

## Retention in maxillofacial prostheses: The ultimate challenge.

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### Abstract

The defects in facial regions caused by accident, trauma, tumour or congenital defects are treated with maxillofacial prostheses. Apart from esthetics, the most common problem encountered with these prostheses is the retention of prostheses. Increase in retention provides easy use and psychological acceptance by the patient thereby up the long prognosis of the prosthesis. In this review article, the methods used for the retention of prostheses from past to present along with the benefits of adhesives and implants, implementation of 3D technology and rapid prototyping were critically appraised.

**Keywords:** Maxillofacial prosthesis, adhesives, retention, implants, rapid prototyping, 3D technology.

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### Introduction

Face forms the physical basis for personal recognition. The father of Indian surgery Sushruta Samhitha said hundreds of years ago that the love of face comes next to the love of life and so the mutilated cry for help. Hence, ours is appearance conscious society. Any defect whether acquired or congenital defects may affect patients' speech, mastication, quality of life, psychology, and social behaviour.<sup>[1]</sup> The primary aim in rehabilitating the maxillofacial defect patients are to restore the function of mastication, deglutition, speech, and to achieve normal orofacial appearance<sup>[2]</sup>. Reconstruction of facial defects may be done either surgically or prosthetically or combination of both which depends on the positioning, size, etiology, severity, age and therefore the expectation of the patient. According to glossary of prosthodontic terms (GPT) maxillofacial prosthetics is defined as the branch of prosthodontics concerned with the restoration and/or replacement of the stomatognathic (jaws) and craniofacial

(facial) structures with prostheses that may or may not be removed on a regular or elective basis".<sup>[1]</sup> Historically maxillofacial prosthesis was defined as the restoration of hard and soft tissues that are lost or missing due to congenital anomalies or acquired defects inside the stomatognathic system and surrounding maxillofacial structures. More recently, the term that is closely associated with intraoral and adjacent structures.<sup>[3]</sup> Historically, the first facial prosthesis as per official records was by French surgeon Ambroise Pare. Developments in facial dentures were accelerated throughout World War I. Until the 1930s, the most widely used vulcanite was replaced with plastic, methyl methacrylate, glass, and silica.<sup>[4]</sup> With the arrival of silicone polymer for the facial prostheses in 1946, the success of medical specialty has redoubled each in terms of aesthetics and performance. Large facial defects are difficult to restore prosthetically due to lack of anatomic undercuts, limited means of retention, mobility of soft tissues, and weight of prosthesis.<sup>[5]</sup> Retention in

maxillofacial prosthodontics has been always very challenging. Increased retention improves comfort as well as the confidence in the patient.<sup>[6]</sup> Methods of auxiliary retention include eyeglasses, magnets, adhesives, and implants and combinations of the above. Advances in techniques used for retention of maxillofacial prosthesis and the materials used have been remarkable in the past several years.<sup>[6]</sup> Over the last 20 years, Osseo integrated implants have been used to improve the hold and retention of facial prosthesis. Implants have been employed for retention in the intra or extraoral craniofacial regions <sup>[7,8]</sup>.

### Classification:

Table no.1- Classification of maxillofacial prosthesis

#### Intra oral prosthesis

**Obturator:** A prosthesis that retains and closes a defect within the oral cavity or other body defect. For both congenital and acquired defects obturators are indicated. For congenital defects simple plate type prosthesis to aid in feeding, or palatal lift prosthesis can be fabricated. For acquired defects surgical, interim or definitive obturators are indicated. There are different type of intraoral prosthesis include:

1. Obturators for defects involving hard palate
  - Surgical obturator: A surgical obturator is one that is fabricated prior to resection of the maxilla.
  - Definitive obturator: After the interim obturator has been worn for 6-12 weeks the definitive obturator is fabricated.
  - Obturators for defects involving soft palate: Speech aid prosthesis/Pharyngeal obturator/Speech bulb prosthesis: Palatopharyngeal insufficiency could be a condition wherever there's lack of effective

closure between the soft palate and one or additional pharyngeal walls throughout swallowing or speech sounds. Speech bulb prosthesis is an best choice for these defects.

- Meatus obturator: It was first described by Schalit in 1946. It only acts as a static obturation and is independent on surrounding muscle activity which actually separates physiologically the nasal and oral structures. In cleft palate rehabilitation, obturator only provides in partial improvement of speech.

- Palatal lift prosthesis: The palatal lift prosthesis (PLP) is used to improve soft palate dysfunction. For dentulous patients the palatopharyngeal section physically raises the soft palate while the palatal section of the PLP is securely retained by the teeth.

Therefore, in the edentulous patient it must include a movable palatopharyngeal section.

2. Prostheses for mandibular continuity defects

- Mandibular resection prosthesis
- Guide flange prosthesis

3. Prostheses for total/partial glossectomy

- Tongue prosthesis
- Palatal augmentation prosthesis

4. Splints and Stents: For stabilizing the bite.

5. TMJ appliance: It help in relieving TMJ trismus and also increase mouth opening. These appliances are basically named as "Jaw exercisers."

6. Radiation stents: Basically anti-radiation stents that protect areas other than the operated site from harmful gamma radiation <sup>[9]</sup>.

**Modes of Retention:** Prostheses that replace soft tissues are known as epithesis. There are four ways to retain such a prosthesis: adhesion, anatomical, mechanical or surgical.<sup>[10]</sup>

## 1. ANATOMIC METHODS:

Anatomic undercut areas act as a mode of retention for maxillofacial prosthesis which can always be created by planning before and after surgery Anatomical retention (Figure 1) is obtained by already existing anatomical structures just as in the case of undercut area in ocular defects.<sup>[11]</sup> Anatomic retention can be either intraoral or extraoral.

**A. Intraoral Retention:** it is obtained by the use of hard and soft tissues. It can be from mucosal, bony tissues and teeth. Anatomic undercuts are found in the palatal area, cheek, retromolar area, remaining teeth, alveolar ridge, septum and anterior nasal aperture <sup>[12]</sup>. A much greater retention can be achieved by large alveolar ridge and high arched palate rather than flat ridges and palate. Intraoral retentive aids are usually very comfortable for the patient for easy removal. For the dentist it is always better to examine of the surgical site in order to check for recurrence of tumour.

**B. Extraoral Retention:** It can be obtained from hard and soft tissues of maxillofacial and neck region. It is more difficult in insertion and removal of prosthesis in case of deep undercuts create. Soft tissues create problem due to their mobility and lesser resistance to displacement when a force is applied.<sup>[12]</sup> Soft tissue undercuts are usually in the maxillary sinus, nasal cavity and orbital regions. The advantages of these prosthesis that these are cost effective, aesthetic and easy to fabricate.

## 2. CHEMICAL RETENTION:

Chemical retention is achieved by adhesives. According to GPT-9, maxillofacial prosthetic adhesive is “a material used to adhere external prosthesis to the skin and associated structures around the periphery of an external

anatomic defect.” Ideal properties of adhesives for maxillofacial prostheses: <sup>[13]</sup>

1. The should be biocompatible, non toxic and non irritant.
2. The material should be odourless and wetrepellent.
3. The dried adhesive should be porous and absorbent to allow <sup>[14]</sup>.Adhesives are the most popular retentive aid in maxillofacial prosthesis retention. The choice of an adhesive is based on certain criteria.
4. The patient should find it easy to apply.
5. The material should dry quickly.
6. The adhesive should hold the prosthesis in place for atleast 12hours daily.
7. The adhesive must be easy to remove without injuring the skin and prosthesis

They include:

1. Bond strength of the adhesive to the prosthetic material and recipient tissues.
2. Biocompatibility
3. Prosthesis design.
4. Patient's skin quality & type.
5. Composition and viscosity.
6. Handling, storage and shelf life. <sup>[12]</sup>

These are available as acrylic or silicone based adhesives, latex, spirit gum or water based adhesives <sup>[15,16]</sup>

**A. Acrylic resin adhesives:** Acrylic resin adhesives consists of acrylic resin distributed in an exceedingly water solvent that once evaporates it leave a rubber like substance . Dispersions of artificial resins and rubbers have recently been termed latex adhesives .

The addition of surfactants and therefore the attainment of the right particle leave controlled penetration and wetting of those adhesives. In order for these adhesives to be successful, one surface must be permeable to water to dry the dispersion and develop the bond.

**B. Silicone adhesive:** Silicone adhesives are a form of room temperature vulcanizing (RTV) silicones usually dissolved in a solvent. These adhesives develop good resistance to moisture and weathering with low water sorption. They can withstand the effects of sunlight, ozone, contact with many oils and chemicals and bio-deterioration. A disadvantage of this material is a low adhesive strength.

**C. Pressure sensitive tapes (Figure 2):** It is used in the retention of facial prostheses which are applied by only finger pressure in the absence of warmth or solvents. These tapes consists of a backing strip composed of cloth, paper, film, foil or a laminate strip coated with a pressure – sensitive adhesive. The tape has adhesive on both surfaces. The bond of the Bi face tape to skin is weaker than the acrylic resin adhesive. The bi-Face tape should be used on materials with poor flexibility and for patients whose defects demonstrate little or no movement

**D. Rubber based liquid adhesive:**

Rubber forms in nature as latex, which is found by tapping the bark of rubber trees. The latex thus obtained is instantly soluble in organic solvent, like benzene or petroleum spirits, to create a natural rubber adhesive. This mixture quickly gels due to atmospheric oxidation reaction. Vulcanization with sulphur converts the sticky rubber into hardened state. Dissolving the reclaimed rubber in naphtha forms a rubber cement with excellent adhesive qualities. These natural rubber adhesives are known for their dry tack

or their ability to adhere two fresh non-sticky surfaces together. This property of dry tack makes natural rubber adhesives helpful for contact adhesives or pressure sensitive adhesives.eg: Bard Appliance Adhesive.

**E. Combination of adhesives:** The previously described adhesives can be used alone or together. In most clinical practices, only one adhesive system is used to simplify the instructions and procedures for the patient. However, the combination of one or more adhesives can serve to solve retention problems in various situations.

Some of the adhesives available are:<sup>[17]</sup>

- Silastic MDX4-4210 medical grade elastomer
- Silastic adhesive silicone type A
- Secure2 Medical Adhesive
- Epithane-3 Adhesive ES
- Skin-Prep protective dressing (Figure 3)
- Uni-Solve adhesive remover
- Pros-Aide adhesive (Figure 4)
- Epithane-3 adhesive
- Telesis Silicone Adhesive (Figure 5)
- 3M bifaceis
- Hollister Medical Adhesive

**Advantages:** Adhesives are cost effective and easy to manipulate and apply. Maxillofacial defect patients who are not willing for implant surgical procedures consider adhesives as a retentive aid<sup>[14]</sup>

**Disadvantages:** Some adhesives require solvents to clean after removal of prosthesis. It provides an unacceptable retention. Its degradation to the prosthetic material also

adds to its disadvantages apart from perspiration, irritation and movement that compromises the bond. In some patients, it may cause allergic reactions.<sup>[18]</sup> The rationale for use of adhesives in combination is based on overcoming the limitation of one adhesive system by combining it with another adhesive system. The end result is a good adhesive bond between the prosthesis and the skin.

### 3. MECHANICAL RETENTION:

The oldest method of retention for facial prostheses is mechanical retention, reported in the field of facial prosthesis. Ambrose Pare gave the idea of strings for the retention artificial nose to the face. Pare also reported that an artificial ear and an orbital prosthesis can be retained by a metal or leather band worn around the head. Mechanical Retention Mechanical anchorage includes: <sup>[18]</sup>

1. Eye glasses and frames.
2. Magnets.
3. Cast clasps.
4. Acrylic buttons.
5. Retentive clips.
6. Elastic and non elastic strap.
7. Precision attachments.

▪ 1. **Eye-glass:** Is a possible means of retaining a nasal, ear, eye prosthesis by utilizing newly designed eyeglass frames for the patients. The opaque eyeglass frame should be used to prevent retention marks from becoming visible (Figure 6,7 and 8).

2. **Magnets:** Presented a technique for the implantation of magnets in the jaw to enhance retention of the prosthesis. They are applicable in maxillectomy patients as well as in microstomia patients. E.g. neodymium

iron boron (NdFe-B).<sup>[19,20]</sup> They are considered as the best source for obtaining retention stabilization and maintenance for the maxillofacial prosthesis (Figure 9).

3. **Cast clasps:** The uses of a cast metal clasp which entering an undercut is the commonest method for the retention of an intraoral prosthesis. The proper clasp design and fabrication will provide splinting, stability, bilateral bracing, and reciprocation, as well as retention (Figure 10). For the success of the obturator prosthesis, retainers are the most important component. It helps in load distribution and in retention of prosthesis<sup>[20]</sup>.

4. **Acrylic buttons:** They are acrylic substructure is a part of acrylic buttons retained facial prosthesis, it fits into the prosthesis, and the substructure generally has one or more mushroom-shaped acrylic projection(buttons). The final prosthesis will snap over the mushroom buttons for retention (Figure 11).

5. **Retentive clips** <sup>[6]</sup>: These are metallic or plastic clips that snap over the bar used as a superstructure connected to the implants. In terms of breakaway retentive force, retentive clips shows more retention than magnets.

6. **Elastic and Non-Elastic Straps:** They are used with extraoral prosthesis. Head bands are in use of auricular prosthesis. Non-elastic straps are in use with buckles for adjustability. It requires a head cap to gain anchorage from orthodontic headgear assemblies like head cap and adjustable strap extension are very useful for extensive maxillofacial prosthesis (Figure 12).<sup>[16]</sup>

7. **Precision Attachment:** <sup>[21]</sup> Bar clips, telescopic crown, extra-coronal ball attachment are most commonly used precision attachment (Figure 13).

#### 4. IMPLANTS:

Endosseous implants may be used in case of diminished retention, stability and support and also in edentulous and partially edentulous patients and can be used for congenital, developmental, traumatic defect [22].

- Anatomical: Anatomic undercuts may be utilized.
- Implants in maxillofacial prosthodontics
- Computed tomography (CT) scans or other radiographic evaluations of bone mass are important. CT scan records are analysed and used for the planning of implant. Implant planning software allows for the assessment of bone volume and density. [23]
- Asar et al. interpreted the classification of the bone regions in which the facial implants made by Jensen and his colleagues could be placed as follows.
- ALFA sites: In these sites amount of bone available is more ranging from 6mm or greater. Bone withstands greater loads. These can be used for the retention of complex facial prosthesis or dental prosthesis. The anterior aspect of maxillary, zygomatic arch, and zygoma are examples. [1,23]
- BETA sites: These are found in the periorbital but also in the temporal, zygomatic, and anterior nasal fossa locations. In 4-5 mm bone volumes, 4 mm craniofacial implants can be used. [1,23]
- DELTA sites: Include the buttress, pyriform, zygomatic arch, medial orbit, temporal and frontal bones, and zygomatico frontal process. The margin areas are 3 mm or less in bone mass. They require the use of craniofacial implants of 3 mm or less. [1,23].

#### *Implant retained auricular prosthesis*

Position of implants: Implants can also be placed in the mastoid area 15mm apart keeping a distance of 20 mm from auditory canal opening. Usually, 2 implants are placed. As retentive mechanism bar and clip, ball clips and magnetic retentive cap systems [24] are used.

#### *Implant retained eye prosthesis*

Mode of retention: Adhesive, Straps, Spectacle frames and Implants. Anatomic undercuts must be utilized in conjunction with flexible conformer in the defective space [26]. Conformer will fit into the socket and holds the prosthesis, maintaining the size of socket. Prevents scar tissue contractures from distorting the socket bed and also maintains competence of the eyelids and residual muscle movement. Position of implants: Implant can also be placed in outer canthus or inner canthus and superior orbital rim (Figure 14 and 15). Additional implant or two was often placed in the inferior orbital rim or zygoma [27]. The implant should not be angled facially [28]

#### *Implant retained nasal prosthesis*

Mode of retention: Adhesive, straps, spectacle frames and implants [29]

#### *Implants in irradiated patients:*

Individuals with diabetes mellitus, osteoporosis and especially irradiated patients are relatively contraindicated for implant placement. In order to reduce risk reduction by trauma on the irradiated tissue. It is advised to wait for a period of 6 months to 1.5 year after radiation therapy [31]. According to literature hyperbaric oxygen therapy can improve the implant success rate by 38% [32].

Survival rate and complications of extra oral implant placement From several studies conducted it is found that the implant survival rate is high for auricular prosthesis followed by nasal and orbital areas, the most common complication seen is periimplantitis which is related to hygiene maintenance around the implant site.<sup>[27,8]</sup>

### Recent advances in maxillofacial prosthetics :

1. **Rapid prototyping:** In 2003, Wolfaardt et al. <sup>[30]</sup> suggested rapid prototyping as an adjunctive tool in digitally designing maxillofacial prosthesis in head and neck construction <sup>[33]</sup> .

- In nasal prosthesis: In case of rhinectomy nasal defects, fabrication of nasal prosthesis should fulfil cosmetic as well as functional purpose. Intra anatomy airway replication design is used, this helps the prosthesis and its sub-dermal prosthesis structure to re-direct the air flow in a normal pattern. So the advantages:

- Reducing chances of displacement of prosthesis in movements which may occur as in coughing or sneezing
- Maintain the cosmetic prosthesis
- Maintains voice resonance
- Intra anatomy designs maintain the sub-dermal section of the prosthesis.

- In calvarian reconstruction: Earlier used materials for reconstruction are commonly used for cranioplasty reconstruction is tantalum, titanium, stainless steel (austenite), vitallium. There are a number of disadvantages associated with metal cranial implants like their high thermal conductivity which may precipitate headache and other neurological symptoms, infection, less biocompatible and difficult to interpret radiologically. Heat polymerized polymethyl – methacrylate are widely used in cranioplasty with no

complications like infection. Only drawback with this is the radiolucency and it becomes difficult to locate it radiographically in case of fracture. A newer implantable material, high-density porous polyethylene (HDPE) which is available in various shapes and forms is found to be an excellent alternative to existing methods of calvarial reconstruction. These HDPE hemispheres are used to recontour the natural shape of the skull <sup>[9]</sup> . The Infinite Technologies Orthotics and Prosthetic 3D scanner is one of the latest innovations in the field of rapid prototyping, it is used currently for the fabrication of cranial helmets, smaller paediatric devices such as a prosthetic finger, foot orthotics, and small componentry used to put together the helmet. Every effort should be made to prevent scarring or contracture of scar that may impact on person's self-perception and well-being. fabricating burn mask can reduce these scars.

2. **Laser scanning, computer-aided design/computer-aided manufacturing:**

It is a faster technique to manufacture provisional prosthesis can be digitally designed and fabricated

- Restores the esthetics of patients
- Adds comfort to the patients
- Affordable cost and simple technique

3. **Three-dimensional printing along with digital scan In ocular prosthesis:**

The recent advancement in digital technique is like 3dMD face™ system (3dMD, Atlanta, GA). In this technique, without contacting the impression surface ,impression is taken in a 3-d pattern, so this is less uncomfortable for the patient and less distortion to the soft tissue as occurs in conventional impression material <sup>[33]</sup> .

- It creates more life-like facial prosthetics that gives more accurate fit,

- Used In burn patients and in acid attack patients.
- Affordable cost and simple technique

Much research has to be carried out in the field of tissue engineering for the regeneration of new tissue, which may have impact in orofacial reconstruction in the future.

**Conclusion :** Maxillofacial defect creates a scar not only in physical appearance but also traumatizes the patient mentally. Fabricating a maxillofacial prosthesis alike to the original tissue is a complex process but with the resultant prosthesis the patient gains confidence to face the world. Retention of the prosthesis controls the comfort of the prosthesis. Various retentive measures of the period of time have evolved. To chose the right retentive aid the prosthodontist should be familiar to all the available options because he has the responsibility to plan the prosthetic rehabilitation for the patient. Optimum results may be difficult to achieve in all cases of maxillofacial defects but thorough evaluation of the situation and careful judgment and treatment planning can give acceptable quality of prosthesis improving the patient's quality of life. The journey from using metal bands to using adhesives to placing implants for retaining a maxillofacial prosthesis has been fascinating and satisfying to many, but, the aim of achieving the full potential still remains incomplete.

**Conflict of interest :** There is no conflict of interest.

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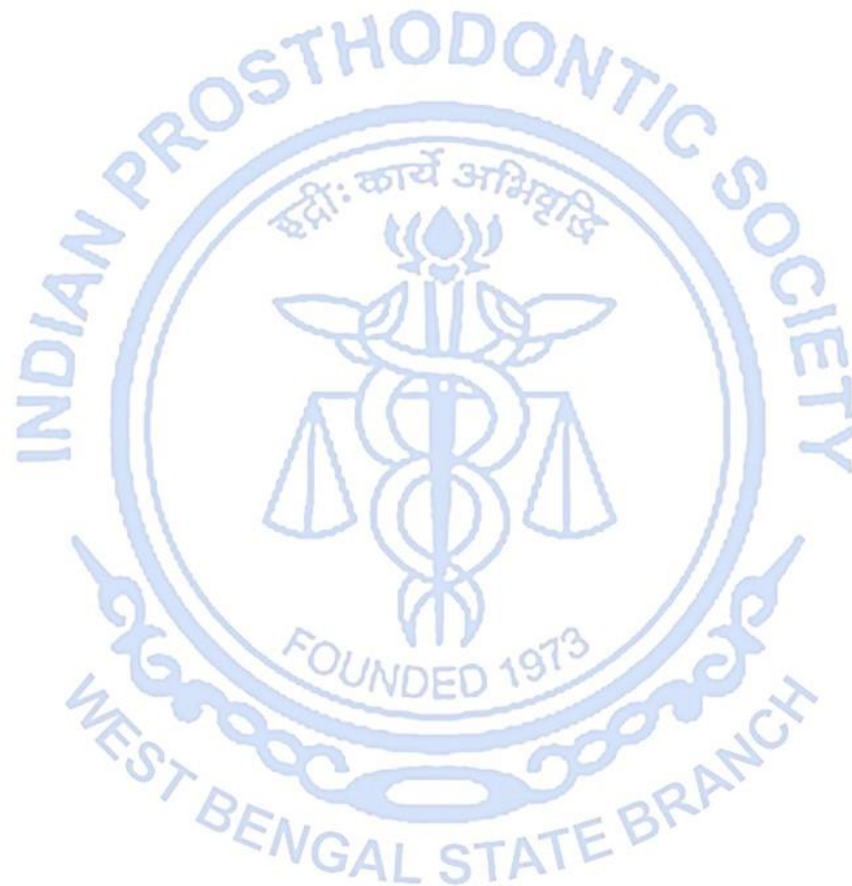
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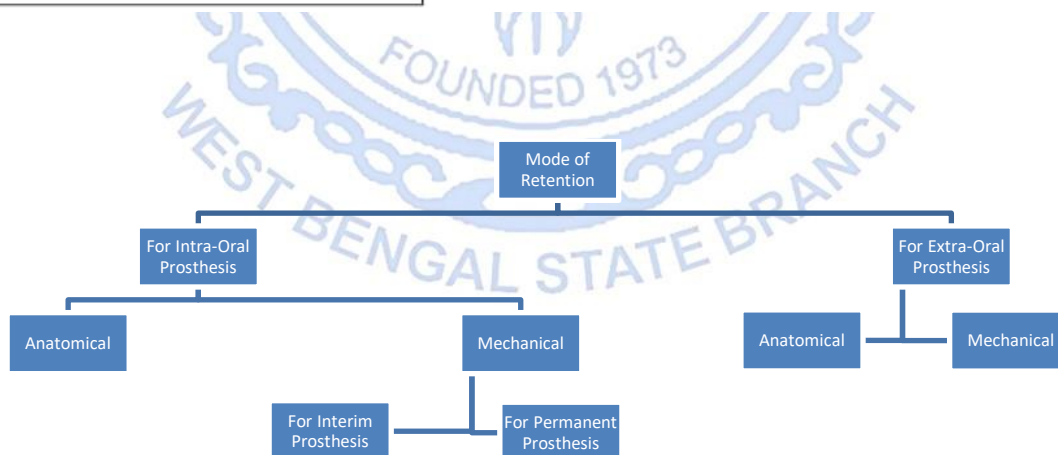
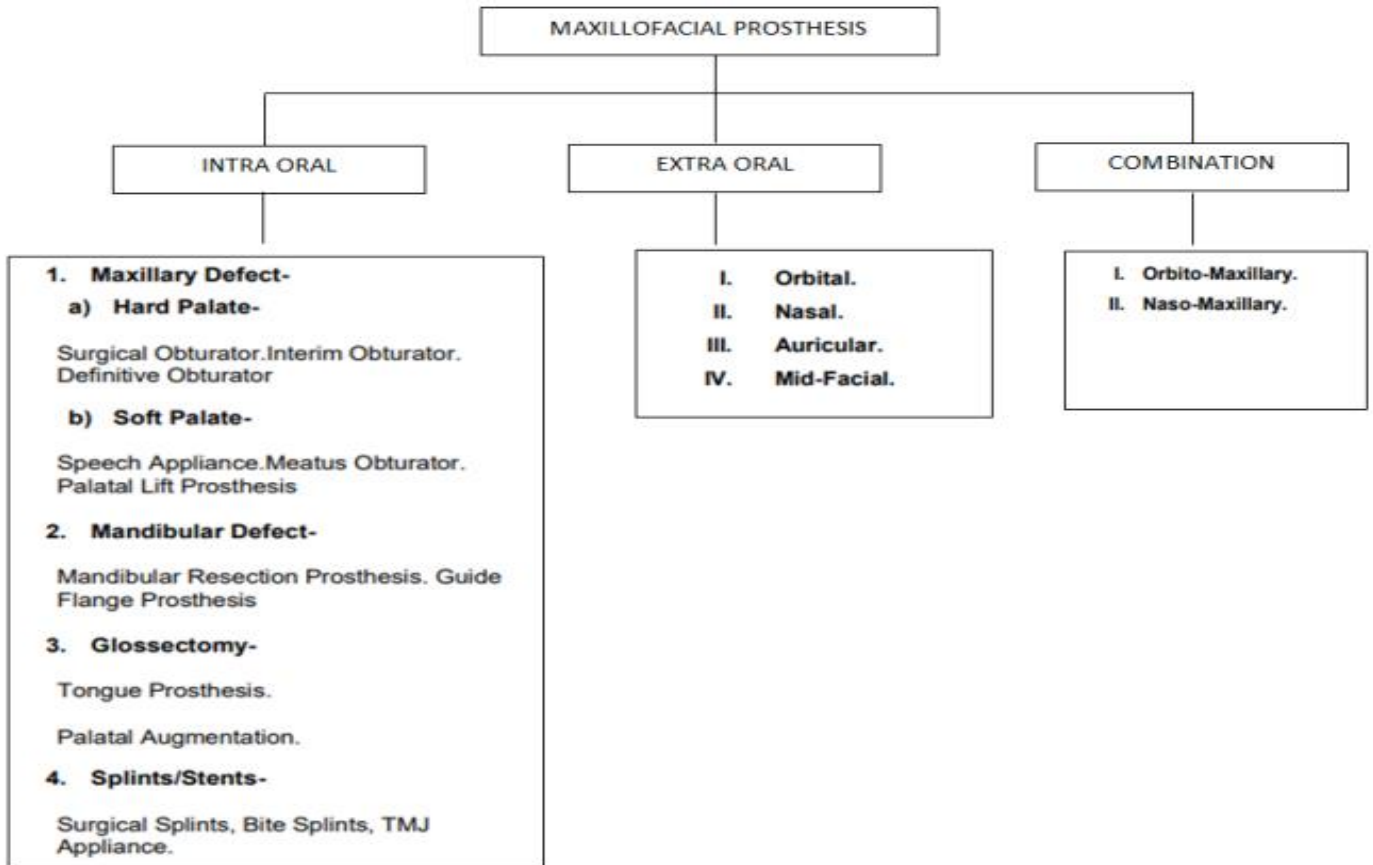
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**Tables:**

**Table No. 1:** Classification of maxillofacial prosthesis



**Table No. 2:** Dr. Harsh Mahajan and Dr. Sandeep Mahajan <sup>[35]</sup> broadly classified the retentive aids of maxillo-facial prosthesis into extra-oral prosthesis and intra-oral prosthesis

**FIGURES:**



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5



Figure 6

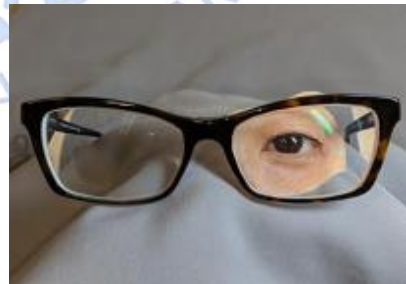


Figure 7



Figure 8



Figure 9



Figure 10



Figure 11



Figure 12



Figure 13



Figure 14



Figure 15

