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Maxillofacial Obturator and its 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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بسم الله الرحمن الرحيم

صدق الله العظيم

Certification of the Supervisor

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

Supervisor's name:

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Dedication

All my success as well as everything I do, I'm honored to dedicate it to my mom and dad souls , the two people who gave me the values , love and paved the path for my journey in life.

My second mother (grandmother), my mentor and role model for the love she planted in me for this field and department and for her generosity in love, knowledge, wisdom and life lessons.

My second father(grandfather), for always pushing me to shine and always trusting me, for being my backbone and granting me the gift of compassion and motivation.

To Rand , the one who shared the journey of learning with me , supporting me and being my best friend.

My sister Rania with the biggest heart, for being my number one cheerleader and for embracing me with her genuine care.

To my big family, for their presence, warmth and endless support.

And of course my friends who shared the journey of learning with me, to our memories here and to the future we hold, may we grow and rise together.

Acknowledgment

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INTRODUCTION

Maxillofacial prosthetics is a branch of prosthodontics associated with restoration and/or replacement of stomatognathic and craniofacial structures with prostheses, which may or may not be removed on a regular or elective basis (**Driscoll *et al*., 2017).** Maxillofacial deformities are embarrassing to patients and may negatively affect their physical and psychological health, potentially resulting in serious psychiatric, familial, and social problems **(Goiato *et al*., 2013).**

These deformities can be congenital, caused by malformation and developmental disturbances, or acquired, caused by pathologies such as necrotizing diseases and oncosurgeries or trauma **(Côas et al., 2005).**

The Glossary of Prosthodontic Terms defines an obturator as "a maxillofacial prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate and/or contiguous alveolar or soft tissue structures**" (Gupta et al., 2006).**

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 **(Kumar et al., 2017).**

The prostheses allow individuals to reintegrate into their social and familial environments, making them happier and more confident. In order to achieve success, it is necessary to integrate different health professionals, such as doctors, nurses, psychologists, physiotherapist, speech therapists, and dentists for prosthetic rehabilitation. **(Kumar et al., 2017)**

AIM OF THE REVIEW

The aim is to review maxillofacial obturators , its classification , design , the principles for these design and the material that we used to fabricate these obturators and find out how the patients use these prosthesis after a maxillofacial defect.

Chapter one
REVIEW OF LITERATURE

1.1 Maxillofacial prosthesis

Maxillofacial prosthetics is the art and science of anatomic, functional and cosmetic reconstruction of missing or defective parts of the maxilla, mandible and/or face which may be missing or mutilated as a result of surgery, trauma, and congenital or developmental defects by using a non- living substitutes**.**

Maxillofacial Prosthesis **(Fig.1):** any prosthesis used to replace part or all of any stomatognathic and/or craniofacial structure **(Fayad, 2010)**.

Early records indicate that artificial eyes, ears, and noses were found on Egyptian mummies. The Chinese also made facial restorations with waxes and resins of various types. In this work the physicians were assisted by sculptors and painters **(Chalian et al., 1971)**.

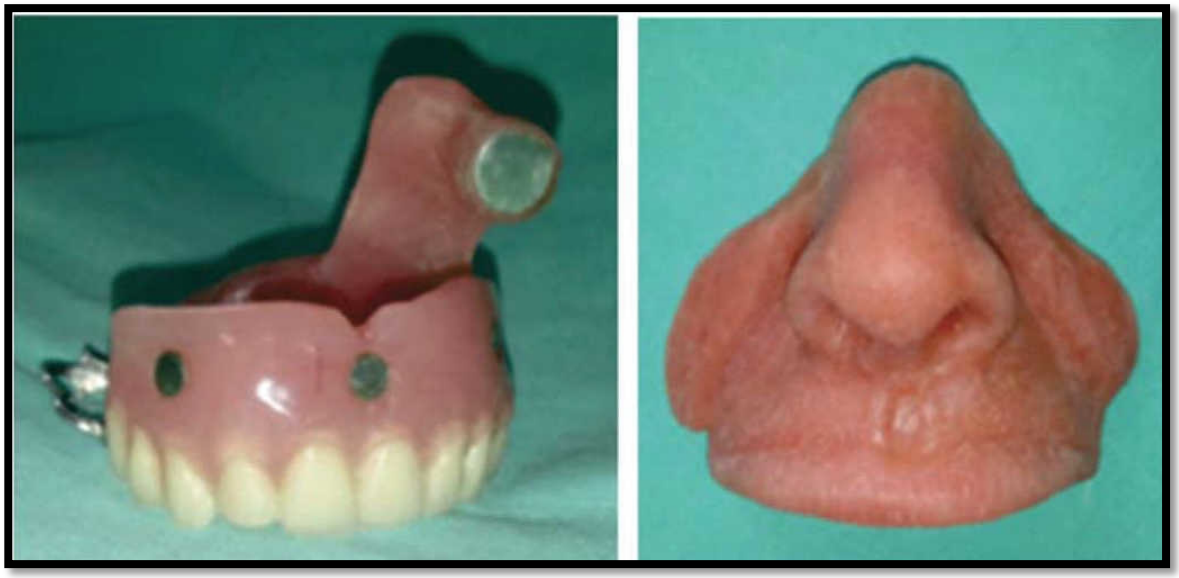


Figure1: maxillofacial obturator (Pigno and Funk,2001)(Kawamoto et al., 2009)

1.1.1 Objectives of maxillofacial prosthetic

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

1-Restoration the esthetics or cosmetic.

2-Appearance of the patient.

3-Restoration of function.

4-Protection of the tissues.

5-Therapeutic or healing effect.

6-Psychological therapy **(Chalian et al., 1971)**.

1.1.2 Guidelines for the applied prostheses

The guidelines 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

Depending on the cause of defect are classified as:

1. congenital
2. acquired : which also classified into:

a. surgical (postoperative)

b. traumatical

Depending on location maxillofacial defects are classified as:

1.2.1.Extra-oral defects

- Auricular defects.
- Orbital defects.
- Nasal defects.
- Lip and cheek defects.

1.2.2 Intraoral defects.

- Maxillary.
- Mandibular.
- Velo-pharingeal.

3. Combined defects **(Hovannisyan et al., 2009).**

1.2.1. Extra-oral Defects

These defects were caused by war traumas or accidents. Currently, facial prostheses are usually applied in cases of defects caused by the surgical removal of tumors or congenital defects. A prosthetic replacement of an exterior part is termed an epithesis **(Doorne, 1994).**

Extra oral defect that require maxillofacial prostheses include: auricular, orbital ,nasal, lip and cheek defects.

a. Auricular defects **(Fig.2.A):** Half of the cases involve carcinoma; the remaining cases involve trauma (such as burns) and congenital defects **(Doorne, 1994).**

Congenital auricular malformations are:

-Microtia (small ear) associated with atresia of the external auditory meatus.
-Anotia (complete absence of the auricle).
-Smaller ear defects **(Hovannisyan et al., 2000).**

b. Orbital defects **(Fig.2.B):** some form of cancer, incidental cases of acongenital defect, or trauma can cause ocular defects. **(Doorne, 1994)**

Congenital orbital malformations are:

-defects in the eye ball with intact eyelids
-an orbital defect involves both the eye ball and the eyelids.
(Hovannisyan et al., 2000).

c. Nasal defects **(fig.2.C)**: these prostheses usually follows carcinoma, exceptional cases of a congenital defect, or trauma. In some cases, the defect is caused by lupus erythematosus or may The defects arising due to surgery are known as rhinotomy defect **(Doorne, 1994).**

d. Lip and cheek defects

- double lip
- Hemi-facial microsomia etc.

e. 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., 2009).**

The common neoplasia of the head and neck that caused extra oral defects are:

1. Epithelial tumors: epithelial facial tumors may have a melanocytic, keratinocytic or adrenal origin.

2.Connective tissue tumors: adenomas, fibromas, leiomyomas and lymphoma **(Nallaswamy et al., 2003)**

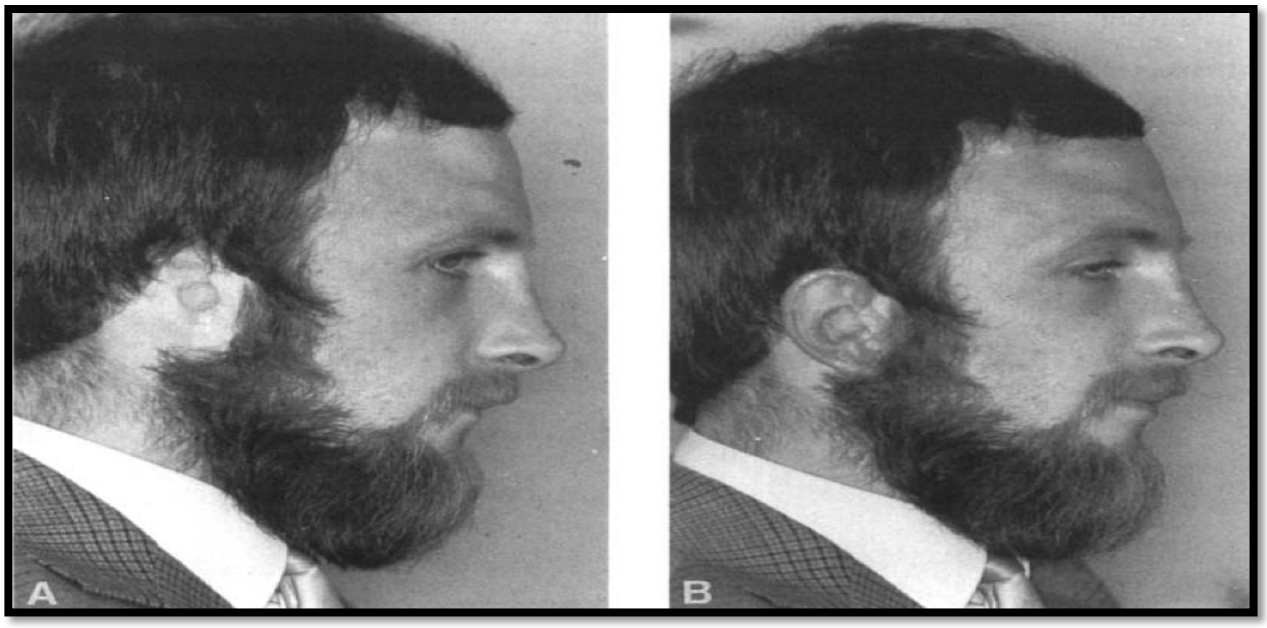
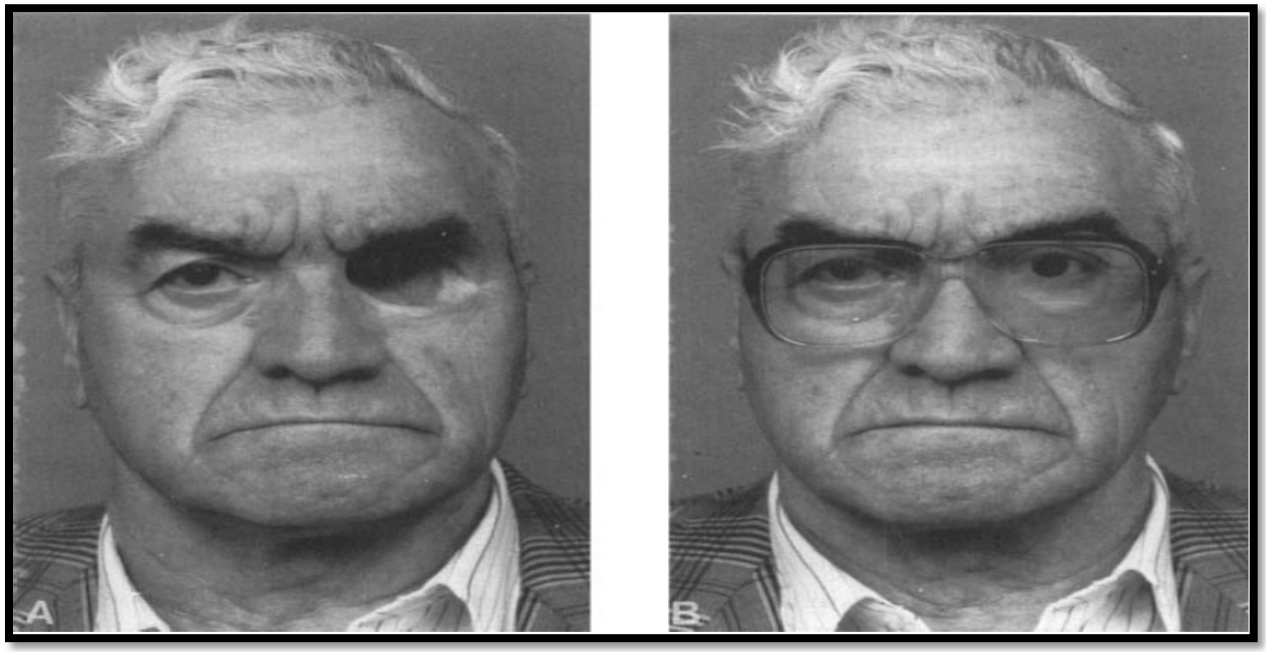


Figure2.A: Auricular defect(A) , coverd with auricular prosthesis(B) (Doorne ,1994).



Figure(2.B) orbital prosthesis: (A) orbital defect,(B)filled with an orbital prosthesis (DOORNE ,1994).

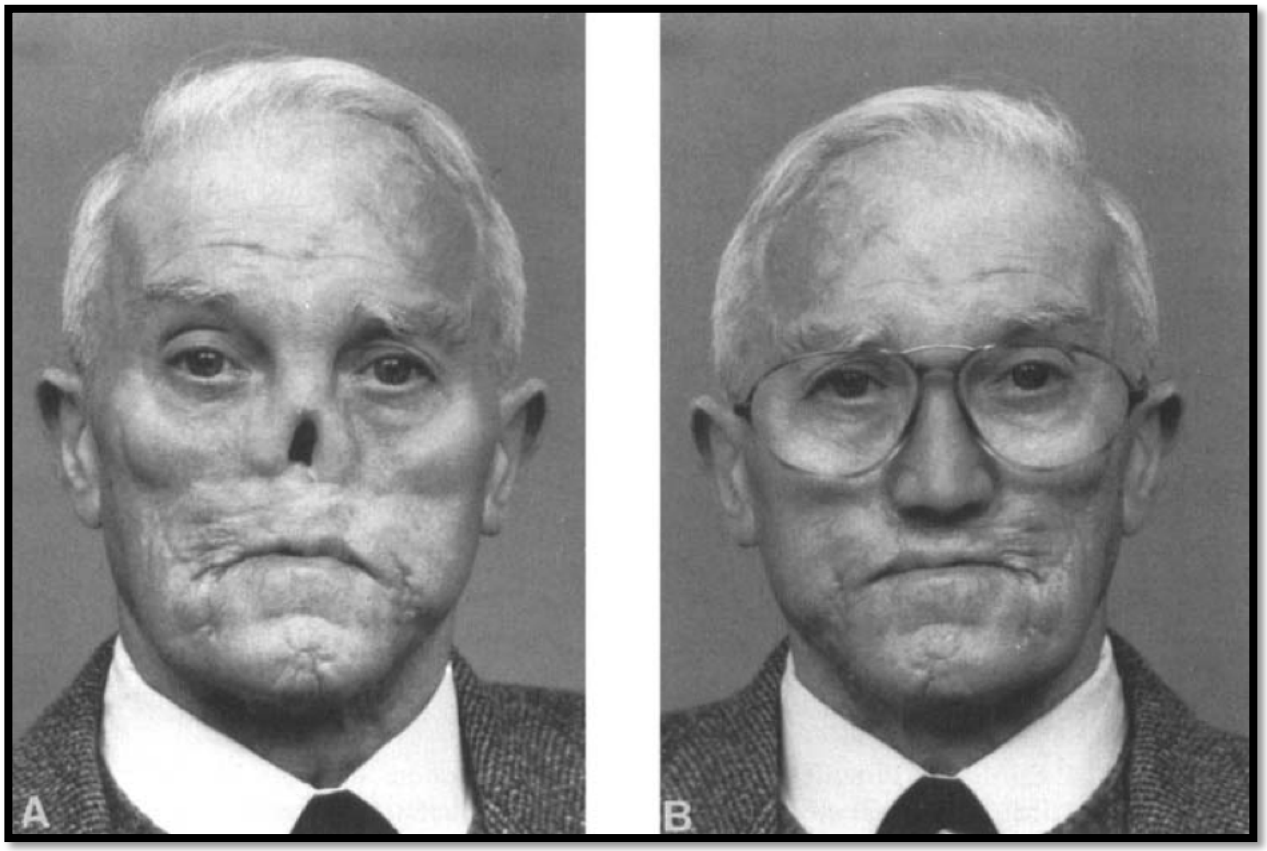


Figure2.C nasal prosthesis : (A) Nasal defect. (B) filled with a nasal epithesis (Doorne ,1994).

1.2.2. Intra-oral Defects

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

1.2.2.A. Maxillary defects

Defects that are either acquired or congenital in nature in the midfacial (maxillary) region are referred to as maxillary defects.They are classified as:

1. Congenital maxillary defects

These defects include the cleft lip and cleft palate.

a. Cleft lip**(Fig.3.A):** The failure of fusion of the frontonasal and maxillary processes, resulting in a cleft of varying extent through the lip, alveolus, and nasal floor (an incomplete cleft does not extend through the nasal floor, while a complete cleft implies lack of connection between the alar base and the medial labial element) **(Semer ,2001).**

If there is a failure on one side, the patient suffers a unilateral defect and if on both the sides, the individual suffers a bilateral defect **(Rangarajin and Padmanabhan, 2017).**

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).**

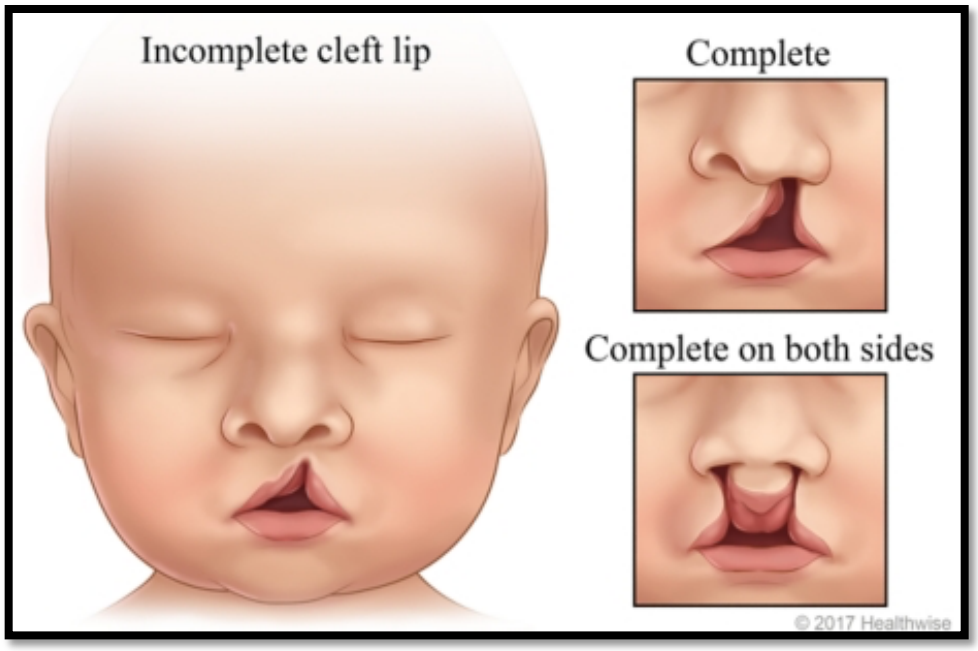


Figure 3.A: cleft lip (oliver et al., 2021)

b. Cleft palate**(Fig3.B):** The failure of fusion of the palatal shelves of the maxillary processes, resulting in a cleft of the hard and/or soft palates **(Semer ,2001).**

Clefts arises during the fourth developmental stage. Exactly where they appears is determined by locations at which fusion of various facial processes failed to occur, this in turn is influenced by the time in embryologic life when some interference with development occurred **(Proffit et al., 2012).**

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).**

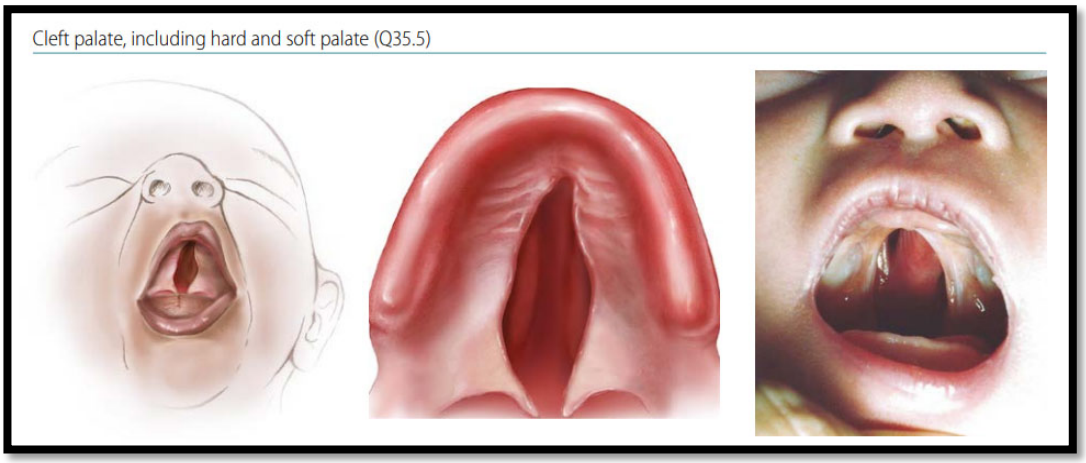


Figure3.B: cleft palate (WHO/2020)

Thus, the typical distribution of cleft types are:

1. Cleft lip alone – 15%
2. Cleft lip and palate – 45%
3. Isolated cleft palate – 40% **(Gaurishankar,2011).**

A detailed classification**(Fig.4)** 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.

Class II: Clefts involving soft and hard palates up to incisive foramen.

Class III: Cleft of soft and hard palates, right forwards through alveolar ridge and continues into lip on one side.

Class IV: Same as Class III only associated with bilateral harelip. **(Fenn et al., 1998)**

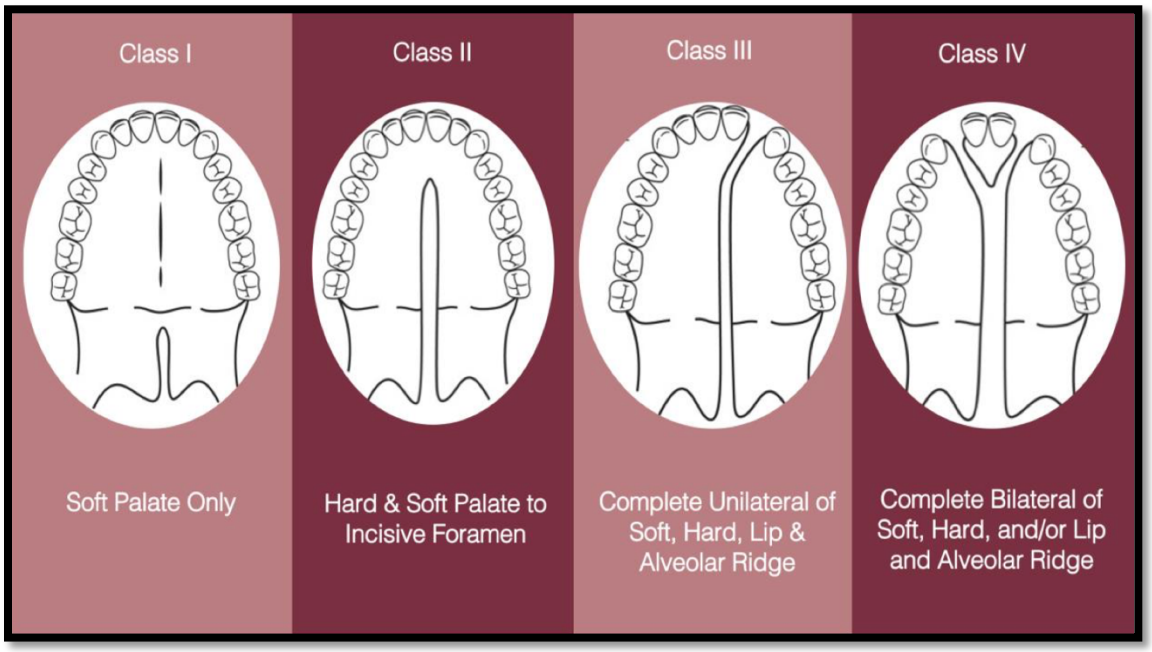


Figure4 cleft lip and palate classification (oliver et al., 2021)

2. Acquired maxillary defects

Acquired maxillofacial defects are those that are created by other than congenital/developmental influences. These are manmade defects more often related to surgical intervention for the elimination of disease process **(Rieger, 2002)**

Except for patients with small oro-antral and oronasal defects, which may be amenable to surgical closure, patients with these defects are rehabilitated by prosthodontic means**. (Rieger, 2002)**

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.5)** 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 the defect on either sides of the remaining maxilla **(Gupta etal., 2016).**

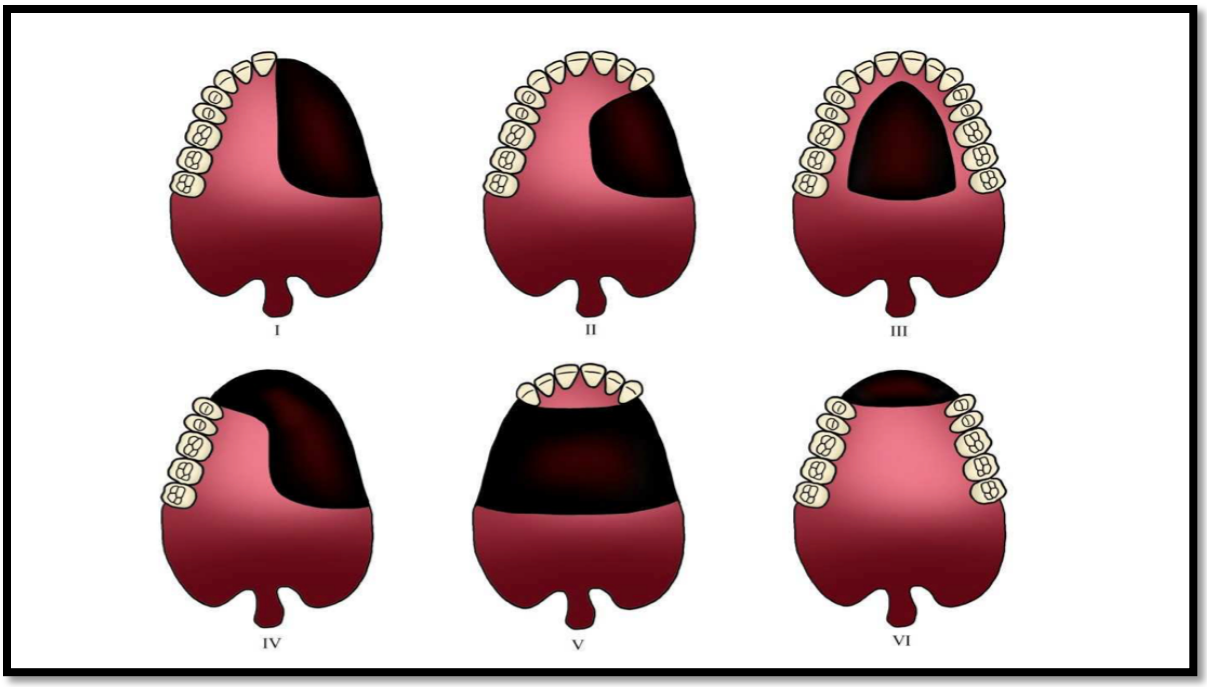


Figure5: Aramany's Classification of maxillectomy defects. (Ali et al., 2015)

1.2.2.B. Mandibular defects

These defects 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 **(Nallaswamy et al., 2003).**

2. Acquired Defects of the Mandible

Acquired segmental defects of the mandible are most commonly secondary to ablative tumor therapy or avulsive traumatic injury. Other less common causes include inflammatory or infectious conditions that result in devitalisation of the

mandibular bone requiring its debridement. Segmental defects secondary to tumour therapy may result from the management of aggressive benign tumours arising within the mandible such as ameloblastoma or myxoma or from malignancies carcinomas/sarcomas) arising in the associated soft tissue envelope that invade or extend to the mandible. Management of oral squamous cell carcinoma is the most common malignancy resulting in acquired segmental defects of the mandible **(Batchu et al., 2009).**

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

Continuity defect **(fig6.A)**: Mandibular continuity defect is defined as loss of a portion of the bone resulting in a gap of ~2cm or more in the lower jaw. The etiology is mainly acquired and rarely congenital. **(August M)**

Causes include cysts, benign and malignant tumors, trauma, and chronic osteomyelitis**(Chiapasco, 2008).**

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.6.B)**

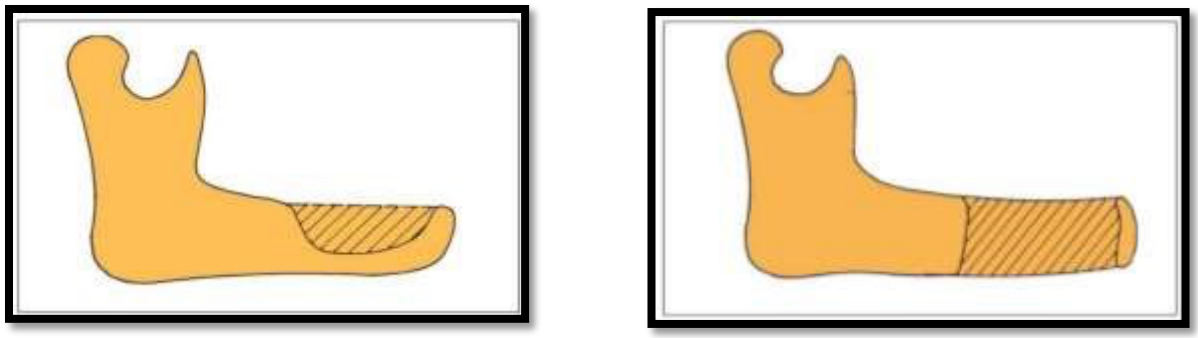


Figure6.A . continuity defect, 6.B discontinuity defect Adopted from (Nallaswamy et al., 2003)

• Class I: Marginal resection. Continuity defect, when the alveolar process is resected, but the lower border of the mandible is preserved

• Class II: Segmental free end resection (discontinuity defect) that does not cross the midline

Modification a: Bilateral resection posterior to the second premolar

Modification b: unilateral resection posterior to the lateral incisor

Modification c: unilateral resection posterior to the lateral incisor side and the second premolar on the other.

• Class III: Segmental free end resection up to or crosses the midline.

• Class IV: Class III+ resection of the tempromandibular joint.

• Class V: Anterior bounded resection **(Hovannisyan et al., 2009).**

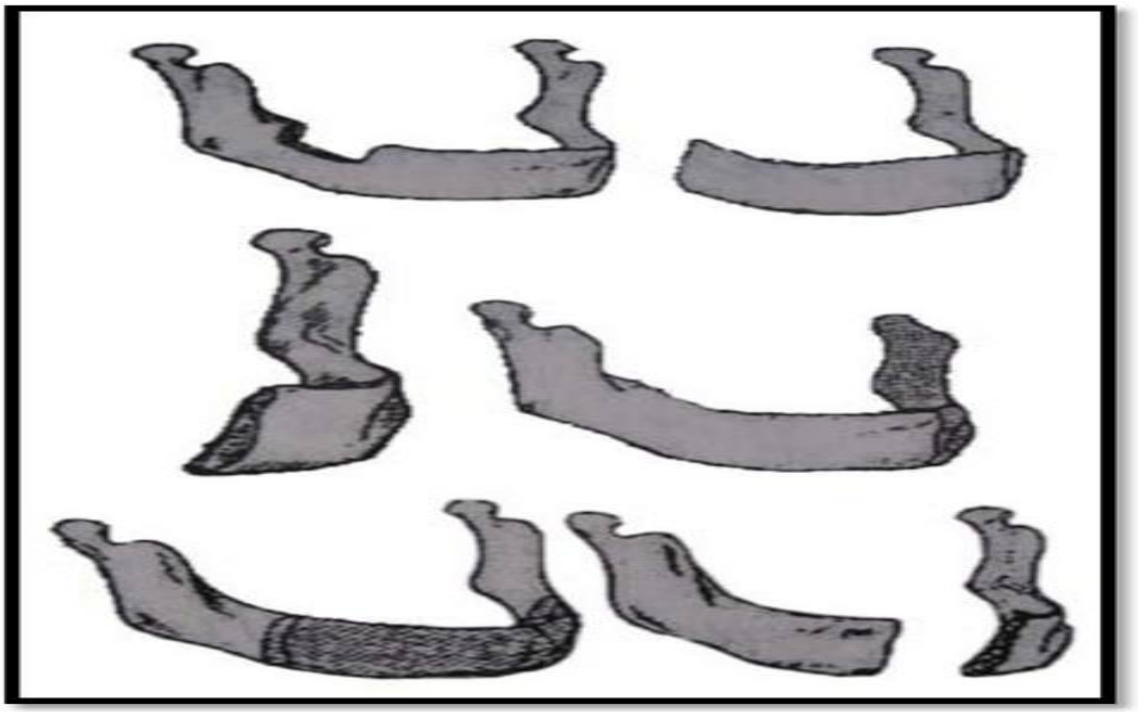


Fig 6.C Cantor and Curtis classification of acquired mandibular defects (Narendra et al., 2016)

1.3. Classification of maxillofacial prostheses

Maxillofacial prosthesis classified as:

a. Extra-oral Defect Prostheses (Epithesis): Prostheses for the deficiencies in the face area are 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 prostheses

*One piece metal casting binding defect prostheses

*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

An auricular prosthesis**(FIG7.A)** is an artificial substitute for the auricle; the term epithesis is used synony- mously. A myriad of materials have been used in the long history of anaplastology. However, the breakthrough came with the introduction of modern silicones and their colorings. ***(*Staudenmaier, 2010)**

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)** .

The retention of the prosthesis is through ear- glass frames, adhesives, hair bands or implants. **(Rangarajin and Padmanabhan, 2017)**

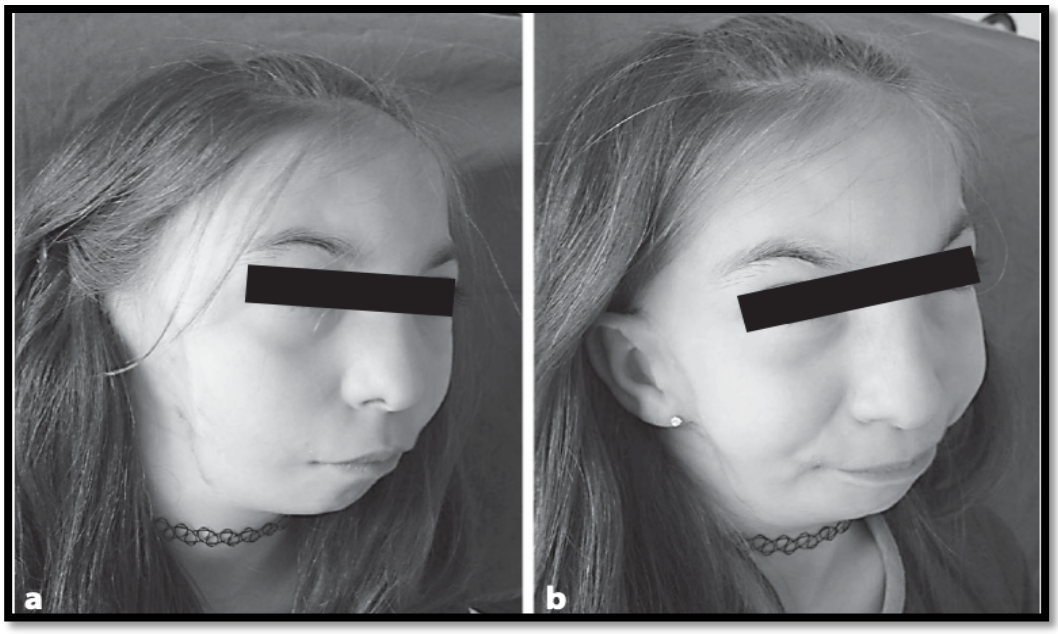


Figure7.A Auricular prosthesis . (Federspil, 2010).

1.3.a.II. Nasal Prosthesis

Since nose is very prominent, centrally located and difficult to disguise on the face, making prosthesis with realistic effect is of vital significance. Presurgical photographs can aid for accurate replication of the patients original 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 **(Fig.7.B).** (**Marunick, et al. 1985 as cited by** Lemon, et al., 2005)

Attempts should be made to camouflage the margin with the surrounding anatomy and match the color, texture and translucency of skin. If cranio-facial implants are indicated preferred site for implant placement is the anterior floor of

the nose and maxilla region, which provides greatest bulk for the superstructure and retention mechanism **(Carr, 1998).**

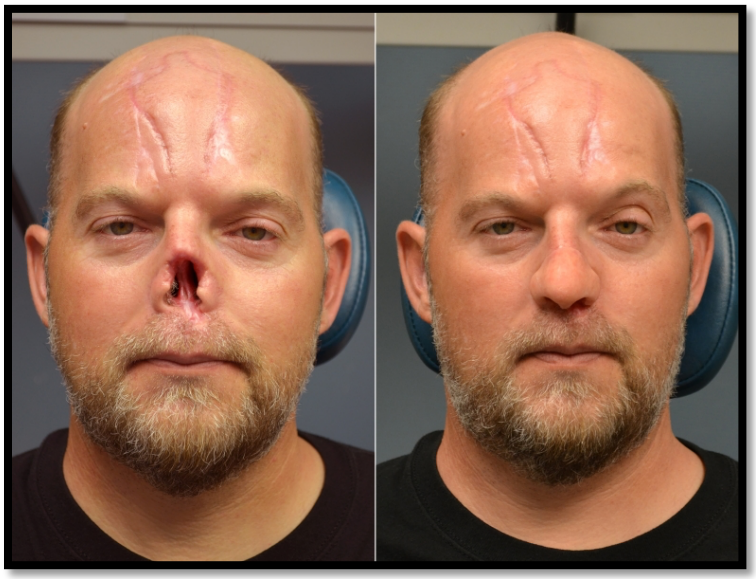


Figure7.B Nasal prosthesis (Travis Bellicchi, 2017)

1.3.a.III. Ocular-Orbital Prosthesis

It is defined as 'a maxillofacial prosthesis that artificially replaces an eye missing as a result of trauma, surgery, or congenital absence **(Fig.7.C) (Prakash and Gupta, 2017).**

An orbital prosthesis is a good alternative to surgical reconstruction for cosmetic and psychological rehabilitation of the patient. It should be aesthetic, durable, light weight, economical, and most importantly retentive.

The aim of the orbital prosthesis was to reinstate the esthetics and boost the psychological and mental state of the patient. The techniques employed along with incorporation of the patient's own hair in eyelashes greatly improved the esthetics **(Saroya et al., 2022).**

The material used for fabrication and the type of retention depend on patient's cosmetic demands, size and extent of defect, type of lifestyle, economical condition etc **(Pruthi et al., 2014).**

Recent materials include polysiloxane, RTV silicones, HTV silicones, silphenylenes, chlorinated polyethylene, polyvinyl chloride, and polyurethane. The most commonly used materials are the RTV silicones **(Yi JYS et al., 2012).**

Figure7.C : Ocular defect and prosthesis adopted from (Mantri and Khan, 2012).

1.3.b. Intra-oral Prosthesis (fig8)

These are used to restore or complement portion of the oral cavity and nearby anatomical structures. Examples: obturators ,speech aids, modified complete and partial dentures and infant feeding prosthesis**(Fig.8)**

(Winkler, 2009).

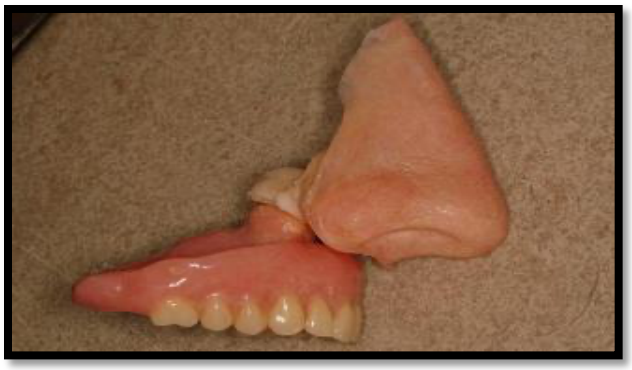


Figure8 Intra-oral Prosthesis (Banerjee et al., 2012)

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

Ambroise Pare was the pioneer to use obturator to close palatal perforations **(Fig.9.A)** 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.9.B)** Delabarre described hinged obturator **(Fig.9.C)** 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 inflatable balloon obturators which were useful in minimizing displacement of soft tissues **(Prakash and Gupta, 2017).**

Figure 9.A: Ambroise pare obturator

Figure 9.B:Pierre Fauchard obturator

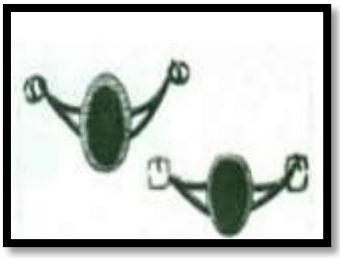


Figure 9.C: Delabarre obturator

Adopted from (Paprocki, 2013)

1.4.2. 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).**

1.4.3. Indications for the use of obturator

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

b. To restore patient's cosmetic appearance rapidly for social contacts.

c. To provide for an inability to meet the expenses of surgery.

d. When the patient's age contraindicates surgery.

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

f. When the local avascular condition of the tissue contraindicates surgery.

g. When the patient is susceptible to recurrence of the original lesion which produced the deformity **(Nidiffer et al., 1957).**

1.4.5. Functions of obturator

1. restore masticatory function.
2. improve speech and cosmetics.
3. preserve the remaining teeth and tissue and provide comfort, function, and aesthetics to the patients.
4. allow adequate deglutition and for feeding porpuse **(Wang, 1997).**
5. Maintains the wound/defective area clean.
6. Enhances the healing of traumatic or post-surgical defects.
7. It can be used as a stent to hold dressings or packs post surgically in maxillary resections **(Sarandha, 2007).**

1.4.6 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).**

1.4.6. 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. Resin obturators.

c. Silicone obturators

III. Based on the 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:

1. **Surgical obturator :**

Immediate surgical obturator **(Fig.10.A)** is fabricated from the impression made before the surgical excision of the lesion and inserted immediately after the surgery. It is usually made of heat activated clear acrylic resin to reduce the amount of residual monomer content which may pose possible irritation to the surgical wound. Immediate surgical obturator has the main advantage of restoring patient's speech and assisting in swallowing. It also serves as a matrix for the surgical dressing and provides psychological support for the patient. Retention of the prosthesis may be achieved by wrought-wire clasps or wire ligatures placed around the remaining teeth. In case, very few or no teeth remains obturator is wired to the zygomatic arches or other bony or soft tissue. No prosthetic teeth are attached to the immediate surgical obturator to avoid occlusal load transferring to surgical site **(Desjardins, 1997).**

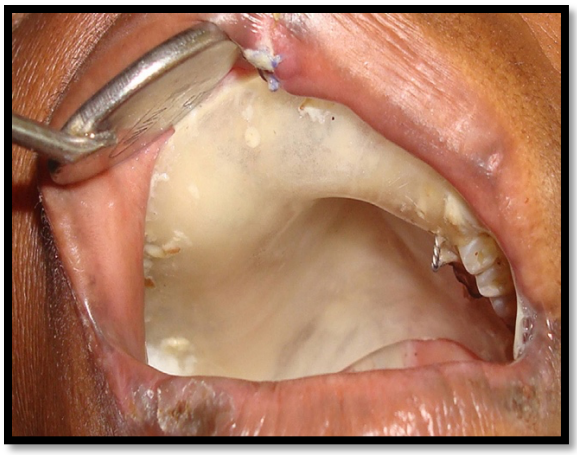


Figure10.A surgical obturator inserted immediately after surgery and retained by ligature wire through the holes. (Arun et al., 2016)

2. Interim obturator :

Interim obturators **(Fig 10.B)** are obturators which are used from the second until the twelfth week 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).**

Oral soft tissues experience significant alteration in shape and size during first 3 weeks after surgery. This reduces the retention and stability of immediate surgical obturator which is already compromised. This necessitates fabrication of new surgical obturator 3–4 weeks after the surgery which is known as interim surgical obturator. It is fabricated either from a new impression made from patient or by adjusting the immediate surgical obturator by soft relining material. Full extension of the obturator prosthesis is not advisable because of

its potential interference with healing. Prosthetic teeth limiting to the anterior segment may be added to enhance in esthetics **(Mukohyama et al., 2004).**

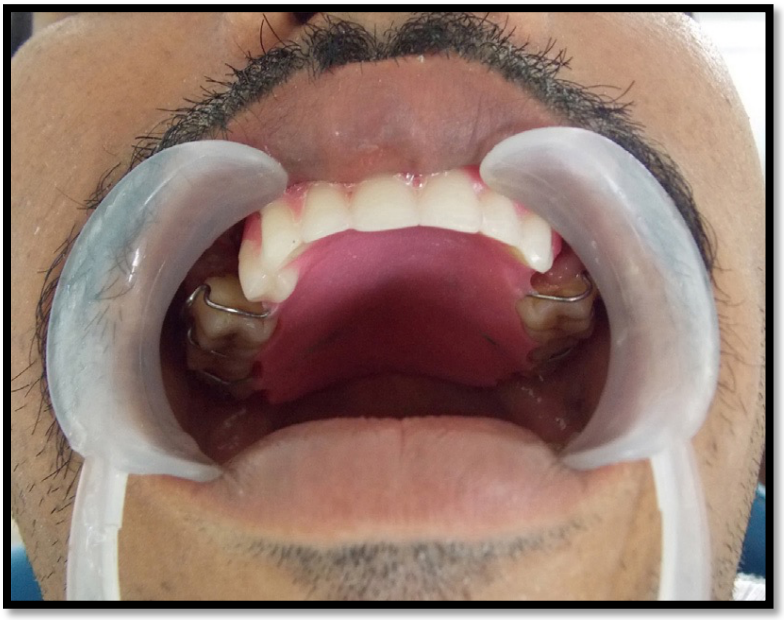


Figure. 10.B – Interim obturator made of heat activated acrylic resin retained by Adams clasp and C clasp. (Arun et al., 2016)

3. definitive obturator (permanent obturator) :

Definitive obturator (**FIG10.C)** is fabricated 6 months after surgery, once complete healing of the oral tissues is ensured. Heat activated acrylic resin or Co-Cr alloy is used as permanent denture base. Recently, titanium alloys are also used to reduce the weight of the prosthesis. Partially edentulous arch necessitates the fabrication of cast partial denture. Aramany has proposed following design principles for the fabrication of cast partial denture prosthesis;

Class I – Linear; Class II – Tripodal; Class III – Quadrilateral; Class IV – Linear; Class V – Tripodal; Class VI – Quadrilateral **(parr et al., 2005).**

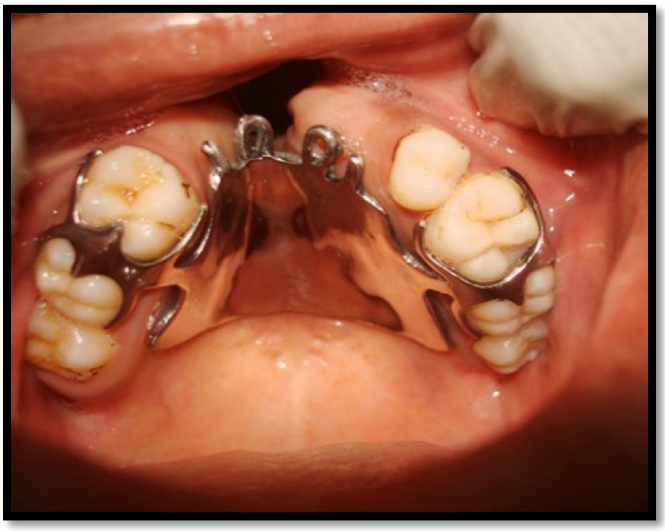


Figure10.C Definitive obturator (Arun et al., 2016)

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 **(Fig11A).** 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; Gay and King, 1980; Martin and King, 1984; Parr et al, 1989).**

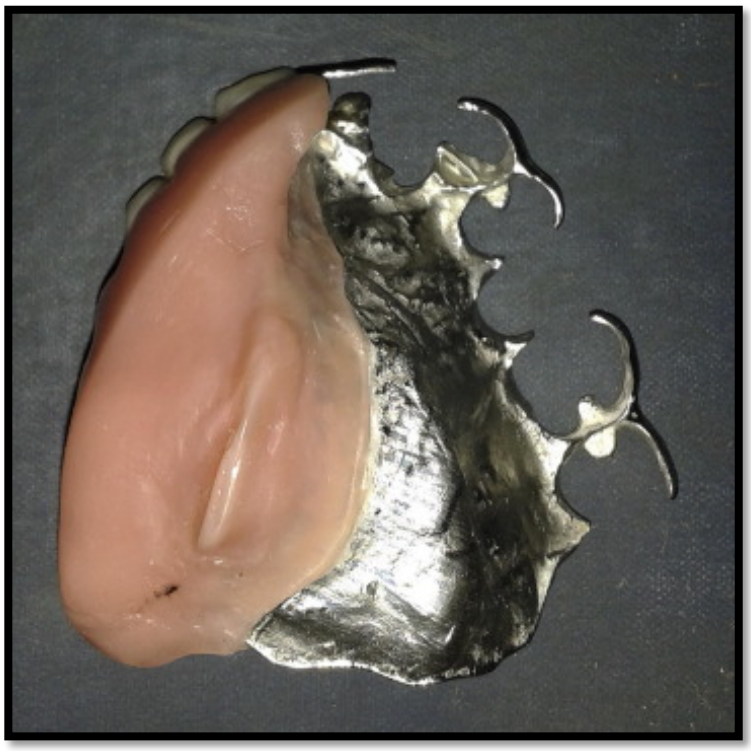


Figure 11.A: metal obturator (Alhajj et al., 2016)

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.11.B)(Khindria et al., 2009;Maller et al., 2010).**

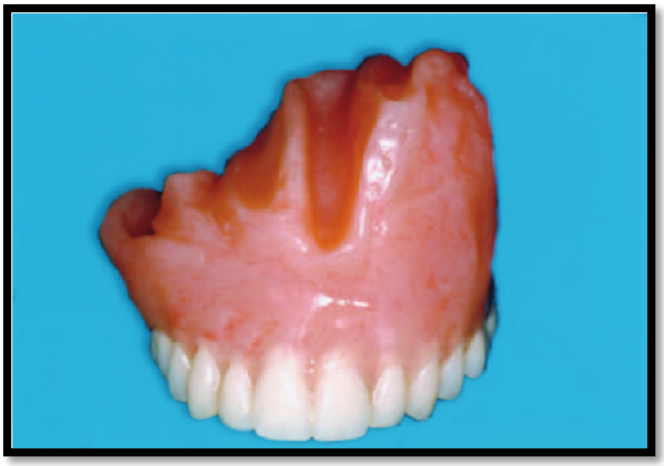


Figure11.B Resin obturator (cheng et al., 2004)

C. Silicone obturator

Silicone elastomer (1960 to 1970), also known as polydimethyl siloxane 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. 11.C). (Mohammad et al, 2010)**.

Figure 11.C: Silicone obturator adopted from (Venugopalan et al, 2013)

1.4.7.III Obturators based on the area of restoration

A. Palatal obturator :

A palatal obturator **(FIG 12.A)** is a prosthesis that totally occludes an opening such as an oronasal fistula (in the roof of the mouth). They are similar to dental retainers, but without the front wire. Palatal obturators are typically short-term prosthetics used to close defects of the hard/soft palate that may affect speech production or cause nasal regurgitation during feeding. Following surgery, there may remain a residual orinasal opening on the palate, alveolar ridge, or vestibule of the larynx. A palatal obturator may be used to compensate for hypernasality

and to aid in speech therapy targeting correction of compensatory articulation caused by the cleft palate. In simpler terms, a palatal obturator covers any fistulas (or "holes") in the roof of the mouth that lead to the nasal cavity, providing the wearer with a plastic/acrylic, removable roof of the mouth, which aids in speech, eating, and proper air flow **(Borzabadi-Farahani et al., 2012).**

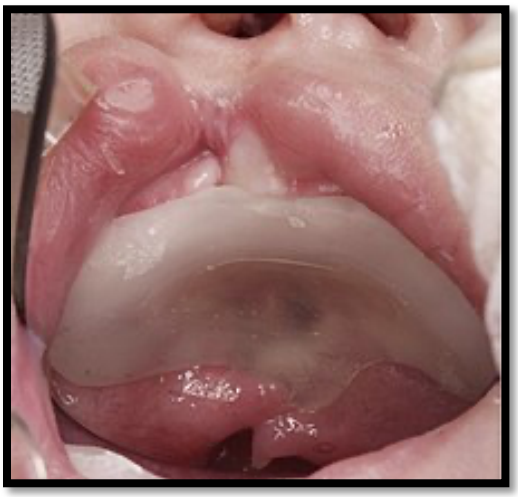


FIG 12.A palatal obturator (Borzabadi-Farahani et al., 2012)

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 defect to 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).**

B. Meatal obturator

Meatal obturators used to close the residual palate and pharynx during speech and deglutition are a prosthetic solution for velopharyngeal insufficiency. The prosthesis consists of a partial or complete denture base and a pharyngeal extension that will physically modify the pharyngeal airway and provide a seal between the oropharynx and the nasopharynx during function**. (Taylor et al., 1983)(Coskun et al., 2006)**

Meatus obturator **(FIG12.B)** is indicated when entire soft palate has been lost in edentulous patients.

Disadvantages of meatal obturator are:

- Nasal air emission cannot be controlled because it is in an area where there is no muscle function.
- Nasal resonance will be altered.

(Nallaswamy, 2017)

FIG12.B Meatal obturator (Anulekha et al., 2018)

1.4.8. Basic principles of obturator design

A. General principles

The general principles are:

- Major connectors should be rigid,
- Occlusal rests should direct occlusal forces along the bony axis of the teeth
- Guide planes should be designed to facilitate stability and bracing, - 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.
- Maximum support should be gained from the residual soft tissues.
- 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 surveyor 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 or rotational 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

In 1978the late Dr. Mohammed Aramany presented the first published system of classification of postsurgical maxillary defects.

He divided all defects into six categories based on the relationship of the defect to the remaining teeth and the frequency of occurrence of the defect in a relatively small patient population that he observed over a 6-year period at the Regional Center for Maxillofacial Re- habilitation in the Pittsburg Eye and Ear Hospital.

Dr. Aramany recognized that, in addition to being a communication tool, a classification that grouped particu- lar combinations of teeth and surgical defects had rele- vance to the eventual design of a maxillary obturator pros- thesis framework. The classification could be used to develop a series of basic obturator designs (templates) that have proven clinically successful and scientifically accept- able in particular situations **(Aramany, 1978)**.

These claases design are:

Class I design :

The class I category representsthe classicmaxillary re- section defect where the hard palate, alveolar, ridge, and dentition areremovedto the midline(**Fig.13.A).**

This unilateral defect is the one most commonly seenin the maxillofacial reha- bilitative practice. Aramany made several recommenda- tions regarding the framework design for this class,pro- posinga linear design if the remaining anterior teeth were not to be used for support or retention and a tripodal design if the anterior teeth were used **(Aramany, 1978)**.

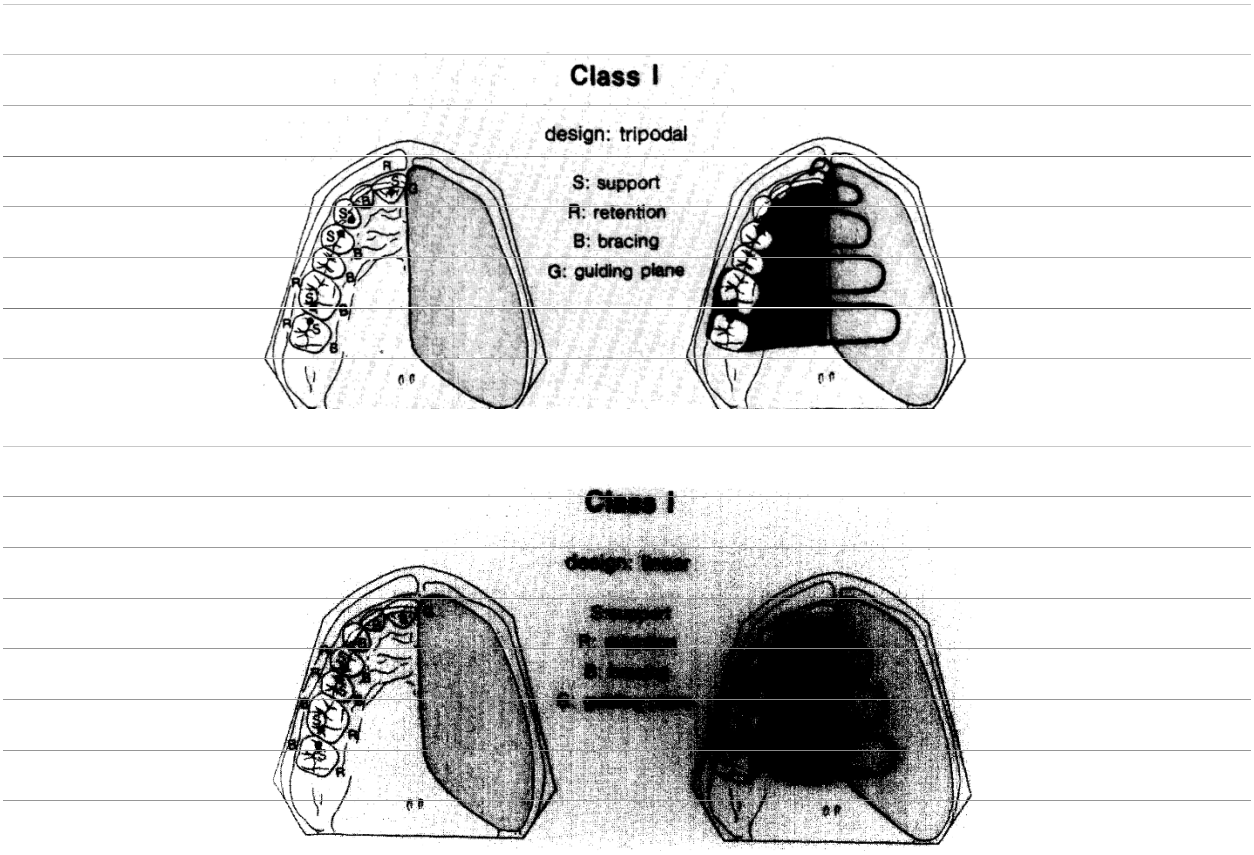


Figure13.A. Aramany class I linear obturator design is used for class I defect when there are no anterior teeth present or when one does not desire to use anterior teeth and remaining posterior teeth are in a relatively straight line. Many design considerations are similar to Aramany class IV obturator design. (Parr, 2005)

CLASS II

ClassII **(Fig.13.B)** includes arches in which the premaxilla and the premaxillary dentition on the contralateral side is main- tained. A single,unilateral defect is located posterior to the remaining teeth. This arch is similar to a Kennedy classII in that a bilateral, tripodal design can always be used.Pre- surgical consultation with the surgeonis an important as- pect of care. Surgeons should be informed of the improved prosthetic prognosis when a class I situation can be converted to a classII situation by carefully planned sur- gery, assuming that tumor removal is not compromised **(Aramany, 1978)**.

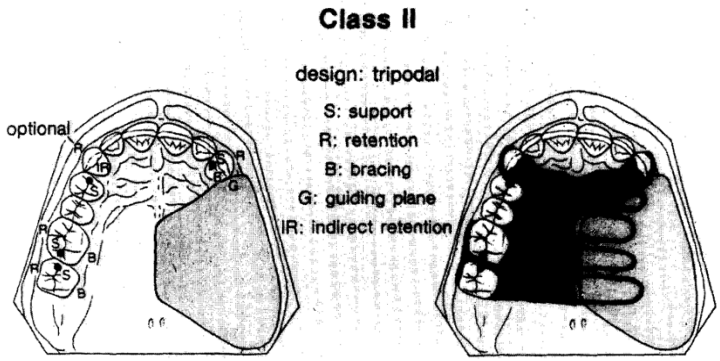


Figure.13.B Armany class II(Parr, 2005)

CLASS III

Class III **(Fig.13.C)** involves a midline defect of the hard palate and may include a variable portion of the soft palate as well. The dentition is usually preserved,

making this obturator prosthesis design simple and effective. The classification and design closely resemble the Kennedy class III RPD design **(Aramany, 1978)**.

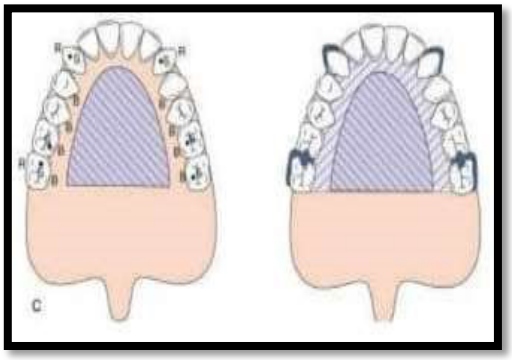


Figure 13.C: class III defect and design (quadrilateral) adopted from (Rangarajin and Padmanabhan, 2017)

CLASS IV

Class IV**(Fig.13.D)** situations involve the surgical removal of the entire premaxillae, leaving a bilateral defect anteriorly and a lateral defect posteriorly. There are often a few remain- ing posterior teeth located in a relatively straight line, cre- ating a unilateral linear design problem where leverage cannot be used to an effective degree **(Aramany, 1978)**.

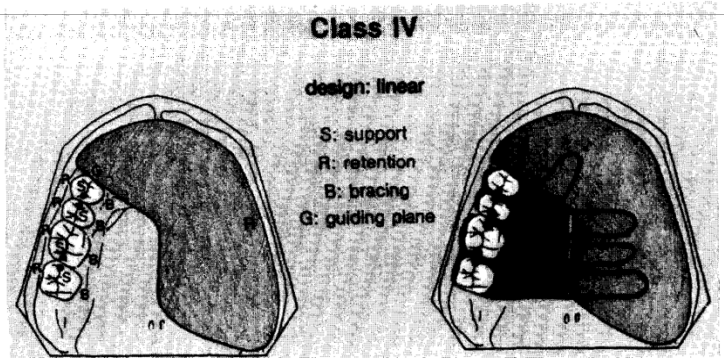


Figure13.D 5. Aramany class IV obturator(Parr, 2005)

CLASS V

This situation involves a bilateral posterior surgical de- fect located posterior to the remaining teeth. Many or all of the teeth are present anterior to the defect. Labial sta- bilization and the use of splinting, especially of the termi- nal abutments, is desirable **(Fig.13.E) (Aramany, 1978)**.

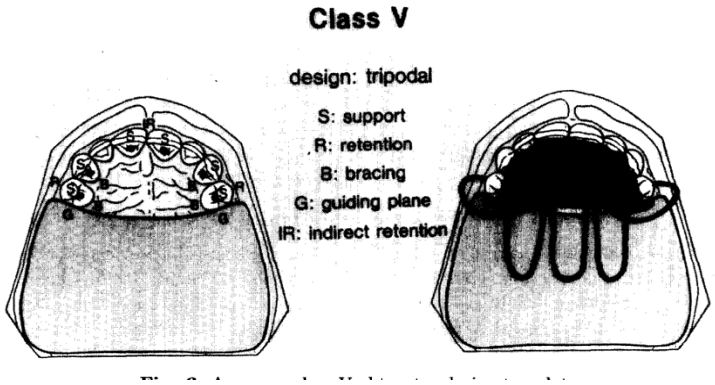


Figure.13.E. Aramany class V obturator design template. (Parr, 2005)

CLASS VI

The class VI **(Fig.13.F)** defect is a rare surgical creation. Most of- ten it results from a congenital anomaly or trauma such as an automobile accident or a self-inflicted wound that removes the entire premaxillae (and may include a portion of one or both of the maxillae), leaving a single bilateral defect located anterior to the remaining teeth. Surgical de- fects of this nature are usually small. Nonsurgical defects are usually large and difficult to manage **(Aramany, 1978)**.

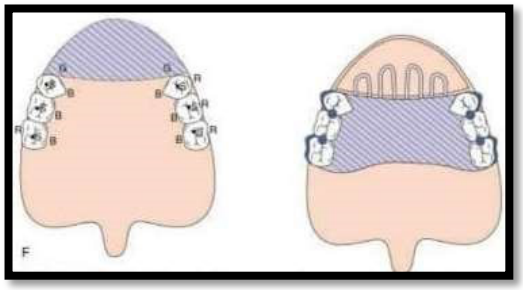


Figure13.F class IV defect and design adopted from (Rangarajin and Padmanabhan, 2017)

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 prosthodontic 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 prevent dislodging 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 **(Da Breo, 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 **(Nallaswamy, 2017).**

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

• High edge strength.

• Elongation.

• High tear strength.

• Softness and compatible to tissue.

• Translucent.

Ideal processing characteristics required in a maxillofacial prosthetic material:

• Should be chemically inert after processing.

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

• Long working time.

• No color change after processing.

• Reusable moulds.

• Retain intrinsic and extrinsic coloration during use.

Ideal biologic properties required in a maxillofacial prosthetic material:

• Non-allergenic.

• Stable with disinfectants.

• Color stability.

• Inert to solvents and skin adhesives.

• Resistant to growth of microorganisms **(Nallaswamy, 2017).**

1.5.1. Classification of maxillofacial materials

Beumer classified materials used for fabricating maxillofacial prosthesis as under:

1. Acrylic resins.
2. Acrylic copolymers.
3. Polyvinyl chloride 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:

- Acrylic powder: Polymethyl methacrylate -

Liquid: Methylmethacrylate.

• Heat polymerized is preferred when compared to auto polymerized because -

No residual monomer.

- Increased color stability.
- Free of tertiary amine activator.

- Color stability when exposed to UV radiation.

Advantages: • Durable • Color stable • Cosmetic • Can be relined/repaired.

Disadvantages: • Rigidity • Duplication of prosthesis is not possible as the mold is destroyed during processing. • There is increase in weight about 0.5% (after about 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 Castleberrytst reported. Chlorinated polyethylene, a material similar to polyvinylchloride in which coloration can be done using oil soluble dyes **(Khindria et al., 2009).**

5. Polyurethane 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 restore defects 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 into four types:

- Implant grade: They are placed within the tissues (breast implants). They must meet or exceed FDA requirements.
- Medical grade: They are approved for external use only. It is the most commonly used variety for fabricating maxillofacial prosthesis.
- Clean grade: Industrial use.
- 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).**

7. New Materials

I. Silicone block copolymers:

Silicone block copolymers are new materials under development to improve some of the weaknesses of silicone elastomers, such as low tear strength, low – percent elongation, and the potential to support bacterial or fungal growth **(Polyzois et al., 1991).**

It has been found that silicone block copolymers are more tear-resistant than are conventional cross – linked silicone polymers. This is achieved by a surface modification consisting of the incorporation of block copolymers containing a PDMS block and a poly [2-(dimethylamino) ethyl methacrylate] (PDMAEMA) block in a PDMS matrix **(Tsai, 1992).**

II. Polyphosphazenes

These were developed mainly as a resilient denture lining materials.

- Major advantage is that freedom of movements of the denture toward the tissue is similar to periodontal membrane around natural tooth.
- The material is expensive.

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

1.6. Management of maxillary defect by alternative methods

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 implants are routinely used in many areas in clinical practice.

Osseointegrated 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. 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 temporalis muscle flap **(Fig.14)** 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 infratemporal 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 natural intraoral lining than the one provided by skin flaps **(Andrades et al., 2011)**.

Figure 14 Temporalis musculofascial rotational flap. Adopted from (Andrades et al., 2011)

III. Osteocutaneous free-flap reconstruction

Intermediate-size defects with better survival rates require complete palatal-alveolar-maxillary restoration to maintain the patient's quality of life, and osteocutaneous free flaps **(Fig.15)** 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 osseointegrated implants, which are usually required for the fixation of dental prostheses **(Andrades et al., 2011).**

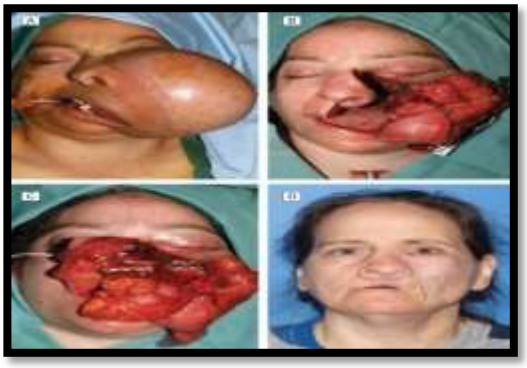


Figure15 Photographs of a woman with a massive maxillary ameloblastoma. Fibula osteocutaneous free flap was used to reconstruct bilateral maxillectomy defect. Adopted from (Andrades et al., 2011)

Chapter tow
CONCLUSION

CONCLUSION

Maxillofacial prosthesis replaces large amount of hard and soft tissues of face. It supports the remaining soft tissues and strangle it is retained by them. Continuous change due to contraction of scar tissue, resorption of bone is taking place, and therefore the prosthesis needs to be altered every now and then. Prosthesis once made, the patient must be induced to wear it, and for this his co-operation is essential. Prosthesis should restore mastication, appearance and speech as best as it can and rehabilitate these badly mutilated patients.

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