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Clinical Aids For Increasing Retention For Removable Implant Supported Prosthesis

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By

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بسم الله الرحمن الرحيم

صدق الله العظيم

Certification of the Supervisor

I certify that this project entitled " **Clinical aids for increasing retention for removable implant supported prosthesis** " was prepared by the fifth-year student **Amena Khalid Hamid** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Certification of the supervisor

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Dedication

I humbly dedicate this piece of work to my loving family with a special feeling of gratitude to my loving parents for their endless guidance and support. And to my very special brother and sister.

I also dedicate this dissertation to my only best friend ***Jaafar Abdulhameed Jaafar*** who has supported me throughout the process. I will always appreciate all what he has done for me.

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Introduction

The contribution of dental implant-retained overdentures to the quality of life in the elderly has been proven in the dental literature (Zhang et al., 2017). It has also been proved in the studies that two dental implants are enough to support a mandibular overdenture (Thomason et al., 2014).

Overdenture patients are generally of older ages, and consequently most elderly patients have some systemic diseases that comprise the management of the dental implant treatment (Karayazgan-Saracoglu et al., 2017; Schimmel et al., 2017).

Advanced age and the systemic problems of overdenture patients necessitate that desirable dental implant management should have a minimal intervention for the surgical and prosthetic maintenance of the overdenture after the delivery of the final prosthesis. This means that the stresses should be minimally transferred to dental implants via the overdenture and its housings to ensure less implant maintenance interventions. Thus, the main goals of the selection among the different attachment types for overdentures are to provide insight into the biological effects of interfacial stress transfer and the most favorable delivery of forces to the dental implant (Ying et al., 2017; Porter et al., 2002)

In contemporary dentistry, there are various attachment systems that allow the removable denture to attach to the dental implants (Manju and Sreelal, 2013). Attachment systems can be classified according to whether the implants are splinted or not (Leão et al., 2018)

In case dental implants are splinted, the connection between the prosthesis and dental implant is provided with bar structures. If the dental implants are not splinted, each dental implant is individually attached to the prosthetic structure. This connection is provided with Locator, ERA, ball, O-ring and various magnet systems.

These attachment types can also be classified according to working principles. The attachment types on which the plastic patrix sits on the abutment (Locator) do not allow the patrix to perform rotational and rolling movements on the abutment. Attachment types that have ball-headed abutment (ball, O-ring) allow the patrix to perform these movements to varying degrees. However, there are also new attachment types that are of the Locator type and allow for these movements (Zest Anchors LLC, Escondido, CA, USA) (Turker, 2020).

Magnet attachment systems work by the principle of magnetization between parts. The selection of attachment type is affected by the dental implant location, degree of retention, the morphology of the edentulous jaw, and the patient's motor dexterity (Takahashi et al., 2018).

The most preferred overdenture attachment type is the Locator and ball because of its ease of application, lesser technical requirements, and lower cost compared to the bar or magnet systems. There is still an effort to offer better attachment systems in dental implantology (Turker, 2020).

The prognosis of dental implants greatly depends on the stress and load distribution of occlusal loads transferred via the attachment systems to the dental implants; in the dental literature, there are numerous studies that have evaluated the stress and occlusal load distribution on the dental implants and supporting tissues transferred via the attachments (Unsal et al., 2019).

Daas investigated the rigid and resilient attachment configurations, and they concluded that "resilient attachments allowed for an increase of the mastication load transiting through denture bearing surface". Due to various deficiencies in existing attachments and certain commercial concerns, new dental systems are being introduced to the dental market day by day. Today, there are many overdenture

attachment systems in the dental field, which are advantageous in various aspects (Daas et al., 2008).

Aim of the review

The purpose of this review is to discuss the different type of attachments that routinely used in implant removable -supported overdenture and their effect on increasing the retention of implant-supported overdenture.

Chapter one

Review of literature

1.1 Implant definition

The goal of modern dentistry is to restore the patient to normal contour, function, comfort, esthetics, speech, and health, whether restoring a single tooth with caries or replacing several teeth. What makes implant dentistry unique is the ability to achieve this goal regardless of the atrophy, disease, or injury of the stomatognathic system (Dewan et al., 2015; Gowd et al., 2017).

dental implant as it is a device of biocompatible material(s) placed within or against the mandibular or maxillary bone to provide additional or enhanced support for prostheses (glossary of prosthodontics, 2017).

Also for understanding the dental implant and its process other terms need to be explained. these terms are,

- Osseointegration

which is a key biologic and biophysical process for the success of dental implant therapy, regarding osseointegration there is two ways to define it, the first one is histologically as direct structural and functional connection between organized, living bone and the surface of a load-bearing implant without intervening soft tissue between the implant and bone (Das et al., 2019).

The second is clinically as the asymptomatic rigid fixation of an alloplastic material (the implant) in bone with the ability to withstand occlusal forces. the important point here is that The primary goal in implant placement is to achieve and maintain an intimate bone-to-implant connection which as explaned earlier as dental osseointegration (Parithimarkalaignan and Padmanabhan, 2013).

- Types of dental implant Depending On the Placement Within the Tissues

  - Endosteal.
  - Subperiosteal.
  - Transosteal (Yeshwante et al., 2015).

Endosteal implants which can be defined as a device inserted into the jaw bone (endosseous) to support a dental prosthesis. It is the 'tooth root' analogue and is often referred to as a 'fixture' (Palmer, 1999).

Endosteal implants pierce only one cortical plate of maxilla and mandible. The most frequently used endosteal implant is root form implant They are the most commonly used dental implants. The subperiosteal They comprise an open mesh framework designed to fit over the surface of the bone beneath the periosteum, it has an implant substructure and superstructure where custom cast frame is placed directly beneath the periosteum. Transosteal implant crosses through both cortical plates It is generally used in cases of severe ridge resorption (Peeran and Ramalingam, 2021).

- **Implant abutment**

The component which attaches to the dental implant and supports the prosthesis (Palmer, 1999).

- **Abutment screw**

A screw used to connect an abutment to the implant **(Figure1)** (Palmer, 1999).

1.2 Indication implant denture

1) Edentulous patient with history of difficulty in wearing removable dentures.
2) When there is severe change in complete denture bearing tissues.
3) Poor oral muscular coordination.
4) Para-functional habits that compromise prosthesis stability.

5) Unrealistic patient expectations for complete dentures.

6) Psychologic benefit from improved stability of the denture.

7) When fewer teeth are present and cannot be saved for tooth supported denture.

8) Hyperactive gag reflex.

9) Low tissue tolerance of supporting mucosa or mucosal irritation (Sarandha et al., 2007).

Figure 1:Abutment screw (Palmer, 1999).

1.3 Contraindication of implant denture

The contraindication is divided into absolute contraindication that is related to health conditions that have the potential to affect the patient overall health and seriously compromise the safety of the implanted systems causing residual chronic complications and relative contra indication while relative contraindication is related directly to nature and severity of the systemic disorders if the disease corrected, carry out the treatment plan if not postpone the procedure until optimal conditions prevail (Acharya et al., 2021).

1.3.1 Absolute Contraindication

1) Recent myocardial infarction.

(because patient is using potent anticoagulants, adrenergic blocking agents, hypotensive drugs).

2) Valvular prosthesis.

(It is important not to plan any implant surgery until the patient is in stable condition, usually between 15 to 18 months after cardiac surgery, because oral cavity is the principle gateway to infection).

3) Severe renal disorder.

(It is the single most important contraindication to any form of implant or bone graft surgery).

This can occur from a number of causes:

i. Nephritis
ii. Malignancy or tumors
iii. Uncontrolled diabetes
iv. Complication arising from kidney stones

4) Treatment-resistant diabetes.
5) Generalized secondary osteoporosis.

(in this there is significant loss of bone mass and volume).

6) Chronic and severe alcoholism.

(Patient with severe alcoholism often present retarded healing aggravated by malnutrition, psychologic disorder, inadequate hygiene and major infection risk).

7) Radiotherapy in progress.

(It Cause disruption of defense mechanisms, a compromised endosseous vascular system and inhibition of osteoinduction).

8) Severe hormone deficiency.

(the endocrine systems most affected are thyroid, parathyroid, pancreas, adrenal, pituitary and gonads).

9) Drug addiction.

(leads to low resistance to disease, predisposition to infection, malnutrition, psychological disorder).

10) Heavy smoking habits.

(Main problems that occur are, early stage poor healing disorders related to poor oral hygiene (Acharya et al., 2021).

1.3.2 Relative contraindication

1) AIDS and other seropositive diseases (HIV-positive).

(These contraindicate any form of surgery).

2) Prolonged use of corticosteroids.

(It is often associated with retarded healing, disorders of phosphocalcific metabolism (osteoporosis), and medullary aplasia. It inhibits bone formation).

3) Hematopoietic disorder.

4) Chemotherapy in progress (administration of anticancer drugs).

5) Mild renal disorders.

6) Hepatopancreatic disorders Gall stones and infectious and viral hepatitis (severe B, C & E).

7) Multiple endocrine disorders, these include

- ❖ Glucocortisteroid disorder (Cushing syndrome and Addison syndrome).
- ❖ Mineralocorticosteroid syndrome (conns syndrome).

- ❖ Parathormone (PTH).
- ❖ Vitamin D3.

8) Psychological disorders- If patient is having psychological disorder and having tremor.

9) Unhealthy life-style.

10) Smoking habits.

11) Lack of understanding and motivation (Carl et al., 2005).

1.4 Implant supported prosthesis

The discovery of osseointegration had a tremendous impact on how dentists treat patients suffering from edentulism. In addition, it has significantly changed patients' expectations and improved their overall quality of life (Vogel et al. 2013; Bekler et al. 2015).

These designs provided patients with opportunity for improved prosthetic performance requiring a fewer number of implants, thereby reducing the financial burden of implant-based treatment while allowing for prosthetic simplicity (Hooghe and Naert, 1997).

Patients were able to remove their prostheses at home, eliminating complications in hygiene while providing greater facial support than the original fixed design (Ouzer, 2015; Spiekermann et al., 1995).

SO implant supported prosthesis can be defined as an Any prosthesis (fixed, removable or maxillofacial) that utilizes dental implants in part or whole for retention, support and stability (Sarandha et al., 2007).

1.5 Implant supported overdenture

Implant supported overdenture is a treatment of choice in case of soft or hard tissue defects in case of alveolar bone resorption. Esthetics can be improved by increasing or decreasing the

amount of denture base material. This change in design can enhance lip and facial support (Sarandha et al., 2007).

According to the glossary of prosthodontic terms, an overdenture is any removable dental prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants. Implant overdenture can be implant-retained or implant-supported (glossary of prosthodontic, 2017).

The purpose of the dental implants is to avoid the lateral and vertical dislodgment of the complete denture. An implant-supported overdenture transfers all of the masticatory forces to the dental implants, and as a consequence, to the alveolar and basal bone, so This type of prosthesis offers the advantages of being completely supported by implants for increased comfort, but is removed by the patient to maintain proper oral hygiene (Tallarico et al., 2018).

In addition to that the implant overdenture is an attractive treatment because the simplicity, minimal invasiveness and economy (Acharya et al., 2021).

Minimum of four implants is often recommended for an implant overdenture in maxilla. Increased number of implants are often due to quality of bone present, which is less dense compared to that present in mandible. The most posterior implant should be inserted as far distally possible to reduce the extension of cantilever (Acharya et al., 2021).

1.6 Types of implant_supported overdenture

I. Type 1

This overdenture uses a combination of implant and soft tissue support and is usually more effective in the mandible than in the maxilla. Two implants are generally used in the cuspid positions**(Figure2)**. The prosthesis is implant retained. The freestanding attachment abutments can be rigid and allow for both implant and soft tissue support concurrently or allow for soft tissue support up to 0.6 mm, which protects the implants from being overloaded. The attachment abutments can be ball attachments (eg, Preci Clix, Preat Corporation,), extracoronal resilient

attachments, (eg, ERA®, Sterngold), o-ring attachments (eg, ORA, Sterngold), or LOCATOR® attachments (Zest Anchors,), depending on how much soft tissue support is necessary (Feine et al., 2002; Carpenteri, 2004).

Figure 2:Type(1) implant supported overdenture whrere Two implants are generally used in the cuspid positions (Carpenteri, 2004).

II. Type 2

This overdenture uses a straight round bar connecting two or more implants or a curved bar supporting two or more implants with two distal rotational attachments **(Figure3).** The prosthesis is implant retained and supported by soft tissue and implants or, depending on the selection of implant attachment abutments, soft tissue supported. The distinguishing feature is that the overdenture is supported by a round or oval bar that allows for rotation. Four implants may be used in this scenario (Kakar, 2001).

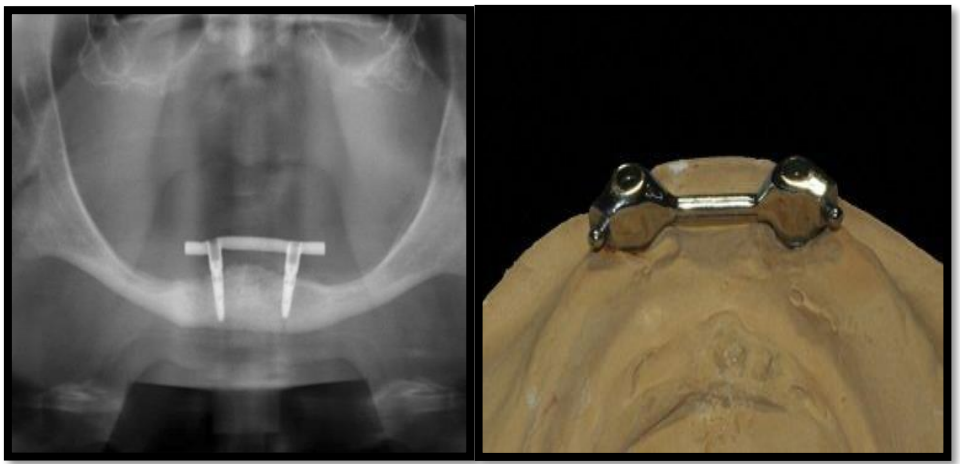

Figure3: Type (2) implant supported overdentue in which straight round bar connecting two or more implants (Kakar, 2001).

III. Type 3

This overdenture is similar to a Type 2 treatment planning option. However, if four implants are placed in and around the cuspid area, the anterior rotational clip and distal ball or other rotational attachments will work together to generate less torquing forces around the implants **(Figure4)**. With four implants, the midline clip functions as an indirect retainer, preventing the posterior base portion of the overdenture from rotating away from the posterior edentulous ridge areas during function. Another advantage of the midline clip is that it provides for a tripod effect, or third reference point to determine a plane. By balancing the mucosal-supported area with the bar/implant-supported area, rotation of the overdenture can be minimized. The midline clip should provide only a positive seat when the overdenture is engaged. It functions in a Type 3 case as an indirect retainer, which is basically a vertical stop for a removable partial denture framework, so the free-end saddles do not move from the tissue (Walton et al., 2002).

Figure4: Type (3) implant supported overdenture in which four implants are placed in and around the cuspid area (Walton et al., 2002).

IV. Type 4

Type 1, type 2, and type 3 overdentures receive a portion of their support from the soft tissue areas. The distinguishing feature of Type 4 overdenture is that the overdenture is completely supported by bars and implants **(Figure5)**. The overdenture base may actually contact the mucosal tissue, but any support is inadvertent. Because this overdenture is completely implant

supported, it requires the same number of implants for support as a fixed prosthesis. Type 1, Type 2, and Type 3 options are usually treatment planned for the lower arch, while Type 4 is frequently planned for the upper arch. A minimum of five implants is planned for the mandibular arch, whereas six are planned for the maxilla. This all depends on many factors, and many practitioners will opt for six implants in the mandible and eight in the maxilla, just to ensure that the implants are not overloaded (Yamada, 2000; Christensen, 2009).

Figure5: Type 4 implant supported overdenture in which overdenture is completely supported by bars and implants (six implants are planned for the maxilla) (Yamada, 2000).

1.6.1 Advantages of implant supported overdenture

1. The implant supported overdenture improves retention, improving comfort and taste by allowing a reduction in palatal coverage.
2. It confers a significant improvement in biting force and chewing efficiency.
3. it improves oral function.
4. improve speech.
5. confer other psychological benefits, including increased self-confidence, improved social interaction, emotional wellbeing and overall quality of life.
6. It facilitates greater access for oral hygiene (Grey and Petel,2021).

1.6.2 Disadvantages of implant supported overdenture

1) It may not satisfy patients with negative attitude towards removable prosthesis.
2) Some overdentures may be bulky especially in a patient who has lost larger amounts of hard and soft supporting tissue since the denture base material is increased to compensate this loss (Sarandha et al., 2007).

1.7 Attachment used with implant supported and implant retained overdenture

An attachment is defined as a mechanical device for the fixation, retention and stabilization of a prosthesis, a retainer consisting of a metal receptacle and a closely fitting part, the former (the female matrix component) is usually contained within normal or expanded contours of the crown of the abutment tooth and the latter (the male patrix component), that is attached to a pontic or the denture framework (Chandan et al., 2017).

The attachment systems are considered the pillars of overdenture treatment. An overdenture attachment permits movement during function and removal from the mouth. Ideally, the attachment should offer the possibility of controlling the degree of retention provided (Misch, 2008).

- The selection of the attaching mechanism for an implant retained over denture depend on:

a. cost effectiveness.

b. amount of retention needed.

c. expected level of oral hygiene.

d. amount of the available bone.

e. patient's social status.

f. patient's expectation maxilla mandibular relationship.

g. inter-implant distance and status of the antagonistic jaw (Trakas et al., 2006).

The anatomic situation of mandible, desired level of retention, hygiene maintenance capability, parallelism of the implants and cost consideration are important factors in choosing appropriate overdenture attachment type (Chandan et al., 2017).

Attachments used in conjunction with implants were found to enhance the retention, the stability and support of over dentures together with the implants, thus extending their longevity (steffen et al., 2004).

1.7.1 Types of attachments based on resiliency according to Prasad

- **Rigid non-resilient attachments**

  No movement occurs between the abutment and the implant. This type of attachment is recommended when a sufficient number of implants are available. A screw-retained hybrid overdenture is an example of a rigid non-resilient attachment **(Figure6).**

Figure6: A rigid non resilient attachment (Prasad et al., 2014).

- **Restricted vertical resilient attachments**

  This type of attachment provides 5–10 percent load relief to the supporting implants, and the prosthesis can move up and down with no lateral, tipping, or rotary movement. In other words, the attachment resists any lateral tipping or rotary movements.

- **Hinge resilient attachments**

This type of attachment resists any lateral tipping, rotational, and skidding forces. Hinge resilient attachments provide almost 30–35 percent load relief to the supporting implant.

- **Combination resilient attachments**

Attachments of this type allow unrestricted vertical and hinge movements. This attachment uniformly transfers the vertical component of masticatory forces to the entire length of the residual ridge. This type of attachment offers 45–55 percent load relief to the supporting implants. The Dolder bar joint (egg shaped) is a combination resilient attachment **(Figure7)** (Shafie, 2007; Prasad et al., 2014).

Figure 7: Mandibular Overdenture with Dolder Bar (Prasad et al., 2014).

1.8 Classification of attachment according to the retentive means according to Al-qutaibi

According to the retentive means we can classify the attachment into:

i. Frictional.

ii. Mechanical.

iii. frictional and mechanical.

iv. magnetic attachments (Al qutaibi, 2016).

The retentive force of the locator, ball and magnetic attachments is gained through mechanical interlocking, frictional contact or magnetic forces of attraction between the patrices and matrices (Al qutaibi, 2016; Becerra and MacEntee, 1987).

Attachments used to connect the denture and implants are fabricated either by machine milling an alloy or custom casted from plastic patterns. Machine-milled attachments are commonly used on the individual implant, while custom-cast attachments in the bar design are popular. Both designs have shown satisfactory results in terms of implant success and patient satisfaction (Timmerman et al., 2004; Klemetti et al., 2003; Al qutaibi, 2016).

The attachments used to retain implant over denture include stud, bar, magnets and telescopic attachments.

1.8.1 Stud attachment

Stud attachments consisted of a female part which is frictionally retained over the male stud and incorporated into the denture resin either by the means of a transfer coping system and the creation of a master cast incorporating a replica of the attachment or directly in the mouth using self-cured or light polymerized resin (Kakar, 2001; Al qutaibi, 2016).

- Stud attachments are one of the oldest attachment systems in use, they can be divided into two groups:
  i. Extraradicular, in which male component projects from the implant
  ii. Intrardicular, in which the male component is a part of denture base (Preiskel, 1996; Prasad *et al*., 2014).

Also the stud attachment can be divided according to function into:

a) **Resilient attachments**

This type permits some tissue ward vertical and rotational movements, thus protecting the underlying abutments or implants against overload. However, resilient attachments usually

require a large space and might cause posterior mandibular resorption with the vertical movement of the denture.

b) **Non-resilient**

This type does not permit any movement of the overdenture during function and were commonly employed when the interocclusal space was limited (Prasad et al., 2014).

Stud attachment include o-ring, ball, ERA and locater attachment (Figure 8).

One of the main benefits of stud attachments is the ability of its use in cases with V-shaped arches where straight connection between the implants can affect the tongue space (Walton et al., 2002; Heckmann et al., 2001; Al qutaibi, 2016).

Figure 8: Attachments evaluated from left to right: ERA, Saturno O-Ring, Locator, Ball (Al qutaibi, 2016).

Stud attachment include

1.8.1.1 O-ring attachment

It consists of a titanium male unit and an easily replaceable rubber-ring female unit that is retained in a metal retainer ring. It transfers the amount of stress to the abutments and

provides an excellent shock resorbing effect during function **(Figure9)** (Winkler et al., 2002; Chandan et al., 2017).

Rodrigues stated that If the O-rings attachments were properly placed parallel each other the retention will be adequate for longer time and the retentive capacity of O-ring was affected by implant inclinations. (Rodrigues *et al.* 2009).

the main drawback of is that the O-rings gradually loose retention, and must be replaced periodically (Alsabeeha et al., 2009; Prasad et al., 2014).

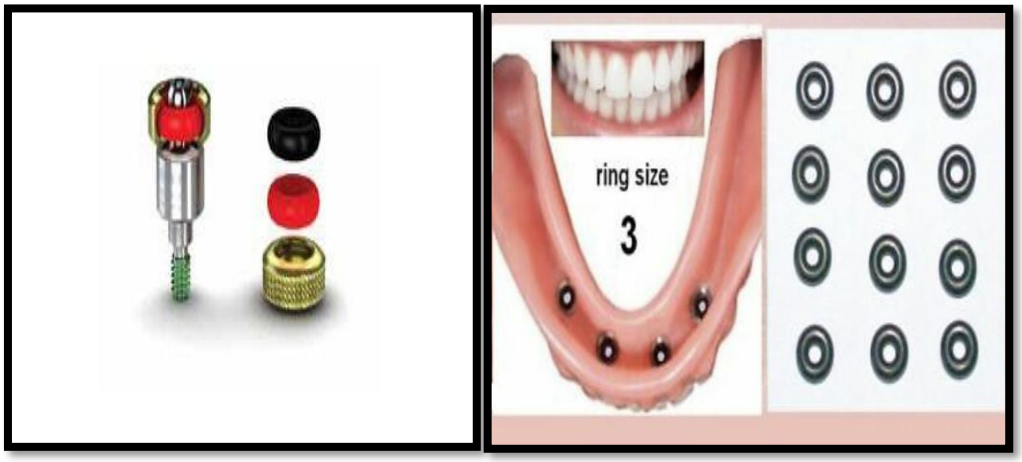

Figure 9: O-ring attachment (Chandan et al., 2017).

1.8.1.2 ERA attachment

It is an extra-radicular attachment with two design systems. The first is a partial denture attachment for placement on the proximal (mesial/distal) aspects of artificial crowns, while the second is an axial (or over denture) attachment, either for placement inside the prepared roots or the ERA implant abutment for over denture prosthesis. Each ERA retentive system is available in four color codes, (white, orange, and blue, gray), that provide different degrees of retention from light to heavy. The abutments are available in two types, **first** is the straight one-piece

abutment type and **second** are the two piece angulated abutment type (5°. 11° and 17 angles**) (Figure10)** (Al qutaibi, 2016).

It's indicated when resiliency is required as it provides vertical resiliency & universal stress relief (Majer, 1992; Chandan et al., 2017).

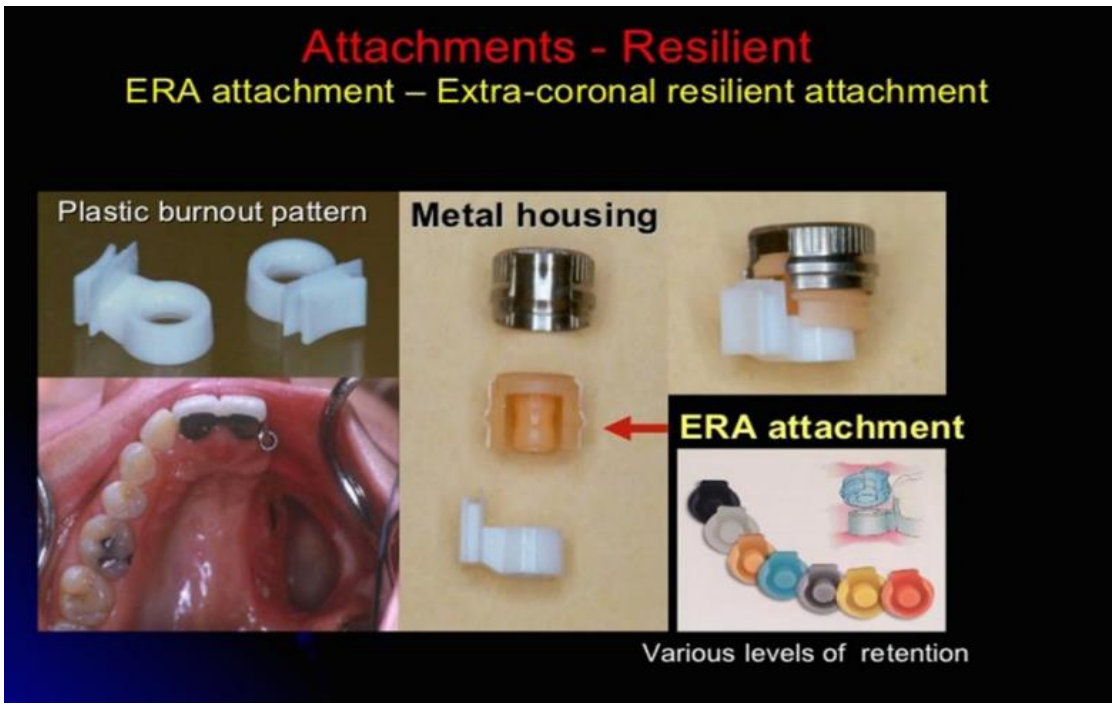

Figure 10: ERA attachment (Al qutaibi, 2016).

1.8.1.3 Ball attachment

The ball and socket attachments consist of a metal ball (male portion) which is screwed into the fixture, where the female part is incorporated in the fitting surface of the denture **(Figure11)** (Chandan et al., 2017).

Ball attachments are among the simplest of all stud attachments widely used because of their low cost, ease of handling, minimal chair side time requirements and their possible applications with both root and implant-supported prostheses (Budtz-Jorgensen, 2001).

Solitary balls were claimed to be less costly, less technique sensitive and easier to clean than bars. Moreover, the potential for mucosal hyperplasia was more reduced with solitary ball attachments (Krennmair et al., 2001; Al qutaibi, 2016).

Many authors agree that for unsplinted implants, the most common attachment used is the ball attachment. This attachment system is a practical, effective, and relatively low cost prosthetic concept (Winkler et al., 2002; Krennmair et al., 2006).

Naert concluded that the ball attachments are the best regarding soft tissue complications, and patient satisfaction when compared to the bar attachment and the magnet attachment (Naert et al., 2004).

studies done, that compared load transfer and denture stability in mandibular implant retained over denture retained by ball, magnet, or bar attachments, suggested that the use of ball attachment was advantageous in regards to optimizing stress and minimizing denture movement (Tokuhisa et al., 2003).

Another study was done to compare the retention of bar/clip, ball and magnet attachment in mandibular implant retained over denture. The ball and socket attachment recorded the highest value followed by the bar/clip then the magnet attachment (van Kampen et al., 2003; Al qutaibi, 2016).

It has been found that implant success and peri implant condition did not differ between both attachments but the ball attachment showed significantly higher frequency of technical complications than that of telescopic and bar attachment in implant supported overdentures (Krennmair et al., 2006).

- **The female part may be one of the following types:**

a. **<u>The O-ring</u>**

In which the retentive element is rubber ring. It’s better to have parallel implants.

b. **A metal part**

As in dalbo system. This permits less resilience however the retentive forces are almost twice those obtained with the O-ring system.

c. **A spherical metal anchor**

In which the female part contains a spring. These attachments have advantage of being resilient and easily activated (Jiménez-Lopez et al., 1999; Al qutaibi, 2016).

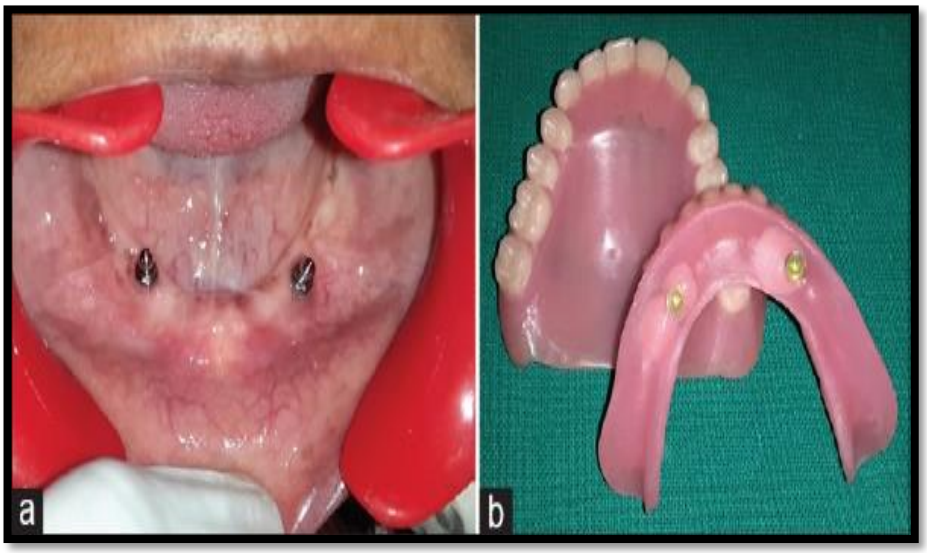

Figure 11: (a) Ball attachment. (b) Metal housing after incorporation in denture (Chandan et al., 2017).

1.8.1.4 Locator (self-aligning) attachment

It is an attachment system with self-aligning feature and has dual retention one is mechanical and another is frictional in different colors with different retention values**(Fgure12)**. Locator attachments are available in different vertical heights**(Figure13).** They are resilient, retentive, durable, and have some built-in angulation compensation. In addition, repair and replacement are fast and easy (Ghotmi et al., 2013).

The male part comprises of an implant screw-metallic abutment and the female part of a metallic cap lined with nylon of various hues relying upon their retention capacity, which is tied down to the denture (Stevens et al., 2000; Alsiyabi et al., 2005).

Locator attachments come in different colors (white, pink and blue) and each has different retentive value. Additional features are the extended range attachments, which can be used to correct implant angulation up to 20o they are offered in green, which has standard retention, and red, which has extra-light retention (Evtimovska et al., 2009).

The reduced height of this attachment is an advantageous for cases with limited interocclusal space or when retrofitting an existing old denture. (Pasciuta et al., 2005).

A laboratory study investigated the properties of this attachment founded that short profile distance of locator may affect the load transfer to the implant. The rounded edges of the abutment help to guide the nylon male within the denture into place (self-aligning feature) (Kleis et al., 2010).

Locator attachment will also accommodate divergent implants up to 20 degrees. A variety of abutment heights, angulations correction and different levels of retention are available that help to create the optimum overdenture restoration for each case (Schneider and Kurtzman, 2002).

In a study evaluating the clinical performance as well as patient and clinician satisfaction on two different prosthodontic retention systems (locator and bar) for implant-over dentures in the mandible, the authors emphasized that patient satisfaction was similar in both groups; the locator system demonstrated better soft tissues scores, however, the frequency of chronic

Figure 12: Locator attachment (Ghotmi et al., 2013).

inflammations around the implants was more around bars attachment group (Cordaro et al., 2012).

Advantages of locator attachment

- ✓ Can be used in cases of limited inter-arch space.
- ✓ Can accommodate inter implant angulations up to 40°.
- ✓ Compatibility with a high number of implant's systems (Prasad et al., 2014).

Disadvantages of locator attachment

- ✓ They cannot be used in cases where rigid restoration is required.
- ✓ Regular replacement of male nylon part due to constant wear and tear (Prasad et al., 2014).

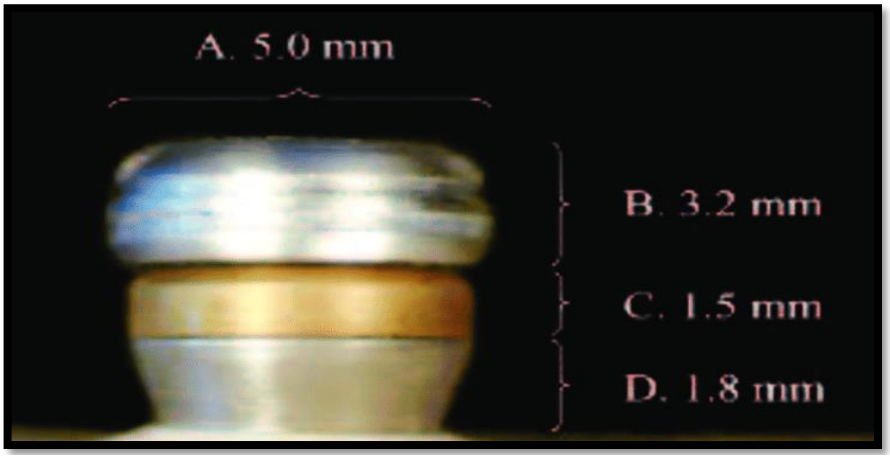

Figure 13: Minimum dimensions for Locator attachment system and Standard Plus Straumann implants. A: Width of attachment, B: Height of attachment. C: Height of abutment, D: Length of implant above bone. Additional 2.0 mm of space required for acrylic resin(In Lee and Agar, 2006) .

1.8.2 Magnet attachments

Magnetic retention is a popular method of attaching removable prosthesis to either retained roots or osseointegrated implants, the magnet is usually cylindrical or dome shaped attached to the fitting surface of the acrylic resin base of the over denture. The magnetic keeper casted to a metal

coping cemented to root surface or screwed over the implant fixture **(Figure14)** (Al qutaibi, 2016).

The retention force of magnet attachments in implant-retained mandibular overdenture treatment is markedly less than the retention force of ball and bar-clip attachments (van Kampen et al., 2003).

Basically, they comprise of one magnet appended to the denture and another to the implant. They comprise a simple and comfortable framework for the patient as magnet attraction guides the denture insertion. Then again, they have a flimsier lateral stability and retention in comparison with mechanic attachments as ball or bar devices (Hindustanwala, 2019).

they are susceptible to corrosion by saliva, explaining why they are clinically less often used (Tokuhisa et al., 2003).

a new generation of rare-earth magnetic attachments could improve their properties and be clinically more often utilized These new attachments may even now be a useful treatment option for edentulous patient with weak muscle disease such as Parkinson's disease patients, because they not only keep the denture stable, but also need less force to insert and remove the denture (Alqutaibi and Kaddah, 2016).

The immediate loading of magnet attachment-retained mandibular implant overdentures is considered as a viable treatment option in cases of complete edentulous patient that increase retention and stability of conventional dentures (Pae et al.,2010).

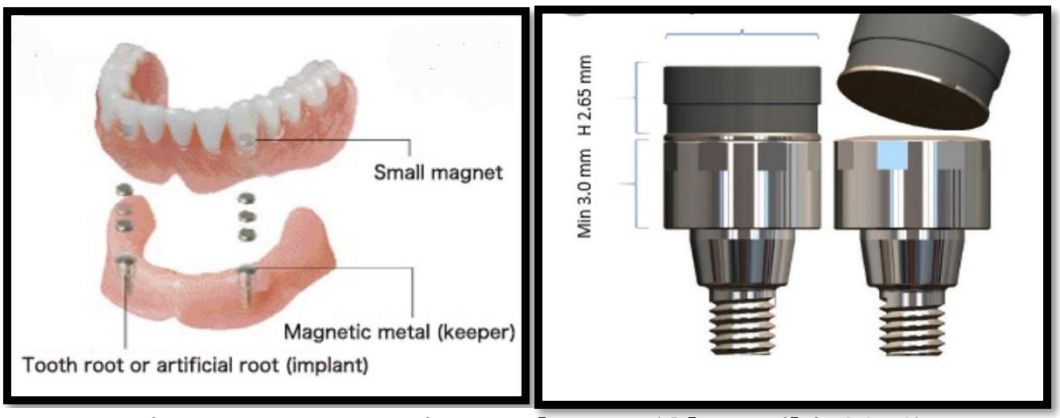

Figure 14: Magnetic attachment (Al qutaibi, 2016).

1.8.3 Bar attachment

The bar attachment consists of a metallic bar that splints two or more implants or natural teeth spanning the edentulous ridge between them and a sleeve (suprastructure) incorporated in the over denture which clips over the original bar to retain the denture. The bar attachments are available in wide variety of forms; they could be prefabricated or custom made **(Figure 15)** (Al qutaibi, 2016).

The primary detriments of bar attachments are the need for a large prosthetic space and the risk of mucositis due to inadequate oral hygiene under the bar. Bars should be parallel to the rotation axis, be straight and be positioned 1-2 mm to the alveolar crest (Hindustanwala et al., 2019).

Bar joints are subdivided into two types:

- ✓ single sleeve, the single sleeve has to run straight without allowing the anteroposterior curvature of the arch, so it is used in square arches.
- ✓ multiple sleeves which can follow the curvature of the arch. It also enables the use of more than one clip. (Yamada,2000).

The prefabricated bars are preferred to milled bars as they are less expensive and more solid with an equal cross section. Prefabricated bars are either round, ovoid or rectangular (U-shaped). Round bars offer more denture rotation than rectangular bars, so produce less torque on implants. However, Round bars require more frequent clip activation than U-shaped, ovoid or rectangular (U-shaped). Therefore, oval or U-shaped bar are preferred when using two implants (Al qutaibi, 2016).

The bar and clip attachments are probably the most widely used attachments for implant tissue supported over dentures as they offer greater mechanical stability and more wear resistance than solitary attachments. In addition, short distal extensions from rigid bars can be achieved which contribute to the stabilization and prevent shifting of the denture (Kakar, 2001).

The assumed advantage of bar attachment is better transmission of forces between the implants due to the primary splinting effect, load sharing, better retention and the least post insertion maintenance (van Kampen et al., 2003).

Figure 15: Bar attachment (Al qutaibi, 2016).

1.8.4 Telescopic attachment

Telescopic crowns are also known as a double crown, crown and sleeve coping (CSC). These crowns consist of an inner or primary telescopic coping, permanently cemented to an abutment, and a congruent detachable outer or secondary telescopic crown, rigidly connected to a detachable prosthesis **(Figure 16)** (Alsiyabi et al., 2005; Klemetti et al., 2003).

These retainers give fantastic retention coming out because of frictional fit between the crown and the sleeve (Langer et al., 2000).

The use of telescopic retainers has been expanded to include implant retained prostheses to make use of their enormous advantages. These retainers provide excellent retention resulting from frictional fit between the crown and the sleeve. They also provide better force distribution due to the circumferential relation of the outer crown to the abutment which make axial transfer of

occlusal load that produce less rotational torque on the abutment by improving the crown root ratio so preserving the tooth and alveolar bone (Keller and Haase, 1991; Hindustanwala, 2019).

According to wall design telescopic retainers can be classified into parallel sided crowns. tapered (conical shaped) crowns and crowns with additional attachments (Kang, 2006).

Telescopic retained restoration has the advantage of the ease of removability, this encourages the patient for repeated cleaning and maintenance purposes. Moreover, the over dentures self-finding mechanism in telescopic constructions facilitated prosthesis insertion which considerably seemed to be an effective treatment modality for geriatric patients with serious systemic diseases as in Parkinson's diseases (Langer et al., 2000; Rothman,2002).

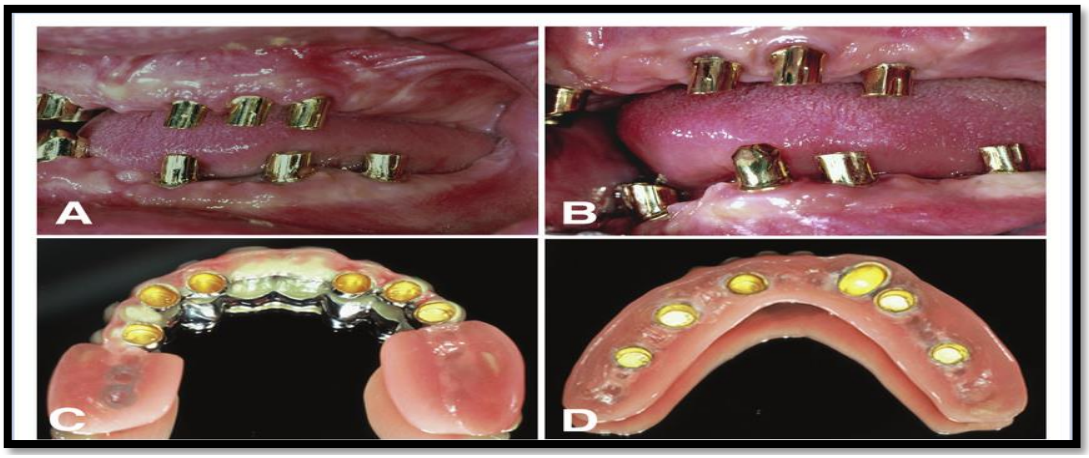

Figure 16 : (A and B) Primary telescopes, right/left. (C and D) Supraconstructions (Alsiyabi et al., 2005).

1.9 Principle of attachment selection for implant supported prosthesis

As we mentioned earlier the successful implant-supported overdenture depends on proper positioning and distribution of the supporting implants. These factors have a direct impact on attachment selection for each particular scenario, this will help the oral surgeon avoid errors of implant positioning and distribution that are related to different attachment assembly designs (Özkurt and Kazazoğlu, 2011).

Learning about the mechanical properties and the load distribution characteristics of different attachments is the easiest way to determine which one to use. Most available attachments demonstrate different levels of resiliency (Oliva et al., 2010).

Attachment resiliency is associated with the movement between the abutment and the prosthesis in a predetermined direction or directions. The more directions or planes in which the prosthesis can move, the less stress is placed on the implant, in turn transferring more forces to the residual ridge. That being said, the attachment is more resilient (Özkurt and Kazazoğlu, 2011).

1.9.1 Factors upon which attachment selection depends

1) Available bone
   - ✓ Patients with advanced resorption of the alveolar ridge are good candidates for bar or telescopic attachment assemblies because these attachments offer considerable horizontal stability.
   - ✓ Patients with minimum alveolar ridge resorption are good candidates for studs or magnetic attachment assemblies. However, magnets provide the least amount of retention compared to the other attachments, and they very soon lose their initial retention capacity.
   - ✓ Studs are ideal for patients with a narrow ridge because in these cases, a bar would interfere with the tongue space.
2) Patient's prosthetic expectation.
3) Financial ability of the patient to cover treatment cost.
4) Personal choice and clinical expertise of dental experience.
5) Experience and technical knowledge of the lab technicians (Özkurt and Kazazoğlu, 2011).

- **Rigid telescopic copings** transfer most of the masticatory force to the supporting implants, but this will increase the risk for implant fatigue and eventual fracture of the implant or its components.

- While using **rigid or minimally resilient attachment** assemblies there is minimum load transfer to the posterior alveolar ridge. Therefore, patients experience the least amount of alveolar bone resorption (Oliva et al., 2010).

1.9.2 Factors influencing the design and resiliency of the attachment assembly

1) Shape of the arch.
2) Distribution of the implants in the arch.
3) Length of the implants and degree of implant-bone interface.
4) Distance between the most anterior and most posterior implants (Özkurt and Kazazoğlu, 2011).

1.9.3 Load Distribution of Stud Attachments vs. a Bar

The in vivo study by Menicucci showed that ball anchors are preferred because they provide better load distribution than bar attachments on the posterior mandibular bone (Menicucci et al., 2007).

Stern et al, through a series of three-dimensional force measurements with two infra-foramina Strauman implants in fully edentulous patients, showed no significant force differences when different attachment assemblies and retention mechanisms were compared (Stern et al., 1996; Özkurt and Kazazoğlu, 2011).

1.9.4 Distal Extension to the Bar

Distal extensions provide a high level of stability against lateral forces, particularly in the mandible, and can protect the denture bearing tissue from loading forces. Distal extensions should not extend beyond the position of first premolar of the mandibular prosthesis, and they cannot compensate for a short central segment. When distal extensions are used, the implants' splinting effects for better force distribution disappear, and the force patterns will be similar to those of unsplinted implants (Özkurt and Kazazoğlu, 2011).

1.10 Use of distal implant to support and increase retention of removable partial denture

Although complete edentulism has decreased, the number of partially edentulous individuals has increased, probably because of the worldwide aging population and oral-health-related prevention policies (Svensson et al., 2011).

According to Curtis 73% of partially edentulous patients present with missing molars and premolars, and 40% of these are classified as Kennedy class I (Curtis et al., 1992).

the design and maintenance of bilateral and unilateral distal extension partial dentures (Kennedy Class I and II) present challenges for clinicians, as these dentures require support from the teeth, the mucosa and the underlying residual alveolar ridges. In particular, the distal extension removable partial denture (RPD) is subjected to vertical, horizontal and torsional forces that may have adverse effects during functional and parafunctional activities (Starr, 2001).

Several prosthetic treatment options are available for partial edentulism, including resin-bonded dental prostheses, fixed dental prostheses retained by teeth or implants, and partial removable dental prostheses (PRDPs), the most commonly used in clinical practice (Carr and Brown, 2010).

When compared with tooth-retained fixed dental prostheses, PRDPs better maintain tooth structure and oral hygiene, are less expensive, and replace a larger number of teeth (Mijiritsky., 2007). However, distal extension PRDPs are associated with some challenges, including the minimization of biomechanical factors (due to resilience differences between the alveolar mucosa and abutment teeth) and limited stability and retention (due to rotational movement during mastication). In addition, discomfort caused by food retention on the residual ridges and the appearance of the clasps are common patient complaints. Periodic relines are also required to maintain the occlusal contacts and to avoid deleterious forces that may increase alveolar reabsorption or damage the abutment teeth (Chikunov et al., 2008).

To prevent displacement of the denture, precision attachments or conventional clasps have been widely used (Turkyilmaz et al., 2009).

Clinical reports have described an increase in the stability of distal extension PRDPs with the use of a few strategically placed implants for retention and support (De Freitas et al., 2012). This therapy provides vertical stabilization for the removable prosthesis and limited rotational movements (Liu et al., 2012).

An implant-retained and -supported PRDP is a feasible and straightforward treatment that improves overall patient satisfaction with respect to retention, comfort, and masticatory capacity (Gonçalves et al., 2014).

Besides the preservation of proprioception, Chikunov reported other advantages related to the implant retained and -supported PRDP, a smaller number of implants, lower cost, fewer time-consuming clinical and laboratory procedures, simplified hygiene when compared with fixed dental prostheses, better distribution of the masticatory loads to the abutment teeth and implants, preservation of residual bone around the implants and remaining teeth, better comfort because of minimal rotational movement, treatment compliance, and possible later conversion into a complete overdenture **(**Chikunov et al., 2008 ; Gonçalves et al., 2014).

To overcome this clinical challenge, single implants may be placed bilaterally at the distal extension of the denture base to minimize the potential for dislodgement of the denture. The chief goal of placing an implant under the posterior-most molar of the distal extension denture base is to stabilize the RPD in a vertical direction. Distal implants effectively convert a Kennedy Class I or II denture to a Kennedy Class III denture. Therefore, a tooth and implant-supported RPD which have the benefits of being:

1) cheaper (because fewer implants are needed)
2) more stable
3) may therefore be a better option for patients with limited financial resources than an implant-supported fixed partial denture (Turkyilmaz et al., 2009).

Uludag and Celik suggested using a distal single implant to provide extra support and retention and to prevent major complications such as swallowing or aspiration (Uludag and Celik, 2007).

1.11 Orbital, nasal, and auricular prosthesis

Maxillofacial prosthetics is defined as that branch of prosthodontics concerned with restoration and replacement of both of stomatognathic and associated facial structures by artificial substitutes that may or may not be removed. Rehabilitation includes treatment of acquired or congenital defects affecting various facial structures which otherwise leads to severe depression (Jenny and Singh, 2018).

Various factors such as size, location and severity of defect, patient's age and satisfaction and lastly economical aspect govern the choice and success of prosthesis. The ultimate goal of the treatment is to create an illusion by developing such a prosthesis for the lost part that would improve the standard of living of the patient (Karthikeyan, 2014).

Retention of prosthesis on the face is the most important factor in creating a useful prosthesis for the patient. Before the dawn of the era of osseointegrated implants, mechanically retained prosthesis using patient's anatomy of defect and undercuts followed by use of bio adhesives majorly governed retention of prosthesis (Wright et al., 1999).

Bar or magnetic abutments are commonly employed retentive measures for implant supported craniofacial prostheses. Bar attachments offer more support and stability when compared to magnetic attachments, but hygiene is a constraint (Saini et al., 2019).

The advisable osseointegration period is 3 months for the auricular region and 6 months for the nasal and orbital region. Osseointegrated implants have many advantages compared to conventional retention methods in maxillofacial prostheses. There are three factors which may affect the outcome of the extraoral implants- the quality and volume of the bone, hygiene condition, and radiation therapy in cases of carcinoma (Saini et al., 2019).

Implant failure, if occurs, is usually attributed to weak or no primary stability of the implant during insertion. Previous studies reported that the mastoid process has the best bone quality in the facial skeleton to achieve primary stability. Extraoral implants are a successful option but should be planned considering the general health condition of the patient and the administered dose for radiotherapy before proceeding with maxillofacial prostheses (Byrne, 2017).

Widely commercially available osseointegrated implant retention systems, (Bar-clip, O-ring or magnets) were considered in maxillofacial prosthesis, Bar-clip has been the choice for most of auricular and nasal prosthesis (Saini et al., 2019).

1.11.1 Orbital Prosthesis

For orbital region, magnet retention has emerged as retentive aid has as magnets are less stressful in comparison to bar-clip and may allow longer implant useful life, but it depends on the bone quality prior to the implant installation (Byrne, 2017).

For an orbital defect, the superior, lateral, and inferior orbital rims are possible sites for 3 or 4 mm implants. Ideally three or four implants are needed. The long axes of the implants should be directed toward the center of the orbit **(Figure 17)**. Normally, the anterior position of the ocular prosthesis is 5 to 8 mm posterior to the supraorbital rim, 0 to 2 mm posterior to the infraorbital rim, and 8 to 12 mm anterior to the lateral orbital rim. It may be necessary to use the medial walls of the defect for additional retention and stability (Gary and Donovan, 1993; Saini et al., 2019).

Figure 17: Superior, Lateral and inferior orbital rims are favourable sites for implant placement (Saini et al., 2019).

1.11.2 Nasal Prosthesis

For a nasal defect, the anterior surface of the maxilla just inferior to the nasal cavity offers sufficient thickness of bone and an optimal position for 4 mm implants. The septal cartilage must be surgically reduced anteriorly. This procedure will provide room for the prosthesis to engage the lateral walls of the defect and increase the stability of the prosthesis. A minimum of two implants are required, positioned in each lateral rounded nasal eminence **(Figure 18)**. Because the implants are not evenly distributed and are located in one part of the defect, the abutments are connected by a bar. The bar can be extended superiorly 10 to 15 mm from the abutments for better distribution of retention for the prosthesis (Saini et al., 2019).

Figure 18: Anterior part of maxilla or lateral rounded eminence serve as preferred sites for implant placement (Saini et al., 2019).

1.11.3 Auricular Prosthesis

The temporal bone has sufficient thickness to accept a 3 or 4 mm implant. The abutments must exit the skin beneath the concha of the anticipated prosthesis so that the contours of the prosthetic ear are not compromised. A minimum of two implants are needed, positioned approximately 18 mm from the center of the external auditory meatus and 15 mm from each other. This design permits better support, stress distribution, and retention of the prosthesis. The abutments are joined by a bar constructed in a C-shaped design to improve the stability

and retention of the prosthesis **(Figure 19)**. The bar can be extended 10 to 15 mm beyond the abutments for better distribution of stability and retention (Saini et al., 2019).

Figure 19:Implants with abutments joined through bar in C-shape(Saini et al., 2019).

1.12 Difference in retention between different types of attachment

The retentive force of the locator, ball and magnetic attachments is gained through mechanical interlocking, frictional contact or magnetic forces of attraction between the patrices and matrices (Al qutaibi, 2016; Becerra and MacEntee, 1987). study was done to compare the retention of bar/clip, ball and magnet attachment in mandibular implant retained over denture. The ball and socket attachment recorded the highest value followed by the bar/clip then the magnet attachment (van Kampen et al., 2003; Al qutaibi, 2016). The retention force of magnet attachments in implant-retained mandibular overdenture treatment is markedly less than the retention force of ball and bar-clip attachments (van Kampen et al., 2003).

Chapter Two

Conclusion

1) Implant supported overdenture is more stable, retentive and improves the mastication and speech dramatically.
2) The attachment retained implant supported over denture solves the problems inherited with conventional denture.
3) Overdenture use is a cheaper treatment than fixed prosthesis.
4) Overdenture use will prevent future aesthetic or phonetic problems in cases with lip support loss.
5) The selection of attachment system depends on amount of retention needed, available inter arch space, manual dexterities of the patient and skills of the dentist.
6) Distal implants with locater abutments provided extra support and retention and prevented dislodgement of the patient's distal extension RPD.
7) Implants are the first choice for auricular prosthesis to increase retention, the bar-clip system was the most chosen. In ocular and nasal regions, either bar-clip or magnets may be selected.

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