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PROSTHODONTIC REHABILITATION OF SPEECH, MASTICATION & FUNCTIONAL OCCLUSION IN MAXILLARY INSUFFICIENCY & MANDIBULAR DISCONTINUITY DEFECTS: A REVIEW

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Abstract

Abstract: Prosthodontic rehabilitation of patients undergoing ablative cancer procedures involves significant challenges and technicalities in the construction of a prosthesis like repeated prosthetic adjustments or remakes, and ultimately improving quality of life. Mandibular resection causes the mandible to deviate towards the defect, which causes loss of occlusion on the non-resected side, altered mandibular movements, cosmetic deformity, difficulty in swallowing, and impaired speech and articulation. Restoring speech, deglutition, mastication, and respiration in individuals who have undergone maxillary resection involving the maxillae, hard and soft palates, and paranasal sinuses is extremely difficult. It may not be feasible to surgically reconstruct in each case. In conjunction with physical therapy, prosthetic rehabilitation assists such patients in regaining form and function and improving their quality of life. It can be achieved by using obturators and mandibular guidance prosthesis, which could efficiently retrain the maxilla and mandible following surgical procedures to achieve a functional occlusal relation, enabling early progression leading to a permanent restoration that functions almost perfectly. This review's objective is to highlight the various rehabilitative prosthesis that can be used to correct maxillary insufficiency and mandibular discontinuity defects following tumour resections using the available information.

Keywords: rehabilitation, prosthesis, maxillofacial defects

Introduction

The goal of oral rehabilitation in hemimandibulectomy patients is to prevent altered mandibular movements, disfigurement, swallowing difficulty, impaired speech and articulation, and mandibular deviation towards the resected site. Various prosthetic options, such as maxillomandibular fixation, implant-supported prosthesis, removable mandibular guide flange prosthesis,

and palatal ramp restoration, can help achieve this. A provisional appliance, such as a mandibular guide flange or palatal ramp prosthesis, can be constructed to restore a normal maxilla-mandibular relationship.[1]

The maxillary sinus is the largest of the paranasal sinuses and has the highest incidence of malignant sinus tumours. 20% of paranasal sinus cancers are in the ethmoid sinus, 80% in the antrum, and less than 1% in the sphenoid and frontal sinus.[2] One of the most difficult aspects of oral and maxillofacial reconstruction is the reconstruction of maxillary bone defects caused by pathological or congenital causes. The primary goal of these reconstructive efforts is to protect and improve the patient's quality of life by attempting to restore the patient's lost form and function.[3] Maxillary neoplasms are commonly treated by surgical resection of the maxilla and adjoining structures (maxillectomy). The surgery often results in abnormal communication between the oral and nasal cavities. The functional and aesthetic rehabilitation of these resected maxillary deformities is a complicated task. The midfacial region is dominated by the maxillae, which also contribute to important midfacial structures such as the orbit, zygomaticomaxillary complex, nasal unit, and stomatognathic complex.[4] Prosthetic obturation's main objectives include separating the oral cavity from the sinonasal cavities and closing the maxillectomy defects to prevent regurgitation.[5] Prosthetic measures at differing stages assist patients in regaining aesthetic and functional abilities. An effective obturator prosthesis enhances speech, mastication, swallowing, and aesthetics.[6]

Figure 1. Aramany's Class IV Maxillary Defect

Classification of Maxillectomy[7]

- Class I: In this group, teeth are retained on one side of the arch and the resection is performed along the midline of the maxilla.
- Class II: A unilateral defect, in which the anterior teeth are retained on the contralateral side.
- Class III: In the central portion of the hard palate, the palatal defect occurs which may involve part of the soft palate. The remaining teeth are not involved in the surgery.
- Class IV: Both sides of the maxillae are involved and the defect crosses the midline with the remaining teeth lying in a straight line (Figure 1).
- Class V: A bilateral defect lying posteriorly to the remaining abutment teeth.
- Class VI: The maxillary deficiency lying anterior to the remaining abutment teeth is unusual. It occurs more frequently as a result of trauma or congenital problems than as a planned surgical intervention.

Classification of mandibular defects.[8]

- Class I: Preservation of mandibular continuity during mandibular resection involving an alveolar defect.
- Class II: Mandibular continuity is lost distal to the canine area.
- Class III: Loss up to the mandibular midline is caused by the resection defect.
- Class IV: The lateral mandibular aspect of the resection defect is affected, but it is augmented to preserve the pseudoarticulation of bone and soft tissues in the ascending ramus region.

- Class V: Only the symphysis and parasymphysis region of the resection defect is affected, with the bilateral temporomandibular articulations being preserved.
- Class VI: Class V-like, with the exception that the mandibular continuity is not preserved.

Tumors may arise in the alveolar mucosa, in the periosteum and bone of the mandible, or from the dental elements requiring segmental or radical resection of the mandible. Squamous cell carcinoma of the alveolar mucosa, ameloblastoma, and osseous sarcomas are prevalent among these lesions.

Ameloblastoma is a rare odontogenic tumor that tends to be locally invasive. It occurs in the mandible 4 times more frequently than in the maxilla. Although midline lesions have been described, ameloblastoma of the mandible often appears as an indolent mass in the third molar area. It is most prevalent during the 3rd and 4th decades of life. Males and females are approximately equally affected.

About 10% of all oral cancers are **Squamous cell carcinomas** of the gingiva and alveolar mucosa. These carcinomas occur more frequently in the mandible and the molar region is primarily affected. They occur more commonly in men than in females (4:1). A 25.9% prevalence of HPV-associated head and neck squamous cell carcinoma (HNSCC) was concluded through a systematic review. In comparison to oral (23.5%) and laryngeal (24.0%) SCC, the prevalence of oropharyngeal squamous cell carcinoma (OPSCC) was higher (35.6%).[9] The majority of these tumours develop in edentulous regions. Tumors often spread to the floor of the mouth and the buccal mucosa. Approximately 30% of patients initially have regional metastasis, which first affects the submandibular nodes. Squamous cell carcinoma of the mandibular alveolar ridge is primarily treated surgically, with a marginal mandibular resection in early lesions and a segmental resection in advanced lesions with extensive bony involvement. Squamous cell carcinoma of the mandibular alveolar ridge is primarily treated surgically, with a marginal mandibular resection in early lesions and a segmental resection in advanced lesions with extensive bony involvement. The remaining mandibular segment deviates toward the defect after a segmental or hemi mandibulectomy for squamous cell carcinoma, and the mandibular occlusal plane rotates inferiorly. Due to the loss of the tissue which controls the mandibular movements, the deviation occurs.[10]

Osteosarcoma is the most frequent primary osseous malignancy, which involves the mandible or maxilla 6 to 7% of the time. The most common sites of involvement in the mandible are the premolar and molar regions, followed by the symphysis, angle, and ramus. A diffuse swelling or a palpable, occasionally painful mass is the most typical sign of osteosarcoma of the mandible. Involvement of the inferior alveolar nerve frequently causes paresthesia of the chin or lip. It typically takes 3 to 4 months for symptoms to manifest before a diagnosis is made. Osteosarcoma presents as a destructive, ill-defined intraosseous lesion with or without an adjacent soft tissue mass on radiographic examination.

In hemimandibulectomy, the mandible deviates due to its loss of continuity, which further results in aberrant muscle function and facial asymmetry resulting in aesthetic deformities, functional impairment, and psychological consequences.[9] At the vertical dimension of rest, the residual mandibular segment retrudes and deviates towards the surgical side in patients who have had a mandibular resection.

Rehabilitation of Mandibular Discontinuity Defects

Mandibular guidance prosthesis

A palatal- or mandibular-based guiding prosthesis can be used for prosthetic rehabilitation to achieve adequate occlusal function in such patients.[10] A mandibular removable partial den-

ture is affixed to the guide flange on the non-resected side of a mandibular guiding prosthesis as shown in (Figure 2). By extending the flange into the maxillary buccal fold, the remaining mandibular segment is guided superiorly and laterally to the desired jaw relationship which can be seen in (Figure 3).[11] "The flange mechanically holds the remaining mandible with minimal to no lateral movement in the proper position for the vertical chewing stroke."[12-14] This extension can be made of acrylic resin, cast in RPD metal, or wrapped in a thick wire loop.[13–19] Although acrylic flanges can be adjusted in the mouth, they are not rigid and are prone to abrasion, so they need to be reinforced with metal or additional thickness. Metal flanges can be thin and rigid, causing no distortion or abrasion of the cheek space. For metal, however, the angle and length must be predicted prior to casting because metal cannot be adjusted once it is inside the patient's mouth. The flange should be "extended 7 to 10 mm from the mandibular RPD in a superior and diagonal position, shorter than the maxillary vestibular depth."[12-14] More specialized techniques for determining the flange angulation are now required due to individual variations in the maxillo-mandibular relationship, mandibular deviation in terms of degree, muscle potency, and the ability to orient the lower jaw towards the non-resected side. Various guidance prosthesis can be used to accomplish this. Mandibular guidance prostheses are broadly classified into two types:

I. A positioning prosthesis with palatal flange and widened maxillary occlusal table i.e. Maxillary inclined plane prosthesis (Palatal-based).

II. Mandibular oblique/lateral guide flange prosthesis (Mandibular-based).[13]

Maxillary inclined plane prosthesis

On the non-defect side, palatal to the maxillary teeth, a functionally generated occlusal record is used and an occlusal table is fabricated which slopes away from the natural teeth occlusally. Interproximal ball clasps or Adams clasps are used to retain the prosthesis. Due to the residual mandible's medial deviation, mandibular closure causes the remaining mandibular teeth to gradually slide up the incline in a superior and lateral position until the occlusal contact is made. The extent of the deviation determines the duration of wear. Positioning prosthesis with palatal flange can be used in patients who can use their pre-surgical intercuspal position after mandibular resection with complaints of inability to prevent the mandible from deviating towards the defect side during sleep. They struggle to reestablish their normal occlusal contact after waking up. Additionally, TMJ discomfort and muscular ache are frequent problems. To reduce

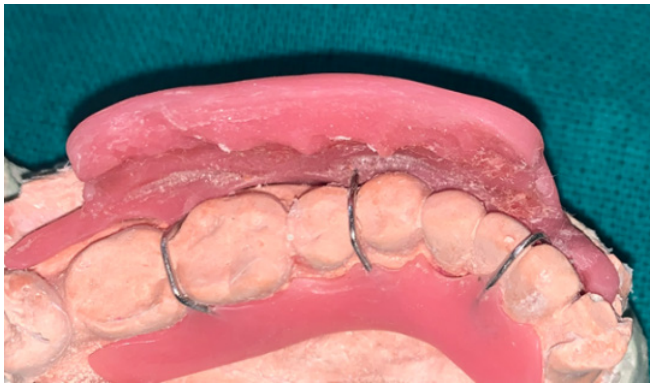

Figure 2. Occlusal View of a Guidance Prosthesis

Figure 3. Guiding flange extending into the maxillary buccal fold.

the nocturnal deviation, a palatal flange can be extended inferiorly into the lingual vestibule between the lateral border of the tongue and the lingual surface of the remaining mandible. This flange can be constructed using auto-polymerizing acrylic resin. The palatal extension should be adequate even when the mouth is open to prevent medial deviation of the unresected jaw. The flange shouldn't impinge on the mandibular lingual mucosa and should only make contact with the lingual surfaces of the teeth when the jaw is opening and closing.[20]

Intermaxillary fixation

For five to seven weeks, Aramany and Myers recommended using intermaxillary fixation with arch bars and elastics following surgical resection. The remaining mandible is retained in its ideal maxillomandibular position, enabling scar formation while the defect heals and the teeth are in occlusion. In the immediate postoperative period, little to no muscle retraining may be necessary with the use of intermaxillary fixation. The amount of deviation appears to be inversely related to how long the mandible is fixated.[21,22]

Vacuum-formed PVC splints

This framework comprises upper and lower splints which are fabricated using upper and lower plaster models. The upper splint encompasses the palatal vault and all standing teeth to provide the greatest amount of lateral stability. The vestibular flanges and teeth, which will serve as the mandible's closure guiding planes, should be included in the lower splint. At the intercuspal position, both the upper and lower models are articulated. Both upper and lower splints are then incorporated into the arches and joined together by adding another layer of heated polymer between them. Flanges and indentations on the lower part of the splint make it simple to place the mandible and lower teeth in the right occlusal relationship when the jaws are closed. Since it is comfortable for the patient to wear, the plastic splint effectively controls and gently restrains jaw motions. The patient may also wear the apartment at night. Once the patient has been accustomed to the path of closure, this appliance must be replaced by a more definite acrylic or metal appliance.[15]

Exercise program

To retrain the residual muscles, enhance the maxillo-mandibular relation, minimize scar contracture, and reduce trismus, prosthetic treatment should be accompanied by a planned exercise program.[23]

Two weeks following surgery, the exercise regimen can commence. Simple mandibular opening and closing with and without the appliance are performed, as well as the patient grabbing the chin and repositioning the mandible away from the surgery site.[24]

Rehabilitation of Maxillary Insufficiency Defects

Maxillary obturators

Maxilla is the site of the majority of intraoral abnormalities, in the form of an opening into the antrum and nasopharynx. The hard and soft palates, alveolar ridges, and floor of the nasal cavity may all be involved, or the opening may be extremely small. Postoperative maxillary abnormalities predispose the patient to hypernasal speech, nasal cavity fluid leakage, and compromised masticatory function.[25]

A maxillary obturator is used to repair the intraoral defects. In cases of partial or complete maxillectomy, an obturator (Latin: *obturare*, to stop up) is fabricated.[25] Prosthetic rehabilitation goals for total and partial maxillectomy patients include separation of the oral and nasal cavities to allow adequate deglutition and articulation, possible support of the orbital contents to prevent enophthalmos and diplopia, soft tissue support to restore the midfacial contour, and an acceptable aesthetic result.[26] The following are the indications for using an obturator::

I. As an interim prosthesis while undergoing surgical repair.
II. To immediately restore the patient's aesthetic appearance for socializing.
III. In case of primary surgical closure is not recommended.
IV. When surgery is not recommended due to the patient's age.
V. When the size and degree of the abnormality precludes surgery.
VI. When surgical intervention is contraindicated due to the local avascularity of the tissues.
VII. When the patient is prone to the recurrence of the lesion.[27]

ARAMANY CLASS I DEFECT DESIGN

A typical maxillectomy resection removes the teeth and alveolar bone along the midline. Desjardins advocated for maintaining the alveolar bone around teeth that were proximal to the defect.[28]

Either linear or tripodal design can be fabricated. Support is attained from the central incisor and the most posterior abutment tooth while two or three anterior teeth can be splinted, if possible. By placing a rest on the canine or the first premolar's distal surface in a tripodal configuration, the notion of efficient indirect retention is applied when the dental arch is curved. Either an I-bar on the central incisor or the labial surface of the anterior teeth with a gate design enables direct retention. The buccal surface of the molars is used for posterior retention, while the bracing is situated palatally. If the anterior teeth are not incorporated into the design, a linear design is indicated.[29]

ARAMANY CLASS II DEFECT DESIGN

The premaxilla on the side with the defect is preserved. The bilateral design resembles a Kennedy Class II removable partial denture. In this case, the tripodal design is indicated. It is advised to splint the two teeth located proximally to the defect. The tooth closest to the defect and the most posterior molar on the opposing side are used for the primary support. The fulcrum line and an indirect retainer are positioned as perpendicularly as possible. On the distal surfaces of the molar and the anterior tooth, guiding planes are situated proximally. On all abutment teeth, the buccal surfaces serve as the site for retention, and the palatal surfaces serve as the location for stabilizing components.[29]

ARAMANY CLASS III DEFECT DESIGN

The entire dentition is preserved, and the defect is located in the center of the palate. It is constructed using a quadrilateral design. Premolars and molars are used to provide support. The buccal surfaces provide retention, while the palatal surfaces provide stability.[29]

ARAMANY CLASS IV DEFECT DESIGN

On the nonsurgerized side, the defect encompasses the premaxilla. A Linear design is recommended. All remaining teeth have support in the middle, as seen in (Figure 4). On the premolars and molars, respectively, retention is seen mesially and palatally. On the palatal surface of the premolars and the buccal surface of the molars, stabilizing components are attached. [29]

Figure 4. Class IV Defect rehabilitated using a linear design.

ARAMANY CLASS V DEFECT DESIGN

The hard palate, portions of the soft palate, and the posterior teeth are resected while the anterior teeth are preserved. Two terminal abutment teeth are advised to splint on each side. The palatal surface of the most distal teeth provides stability and support, while I-bar clasps are positioned bilaterally on their buccal surfaces. This arrangement is basically tripodal. A gate prosthesis could also be fabricated in such cases as an alternative.[29]

ARAMANY CLASS VI DEFECT DESIGN

The least common class of anterior palatal defects is generally caused by trauma rather than surgery. Such defects involve the bilateral splinting of two anterior teeth and they are joined together by a transverse splint bar. A quadrilateral design is fabricated in case of a large defect or when the remaining teeth have a poor prognosis.[29]

Rehabilitation of Maxillary Insufficiency & Mandibular Discontinuity Defects using Patient Specific Implants

Due to the patient's advanced age and the severity of the defect, rehabilitation for these patients continues to be an enormous challenge. Numerous challenges associated with surgery and prosthetic rehabilitation like lack of maxillary bone including pterygoid plates sometimes zygomatic bone involvement, loss of lip support, adherence of nasal and sinus mucosa with palatal mucosa, fibrosed palatal mucosa, lack of vertical guidance, reduced stress-bearing area, and over closure of mandible need to be addressed. Establishing normal function with low morbidity and long-term sustainability must be the main objective of these patients' rehabilitation.[30] Autografts are considered to be the gold standard for management for these type of defects.[31] But there are associated problems with its use such as selecting a suitable donor site, the morbidity of the donor site, especially for larger defects, complications associated with tissue harvesting, the discomfort of the patient, potential for infection both at the recipient's and donor's sites, the additional skilled surgical team required, prolonged surgical time, and graft resorption. Due to these restrictions, research is still being done to find an appropriate alloplastic material and accurate presurgical planning is needed to enhance craniofacial reconstruction.[32]

For mandibular defects, locking reconstruction plates are advised to be used; however, these plates must be properly bent to achieve the proper mandibular contour. Preoperative plate bending using three-dimensional (3D) stereolithographic models is becoming more and more popular among surgeons.[33] Engineering patient-specific designs whose performance can be accurately and precisely predicted will assist surgeons in their routine procedures. The ability to precisely plan preoperatively, carry out virtual osteotomies or resections, and design patient-specific implants are all facilitated by computer-assisted designing and manufacturing systems. Because of this cutting-edge technology, it is now possible to create patient-specific implants using virtual designs and models.[34] The advent of computer-assisted design and manufacturing techniques for maxillofacial reconstruction has significantly improved surgical success since the length and form of the implant may be customized to the needs of the patient and the surgeon's preferences.[32,35]

Conclusion

Taking the entire stomatognathic system into overview in both mandibular guidance therapy as well as maxillectomy/midfacial defects classified as per the extent of resection, requires a multidisciplinary approach viz. prosthetic (guidance prosthesis, inclined plane prosthesis), via splints, IMF, grafts, obturators, etc. To provide

the best treatment, one must employ a philosophic approach that would concentrate on selecting the most suitable material and technique along with a good physiotherapy regimen for an overall successful and positive rehabilitation experience.

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