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Maxillofacial Obturator and Materials

A Project Submitted to

The College of Dentistry, University of Baghdad, Department of Prosthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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CERTIFICATION OF THE SUPERVISOR

I certify that this project entitled "Maxillofacial obturator and materials “was prepared by the fifth-year student **Asraa Hameed Ghulam** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervised by

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DEDICATION

After the school trip, which lasted about 17 years of fatigue, effort, perseverance, study and staying up late, I ended my academic career with this beautiful project. I dedicate this project to my beloved father and mother who supported me in every step of my academic career and I would like to thank (Dad) who gave me strength all the time and I thank (Mother) who stayed with me all these years and who worked so hard for her to see me as a doctor I love you so much Mom, my Cindy. I dedicate this project to my sister (Memo), who is always proud of me, my brother (Mohammed), who aspires tobecome a dentist in the future, and to my friends in college, and of course to all dentists, I thank you from my heart and wish success to all. And last but not least, I thank my mother very much and I love you from the bottom of my heart.

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INTRODUCTION

Maxillofacial prosthetics is a subspecialty of prosthodontics that deals with rehabilitation of patients with defects or disabilities caused by trauma, tumor, or congenital disorders.(Hatamleh al,2010)

Prostheses are made to replace teeth, lost bone, or soft tissue to restore oral function and esthetics. Prosthetic devices also are fabricated to shield and protect the facial structure during radiotherapy. Sometime, facial or body prosthesis is fabricated for psychosocial reasons. Given the vast services provided to patients as illustrated above, maxillofacial prosthodontists (MFP) are trained to work in a multidisciplinary setting together with oral surgeons; ear, nose, and throat surgeons; plastic surgeons; speech pathologists; etc.(Salinas al,2010)

A definitive maxillary obturator prosthesis can be used to rehabilitate a maxillary defect with the aim of improving speech, deglutition, and elimination of oronasal regurgitation. The aims of this study were (1) to determine the time required to fabricate a definitive maxillary obturator prosthesis and (2) to compare the fabrication and follow-up times between a patient's first and second definitive maxillary obturator prosthesis. **(Desijardins et al., 1978).**

The degree of obturator extension into the defect varies according to the configuration of the defect, character of its lining tissue, and functional requirements for stabilization, support, and retention of the prosthesis **(J. Kumar et al.,).**

AIM OF THE REVIEW

This review aimed to evaluate the functioning of obturators prosthesis in patients after maxillectomy , the basic principles for these designsand the materials used for fabrication of these prostheses.

RRVIEW OF LITERATURE

1.1 Maxillofacial prosthesis

Maxillofacial prosthetic materials are used to replace facial parts lost through disease or trauma. Facial defect should be surgically corrected to restore function and esthetics. However, surgical reconstruction may not be possible because of size of defect and location of the defect hence prosthetic rehabilitation is indicated in such cases. The appearance can be restored by the maxillofacial prosthesis and provides great psychological benefits to the patient.(Feyad,2010)

1.1.1 Objectives of maxillofacial prosthetic

Objectives of maxillofacial prosthetics

The most important objectives of maxillofacial prosthetics and rehabilitation include:-

-Restoration the esthetics or cosmetic

-appearance of the patient

-Restoration of function

protection of the tissues

-Therapeutic or healing effect

-Psychological therapy

(Marwah et al,2018)

1.1.2 Guide lines for the applied prostheses

The guide lines for maxillofacial prosthesis are:

a. Should be easily placed and removed

b. Should fix the lost function

c. The appearance should be close to normal and easily cleaned

d. Should be long lasting and resistant

e. Should not have dimensional changes

f. Should be light and easy to make**(Atay,2013)**

1.2. Classification of maxillofacial defects

CLASSIFICATION OF MAXILLOFACIAL

DEFECTS:Maxillofacial defects are classified as:

1. congenital

2. acquired

a. surgical (postoperative)

b. traumatical

Depending on location maxillofacial defects are classified as:

1. Extra oral

a. Auricular defects

b. Ocular defects

c. Orbital defects

d. Nasal defects

e. Lip and cheek defects

2. Intraoral

a. Maxillary

b. Mandibular

c. Velo-pharingeal

3. Composite defects

(Hovannisyan et al.,2009)

1.2.1. Extra-oral Defects

Extraoral defects occur due to trauma, neoplasm or congenital malformation. Extra oral defects that occur due to trauma are dealt separately under traumatic defects. The common neoplasia of the head and neck are:

a. Epithelial tumors: epithelial facial tumors may have a melanocytic

Keratinocyticor adrenal origin.

b. Connective tissue tumors :adenomas, fibromas, leiomyomas andlymphoma.**(Nallaswamy et al.,2003).**

Extra oral congenital malformations that require maxillofacial prostheses include: auricular, ocular ,nasal, lip and cheek defects.

a. Auricular defects(Fig.1.1):

1-Microtia (small ear) associated with atresia of the external auditory meatus.

2-Anotia (complete absence of the auricle).

3-Smaller ear defects.

a. Nasal defects: The defects arising due to surgery are known as rhinotomy defect.(Fig.1.2)

b. Ocular defects(Fig.1.3)It involves the:

1-defects in the eye ball with intact eyelids

2-an orbital defect involves both the eye ball and the eyelids.

c. Lip and cheek defects

3-double lip

4-Hemi-facial micro somatic.

d. Combination of the above mentioned defects. Aesthetics is the major principle behind the placement of these prosthetic appliances. Hence, most of these prostheses are non-functional**.(Hovannisyan et al.,200)**

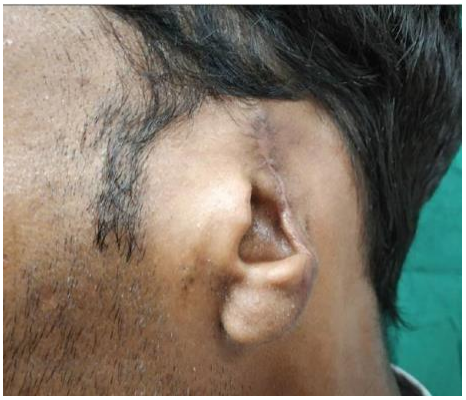


Figure1.1:auricular defect adopted from**(Chalianetal.,1971).**

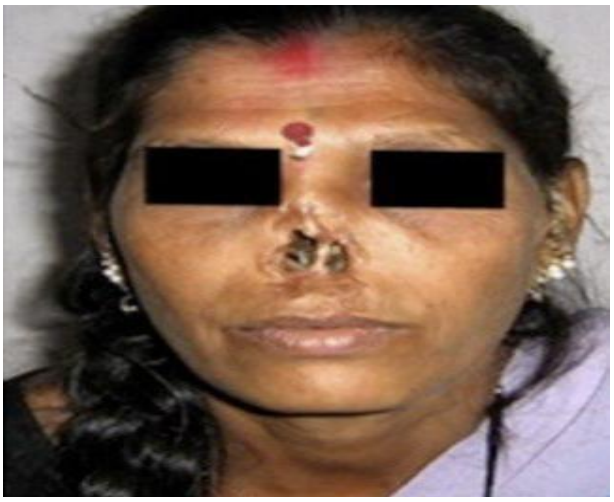


Figure 1.2: nasal defect adopted from **(Chalianetal.,1971).**

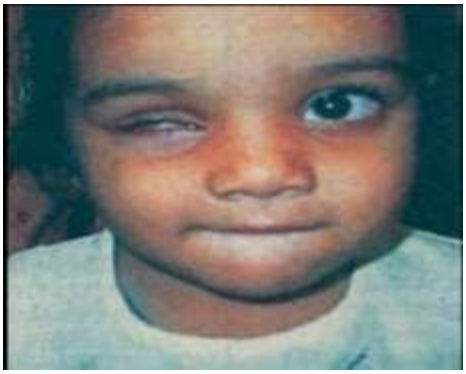


Figure1.3:ocular defect adopted from **(Soratur, 2006).**

1.2.2. Intra-oral Defects

Intra-oral defects include: A. Maxillary defects. B. Mandibular defects

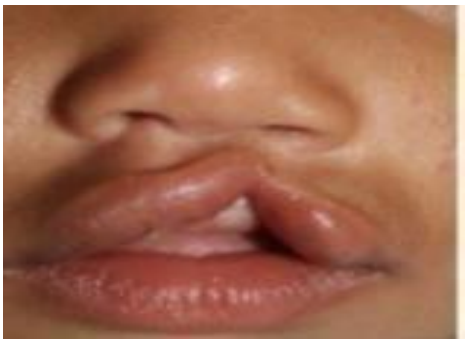
1.2.2.A Maxillary defects

Maxillary defects are created by surgical treatment of benign or malignant neoplasms, congenital malformation and trauma.[1] Their occurrence is also associated with the enucleation of maxillary cysts.. They are classified as:1.Congenital maxillary defects

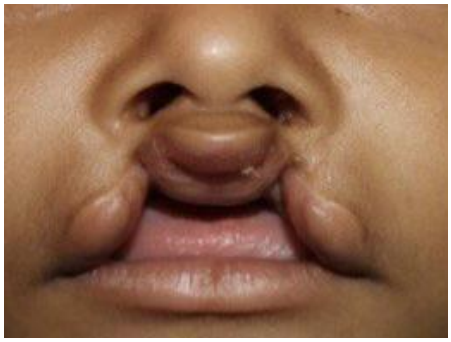
These defects include the cleft lip and cleft palate.

I. Cleft lip::

This defect is formed when one or both maxillary processes do not fuse with the medial nasal process. If there is a failure on one side, the patient suffers a unilateral defect (Fig.1.4.a) and if on both the sides, the individual suffers a bilateral defect (Fig.1.4.b). The defective development of lower part of the frontal process may give rise to a midline defect of the upper lip. This condition is encountered less often. The common etiology for these could be infections, drug induced or due to hormonal imbalance and may also be genetically inherited **(Rangarajin and Padmanabhan,2017)**



A



B

Figure 1.4 cleft lip ,a unilateral b. Bilateral. Adopted from **(Berkowitz,2006)**

II.Cleft palate

Is a defective fusion of various components of palate gives rise to cleft in the palate. The defect may be from a simple cleft of the alveolus, to an extensive defect involving the soft and hard palate. The alveolar cleft may occur unilaterally or bilaterally also. Many a times the palatal clefts are also associated with the cleft lip.**(Rangarajin and Padmanabhan,2017)**

A detailed classification of cleft palates and one that is generally accepted is that of the famous French plastic surgeon, Victor Veau, which is as follows:

Class I: Clefts involving soft palate only.(Fig.1.5.a)

Class II: Clefts involving soft and hard palates up to incisive foramen.(Fig.1.5.b)

Class III: Cleft of soft and hard palates, right forwards through alveolar ridge and continues in to lip on one side.(Fig.1.5.c)

Class IV: Same as Class III only associated with bilateral hare lip.(Fig.1.5.d)

(Fenn,et al,1998)

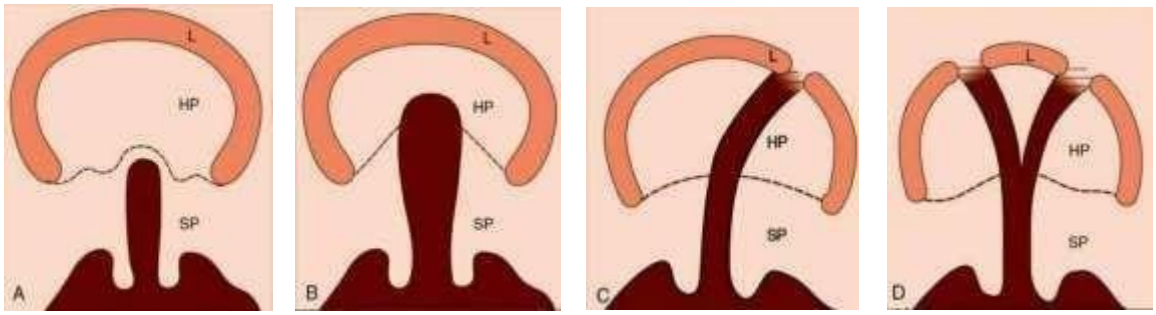


Figure1.5:A.classI B. class II C. class III D. class IV Adopted from **(Rangarajin and Padmanabhan,2017)**

2.Acquired maxillary defects

Most acquired maxillary defects occur due to surgical resection of tumors. Benign lesions require a smaller resection and are easy to restore. Whereas malignant tumors require extensive resection, which are very difficult to restore. Common tumor soft his region are epidermoid carcinoma (mostly arising from the maxillary sinus), salivary gland tumors(pleomorphic adenoma, adenoid cystic carcinoma, mucoepidermoid carcinoma and adenocarcinoma),malignant mesenchymal tumors.

Tumors of dental origin can also occur in the palate. One other major cause for an acquired maxillary defect is trauma. Acquired maxillary defects are usually classified based on their extent. If both the maxillae are resected, the defect is considered as total maxillectomy. Resection of one or a part of the maxilla or palate is considered as Partial maxillectomy.

(Nallaswamy et al.,2003)

Aramany presented a classification for maxillectomy defects in 1987(Fig.1.6).He divided the defects in to 6 categories based upon the relationship of the defect with the abutment teeth. The classification is as follows-

Class1:- Resection is performed in the anterior midline of the maxilla, with abutment teeth present on one side of the arch.

Class2:-The defect is unilateral, retaining the teeth on the contralateral side.

Class 3:- Defect occurs in the central portion of the hard palate and may involve part of the soft palate.

Class4:-Defect crosses the midline and involves both sides of the maxilla, with abutment teeth present on one side.

Class5:-Defect is bilateral and lies posterior to abutment teeth.

Class6:- Anterior maxillary defect with abutment teeth present posterior to thedefect on either sides of the remaining maxilla.

(Guptaetal., 2016).

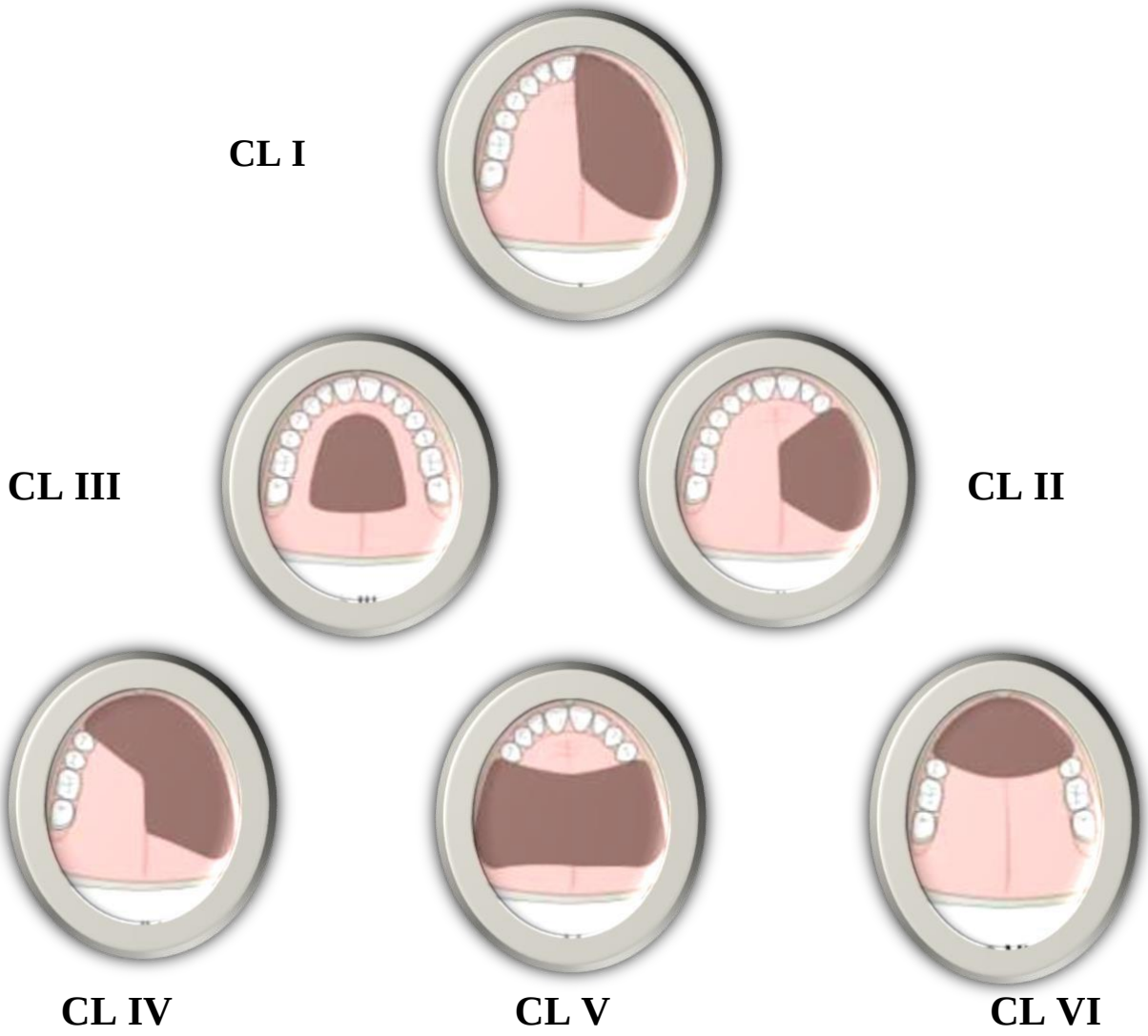


Figure1.6:Aramany classification adopted from**(Field and Storey, 2020)**

1.2.2.B Mandibular defects

Thesedefects include:

1. **Congenital Defects of the Mandible**

Congenital mandibular defects that require a maxillofacial prosthesis are uncommon. Common congenital defects of the mandible include micrognathia, mandibulofacial dysostosis, ankylosis of the TMJ, etc.

2. **Acquired Defects of the Mandible**

As for the maxilla, neoplastic resection is one of the most common causes for an acquired mandibular defect. The common neoplasia which advocate the need for resection are squamous cell carcinoma of the tongue, oropharynx and floor of the mouth. Resection of the mandible often lead to speech and swallowing dysfunction, which are very difficult to manage.**(Nallaswamy et al,2003)**

Based on the amount of resection or bone loss(extent),mandibular defects can beclassified as follows:

- **Continuity defect :**Here the superior portion of them is resected and the lower border is left intact. The defect is located in alveolar process and integrity of mandible is preserved. These defects do not show any deviation and are easy to restore.(Fig.1.7.A)
- **Discontinuity defect:** Here the entire segment of the mandible is resected. Since there is no connection between the remaining parts of the mandible, there will be midline deviation of the mandible due to the movement of the bone. Deviation may also occur when the remaining ends are surgically approximated in order to produce continuity. The amount of facial disfigurement of these defects is remarkable.(Fig.1.7.B)

Cantor and Curtis classification of acquired mandibular defects:

- **ClassI:** Marginal resection.Continuity defect,when the alveolar process isresected, but the lower border of the mandible is preserved(Fig.1.8.A)
- **Class II**: Segmental free end resection (discontinuity defect) that does not crossthe midline.(Fig.1.8.B)

 Modification a: Bilateral resection posterior to the second premolar (Fig.1.8.C)

 Modification b: Unilateral resection posterior to the lateral incisors(Fig.1.8.D)

 Modification c: Bilateral resection posterior to the lateral incisor on one side and the second premolar on the other side and the second premolar on the other.(Fig.1.8.E)

- **Class III**: Segmental free end resection up to or crosses the midline.(Fig.1.8.F)
- **Class IV**: Class III+ resection of the tempromandibular joint. (Fig.1.8.G)
- **Class V:** Anterior bounded resection.(Fig.1.8.H)

(Hovannisyan et al.,2009).

A B

A. Figure1.7: A. continuity defect, B. discontinuity defect Adopted from **(Nallaswamy et al.,2003).**

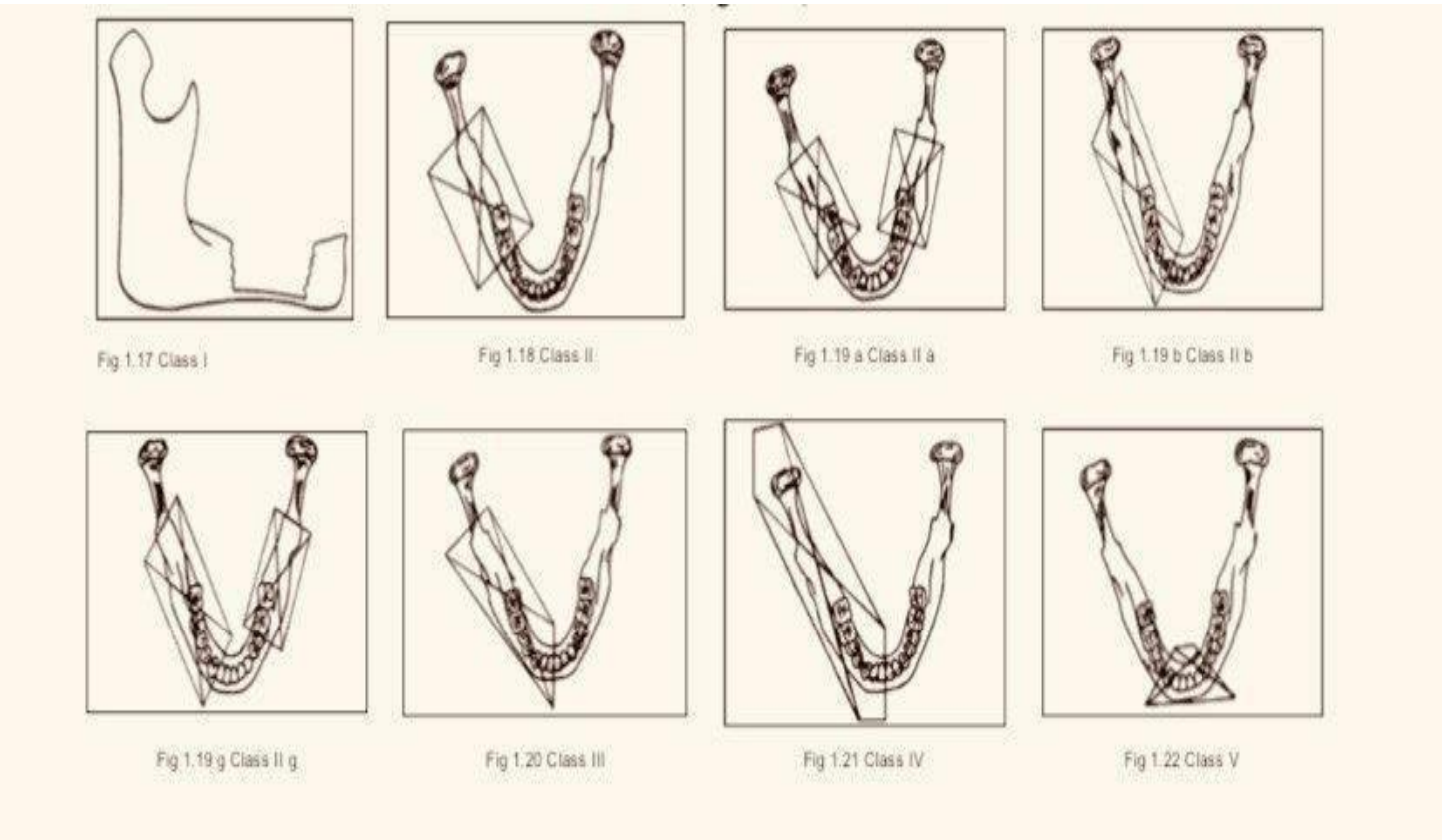


Figure1.8:Cantor and Curtis classification of acquired mandibular defects adopted from**(Nallaswamy et al.,2003).**

1.3 Classification of maxillofacial prostheses

Maxillofacialprosthesis classified as:

a. Extra-oral Defect Prostheses (Epithesis): Prostheses for the deficiencies in the face called " epithesis ." I. Auricular prostheses

II. Nasal prostheses

III. Ocular-orbital prostheses: Prostheses in the eye area around bulbus oculi and surrounding tissue deficiencies are called "orbital prostheses. " Only the prostheses that imitate bulbus oculi are called "ocular prostheses."

b. Intra-oral defect prostheses I. Maxillary obturators

II. Mandibular defect prosthese

1. One piece metal casting binding defect prostheses

2. Defect prostheses with guidance plane

c. Combined defect prostheses

I. Nasomaxillary epithesis

II. Orbital epithesis

III. Orbito-naso-maxillary epithesis

(Atay,2013).

1.3.a. Extra-oral prosthesis

Facial restorations that are used to return the patient's appearance to an acceptable esthetic state.**(Winkler,2009)**

1.3.a.I. Auricular prosthesis

It is an ear prosthesis that fabricated from impressions made with silicone or irreversible hydrocolloids (Fig.1.9) ,during impression making the patient is made to lie in a supine position, the defect area should be confined with wax. 50% additional water can be added while mixing irreversible hydrocolloids to increase the flow. The shape of the ear can be formed with reference to a pre-surgical cast or using the healthy ear and his procedure is known as sculpting, then stippling is done to match the texture of the prosthesis with the adjacent skin and facilitates extrinsic tinting. It provides mechanical retention for extrinsic colorants.**(Nallaswamy et al.,2003)**

There tention of theprosthesis is through ear-glass frames ,adhesives ,hair bands or implants.**(Rangarajin and Padmanabhan,2017)**

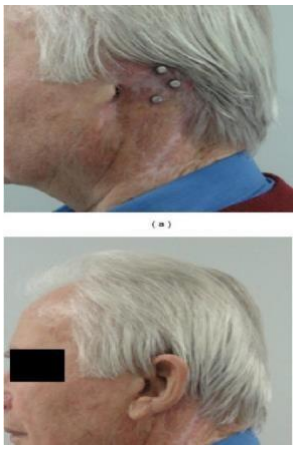


Figure1.9:a.auricular prosthesis in place. b. internal surface of auricular prosthesis adopted from(Taylor,2000).

1.3.a.II. Nasal Prosthesis

Nose is very prominent, centrally located and difficult to disguise on the face, making prosthesis with realistic effect is of vital significance.

Pre surgical photographs can aid for accurate replication of the patients nose preservation of nasal bone to provide retention and support should be emphasized. Maintaining the anterior nasal spine helps to determine the final position of lip (**Marunick, et al. 1985 as cited byLemon,et al.,2005).**

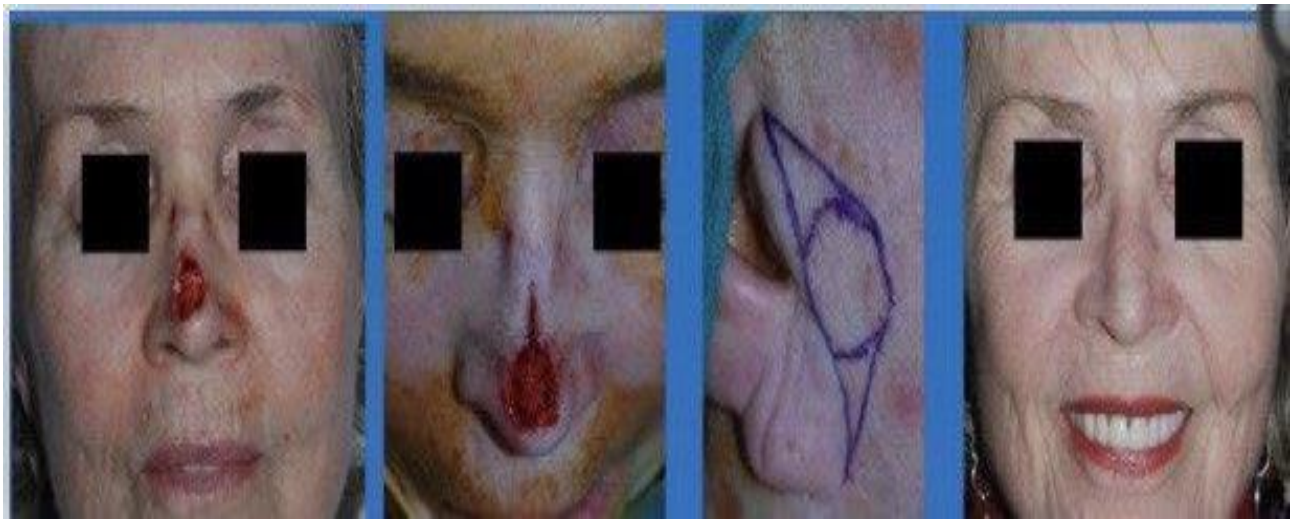


Figure1.10:A & B.Maxillofacial prosthesis replacing nose adopted from **(Soratur,2006)**.

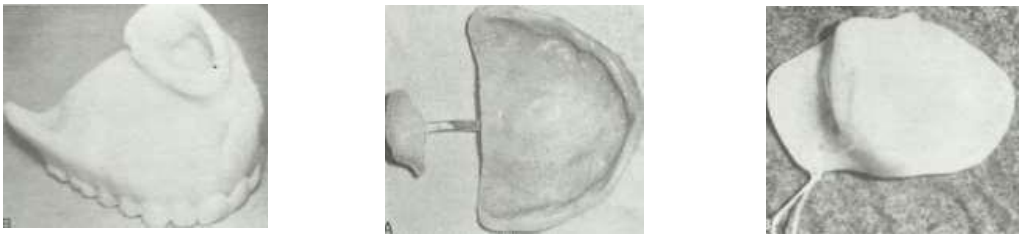
1.3.a.III. Ocular-Orbital Prosthesis

It is defined as ‘a maxillofacial prosthesis that artificially replaces any missing as a result of trauma, surgery, or congenital absence (Fig.1.11).The prosthesis does not replace missing eyelids or adjacent skin, mucosa or muscle. Ocular prosthesis is made 10–14 days post-surgery. At the time of surgery, a conformer is usually placed into the socket to maintain the fornices. Conformer is made of clear acrylic and should be large enough to support the lids and keep them from collapsing until the artificial eye is fabricated. The eye socket is carefully examined to analyze the amount of orbital adipose tissue and the extent of atrophy of muscle and other related tissues. Plastic ocular prosthesis is superior to the glassocular prosthesis.**(Prakash and Gupta,2017)**

Figure1.11:Ocular defect and prosthesis adopted from**(Mantri and Khan,2012)**.

1.3.b. Intra-oral Prosthesis

These are used to restore or complement portion of the oral cavity and nearby anatomical structures .Examples: obturators (Fig.1.12.a), speech aids (Fig.1.12.b), modified complete and partial dentures and infant feeding prosthesis(Fig.1.12.c).**(Winkler,2009).**



A B C

Figure1.12: a.obturator b. speech aid c. feeding prosthesis Adopted from**(Winkler,2009).**

1.4 OBTURATOR

An obturator is a maxillofacial prosthesis used to close, cover, or maintain the integrity of the oral and nasal compartments resulting from a congenital, acquired, or developmental disease process. The prosthesis facilitates speech and deglutition by replacing those tissues lost and can, as a result, reduce nasal regurgitation and hyper nasal speech and improve articulation, deglutition, and mastication**.(Punjabi et al.,2019).**

1.4.1 Historical background of obturators

Amboise Pare was the pioneer to use obturator to close palatal perforations (Fig.1.13)in the early 1500s. Then Pierre Fauchard described two types of palatal obturator; one type had wings in the shape of propellers and the other type had butterfly-shaped wing for retention. Both types were operated by a special key (Fig.1.14) Delabarre described hinged obturator(Fig.1.15) in 1820. Claude Martin described the use of surgical obturator prosthesis in 1875**.**B. Steadman described the use of an acrylic resin prosthesis lined with gutta-perch to hold a skin graft within the maxillectomy defect in 1956. Then K.W.Coffey: In 1984 first described the in flatable balloon obturators which were useful in minimizing displacement of soft tissues.**(Prakash and Gupta,2017).**

Figure1.13:Ambroise pare obturator

Figure1.14:Pierre Fauchard obturator

Figure1.15:Delabarre obturator Adopted from**(Paprocki,2013)**

1.4.2 Indication of obturator

The indications for the use of an obturator are:

a- To serve as a temporary prosthesis during the period of surgical correction

b- To restore the esthetic appearance of the patient rapidly for social contact

c- When surgical primary closure is contraindicated

d- When the age of the patient contraindicates surgery

e- When the size and extent of the deformity contraindicates surgery

f- When the local avascular condition of the tissues contraindicates surgery

g-When the patient is susceptible to recurrence of the original lesion which produced the deformity **(Sarandha,2007**).

1.4.3 Requirements of obturator

In both operated and un-operated cases the obturator should be;

a. Stable. b. Light in weight.

c. Comfortable. d. Well designed.

(Soratur,2006).

1.4.4 Parts of an obturator

The parts of obturator are:

a. Hard palate section: This helps in the retention of the appliance and restores occlusion and speech.

b. Soft palate extension: This closes the cleft of the soft palate and helps in swallowing and speech.

c. Pharyngeal projection which extends almost to the posterior pharyngeal wall.

(Soratur,2006).

1.4.5. Function of obturator :

a_Including satisfaction with facial appearance, _Ability to speak in public,

b_Leakage with liquids and solids,

c_Dryness of mouth,

Insertion of an obturator,

d_Chewing or eating,

e_Social-family interactions and overall OFS, were scored.(Riaz N al,2010)

1.4.6. Classification of obturators

Obturators can be classified as follows:

I. Based on the phase of treatment

a. Surgical obturators.

b. Interim obturators.

c. Definitive obturators

II. Based on the material

used

a. Metal obturators.

b. Resinobturators.

c. Silicone obturators

III. Based onthe area of restoration

a. Palatal obturator.

b. Meatal obturator.

(Rao,2015).

1.4.7.I Obturators based on the phase of treatment

There are three types:

A. Surgical obturator

The surgical obturator serves some rudimentary goals:

1. To support the surgical packing placed in the resection cavity created by removal of the walls of the maxillary sinus

2. To restore continuity of the hard palate. This prosthesis enables the patient to speak and swallow effectively after surgery. It also allows the patient to take oral nutrition immediately postoperatively and, if the swallowing mechanism is not disrupted by extensive surgery to the pharynx, precludes use of a nasogastric feeding tube. Speech is generally quite normal with the surgical obturator. This prosthesis will be in service for approximately 5 to10 days.**(Zarb et al.,2013)**

The patient must have a pre surgical dental examination to determine if there is non-salvageable dentition or a need for pre prosthetic surgery to remove epuli, reduce pendulous tuberosities, or relieve bony undercuts.

Ideally, these procedures are performed concurrently with the tumor resection. The primary purpose of the cameo surface of the prosthesis is to store normal palatal and alveolar form to facilitate postoperative speech and deglutition. The immediate surgical obturator for edentulous patients should be fabricated from a maxillary alginate impression much like an immediate denture record base. If the tumor mass changes the normal contours of the hard palate, the cast should be altered to restore appropriate palatal contour**. (Zarb et al.,2004).**

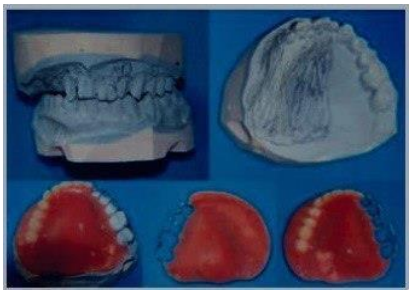


Figure 1.16: The surgical margins are plotted on the dental cast and the fabricated prosthesis (surgical obturator) **(Dalkiz,2018).**

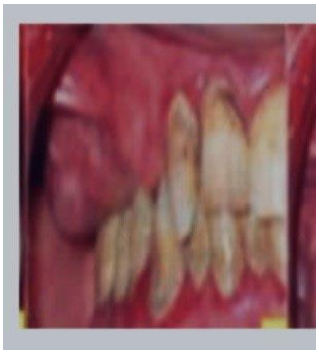


Figure1.17.A:the affected area before surgery **(Dalkiz,2018).**

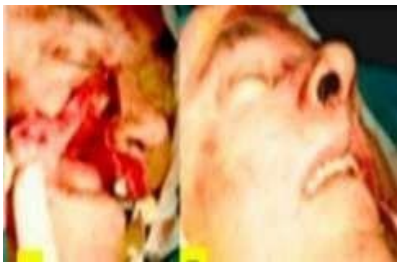


Figure1.17.B:The affected area during surgery **(Dalkiz,2018).**

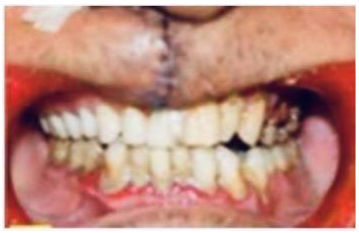


Figure1.17.C: The affected area after surgery **(Dalkiz,2018).**

Figure1.17:clinical images show the affected area before surgery**A**,during surgery **B** and after surgical intervention **C** with immediate surgical obturator application Adopted from **(Dalkiz,2018)**

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B. Interim obturator

Interim obturators are obturators which are used from the 2 until the 12week of post-operative period. They also known as "therapeutic" or "treatment" obturators because of their therapeutic, wound healing, and directive functions.

They are also known as "interim" or "transitional "obturators because they are also transitive prostheses between immediate surgery obturators and permanent obturators.**(Atay,2013).**

Prosthesis fabrication:

- In dentulous patients

1) The prosthesis will be fabricated as the immediate obturator ,from acrylic resin base with wrought wire clasp.(Fig.1.18)

2) Anterior teeth, if missing, can be included for esthetic reason.

3) Posterior occlusion should be avoided to reduce the movement of the acrylic resin extension against tissue, but as healing proceeds, posterior occlusal ramps can be established with addition of self-curing resin to help the patient to retain the prosthesis in position.

4) The prosthesis is delivered and adjusted using pressure indicating paste and articulating paper. If it fits well and is well retained, it is not necessary to add temporary lining material.

- In edentulous patients

It is preferable to use the patient own maxillary denture as a delayed surgical obturator, with the following modifications:

1) The labial and/ or buccal flanges of the denture are shortened on the side of defect.

2) The existing denture is inspected to insure that it well adequately obturates the surgical defect.

3) Self-cure acrylic resin may be added to the denture to cover the margin of resection on the soft palate.

4) After adjustment of the denture the obturator should be lined with relining material.**(Fayad,2010)**

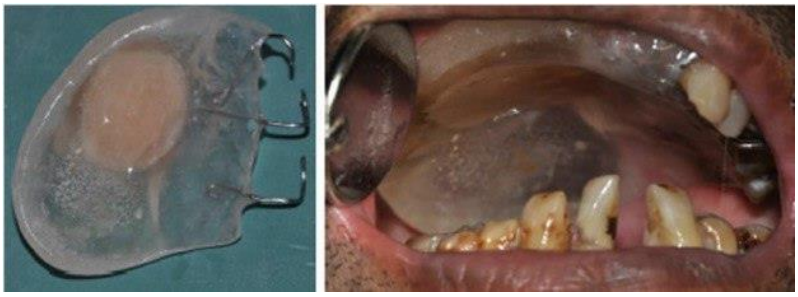

Figure1.18:Interim obturator with wrought wire clasp adopted from

(Rangarajin and Padmanabhan,2017).

C. Definitive obturator

A definitive obturator (permanent obturator) is not indicated until the surgical siteis healed and dimensionally stable and the patient is prepared physically and emotionally for the restorative care that maybe necessary.**(Chalian et al,1971)**

After the completion of the epithelization and cicatrisation of the remaining tissues from maxillary resection, permanent obturator fabrication starts. It is known that the treatment obturator can be replaced with a permanent obturator twelve weeks after the maxilla resection. Alternatively, this timing can be prolonged due to patient's general condition, limitation of the mouth openness, not enough healing at the defect, insufficient oral hygiene control, or permanent obturator usage can be otherwise delayed. This timing can change according to a patient's general condition, age, the location and the size of the resection, and is approximately 3-4 months. It is known that in patients with big defects who received radiotherapy, the permanent obturator application can be delayed up to 6-12 months due to the dosage of the radiotherapy .**(Atay,2013).**

1.4.7.II Obturators based on the materials used

A. **Metal obturator**

Metal such as cobalt-chromium alloy may be used to make denture bases for definitive obturator. The basic principles of removable partial denture design should be reviewed when designing a framework for an obturator(Fig.1.20).Major connectors should be rigid, occlusal rests should direct occlusal forces along the long axis of the teeth, guide planes should

be designed to facilitate stability and bracing, retention should be within the physiological limits of the periodontal ligament and maximum support should be gained from the residual soft tissues. The number and location of occlusal and incisal rests is determined by the number, position and health of the remaining teeth as well as by the size and location of the defect. Multiple occlusal rests are suggested to improve stability and support for the obturator prostheses and to minimize the movement of the prosthesis towards the tissue. Occlusal rests should be located as close to the defect as possible

and adjacent to edentulous areas. They should be well-rounded so as to permit some prosthesis movement without placing excessive stress on the teeth. **(Desjardins, 1978; GayandKing, 1980; MartinandKing, 1984; Parret al,1989).**

Figure1.20: metal obturator Adopted fro**m(Ali et al, 2015).**

B. **Resin obturator**

Acrylic resins (1940 - 1960): Particularly used in cases where there is least movement of tissue bed during function. Various advantages being, its ready availability, color stability, can be relined and repaired, have good strength, can be fabricated with feather margin and a goods half-life of about two years. However, they are rigid, have water absorption and duplication is not possible(Fig.1.21)**(Khindria et al,2009;Maller et al,2010).**

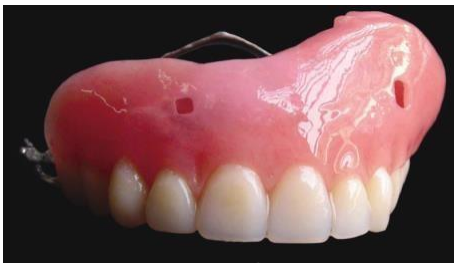

Figure1.21:resin obturator .Adopted from**(Shrestha et al,2015).**

C. **Silicone obturator**

Silicone elastomer (1960 to 1970), also known as polydimethylsiloxane is the most successful maxillofacial prosthetic material till now and the new advances are being made to this material to overcome their weaknesses. These became more popular over other materials as they have a range of good physical properties (such as excellent tear and tensile strength)over a range of temperature, easier to manipulate, high degree of chemical inertness, low degree of toxicity, and high degree of thermal and oxidative stability. Further they can be stained intrinsically and/or extrinsically to give them more lifelike natural appearance. When adequately cured, silicones elastomers resist absorbing organic materials that lead to bacterial growth and so with simple cleaning these materials are relatively safe and sanitary compared to other materials(Fig.1.22)**(Mohammad et al,2010).**

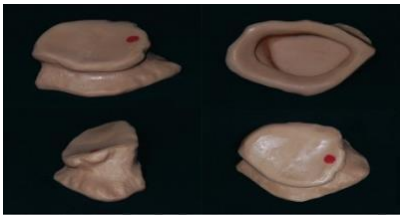

Figure1.22:Silicone obturator adopted from**(Venugopalan et al, 2013).**

1.4.7.III Obturators based on the area of restoration

A. **Palatal obturator**

Palatal obturator is a prosthetic device and is indicated in patients with cleft palate, traumatic injuries and tumors of palate. Palatal obturator consists of an acrylic plate and retention clasps of orthodontic wire, which covers a fistula of the palate (Fig. 1.23). It serves to restore speech, mastication, deglutition and aesthetics.**(Ahuja et al,2014).**

Fabrication of a Palatal Obturator

a. Diagnosis and treatment planning: The type of the defect will determine the size,location and extent of the obturator.

b. Preliminary impression using alginate: Care should be taken to record the undercuts. The junction of the graft and the mucosa should be properly recorded, as it is an important retentive feature.

c. Fabrication of custom tray:A custom tray is fabricated using any of the methods used.Additional care should be given to orient the tray into the defect.

d. Border molding: The velo-pharyngeal extension can be recorded by asking the patient to swallow. Additional exercises like turning the head from side to side, placing the chin down onto the chest may also be required. Acrylic special trays are preferred for these patients.

e. Final impression with elastic impression material: It can be made using alginate or elastomeric impression materials. The tray should be positioned properly and the scar band area must be accurately reproduced. The elastic recoil (purse string action) seen in the scar and tissues is responsible for the retention of the obturator. If the scar band is not effective, implants can be placed in to the defectto improve retention.

f. Jaw relation: It is very challenging to record the jaw relation for these patients. Acrylic denture bases are preferred because it is difficult to position other denture bases.

g. Teeth arrangement should be done such that balanced occlusion is obtained
h. Insertion and post-insertional management is carried out as usual.

(Nallaswamy et al.,2003).

Figure1.23:palatalobturator adopted from**(Domingues et al, 2016).**

B. Meatal obturator

Meat us type of obturator prosthesis extends obliquely upward from the hard soft palate junction to occlude against the turbinate and superior aspect of nasal cavity up to the nasal meatus. It separates the

oral and the nasal cavities. It is a speech aid prosthesis designed to close the posterior nasal conches through a vertical extension from the distal aspect of the maxillary prosthesis (Fig. 1.24). This is indicated when entire soft palate has been lost. It is most applicable to the fully edentulous patient who has undergo neatotal soft palate resection.**(Bhandari,2017).**

Disadvantages of metal obturator are:

a. Nasal air emission can not be controlled because it is in an area where there is nomuscle function.

b. Nasal resonance will be altered.

(Nallaswamy,2017).

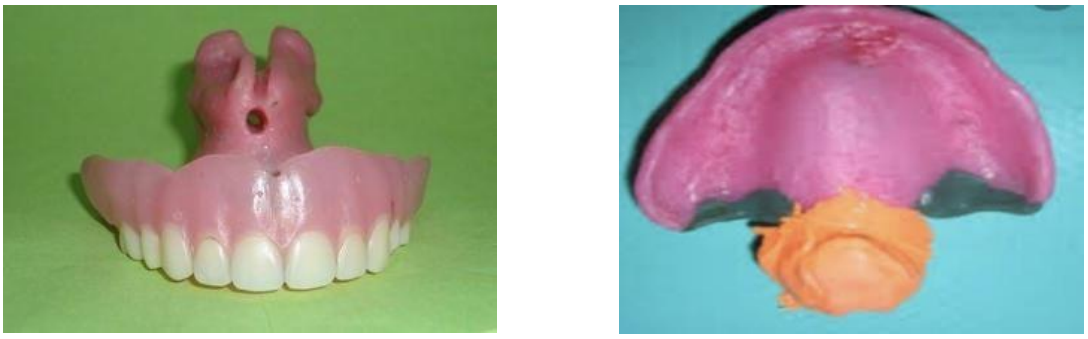

Figure1.24:Meatal obturator adopted from**(Taylor,2000).**

1.4.8. Basic principles of obturator design

A. **General principles**

The general principles are:

a. Major connectors should be rigid,

b. Occlusal rests should direct occlusal forces along the bony axis of the teeth

c. Guide planes should be designed to facilitate stability and bracing,

d. Retention should be within the physiologic limits of the periodontal ligaments.The clasp arms should be passive when not functionally stressed and provide minimal retention needed to resist displacement.

e. Maximum support should be gained from the residual soft tissues.

f. Indirect retainer should be distributed as even as possible.**(Fayad,2010)**

B. **Considerations in obturator design**

Additional considerations in obturator design are:

1. Location and size of the defect, especially as It relates to the remaining teeth.
2. Importance of the abutment tooth adjacent to the defect, which Is critical to the support and retention of the obturator prosthesis.
3. Usefulness of the lateral scar band, which flexes to allow insertion of the prosthesis but tends to resist its displacement.
4. Use of the survey or to examine the defect for the purpose of locating and preserving useful undercuts or eliminating undesirable undercuts.**(Rangarajin and Padmanabhan,2017).**

C. **The forces applied on obturators**

Although the pattern of forces affecting the obturator prosthesis are complex because of their concurrent occurrence, these forces may be categorized as:vertical dislodging force, occlusal vertical force, torque orr otational force, lateral force, and anterior-posterior force.

The weight of the nasal extension of the obturator exerts dislodging and rotational forces on abutment teeth. Obviously, then, it would be desirable that the weight of the obturator be minimal. Direct retention and extending the buccal wall of the nasal extension superiorly help resist such forces.

Occlusal vertical force is activated during mastication and swallowing. Wide distribution of occlusal rests will help counteract such force. Preservation of teeth or part of the residual ridge across the midline will greatly improve obturator stability. Maximum support should be planned through utilization of full palatal coverage. Stress created by lateral forces is minimized by the proper selection of an occlusal scheme, elimination of premature occlusal contacts, and wide distribution of stabilizing components. If the medial wall of the defect is covered by a palatal flap, it can help in resisting lateral forces.**(Aramany,2001).**

1.4.9. Obturator Designs

The various designs of obturator for different classes of maxillary defectare as follows**(Rangarajin and Padmanabhan,2017)**.

Class I design

The design can be either linear or tripodal (Fig.1.25). Two or three anterior teeth are splinted whenever possible, and support Is derived from the central incisor and the most posterior abutment tooth. If the dental arch is curved, the principle of effective indirect retention is utilized by the location of a rest on the canine, or on the distal surface of the first premolar in

A tripodal design. Direct retention is obtained either from the labial surface of the anterior teeth with a gate design or an I-bar on the central incisor.

Posterior retention is placed on the buccal surface of the molars, and bracing is located palatally. If the anterior teeth are not included in the design, a linear design is recommended. Miller3 states that a unilateral design requires bilateral retention and stabilization on the same abutment teeth. A diagonally opposed retention and stabilization system can be utilized.

Support is located in a linear fashion, and retention is located on the buccal surfaces of the premolars and the palatal surfaces of the molars. Stabilizing

components are placed on the palatal surfaces of the premolars and buccal surfaces of the molars**(Aramany,2001)**.

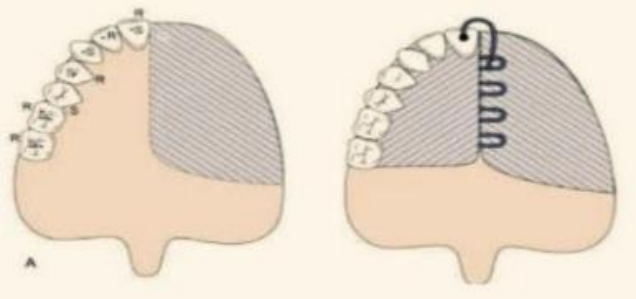

Figure1.25: class I defect and design adopted from**(Rangarajin and Padmanabhan,2017).**

Class II design

In this classification, the premaxilla on the defect side is maintained. The bilateral design is similar to a Kennedy Class II removable partial denture design. A tripodal design is recommended. Splinting of the two teeth adjacent to the defect is advisable. Primary support is placed on the tooth nearest the defect as well as the most posterior molar on the opposite side. An indirect retainer is positioned as perpendicular to the fulcrum line as possible. Guiding planes are lo

cated proximally on the distal surface of the anterior tooth and the distal surface of the molar (Fig. 1.26). Retention on all abutment teeth is located on the buccal surfaces,and stabilizing components replaced on the palatal surfaces**(Aramany,2001)**.

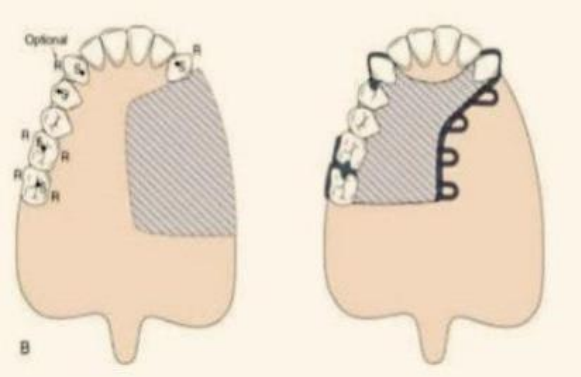

Figure1.26:class II defect and design adopted from**(Rangarajin and Padmanabhan,2017).**

Class III design

The defect is located on the central portion of the palate, and all of the dentition is preserved. The design is based on quadrilateral configurations. Support is widely distributed on both premolars and molars (Fig. 1.27).

Retention is derived from the buccal surfaces and stabilization from the palatal surfaces**(Aramany,2001)**.

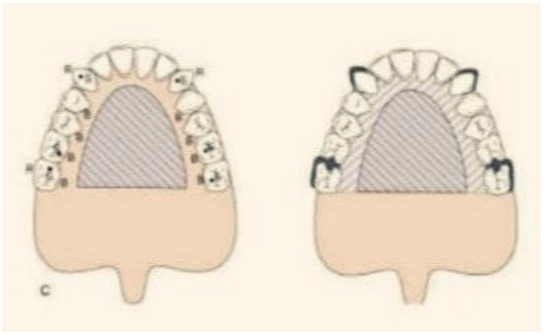

Figure1.27:class III defect and design(quadrilateral) adopted from

(Rangarajin and Padmanabhan,2017).

Class IV design

The defect includes the pre maxilla on the non-surgerized side. The design is linear(Fig.1.28).Support is located on the center of all remaining teeth.

Retention is located mesially on the premolars and palatally on the molars. Stabilizing components are palatal on the premolars and buccal on the molars**(Aramany,2001)**.

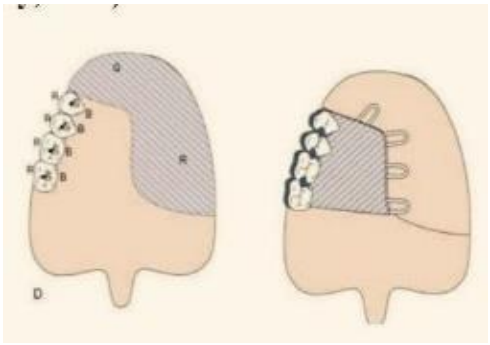

Figure 1.28: class IV defect and design (linear) adopted from (**Rangarajin and Padmanabhan,2017).**

Class V design

The anterior teeth are preserved, and the posterior teeth, hard palate, and portions of the soft palate are resected. Splinting of at least two terminal abutment teeth on each side is suggested. I-bar clasps are placed bilaterally on the buccal surface of the most distal teeth, and stabilization and support are located on the palatal surfaces. This is basically tripodal configuration.

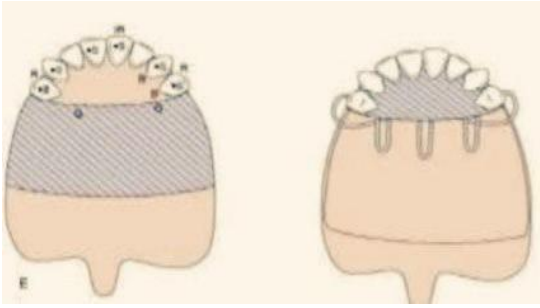

Figure1.29:class V defect and design adopted from**(Rangarajin and Padmanabhan,2017).**

Class VI design

Anterior palatal defects, the least frequently occurring class, are caused by trauma more often than by surgery. In such defects, two anterior teeth are splinted bilaterally and connected by a transverse splint bar (Fig.1.30). Aclipattachmentmaybeusedwithoutanelaboratepartialframework.Ifthedefect is large, or the remaining teeth are in less than optimal condition, a quadri lateral configuration design is followed**(Aramany,2001).**

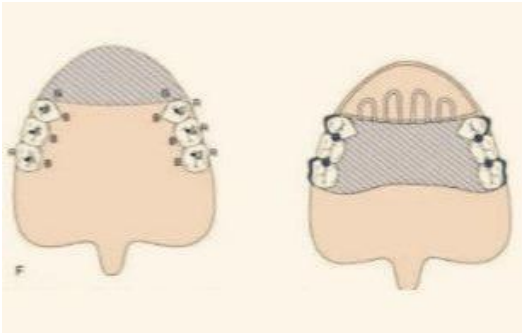

Figure1.30:class IV defect and design adopted from**(Rangarajin and Padmanabhan,2017).**

1.4.10. Movement of the obturator prosthesis

The obturator may be displaced superiorly with the stress of mastication and will tend to drop without occlusal contact. The degree of movement will vary with the number and position of teeth that are available for retention, the size and configuration of the defect, the amount and contour of the remaining palatal shelf, height of the residual alveolar ridge, the size, contour, and lining mucosa of the defect and the availability of undercuts.

Lack of retention, stability and support are common prosthodontics treatment problems for patients who have had a maxillectomy.**(Keyf,2001)**

If teeth are present, they greatly improve obturator retention and stability. One of the forces to be counteracted in the dentulous maxillary obturator is rotational stress on the abutment teeth caused by occlusion and gravity. Thus the weight of the bulb section of the obturator should be as light as possible. The buccal flange of the obturator should also be constructed to engage the lateral scar band superiorly. This design helps to restore the facial contour as well as preventd is lodging forces from unseating the obturator. The obturator prosthesis should extend minimally along the lateral wall of the defect. The high lateral extension improves retention and lateral stability and provides support for the lip and cheek. The anterior movement of the coronoid process into the postero-lateral region of the defect must be accommodated during muscle molding and final impression procedures. The extension superiorly along the medial margin of the defect should not exceed the level of the repositioned palatal mucosa. In selected patients, extension across the nasal surface of the soft palate or into the nasal aperture may improve retention.**(DaBreo,1993).**

1.5 Maxillofacial prosthetic materials

Over the past century, many materials have been experimented for facial reconstruction. Even today there is no material that fulfills all the ideal requirements for facial reconstruction.

Ideal physical and mechanical properties required in a maxillofacial prosthetic material:

a. High edge strength

b. Elongation

c. High tear strength

d. Softness and compatible to tissue

e. Translucent

Ideal processing characteristics required in a maxillofacial prosthetic material:

a. Should be chemically inert after processing

b. Ease of intrinsic and extrinsic coloring with commercially available colorants

c. Long working time

d. No color change after processing

e. Reusable moulds

f. Retain intrinsic and extrinsic coloration during use.

Ideal biologic properties required in a maxillofacial prosthetic material:

a. Non-allergenic

b. Stable with disinfectants

c. Color stability

d. Inert to solvents and skin adhesives

e. Resistant to growth of micro organisms.**(Nallaswamy,2017).**

1.5.1Classification of maxillofacial materials

Beumer classified materials used forfabricating maxillofacial prosthesis as under:

1. Acrylic resins.
2. Acrylic copolymers.
3. Polyvinylchloride and copolymers.
4. Chlorinated polyethylene(CPE).
5. Polyurethane elastomers.
6. Silicone elastomers HTV, RTV, and foaming silicones.
7. New materials-silicone block copolymers and polyphosphazenes.

(Abraham, et al, 2018).

1. Acrylic resin

It is used particularly in those cases in which little movement of the tissue bed takes place during function. • The composition includes:

a. Acrylic powder: Poly methyl methacrylate

b. Liquid: Methyl methacrylate.

Heat polymerized is preferred when compared to auto polymerized because

a. No residual monomer.

b. Increased color stability.

c. Free of tertiary amine activator.

d. Color stability when exposed to UV radiation.

Advantages:a. Durable b. Colorstable c. Cosmetic d. Canberelined/repaired.

Disadvantages: a. Rigidity b. Duplication of prosthesis is not possible as the mold isdestroyed during processing. c. There is increase in weight about0.5%(afterabout a week) due to water sorption.**(Nallaswamy,2017).**

2. Acrylic copolymer

Acrylic copolymers are soft and elastic but have not received wide acceptance because of poor edge strength, poor durability and being subject to degradation when exposed to sunlight.In addition complete restoration is often tacky predisposing to direct collection and staining.

(Khindria, et al,2009).

3. Vinyl polymers and copolymers

Introduced in the mid-1940s as plastisols. Most widely accepted are realistic (polyvinyl chloride) and mediplas (polyvinyl acetate chloride), they are susceptible to the degradation or destruction by UV light, ozone, peroxide, and tetraethyl lead and they are relatively rigid and must be made flexible by the use of a plasticizer.**(Reddy, et al,2015).**

4. Chlorinated polyethylene

Lewis and Castle berry's reported. Chlorinated polyethylene, a material similar to polyvinylchloride in which coloration can be done using oil soluble dyes.**(Khindria, et al,2009).**

5. Poly urethane Elastomers

They are elastomers with urethane linkages. Hence, they are known as polyurethanes.The urethane linkages are formed by combination of one isocyanate group with a hydroxyl group. These materials have excellent properties like elasticity without compromised edge strength(this helps to thin the material at the margins). They can be used to restored effects with mobile tissue beds. The disadvantages include the moisture sensitivity during processing and poor color stability.(**Hovannisyan et al.,2009**).

6. Silicones

Long chain molecules composed of alternating chain of silicone and oxygen atoms, by adjusting the length of this silicon-oxygen chain silicones can be produced in the form of fluids, resins, or elastomers (rubbers). They have better physical and chemical properties. The extraordinary properties of silicones are due to the special characteristics of the silicon-oxygen bonds in their backbone. Because the silicon-oxygen bond is much stronger than the carbon-carbon bond of organic polymers, silicones make better electric Insulators and are more resistant to oxidation.**(Reddy, et al,2015) .**

Types of Silicones:

Based on their use, silicones can be classified in to four types:

a. Implant grade: They are placed with in the tissues(breast implants).They mustmeet or exceed FDA requirements.

b. Medical grade: They are approved for external use only. It is the most commonlyused variety for fabricating maxillofacial prosthesis.

c. Clean grade: Industrial use.

d. Industrial grade: Industrial use.

Classification Based on the Vulcanization Temperature

HTV- Silicone: It requires heat for vulcanization. It is a highly viscous, white, opaque materials available as one or two-component putty. The catalyst or the vulcanizing agent used is dichlorobenzoic acid (for condensation polymerization)or platinum salts(for addition polymerization)It requires advanced equipment for processing. They have better physical properties.**(Hovannisyan et al.,2009).**

1. New Materials

I. Silicone block copolymers

Silicone bock copolymers are new material under development to improve some of the weaknesses of silicone elastomers, such as low tear strength, low recent elongation, and the potential to support bacterial or fungal growth. It has been found that silicone block copolymers are more tear resistant than are conventional cross-linked silicone polymers. In this blocks of polymers other than siloxane are positioned with the traditional siloxane polymers. The hydrophobic nature and foreign nature of silicones have been proven to cause problems, especially with regard to the interaction with the body on a molecular level.

This can lead to the induction of foreign body reactions and the development of infections particularly at the interface between silicone and tissue. These silicone block copolymers can to some extent overcome these problems as the more hydrophilic part of these amphiphilic polymers provide improved wettability and thus tissue compatibility. An example of this is the intertwining of polymethyl methacrylate in to the chains of siloxane.**(Abraham,et al,2018).**

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II. **Polyphosphazenes**

These were developed mainly as a resilient denture lining materials.

a. Major advantage is that freedom of movements of the denture toward the tissue issimilar to periodontal membrane around natural tooth.

b. The material is expensive.

c. Latest research proves that compounding polyphosphazenes with little or no fillers and decreasing the ratio of acrylic to rubber yields as after rubber, similar to that of human skin.**(Nallaswamy,2017).**

1.6 Management of maxillary defect

I. Implant use in maxillary defects

Soft palate in defect area, residual hard palate, anterior nasal patency,lateral scar band and height of the lateral wall provides retention.Endosseous impla nts are routinely used in many are as in clinical practice.
Osseo integrated implants, the obturator can assist in the retention, stability, and support of prostheses, dental implants have distinct advantages in the treatment of jaw facial defects. Loss of soft and hard tissues often provides implant-protected delay times, which are necessary to adequately support lips and cheeks and restore oral functions. Al-Salehi., et al. 2007 reported that excessive wear of implant was preferred treatment when severe soft and hard tissue deficiency was present. Implant-supported prostheses are a good treatment alternative to provide aesthetic, structural and functional rehabilitation of patients with the maxillary defect. In most cases of maxillary resection, implant- assisted overdentures are more suitable than fixed prostheses and may even be the only treatment alternative. Most of these patients have less than 5 years of life and require effective and practical treatment. The overall survival rate for implants supporting maxillofacial prosthesis was reported to be more than 95%. Dental implants can be used on both the defect and non-defect sides of the maxillary arch ,the zygomatic bone around the defect with sufficient bone volume to place the implants can be placed in the processus frontalis, orbital bone, tuber maxilla and pterygoid region of the maxilla.
(Akay and Fadhil,2019).

II. **Soft-tissue free-flap reconstruction**

Management of palatal or hemi palatal defects (small to medium sized)with preservation of the orbital floor remains controversial because there are many options that can successfully treat these patients. While dental obturation remains an effective option in patients not expected to receive radiation,the use of local, regional, or distant free flaps all can result in good function and aesthetics, especially in larger defects. Although the obliterated maxillectomy cavity was thought to potentially delay the diagnosis of tumor recurrence, available evidence does not support this hypothesis, which may be related to an increase in the use of anatomic and metabolic imaging strategies in routine follow-up.6 Although free flaps are more commonly used, a temporal is muscle flap (Fig.1.31) may be used for

small-and medium-sized palate defects. The use of this flap is more intuitive than other regional options because the harvest can be combined with an approach often needed to expose the infra temporal fossa.14 After harvest through an ipsilateral hemi-coronal incision, the flap can be passed into the maxillectomy/ palatectomy cavity by removal (and subsequent replacement)of the zygomatic arcade.

The fascial surface is allowed to mucosalize intraorally, often forming more naturalintraoral lining than the one provided by skin flaps**(Andrades,2011).**

Figure1.31:Temporalis musculofascial rotational flap.Adopted from **(Andrades,2011).**

III. Osteocutaneous free-flap reconstruction

Intermediate-size defects with better survival rates require complete palatalalveolar-maxillary restoration to maintain the patient's quality of life, and Osteocutaneous free flaps (Fig. 1.32) are the best option. Although the selection of the reconstructive method depends on the extent of the bony and soft-tissue defect, there is no clear or generally accepted recommendation.

The amount, location, and quality of residual bone of the midface and dentition or denture-bearing alveolar arch largely determine whether a bone containing flap is necessary. Bone reconstruction should be considered in medium-sized to large maxillectomy defects, with good oncologic prognosis, whenever oral rehabilitation, midface contour, and orbital support are a priority. Although these same defects may also be treated using a prosthetic obturator or a soft-tissue free flap, vascularized bone flaps are often needed to restore midfacial height, width, and projection, as well as to provide adequate bone stock for mastication and Osseo integrated implants,which are usually required for the fixation of dental prostheses.

(Andrades,2011).

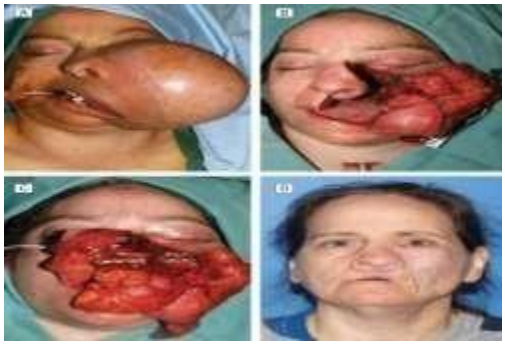

Figure 1.32:Photographs of a woman with a massive maxillary ameloblastoma. Fibula osteocutaneous free flap was used to reconstruct bilateral maxillectomy defect.Adopted from**(Andrades,2011).**

CONCLUSION

a. Maxillofacial prosthesis replaces large amount of hard and soft tissues of face.
b. Facial traumas necessitate the collaboration between many clinical figures as maxillofacial surgeon, plastic surgeon, and prosthodontist.

c. The multidisciplinary approach is helped by a painstaking clinical data collection.

d. The recognition of certain clinical parameters is fundamental to frame diagnosis and successful treatment planning.

e. Patients suffering soft tissues damage and reconstructed patients are the most difficult to rehabilitate.

f. Predictability of patients outcomes isthe key to better plan traumatized patients.
g. Soft tissues represent a subjective element of evaluation that can alter our parameters.

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