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MANDIBULAR DEFECTS AND THEIR TREATMENT: AN OVERVIEW

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ABSTRACT

Mandible is one of the most important anatomical structure responsible for various function and aesthetics in head and neck region. A patient with mandibular resection can present with mild to severe disfigurement of face along with numerous and unpredictable functional inculpabilities. Problems associated with the treatment of mandibulectomy patient depends on many factors like size of the defect, location in the arch and the contiguous structures lost. Determining an appropriate treatment plan along with predicting prognosis is most challenging in these patients. In recent years, reconstructive surgery has greatly enhanced the prosthetic success and improved of quality of life of such patients. Successful prosthodontic rehabilitation involves understanding of the altered mandibular function and the possible treatment options available to address individual patient requirements. The following paper provides an overview of challenges and treatment following mandibular resective surgery.

KEYWORDS: Mandibular resection, mandibular deviation, rehabilitation, mandibular guidance therapy, classification.

INTRODUCTION[1-4]

The patient with maxillofacial defects with partial or completely resected mandible is one of the most challenging tasks in maxillofacial rehabilitation.[1] Segmental resection of the mandible leads to significant patient morbidity. Loss of mandibular support to the teeth, tongue and lip causes dysfunctional mastication, swallowing, speech, airway protection and oral competence. Patients also suffer disfigurement following segmental mandibulectomy because the mandible is an important aesthetic landmark.[2] Knowledge of the complexity of cancer treatments, radiographic diagnostics, surgical techniques and osseointegrated implants improve the predictability of rehabilitation.[3] Prosthodontic success in the mandibular resection patient is closely allied with the surgical reconstruction. It is hoped that future developments will continue to improve outcomes of postmandibulectomy treatment to further improve the quality of life for patients requiring such treatment.[4]

CLASSIFICATION OF MANDIBULAR DEFECTS[5-9]

Numerous classifications and nomenclatures exist in literature to describe maxillofacial defects.

1. Cantor and curtis classification (1971)[5,6]

Class I: Mandibular resection involving alveolar defect with preservation of mandibular continuity.

Class II: Resection defects involve loss of mandibular continuity distal to the canine area.

Class III: Resection defect involves loss up to the mandibular midline region.

Class IV: Resection defect involves the lateral aspect of the mandible, but are augmented to maintain pseudo articulation of bone and soft tissues in the region of the ascending ramus.

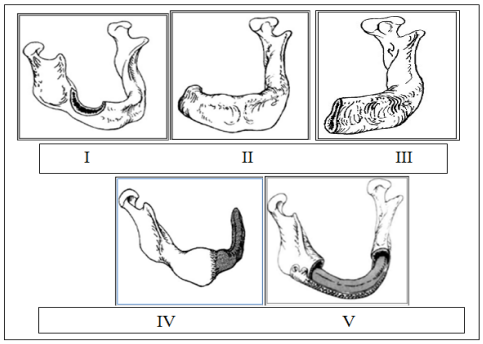
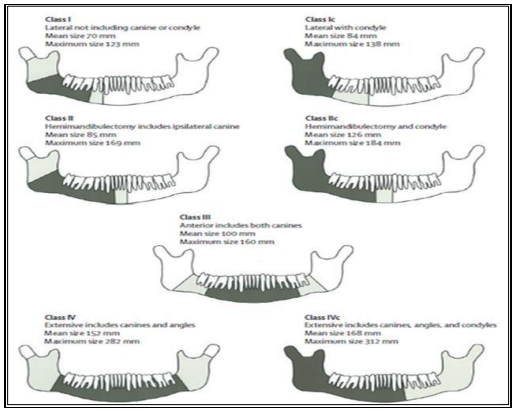


Figure 1: Class I, II, III, IV, V according to Cantor and Curtis classification.

Class V: Resection defect involves the symphysis and parasymphysis region only, augmented to preserve bilateral temporomandibular articulations.
Class VI: Similar to class V, except that the mandibular continuity is not restored.(fig.1)

2. Jewer's and Boyd's classification (1993)[7,8]: Based on Jewer's classification (1989) where the mandible was divided into three segments. Here mucosal component was added by Boyd. Here H stands for lateral defects of any length up to midline including condyle, C for defects involve central segment containing 4 incisors and 2 canines and L constitutes lateral defects excluding the condyle. Lower case letters describe soft tissue component s:skin deficit, m: mucosa deficit, o: absence of mucosa and skin component.

3. Brown's classification (2016)[8]: It is based on the principle that the mandible has four corners: two vertical corners that make the angles of the mandible, and two horizontal corners that are centred at the canine teeth on each side in the dentate mandible, and are roughly 7 mm anterior from the mental foramen in the edentulous jaw.(fig. 3)
Class I: (angle) Lateral defect not including ipsilateral canine or condyle
Class Ic: (angle and condyle) Lateral defect including condyle
Class II: (angle and canine) Hemimandibulectomy including ipsilateral but not contralateral canine or condyle
Class IIc: (angle, canine, and condyle) Hemimandibulectomy including condyle
Class III: (both canines) Anterior mandibulectomy includes both canines but neither angle
Class IV: (both canines and at least one angle) Extensive anterior mandibulectomy including both canines and one or both angles
Class IVc: (both canines and at least one condyle) Extensive anterior mandibulectomy including both canines and one or both condyles. A drawback of this new classification is that soft tissue defects and type of mandible, in terms of dentate status, have not been incorporated.



Soft tissue defect	Bony defect: Anterior	Bony defect: Hemimandible	Bony defect: Lateral
None	IA	IIA	IIIA
Intraoral only	IB	IIB1 ≤ 2 zones IIB2 ≥ 3 zones	IIIB
Skin only	IC	IIC	IIIC
Intraoral + skin	ID	IID	IIID

Brown's classification **Cordeiro's classification**

Figure 2: Brown and Cordeiro classification.

5. Cordeiro et al's classification (2017)[9]
A novel and broadly applicable defect classification system and flap selection algorithm for segmental mandibulectomy defects that emphasized the importance of the soft tissue deficit, in addition to that of the bony defect. (fig. 2)
Type I: Anterior (any defect that includes the mandibular symphysis)
Type II**:** Hemimandible (includes the body, angle, and ascending ramus, with or without the condyle)
Type III: Lateral (includes one or two of the body, angle, and ascending ramus, but not all three).
A: no soft-tissue defect
B: intraoral structure or mucosal lining defect only
C: skin defect only
D: both intraoral structures/lining and skin defect
A subclassification of B1 and B2 was created. Based on five zones of intraoral structures (i.e., buccal mucosa, floor of mouth, palate, tongue, and pharynx), excision of two or fewer zones is denoted B1 and excision of three or more zones is denoted B2. When the bony and soft-tissue deficit designations are combined, a streamlined classification system of 13 defect types emerges: IA, IB, IC, ID, IIA, IIB1, IIB2, IIC, IID, IIIA, IIIB, IIIC, and IIID.

CHALLENGES IN TREATMENT OF MANDIBULAR DEFECTS[3,4,6,10-17]
Maxillofacial defects results in varied physical and emotional responses from the patient and have the potential to be emotionally traumatizing. This may result in unachievable expectations and unreasonable demands that may hinder the prosthodontist's ability to provide

adequate treatment.[4] Swallowing, speech, mandibular movements, mastication, control of saliva, respiration, and psychic functioning are adversely affected by radical mandibular surgery. This may be due to loss or reduced muscular and neuromuscular control of oral and laryngeal structures that restrict the anterior elevation of the floor of the mouth, hyoid bone and larynx.[6]

Resection of mylohyoid could result in reduced mobility of tongue and resection of the lingual and inferior alveolar nerves could result in a loss of sensation in the mucosa of the cheek, alveolar process, lower lip etc. Loss of the muscles of mastication results in distortions of mandibular movements along with facial disfigurement. These are most commonly observed in Class I and Class II resections. In class III, lower denture space is severely obliterated along with inability to maintain tongue position. Reconstruction in Class IV resections results in prosthetic convenience although loss of muscular innervation can continue to cause restrictions of various function. The most debilitating situation is seen in cases of Class V anterior mandibular resection situation due to loss of key muscles.[4] Furthermore, denervation of the glossopharyngeal, vagus and superior laryngeal nerves, along with fibrosis and scarring of cricopharyngeal muscle results in inability to open the oesophagus. Liquid and food pools in the hypopharynx. If laryngeal movements are severely restricted or if the larynx and hypopharynx are denervated, the lungs will be unprotected from food and liquid in such cases affecting the airway patency and respiratory difficulties.[6]

Tissues that have been radiated are fragile, sensitive to manipulation, desiccated, slow to heal, prone to infection, and at risk for osteoradionecrosis, particularly in the mandible.[4] This compromises denture mucosal interface and thus a fixed prosthesis may be the best prosthetic solution.[10] Xerostomia due to radiation therapy also results in problems with food processing, bolus formation and bolus transport during eating, delaying the swallow initiation, decreasing pharyngeal transport, and compromising laryngeal protection.[11]

Another debilitating consequences of radical surgery is speech impairement due to restricted motion of the tongue and lack of linguopalatal contact.[12] Distortion of consonants such as “d” or “t” occurs due to anterior tongue restriction while “g” and “k” will be affected by posterior tongue restriction. The displacement or scarring of the lower lip can interfere with articulation of sounds such as “v” and “f.”[6]

Larger lesions that compromise the lips, prevent functional lip seal and salivary control. These patients often demonstrate drooling and slurred speech, secondary to pooling of saliva and inadequate lip seal.[13] Moreover, denture irritation, can also lead to excessive salivation.[6]

After segmental or hemimandibulectomy, if hard tissue reconstruction is not carried out, the chewing function is deteriorated because the remaining mandible loses the bilateral fulcrums of the temporomandibular joint.[14] The patient is seldom capable of a coordinated muscular movement for normal mastication leading to a deflected pathway[6] and rotation of mandibular occlusal plane inferiorly.[15] The interocclusal relationships are unstable with lack of posterior support and vertical overlap.[10] Mandibular deviation toward the defect side occurs primarily because of the loss of tissue involved in the surgical resection.[4]

The pull of the suprahyoid muscles on the residual mandibular fragment causes inferior displacement and rotation of mandible leading to an anterior open bite.[16]

When viewed from the frontal plane, teeth on the surgical side of the mandible move away from their opposing maxillary teeth after their initial contact on the nonsurgical side has been established.(fig. 3) As the force of closure is increased, the remaining mandible actually rotates through the frontal plane known as frontal plane rotation.[13]

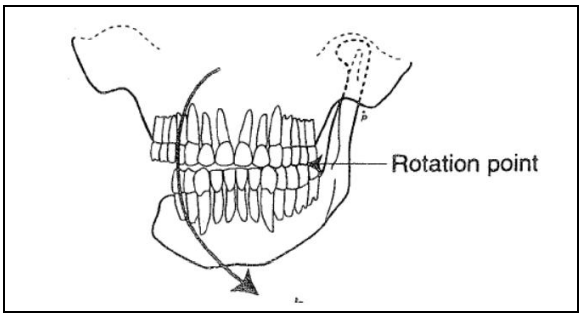


Figure 3: As force of mandibular closure is increased, mandible rotates around occlusal contacts on unresected side.

Due to this, buccal shelf is at an even more horizontal angulation and the buccal aspect of the alveolus at the premolar region is not regarded as a denture bearing area due to its relatively vertical angulation.[13] (fig. 4)

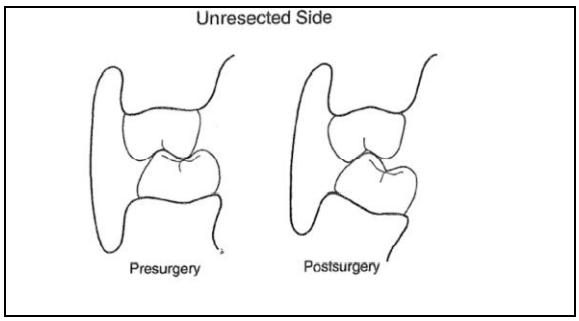


Figure 4: Occlusal relationship displaying lateral discontinuity defect on unresected side.

It is not uncommon to find the coronoid process of the contralateral side obliterating the buccal sulcus of the maxilla posteriorly. (fig.5)This commonly results in

difficulties in the development of buccal flange in the maxillary prosthesis.

Figure 5: Underdeveloped distobuccal aspect of the maxillary denture flange as a result of mandibular resection over the contralateral side.

On mouth opening, deviation increases and the path of closure is no longer a straight hinge movement in the sagittal plane. Up to 20 mm of lateral deviation and 10 mm of posterior retrusion may be encountered.[3]

The degree of deviation is dependent on several factors like location and extent of osseous and soft tissue resection, the method of surgical site closure, degree of impaired tongue function, presence and condition of the remaining natural teeth, degree to which the innervation has been involved, adjunctive procedures like radiation therapy. Usually greater the resection equates to more deviation but it is difficult to determine contribution of these factors on mandibular malpositioning.[17]

Early post resection physical therapy is indicated to reposition the mandibular fragment towards more normal position and to minimize the effect of scar formation.[4] Time factor has a major effect on the improvement rate of mandibular deviation.[17]

Postsurgical trismus may also occur and be treated effectively if treatment is undertaken soon after surgery. Stretching exercises, moist heat, and analgesics will be beneficial and must be initiated within 2 weeks following surgery.[4]

TREATMENT MODALITIES FOR PROSTHETIC REHABILITATION[13]

In partially edentulous patients, the primary determinant is occlusion. In these patients, definitive prosthesis is delayed until a proper maxillomandibular relationship is obtained or mandibular guidance therapy has been completed.

The usual principles of partial denture design apply to partially edentulous patients. In case of anterior resections involving construction with free bone graft or vascularized flap, the process of healing may result into rotation of posterior segments medially due to mylohyoid particularly reconstruction plate is non rigid or not properly secured. This creates undesirable undercuts in lingual surfaces of remaining posterior teeth. Thus, rotational path RPD are employed.

Unlike the partially edentulous patient the primary determinant of prognosis in edentulous patient is tongue function. Edentulous patients who have undergone marginal mandibulectomy, conventional complete denture proves to be quite satisfactory. The treatment outcomes can be further enhanced with vestibuloplasty and skin grafting.

Moreover, discontinuity defects are challenging for a prosthodontist. The various factors that compromise patient's ability to masticate are lack of stability, support and retention are compromised as only one half to two thirds of mandible remains. dislodgement the dentures due to angular path closure, compromised seal of maxillary denture due to flaps and mandibular deviation and impairment of motor and sensory innervation leading to lack of ability to control prosthesis.

If the patient demonstrates mandible that can be brought into acceptable maxillomandibular relationship but lack of motor control to achieve this, mandibular guidance therapy is initiated about 2 weeks postsurgery. These are given on interim basis until acceptable occlusal relationship and proper proprioception is reestablished. The guidance prosthesis consist of an RPD framework with metal flange extending 7-10 mm laterally and superiorly on buccal aspect of premolar and molar on nondefect side. A maxillary guidance ramp of acrylic resin is suggested for a patient with severe mandibular deviation on an interim basis until acceptable occlusion is achieved.

During the fabrication of complete dentures, neutrocentric concept of occlusion should be used. Maxillary anterior teeth should be placed slightly lingual to and mandibular slightly labial to their usual positions. The lingual inclination of residual mandible on unresected side due to frontal plane rotation, results in elevation of buccal shelf area likely to be at right angle to occlusal forces. This makes it the primary support area and the placement of posterior teeth should be towards the buccal side of residual alveolar ridge. Whereas the placement of posterior mandibular teeth on resected side should be more lingual to crest of ridge to compensate for deviation of mandible.The ramps provided should be 5-10 mm wide and should provide 3-4 mm of horizontal overlap with mandibular posterior teeth.[13]

IMPLANT SUPPORTED PROSTHESIS[2,4,18-20]

The use of osseointegrated implants allows stable anchorage for placement of implant-borne dentures, even in the absence of an alveolar ridge.[2] In mandibulectomy patients it is common to find crest of residual mandible between the surgically altered buccal soft tissues and the

floor of mouth or residual tongue.[4] Defects restored with free bone grafts generally present with excess of soft tissue overlying the graft. The major challenge encountered is creation of thin, attached, keratinized tissues around the implants. If fixed restoration is planned, implants should be placed in sites to be occupied by teeth rather than in interproximal areas. In completely edentulous patients the placement of osseointegrated implants enables fabrication of well retained and stable overlay prostheses that permits effective mastication if the patient presents with reasonable tongue function.[13] Improved chewing function has been demonstrated through experiments.[18,19] Placement of implants decreases the total number of surgical procedures and achieves a more rapid return to normal function.[20]

ADVANCEMENTS IN MANDIBULAR RECONSTRUCTION AND FUTURE TRENDS[19,21-26]

A wide variety of implantable materials are available to aid in mandibular reconstruction.[19] These include metallic materials like titanium alloys.[21] magnesium alloys.[22] Polymer materials like non degradable Polyethylene, Polypropylene, Polytetrafluorethylene[23] and degradable poly lacticacid, polycaprolactone and polyhydroxybutyrate.[24] Bone substitute materials like bioactive ceramics like hydroxyapatite (HA), tricalcium phosphate (TCP), bioactive glasses have been introduced.[25] Betatricalcium phosphate is one of the most common synthetic materials used for bone reconstruction in maxillofacial surgery.[26]

CONCLUSION

Prosthodontic rehabilitation of the mandibular resection patient either discontinuity maintained or reestablished poses strong impact in functional and psychological aspects. The success of rehabilitation of such patients depends on strategic treatment planning and choice of most suitable treatment modality. The constructive thinking about the rehabilitation should not be concentrated on what is missing in the remaining anatomy, but rather captivating full advantage of the structures still present.

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