



METHOD OF RETENTIVE FOR MAXILLOFACIAL PROSTHESIS : A REVIEW

¹Dr Shivani Kotewar , ²Dr Nazish Baig , ³Dr Vivek Jadhav , ⁴Dr Ruchi Kasat

¹MDS II student , ²professor and guide , ³professor and guide, ⁴professor and guide

¹muhs

ABSTRACT :

One of the most important factors that determines the success of a maxillofacial prosthesis is retention. Retention has always been a problem in prosthodontics. Increased retention improves comfort as well as the confidence in the patient while wearing a facial prosthesis at work and in social settings. 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. The present article tries to describe different types of retentive aids in maxillofacial prosthesis.

KEYWORDS :

Retention, maxillofacial prosthesis

INTRODUCTION :-

Retention as per The Glossary of Prosthodontic Terms-9 is defined as, “retention is that quality inherent in the dental prosthesis acting to resist the forces of dislodgement along the path of placement”.¹

The success of a prosthetic restoration of any part of the body depends on the availability of a method of attaching the artificial substitute securely to its proper place without discomfort and irritation to the tissues with which

it comes in contact. The materials used for rehabilitation have travelled a long way from wood to polymers and the retentive aids used from metal bands to implants.

Methods of Retention used for maxillofacial prostheses fall into four categories: ²

1. Anatomical, in which the retentive contours existing at the site of deformity are used to retain the prosthesis.
2. Chemical, in which adhesive materials are used to retain the prosthesis.
3. Mechanical.
4. Implant, in which implant fixtures anchored into the bone are used to retain the facial prosthesis.

1. ANATOMIC RETENTION:

Anatomic undercut areas can always be created by planning before and after surgery as a mode of retention for maxillofacial prosthesis. Anatomical retention (Fig 1) is obtained by already existing anatomical structures just as in the case of undercut area in ocular defects. ³ Anatomic retention can be either intraoral or extraoral.



Fig.1.Anatomic retention for prosthesis

A. Intraoral Retention:

Intraoral retention is achieved by the use of hard and soft tissues. It can be from teeth, mucosal and bony tissues. Anatomic undercuts are found

in the palatal area, cheek, retromolar area, remaining teeth, alveolar ridge, septum and anterior nasal aperture. ⁴ Large alveolar ridge and high arched palate provides greater retention than flat ridges and palate. Intraoral retentive aids are usually considered comfortable for the patient for easy removal and for the examination of the surgical site by the dentist in order to check for recurrence of tumour.

B. Extraoral Retention:

Extraoral retention can be achieved from hard and soft tissues of maxillofacial and neck region. Deep undercuts create difficulties in insertion and removal of prosthesis. Soft tissues create problem due to their mobility and lesser resistance to displacement when a force is applied. ⁴ Soft tissue undercuts are usually in the maxillary sinus, nasal cavity and orbital regions. The advantages of prosthesis used in these areas are that they are cost effective, aesthetic and easy to fabricate.

2. CHEMICAL:

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: ⁵

1. The adhesive must be biocompatible, non toxic and non irritating.
2. The material should be odourless and moisture repellent.
3. The dried adhesive should be porous and absorbent to allow passage of secretions.
4. The patient should find it easy to apply.
5. The material should dry quickly.
6. The bond should hold the prosthesis in place for atleast 12hours daily.
7. The adhesive must be easy to remove without injuring the skin and prosthesis.

8. The adhesive should be available in a travel sized package.

Adhesives are considered as the most popular retentive aid in maxillofacial prosthesis retention. The selection of an adhesive is based on certain criteria. They include:

1. Bond strength of the adhesive to the prosthetic material and recipient tissues.
2. Biocompatibility
3. Prosthesis design.
4. Type and quality of patient's skin.
5. Composition and viscosity.
6. Handling, storage and shelf life. ⁴

These are available as acrylic or silicone based adhesives, latex, spirit gum or water based adhesives. ^{4,6}

A. Acrylic resin adhesives:

Acrylic resin adhesives consists of acrylic resin dispersed in a water solvent which when evaporated leaves a rubber like substance. Dispersions of synthetic resins and rubbers have recently been termed latex adhesives. The addition of surfactants and the attainment of the proper particle allow for controlled penetration and wetting of these 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. Once the adhesive is applied, the solvent evaporates and a tacky adhesive results, which may then be contact bonded to another surface such as a skin. These adhesive 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:

Pressure sensitive tapes (Fig 2) used in the retention of facial prostheses are applied by finger pressure in the absence of heat or solvents. These tapes consist 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 can be used on materials with poor flexibility and for patients whose defects demonstrate little or no movement.

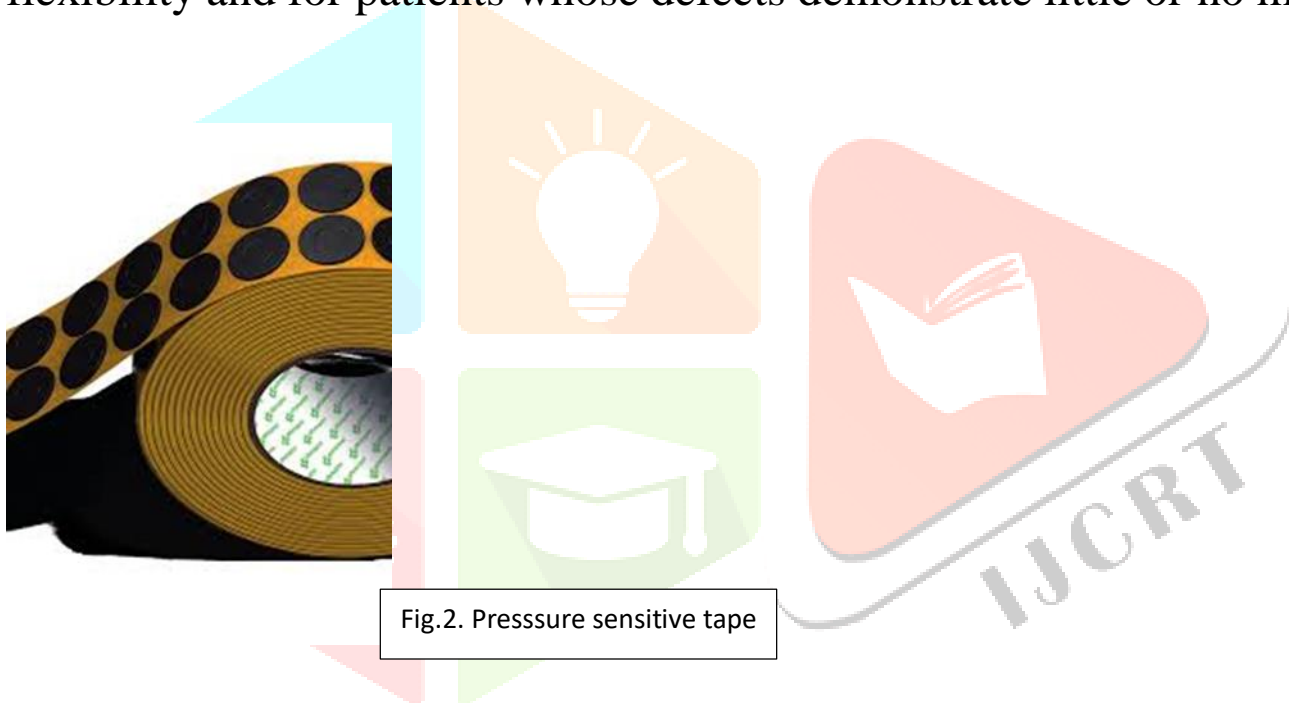


Fig.2. Pressure sensitive tape

D. Rubber based liquid adhesive:

Rubber occurs in nature as latex, which is obtained by tapping the bark of rubber trees. The latex thus obtained is readily soluble in organic solvent, such as benzene or petroleum spirits, to form a natural rubber adhesive. This mixture quickly gels because of atmospheric oxidation. Subsequent vulcanization with sulphur converts the sticky rubber into a 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 useful for contact adhesives or pressure sensitive adhesives.eg: Bard Appliance Adhesive.

E. Combination of adhesives:

The previously described adhesives can be used alone or in combination. 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: ⁷

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



Fig 3: Skin Prep Wipes



Fig 4: Pros-Aide Adhesive



Fig 5 : Silicone 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. ⁸

Disadvantages:

Certain adhesives require solvents to clean after removal of prosthesis. It provides an unreliable retention. Its degradation to the prosthetic material adds to its disadvantages apart from irritation, perspiration and movement that compromises the bond. In some patients, it may cause allergic reactions. ⁸

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:

Mechanical retention of facial prostheses is the oldest method of retention reported in the field of facial prosthesis. Ambrose Pare reported the retention of an artificial nose to the face by means of strings. Pare also reported the retention of an artificial ear and an orbital prosthesis by a metal or leather band worn around the head.

Mechanical Retention Mechanical anchorage includes:⁸

1. Eye glasses and frames.
2. Extension from denture.
3. Precision attachments.
4. Elastic and non-elastic straps.
5. Magnets.

1. Eyeglasses:

Eyeglasses can be used to retain nasal, auricular (Fig 31) and orbital (Fig 6,7) prostheses. It also helps in masking the borders of the prosthesis.⁹. In case of auricular prosthesis the bow of the frame of the glasses must be sufficiently rigid to retain the auricular prosthesis against the head. There also must be sufficient space in the crevice media to the helix to receive the curved portion of the bow.

Eyeglasses can be used effectively to retain nasal prostheses when other means are not available. The eyeglasses selected should have moderately thick frame. Thin frame tend to attract attention to the prosthesis.



Fig 6: Ear prosthesis supported by



Fig 7: Eye prosthesis supported by eyeglasses



Fig 8: Eye prosthesis supported by eyeglasses

It is advantageous, if the eyeglasses frame is made of acrylic resin, which will enable a chemical bond by using auto polymerizing resin between the glasses and some of the currently available types of facial materials. The eyeglass frame should be opaque in color rather than translucent to prevent retention marks from becoming visible.⁴ The attachment of a nasal prosthesis to eyeglasses frames as a permanent fixation should be avoided since removal of the glasses by necessity causes removal of the prosthesis, which can be very embarrassing.

2. Extension from Denture:

Most primitive type of retentive aids namely cast clasps, retentive clips and acrylic buttons are still being used as they are the most economical amongst the others. ⁸(Fig 9)

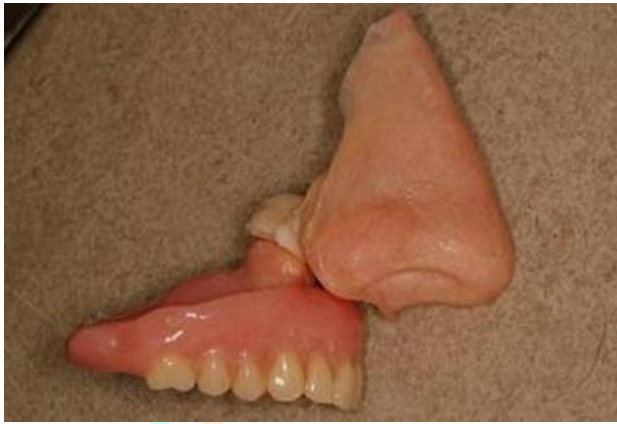


Fig 9: Extension from denture

a. Cast clasps:

The most common method for retaining an intraoral prosthesis uses a cast metal clasp which enters an undercut. The properly designed and fabricated clasp will provide stability, splinting, bilateral bracing, and reciprocation, as well as retention. ⁴(Fig 10)



Fig 10: Cast clasps

b. Retentive clips:

Retentive clips are metallic or plastic clips that snap over the bar used as a superstructure connected to the implants. Retentive clips have more retentive ability in terms of breakaway retentive force than magnets. However, retentive clips tend to wear at a faster rate than the magnets. Retentive clips have an advantage over magnets in that they are not subject to the effects to bodily fluids as magnets are.

Retentive clips are useful in retaining facial prostheses in patients with good dexterity and where retention is to be maximized in areas with little muscle force. An example of such a clinical situation would be for retention of an auricular prosthesis.

c. Acrylic buttons:

Acrylic buttons – retained facial prostheses usually have an acrylic substructure that fits into the defect and one or more mushroom – shaped acrylic projections (buttons) attached to the substructure. Metal buttons (Fig 11) are also widely used for retention. The final prosthesis is fabricated so that it will snap over the mushroom buttons for retention.



Fig 11: Metal buttons to retain prosthesis

3. Precision Attachments:

Bar clips are most commonly used precision attachment that connects the prostheses and implant and between different parts of prosthesis. Telescopic crowns and extracoronal ball attachments (Fig 12) are used to increase and improve retentive force in maxillofacial prosthesis cases.

4. Elastic and Non-Elastic Straps:

They are used with extraoral prosthesis. Head bands are used in cases of auricular prosthesis. Non-elastic straps are used along with buckles to make it adjustable. 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.⁶ (Fig 13)

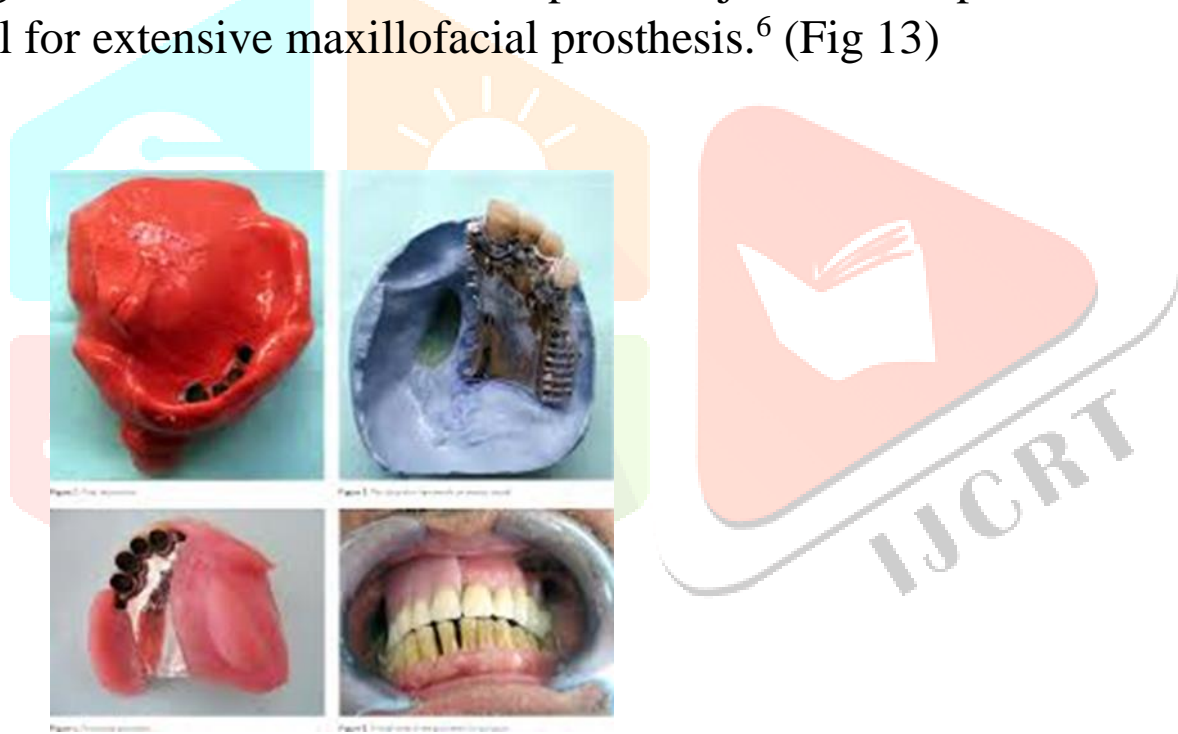


Fig 12: Precision attachment used for retention of prosthesis



Fig 13: Elastic straps used for retention of prosthesis

5. Magnets:

Magnets gained popularity in the field of maxillofacial prosthesis due to their small size and strong attractive forces.¹⁰ These attributes allow them to be placed within prostheses without being obtrusive in the mouth. Magnets (Fig 14) are used as retentive aid for sectional dentures, hemi-maxillectomy, obturators, complete dentures or extensively atrophied ridges. Magnets are used in nasal (Fig 15) orbital (Fig 16) prosthesis auricular prosthesis, large and small maxillary defects and intra oral-extra oral combination prosthesis.¹¹ Mainly two types of alloys are used for the manufacture of small dental magnets. They are cobalt-samarium and iron neodymium and boron. They have high attractive forces in very small sizes, but have low corrosion resistance.¹² The design of magnetic attachments has changed in the last 20 years with new rare earth materials based on neodymium-Iron-Boron alloy.¹³



Fig 14: Magnets used for retention of prosthesis

Components:

The standard magnetic retention unit is a two component system:

Magnetic retention element and keeper element. The magnetic retention element is made up of paired magnets, an attached keeper, and two protective and plates covering the paired magnet faces. The magnetic retention element is oval in shape and is 5mm long, 3.2mm wide and 3mm high.

The keeper element is a detachable, oval shaped, magnetizable preferred disk or a cast root cap. The keeper element is prepared with a magnetizable alloy, which is not a magnet but it acts as a magnet(induced magnet) when it comes in contact with magnetic retention of element. The alloy used is Pd-Co-Ni alloy or stainless steel alloy.

Recently a new permanent magnetic alloy introduced is an alloy of neodymium-ironboron, which has got 20% more magnetic strength than cobalt samarium per unit volume. Cemented in keeper is a preformed disk of 5mm long, 3.2mm wide and 1.2mm thick. Screwed on keeper is a preformed disk 1.2mm thick with one face 5mm long and 3.2mm wide and the other face 6mm long and 4mm wide.

Advantages: ¹²

1. Magnets provide both retention and stability.
2. Rotates a functional 12 degrees, allowing for up to 24 degrees of abutment divergence.
3. This also provides for an easy non-critical path of prosthesis insertion and removal.
4. Parallelism of the roots or implants is not must .
5. Soft tissue undercuts may be engaged.
6. Potentially pathologic lateral or rotated forces are eliminated providing maximum abutment protection.
7. Enables automatic reseating of the denture if dislodged during chewing.

8. Shorter roots equal to 3mm of bone support also are adequate and can function abutments with magnetic appliances.
9. The root abutments are not subjected to direct stress

Disadvantages:

1. Corrosion is the main problem associated with the use of magnets as retentive aid .The Sm- Co and Nd-Fe-B magnets ^{13,14} possessing the properties of brittleness and susceptibility to corrosion, more seen in chloridecontaining environments such as saliva and the presence of bacteria increases the corrosion of Nd Fe-B magnets.

Corrosion of magnetic attachments may occur by 2 different mechanisms. ¹⁵

- Breakdown of the encapsulating material.
 - Diffusion of moisture and ions through the epoxy seal between can and magnet.
2. Deep scratches and gouges caused due to wear on the surface and also by debris and other particles that become trapped between the magnet and the root.
 3. The abrasive nature of the titanium nitride-coated soft magnetic tooth keeper which is also used with some implant system may lead to excessive wear of the magnet.
 4. Both Nd-Fe-B and Sm-Co magnets corrode rapidly in saliva and the presence of bacteria has been shown to increase the corrosion of Nd-Fe-B magnets.

Various methods have been used to try to eliminate the problem of corrosion; these involve encapsulating or coating the magnets for use intra orally. Titanium and stainless steel are the most common materials used for encapsulation of dental attachments, but polymeric materials also have been used. However, continual wear of the encapsulation material leads to exposure of the magnet. An additional problem associated with attachments sealed by polymeric materials is the diffusion of moisture and ions, which attack the magnet component, through the seal. To achieve a highly reliable

system, other non-permeable sealing techniques, such as laser welding should be used.



Fig 15: Magnet retained nasal prosthesis

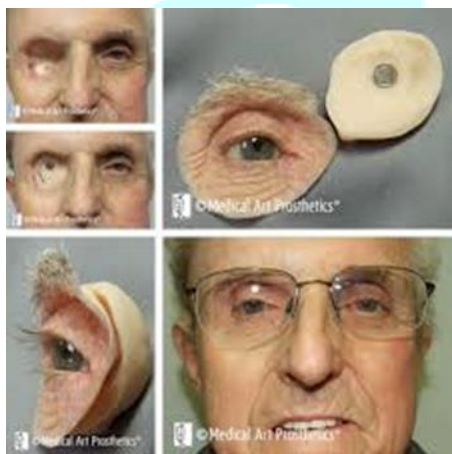


Fig 16: Magnet retained eye prosthesis

4. IMPLANTS:

The successful clinical development of intraoral implants to retain dentures and other prosthetic replacements for missing teeth has led to use of implants to retain extra oral structures.⁴ Titanium implants can be placed for fixation of prosthetic ears,(Fig 19) nose and eyes. (Fig 17) In facial deformities, zygomatic implants, orbital, auricular and nasal implants are the extraoral implants placed. They provide most reliable form of retention for maxillofacial prosthesis. It also enhances function of prosthesis and good marginal fit makes the margins less obvious. Placement of osseointegrated

implants has a great effect on the function of facial prosthesis in a matter of retention, stability and support.^{16,17,18,19}

Most commonly used are cylindrical or tapered root form titanium implants. They are mechanically anchored to bone. Marius Implant Bridge is a prosthetic rehabilitation for the completely edentulous upper jaw with moderate-to-severe resorption cases.²⁰

The most ideal location for implants in edentulous total maxillectomy (Fig 18) patients is residual premaxilla. Zygomatic implants are also used in the treatment of maxillary defects secondary to trauma, tumour resection or any congenital defects. For nasal prosthesis, ideal site is maxilla region and anterior floor of nose with tissue bar and clip design. The ability to recreate the normal anatomy and the reaction of the orbital soft tissue to the biomaterial used in reconstruction are two major factors that are important while reconstructing the internal orbit. Supraorbital rim or lateral rim of orbit is the preferred site for ocular prosthesis.

Branemark and others began using titanium implants for the treatment of edentulous patients in 1965. Titanium implants for the attachment of bone anchored hearing device have been in clinical use in Sweden since 1977. Tjellstrom and others further demonstrated the feasibility of using transcutaneous, osseointegrated implants in the temporal bone for retaining ear prostheses. Parel, Jacobson, and others have gone on to demonstrate the success of osseointegrated skin penetrating titanium fixtures in retaining facial prostheses.²¹ Aydin C et al (2008) found implant success rate to be 100% for silicone auricular prosthesis.²²

PEEK (Polyetherether Ketone) is a polymer which has become recently familiar due to their biocompatibility, strength, stiffness and durability.²³ Owing to its mechanical and physical properties being similar to bone and dentin, PEEK can be used for a number of applications in dentistry.²⁴ PEEK exhibits excellent biocompatibility and stability when exposed to body fluids. Few of the cranial, frontal, ocular, maxillary and mandibular defects are being reconstructed by 3D printing using PEEK

(Polyetherether ketone). PEEK implants can be machined to many organic shapes and fixated to the adjacent bone standard screws and plates.²⁵

Through the years it has become obvious that this complex field of dental implantology would require the optimization of several important variables to enhance the chances of success. These include:

1. Proper material selection and design.
2. Understanding and evaluation of the biologic interaction at the interface between the implant and tissue
3. Evaluation of the quality of the existing bone.
4. Careful and controlled surgical technique.
5. Joint approach between the various specialties to optimize patient selection.
6. Prosthodontic geometry
7. Follow up care.

The retention provided by the implants makes it possible to fabricate large maxillofacial prostheses that rest on movable tissue bed. The advent and increasing availability of 3-D cone beam computerized tomography (CT) and 3-D digital panoramic imaging machines makes it easier, timely and less costly to obtain images C.T. images are extremely useful as a visualization and diagnostic tool.



Fig 17: Implant placed for retention in eye prosthesis case

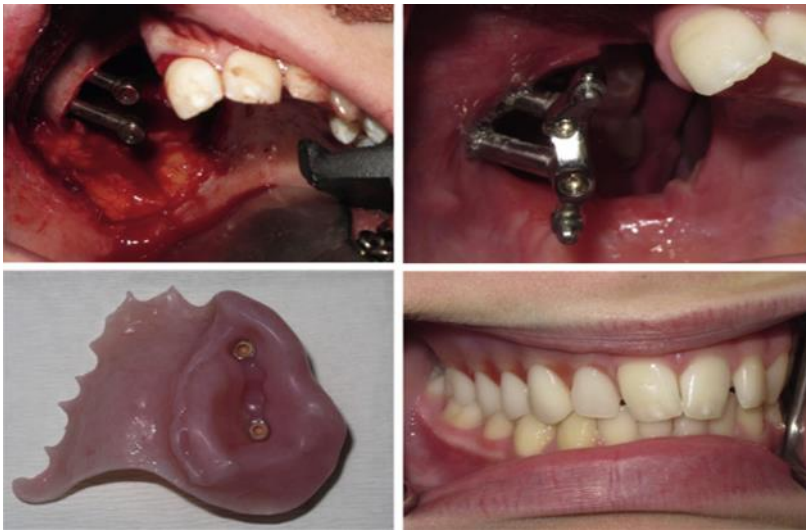


Fig 18: Implant used as retentive aid for maxillary defect

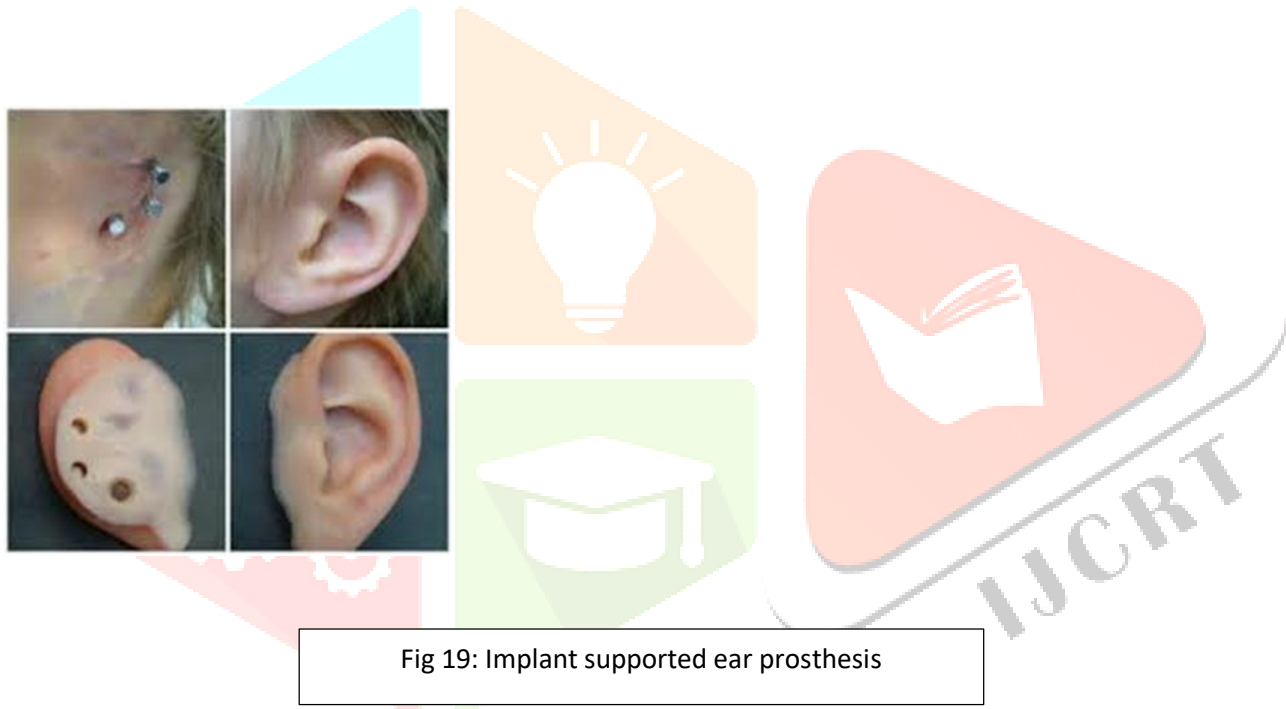


Fig 19: Implant supported ear prosthesis

The use of implants in the field of maxillofacial prosthodontics has widened the treatment spectrum and has opened gates to horizons of replacing lost parts in a beautiful and effective manner. In cases where using other alternative retentive aids is not possible implants provide a ray of sunshine and make the impossible possible upto a very large extent in relation to the retention provided.

A variety of technique and equipments are available to retain a maxillofacial prosthesis. To choose the right retentive aid the prosthodontist needs to be familiar to all the available options because he carries the responsibility to

plan the prosthetic rehabilitation that suits 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.

To reduce the burden of physical and psychological trauma and for the well-being of the patient, the replacement of facial defect becomes the responsibility of the maxillofacial prosthodontist. The aesthetics achieved after complete treatment depends on the amount of tissue removed, good contour and merging of the margins and minimal sagging due to the weight of the prosthesis. The advantage of maxillofacial prostheses is that it requires minimal or no surgery, as it restores the aesthetics and function in a near natural appearance. Retention is a key factor in maxillofacial prosthesis. The need for professional evaluation on a periodic basis should be encouraged to determine the adaptability of prosthesis to soft tissues, stability, retention, function and aesthetics.

Patient acceptance is significantly enhanced because of the quality of the retention. Methods for attaching and holding extraoral facial prostheses must be as invisible as possible to make them aesthetically pleasing. Using tissue undercuts or attaching the prosthesis to the patient's eyeglasses or dentures can help mechanically retain the device. Medical-grade adhesives or tapes are also used; however, they collect dirt and are unhygienic. A prosthodontist, with his or her skills and experience, has to decide the best mode of retention possible for a maxillofacial prosthesis. Thorough evaluation of the situation and careful judgment and treatment planning can give acceptable quality of maxillofacial prostheses, thus, improving the patient's quality of life.

CONCLUSION :-

A variety of technique and equipments are available to retain a maxillofacial prosthesis. To chose the right retentive aid the prosthodontist needs to be familiar to all the available options because he carries the responsibility to plan the prosthetic rehabilitation that suits 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.

REFERENCES :-

1. Glossary of Prosthodontic terms. 9th ed. J Prosthet Dent.2017;117(55):e1-e105.
2. McKinstry RE. Retention and facial prostheses. In: McKinstry RE. Fundamental of facial prosthetics. Arlington (USA): ABI Professional Publications; 1995. p. 19–30.
3. Karthikeyan I, Khatree M, Gaddale R, et al. A review on prosthetic rehabilitation of maxillofacial region. Journal of Scientific Dentistry 2016;6(1):6-12.
4. Rajesh Gurjar, Sunil Kumar M.V., Harikesh Rao, Alok Sharma, Sumit Bhansali. Retentive Aids in Maxillofacial Prosthodontics - A Review. IJCD 2011; 2(3):84-88.
5. Maxillofacial Rehabilitation. John Beumer, Mark T. Marunick, Salvatore J. Esposito.3rd Edition.pg no-267.
6. Yeshwante B, Patil SJ, Baig N. Retentive aids used in maxillofacial prosthesis. IJCDS 2014;5(2):12-20.
7. Sudarat Kiat-amnuay, Lawrence Gettleman, Zafrulla Khan, and L. Jane Goldsmith. Effect of adhesive retention on maxillofacial prostheses. Part I: Skin dressings and solvent removers. jpd 2000;84(3)-335-340
8. Kanathila H, Pangi A. The changing concepts in the retention of maxillofacial prosthesis from past to present- a review. J. Evolution Med. Dent. Sci. 2017;6(84):5879-5883
9. Muddugangadhar BC, Sonika R, Chheda PS, et al. Rehabilitation of an orbital defect: a simplified technique. J Int Oral Health 2015;7(7):121-3.
10. Bhat VS, Shenoy KK, Premkumar P, et al. Magnets in dentistry. AMHS 2013;1(1):73-9.

11. Bhat.V : A close-up on obturators using magnets : Part 11. J.Indian.Prost Society Sep2006:6(3); 148-53.
12. Highton R, Caputo AA, Pezzoli M, Matyas J. Retentive characteristics of different magnetic system for dental applications. J Prosthet Dent 1986;56:104–6.
13. Melissa Alessandra Riley et al: Magnets in prosthetic dentistry. J Prosthet Dent 2001; 86:137-42.
14. Coey J.M.D: Magnetism in future. J.Magnetism and Magnetic Materials 226-30(2001)2107-2112.
15. Riley MA, Williams AJ, Speight JD, Walmsley AD, Harris JR. Investigations into the failure of dental magnets. Int J Prosthodont 1999;12:249–54.
16. Kantola R. Use of fibre-reinforced composite framework and thermochromic pigment in facial prosthesis. Turun Yliopisto University of Turku. Turku 2014: p. 13.
17. Parel SM, Tjellström A. The United States and Swedish experience with osseointegration and facial prostheses. Int J Oral Maxillofac Implants 1991;6(1):75-9.
18. Watson RM, Coward TJ, Forman GH. Results of treatment of 20 patients with implants-retained auricular prostheses. Int J Oral Maxillofac Implants 1995;10(4):445-9.
19. Arcuri MR, Rubenstein JT. Facial implants. Dent Clin North Am 1998;42(1):161-75.
20. Fortin Y, Sullivan RM, Rangert BR. The Marius implant bridge: surgical and prosthetic rehabilitation for the completely edentulous upper jaw with moderate to severe resorption: a 5-year retrospective clinical study. Clin Implant Dent Relat Res 2002;4(2):69-77.
21. Schaaf NG, Kielch M. Implant retained facial prostheses. In: Mckinstry RE. Fundamental of facial prosthetics. Arlington (USA): ABI Professional Publications; 1995. p. 169–79.
22. Yoon HI, Han JS. Prosthetic rehabilitation with an implant-supported fixed prosthesis using computeraided design and

computer-aided manufacturing dental technology for a patient with a mandibulectomy: a clinical report. *Journal of Prosthetic Dentistry* 2016;115(2):133-6.

23. Kim MM. Use of customized polyetheretheretone (PEE) implants in the reconstruction of comple maxillofacial defects. *Arch Facial Plas Surg* 2009;11(1):53-7.
24. Najeeb S, Zafar MS, Khurshid Z, et al. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. *Journal of Prosthodontic Research* 2016;60(1):12-9.
25. Herford AS, Miller M, Lauritano F, et al. The use of virtual surgical planning and navigation in the treatment of orbital trauma. *Chinese Journal of Traumatology* 2017;20(1):9-13.

