The osteomucosal-bearing surface showed a moderate deep palate and covered with a thick, adherent fibro mucosa. On the left side, an existing surgical maxillary defect with adequate healing was noticed in the hard palate. This defect was connecting the oral cavity to the left maxillary sinus and the nasal fossae. It also presented two moderately deep anterior and posterior undercuts. The radiological examination panoramic radiography confirms the existence of the maxillary defect.

Case Report 3:

A 45-year-old male patient presented to the Department of Prosthodontics and Crown & Bridge at Trivandrum with complaints of missing teeth, difficulty chewing, drinking, speaking, and facial deformity resulting from partial maxillary resection. His medical history was otherwise unremarkable. The treatment report indicated that he had undergone resection of the maxillary ridge, extending from the right lateral incisor to the left first premolar, 12 months prior due to post COVID mucormycosis. Extraoral examination revealed a Class 3 skeletal base with the vertical dimension preserved. Intraoral examination showed an Aramany Class VI maxillectomy defect, resulting in inadequate lip support and a depressed nasolabial fold. The patient had been initially rehabilitated with an interim obturator and need to get replaced. All mandibular teeth were found to be vital

Diagnosis and Treatment Plan

The patient's diagnosis includes an acquired palatal defect resulting from surgical removal and associated tooth loss. The primary objective of the treatment was to close the communication between the oral and nasal cavities with an obturator, thereby addressing issues related to speech, swallowing, and deglutition. Additionally, the treatment aimed to improve both the aesthetics and functionality of the patient's oral cavity.

The proposed treatment plan involved several steps: providing oral health instructions (OHI), performing supra- and subgingival scaling and polishing, offering advice on floss and interdental brush use, recommending a fluoridated mouthwash containing 0.05% sodium fluoride (NaF), and suggesting a toothpaste with at least 1350 parts per million (ppm) of fluoride. After these interventions, the plan was to rehabilitate the patient with a removable cobalt-chrome partial obturator for the maxilla using an Altered Cast impression technique and Direct Metal Laser Sintering (DMLS) fabrication method, as well as a conventional removable partial denture (RPD) for the missing teeth in the mandibular arch.

CASE 1:

Design for the cobalt-chrome removable partial obturator (Case report:1)

Compo-nent of RPD	Right side	Left side
Guide plane	Mesial proximal surface of central incisor	None

Rests	Distal occlusal rest rest on canine; mesial and distal occlusal rests on first and second molar	None
Clasps	Wrought wire clasp on central incisor	None
Reciprocal components	Part of the major connector on the first premolar, second premolar, first molar, and second molar.	None
Major connector	Palatal plate major connector	

CASE 2:

Design for the cobalt-chrome removable partial obturator (Case report :2)

Component of RPD	Right side	Left side
Guide plane	Mesial proximal surface of canine	none
Rests	Mesial and distal occlusal rests on canine and first premolar; first molar and second molar	None
Clasps	Occlusally approaching clasps on canine and first premolar; first molar, and second molar.	None
Reciprocal components	Part of the major connector on canine and first molar, and second molar.	None
	Palatal plate major connector	
Major connector		

CASE 3:

Design for the cobalt-chrome removable partial obturator (Case report:3)

Component of RPD	Right side	Left side
Guide plane	Mesial proximal surface of canine	Mesial proximal surface of second premolar
Rests	Mesial and distal occlusal rests on the first premolar and second premolar; mesial and distal occlusal rests on first molar second molar.	Mesial and distal occlusal rests on second premolar and first molar
Clasps	Wrought wire clasp on canine. Occlusally approaching clasps on first and second premolar and first molar	Occlusally approaching clasps on the second premolar, and first molar.
Reciprocal components	Part of the major connector on the first premolar, second premolar, and first molar	Part of the major connector on second premolar and first molar.
Major connector	Palatal plate major connector	

Procedure

In all cases, primary impressions were taken using conventional impression techniques since patient's had normal mouth openings. Before taking the impression, any undesirable

undercuts were blocked with gauze coated in petroleum jelly to protect the defect area. An impression was made using irreversible fast-setting hydrocolloid (AlgitexR) after modifying the upper stock tray for a better fit and blocking undercuts with the petroleum-laden gauze. These impressions were then poured with dental stone type IV (dfine) to create study models.

The maxillary cast was duplicated for future reference. Then the study casts were carefully surveyed to design the metal framework. Considering functional and aesthetic needs, a removable cobalt-chrome partial obturator for the maxillary arch was planned. Mouth preparation involved creating a special tray using cold-cure acrylic resin (Pyrax Rapid Repair), performing border molding with green stick compound (DPIR pinnacle tracing stick), and taking the final impression with polyvinyl siloxane (PVS) material (Perfit elastomeric impression material). The impression was poured with extra-hard type IV dental stone (dfine, Type IV Dental Stone) to obtain the master cast, which

Fig. 1: (A) Pre rehabilitative maxillary occlusal view **(B)** Primary impression **(C)** Final impression **(D)** Try in of Metal framework **(E)** Metal framework with modified impression of defect area. **(F)** Altered cast fabrication **(G)** Try in of prosthesis **(H)** Definitive prosthesis **(I)** Post rehabilitative extra oral view

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was then duplicated to create a refractory cast from investment material.

The master cast was then scanned using shining 3d Autoscan Ds-Ex C Pro Lab Scanner and the metal framework was designed using CAD (EXOCAD) and fabricated with Direct Metal Laser Sintering (DMLS) technology (EOSINT M270, Germany), enhancing accuracy and precision. The fit of the framework was assessed by placing it in the patient's mouth and using a pressure indicator paste. The master cast was modified by slicing it on the defect side, inverting the metal framework with the defect impression onto the cast, and pouring after beading and boxing. Once the cast is set, it was removed to form the altered cast. A denture base using heat cure acrylic (Acryton-H) was then made on the altered cast with the framework in place on the defect side.

Fig. 2 (A) Pre rehabilitative maxillary occlusal view **(B)** Primary impression **(C)** Final impression **(D)**Metal frame work in situ **(E)** Metal framework with modified impression of defect area. **(F)** Fabrication of altered cast **(G)** Try in of prosthesis **(H)** Definitive prosthesis **(I)** Post rehabilitative extra oral view

Jaw relations were recorded for centric relation, and the casts were mounted on an articulator. Teeth selection and arrangement were performed, followed by a try-in to check for retention, stability, function, and aesthetics. The obturator was made in two parts: the bulb and the lid. An elastomeric index of the defect area was created, and a 1.5mm thick thermoplastic resin sheet (Dentmark) was adapted on both superior and inferior surfaces to form a hollow bulb. The bulb and lid parts were bonded with self-cure resin (Pyrax Rapid Repair) to create a single hollow structure. The obturator's seal was tested by immersing it in water.

After successful try-in and hollow bulb fabrication, flasking and dewaxing were carried out. During packing, the defect area was first filled with heat-polymerizing acrylic resin (Acryton-H), and the previously made hollow thermoplastic body was adapted over it. The entire area was then

Fig. 3: (A) Pre rehabilitative maxillary occlusal view **(B)** Primary impression **(C)** Final impression **(D)** Try in of Metal framework **(E)** Try in prosthesis **(F)** Definitive prosthesis **(I)** Post rehabilitative extra oral view

loaded with heat-cure acrylic resin and cured. The prosthesis was finished and polished using standard methods. The following procedures were followed in all three case reports.

The final obturator was evaluated for fit, aesthetics, and function. During insertion, pressure indicator paste (PIP) was used to detect any excessive pressure points. The denture was placed in the patient's mouth, and care instructions were provided. The patient was monitored monthly for the first three months and then every three months for one year, reporting satisfaction with the improvements in function, speech, and aesthetics

Discussion

Patients who have undergone maxillectomy often face ongoing challenges in prosthodontic treatment, particularly issues with support, retention, and stability of the prosthetic device. Factors such as the extent of the defect, the number of remaining teeth, the condition of the surrounding bone and mucosa, the effects of radiation therapy, and the patient's ability to adapt to the prosthesis all influence the success of the treatment[6]. Preserving as many of the remaining teeth as possible is crucial for achieving optimal prosthesis design and functionality. However, a large, heavy obturator can put continuous pressure on tissues, potentially affecting tissue health, function, and comfort.

Retention of the obturator can be achieved through several methods, including using remaining teeth, the ridge, lateral aspects of the defect, undercuts in soft tissue, and scar tissue. Stabilization and indirect retention components must be carefully positioned to prevent movement of the prosthesis over the defect[2].

Implant-supported fixed prostheses are generally not recommended for these patients because they require periodic removal and cleaning, which can be challenging given the secretions from palatal defect areas. Implant-supported overdentures are a better option but come with higher costs and the need for a second surgery[7]. In such cases, conventional cast partial dentures are often preferred over acrylic partial dentures. Cast partial dentures offer superior accuracy, durability, resistance to distortion, thermal conductivity, cleanliness, and reduced bulk. Despite these advantages, cast partial dentures also have limitations, such as fabrication difficulties, the need for more equipment, and potential inaccuracies from manual casting processes[2].

To address these challenges, Additive Manufacturing (3D printing), particularly Direct Metal Laser Sintering (DMLS), has gained significant attention in the dental field. This technology allows for the creation of metal-based appliances with improved accuracy and precision. The digital workflow provided by 3D printing offers many benefits, including shorter laboratory and clinical treatment times, optimized production steps, reduced human error, electronic file transfer and storage, enhanced accuracy, and better patient satisfaction. Additionally, it allows for finer details and more precise anatomical features, resulting in less material waste[8]. In the present case series, the prosthetic rehabilitation of partial maxillectomy patients were performed using DMLS-designed cast partial dentures. DMLS is a fabrication process that builds complex 3D structures directly from CAD designs in thin layers without additional machining, leading to improvements in fit, function, and aesthetics. The use of DMLS and other technologies, such as milling machines, has been shown to surpass conventional casting methods in producing metal denture frameworks[5].

Various techniques have been developed for fabricating removable obturator prostheses, with the extent of the prosthesis dependent on the ability to accurately record the defect's maximum tissue extent. Accurate impression techniques are crucial for providing stability. Techniques such as the two-piece impression technique, custom adapted trays, and separate defect impressions have been used, but they may have limitations related to the integration of the defect into the denture base. The retention of obturators relies on engaging remaining teeth or undercuts in the defect, which obstruct the removal path, particularly on the defect's lateral wall. Recording greater depths in a large maxillary defect helps create a long lever arm for increased stability and retention. The two-stage impression technique with an altered cast technique can help overcome many limitations of previous methods(7).

Heat-polymerizing acrylic resin is commonly used due to its ease of manipulation, superior hygiene, color stability, durability, and tissue compatibility. It contributes to the lightweight nature of the prosthesis, which helps in cantilever mechanics, minimizes soft tissue burden, and enhances speech resonance. The bulb component of the obturator is often hollowed out to reduce weight, which can decrease the prosthesis's overall weight by up to 33%, depending on the defect's extent[9].

The design of the obturator framework should follow fundamental prosthodontic principles, including stress distribution over a broad area, use of a rigid major connector for cross-arch stabilization, and strategic placement of stabilizing and retaining components to minimize displacement due to functional forces. It is essential to wait for the defect site to fully heal and stabilize before constructing the definitive obturator, typically between 3 to 6 months post-surgery, depending on various factors such as tumor prognosis, defect size, healing progress, and tooth presence[3].

Improving the quality of life for hemi maxillectomy patients is more challenging compared to those with conventional prostheses. However, with expertise, knowledge, and experience, specialists can achieve significant improvements. A team approach, leveraging skills and experience at each stage of treatment, and regular patient evaluations can effectively address the challenges faced by hemi maxillectomy patients.

Conclusion

The primary challenge in a maxillectomy patient's recovery is ensuring adequate retention, stability, and support. A thorough understanding of the patient's needs and extensive expertise is critical in effectively rehabilitating these individuals(10). The patient's masticatory abilities, speech intelligibility, and overall quality of life can be significantly improved by designing a definitive obturator prosthesis with maximum coverage and appropriate design.

Conflict of Interests Statement

The authors declare no conflicts of interest.

Consent and Ethical Clearance

As per international standard or university standard, patient's written consent has been collected and preserved.

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