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Basic principles of clasp design of cr co RPD

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صدق الله العظيم

Certification of the Supervisor

I certify that this project entitled **"Basic principles of clasp design of cr co RPD"** was prepared by the fifth-year student **Ahmed Aqeel Abdulkareem** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Signature

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Dedication

I dedicate this research to my family who have always believed in me and supported me throughout my life. Also, my friends for being there for me.

Acknowledgment

First of all, I thank God Almighty, who blessed me with wisdom, patience, and willpower to reach this level in my life.

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Table of Contents

Subjects		Page No.
Certification of the Supervisor		I
Dedication		II
Acknowledgment		III
List of Contents		IV
List of Figures		V
List of Abbreviations		VI
Introduction		1
Aim of the review		3
Chapter One: Review of literature		**4**
1.1	Terms and defenitions of clasp retainer	4
1.1.1	Structures of clasp assembly	4
1.2	Clasp Design	7
1.2.1	Basic principles of Clasp design	7
1.3	Classification of clasps	10
1.3.1	Classification of clasps according to clasp location on tooth	10
1.3.2	Classification of clasp with or without movement accommodation	12
1.4	Functional requirement of clasp	18
1.5	Length and diameter of clasp	19
1.6	Prosthodontics opinion on clasp design	20
1.7	The effect of clasp design on gingival health	22
Chapter Two: Conclusions		24
References		25

List of Figures

Figure No.	Figure title	Page No.
1.1	Clasp assembly	5
1.2	The retentive terminal	6
1.3	The reciprocal element	6
1.4	The principle of encirclement	8
1.5	Mechanical law of the reciprocal and retentiveelements	10
1.6	Example of different clasp design	11
1.7	Extracoronal circumferential direct retainer	13
1.8	Length of clasp	19

List of Abbreviations

RPD	**Removable partial denture**

Introduction

Numerous treatment options exist to restore the partially edentulous mouth. Removable partial dentures (RPD) are an effective and affordable treatment modality to restore function and aesthetics **(Beaumontor and Arthur , 2002)**

Several types of polymers and metal alloys could be used in the construction of RPDs, Clasps are the most commonly used direct retainers for the RPDs and they are frequently made from the same alloy as the metal framework.

The flexible clasp tip engages the undercut of the abutment in order to provide retention, The components of any clasp assembly must fulfil at least six biomechanical requirements, namely retention, stability, support, reciprocation, encirclement and passivity, In addition, the clasp assembly must ideally not affect aesthetics adversely **(Khan and Geerts, 2005).**

The most commonly used alloys for RPDs are cobalt-chromium (Co-Cr), gold andtitanium alloys, although they are not aesthetically pleasing, Since their commercial launch 80 years ago, Co-Cr alloys have undergone several modifications, There has been an increase in the use of such alloys and they are currently the most current material of choice for RPD metal frameworks **(De Delgado *et al*, 1985).**

Co-Cr alloys can be generally described as alloys that have high strength, are heat- resistant and non-magnetic, and have favorable resistance to wear, corrosion, and tarnish **(Al Jabbari and Youssef, 2014).**

They possess excellent biocompatibility and corrosion and tarnish resistance, while the high modulus of elasticity (E) provides the requisite strength and rigidity

without the need for heavy cross-sections, thus reducing the weight of metalsubstructures **(Viennot *et al,* 2005).**

Aim of the review

The aim is to study the clasp design of cr\co as a part of having appropriate RPD design for RPD patients.

Review of literature

1.1 Direct retainer (Clasps):

A direct retainer is a unit of a removable partial denture that engages an abutment tooth in such a manner as to resist displacement of the prosthesis away from basal seat tissues, It is usually composed of a retentive arm, a reciprocal (bracing)element or arm, a rest and a minor connector **(loney, 2011).**

The clasp is the component of the clasp assembly that engages a portion of the tooth surface and either enters an undercut for retention or remains entirely above the height of contour to act as a reciprocating element, The part of the clasp assembly that enters an undercut for retention is frequently called the retentive clasp arm **(Louis and mosby, 1994).**

1.1.1 structures of a clasp assembly

To function effectively, a retentive arm must be accompanied by other structural elements, when combined, these structural elements form a clasp assembly.

A properly designed clasp assembly has the following parts: (1) a rest, (2) a retentive arm, (3) a reciprocal element, and (4) one or more minor connectors **(Phoenix *et al,* 2003)** (figure 1.1)

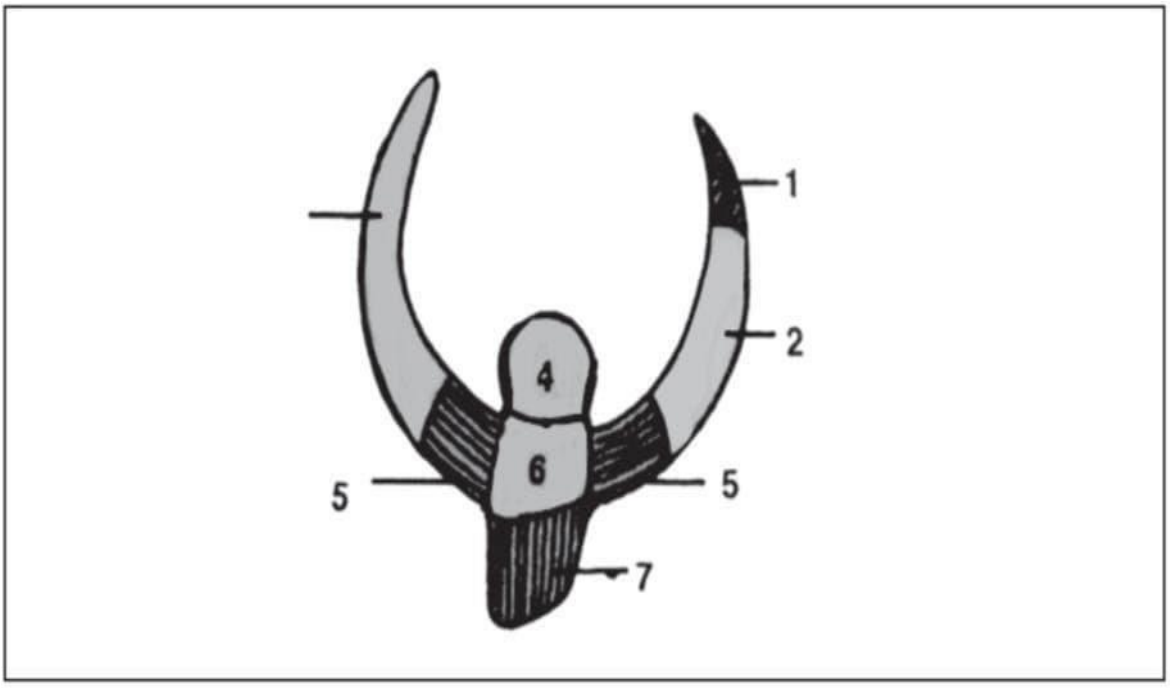


Figure 1.1. clasp assembly : (1) Retentive terminal (2) Retentive clasp arm (3) Reciprocal arm (4) Occlusal rest (5) Shoulder (6) Body (7) Minor connector (Nallaswamy and Deepak, 2017)

1) rest: The component of a clasp that provides vertical support for the prosthesis is called a rest The portion of the abutment prepared to receive therest is a rest seat , Properly prepared rest seats and the corresponding rests serve to :

a) Resist displacement of the prosthesis toward the supporting tissues.

b) Transmit functional forces parallel to the long axes of the abutments. Since forces acting on a removable partial denture may be substantial, the structural integrity of each rest is critical. Therefore, each rest must be rigidly joined to the remainder of the framework in order to resist fracture (Prothero and James, 1928)

2) A retentive arm is the only portion of a removable partial denture that contacts the surface of an abutment apical to the height of contour **(Phoenix *et al*, 2003)** (Figure 1.2).

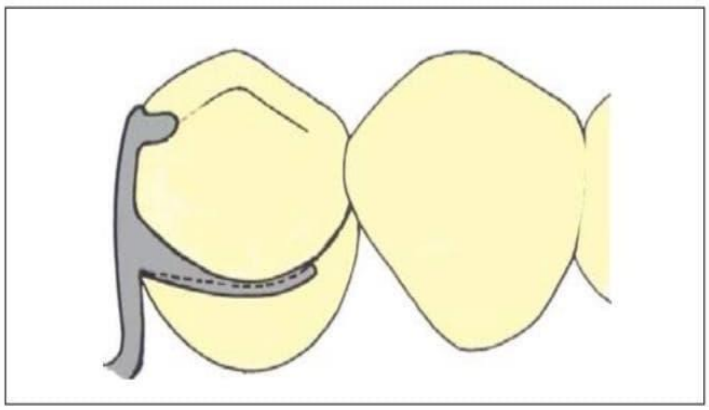


Figure 1.2 The retentive terminal (the only flexible component of the clasp) is theonly component that crosses the height of contour during insertion and removal (Nallaswamy and Deepak, 2017).

2) reciprocal elemnt : The component of a clasp assembly that braces an abutment during prosthesis insertion and removal . Regardless of form, the reciprocal element must contact the abutment tooth at or occlusal to the height of contour **(Phoenix *et al*, 2003)** (figure 1.3).

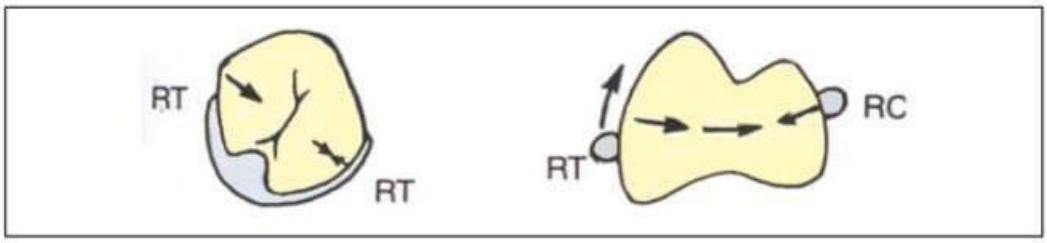


Figure 1.3 The reciprocal arm (RC)serves to counter act the forces of the retentivearm (RT) and stabilize the abutment (Nallaswamy and Deepak, 2017)

3) minor connector often join elements of a clasp assembly to other components of a removable partial denture Hence, it must be rigid. Depending on the philosophy of design, a minor connector may serve as (a) a guiding plate to direct insertion and removal of the removable partial denture, (b) a reciprocal element to counteract non-axial forces produced by a retentive clasp, or (c) an approach arm for an infrabulge clasp **(Phoenix *etal*, 2003).**

1.2 clasp design

1.2.1 Basic principles of clasp design:

The clasp assembly serves a similar function for a removable partial denture that aretainer crown serves for a fixed partial denture, both must encircle the prepared tooth in a manner that prevents movement of the tooth separate from the retainer. To borrow from a fixed prosthodontic term, limiting the freedom of displacement refers to the effect of one cylindrical surface (the framework encircling the tooth) on another cylindrical surface (the tooth), It implies that the curve that defines the framework is properly shaped if it prevents movement at right angles to the tooth axis.

This basic principle of clasp design offers a two-way benefit:

First, it ensures the stability of the tooth position because of the restraint from encirclement, and **second,** it ensures stability of the clasp assembly because of the controlled position of the clasp in three dimensions,Therefore the basic principle ofclasp design, referred to as **the principle of encirclement**, means that more than 180 degrees in the greatest circumference of the tooth, passing from divergingaxial surfaces to converging axial surfaces, must be engaged by the clasp assembly **(Carr *et al* ,2010)** (figure 1.4).

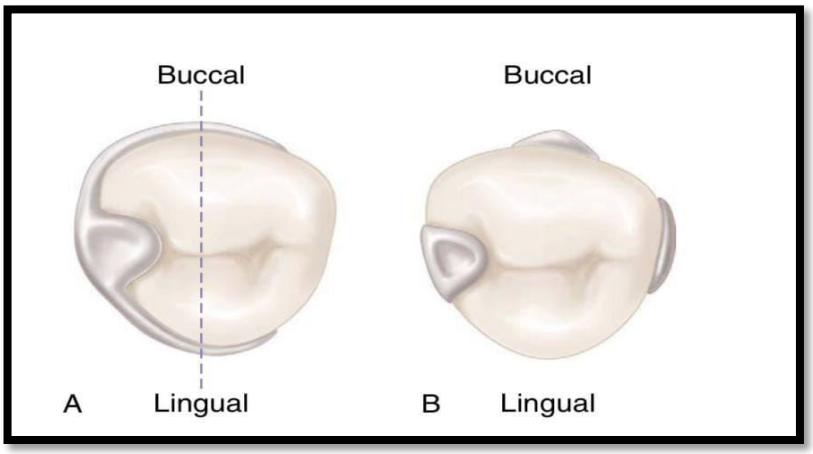


Figure 1.4: A, Line drawn through the illustration represents 180 degrees of greatest circumference of abutment from the occlusal rest, if respective arms of the retainer were not extended beyond the line, the abutment tooth could be forced away from the retainer through torquing action of the clasp. B, Bar-type clasp assembly engagement of more than180 degrees of circumference of the abutment is realized by the minor connector for the occlusal rest, the minor connector contacting the guiding plane on the distal proximal surface, and the retentive bar arm. (Carr *et al* ,2010)

The engagement can occur in the form of continuous contact, such as in

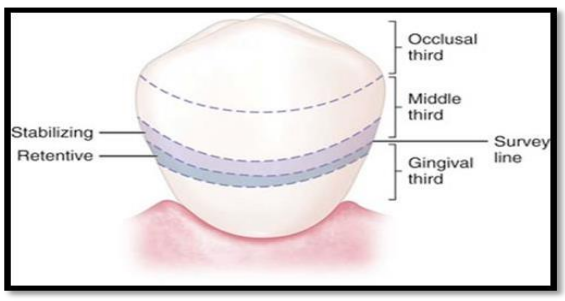
a circumferential clasp, or discontinuous contact, such as in the use of a bar clasp. Both provide tooth contact in at least three areas encircling the tooth: the occlusal rest area, the retentive clasp terminal area, and the reciprocal clasp terminal area.

In addition to encirclement, other basic principles of clasp design are as follows:

1. The occlusal rest must be designed to prevent movement of the clasp armstoward the cervical.
2. Each retentive terminal should be opposed by a reciprocal component capable of resisting any transient pressures exerted by the retentive arm during placement and removal. Stabilizing and reciprocal components must be

rigidly connected bilaterally (cross-arch) to realize reciprocation of the retentive element.

3. Clasp retainers on abutment teeth adjacent to distal extension bases should be designed so that they will avoid direct transmission of tipping and rotational forces to the abutment. In effect, they must act as stress-breakers, either by their design or by their construction. This is accomplished through proper location of the retentive terminal relative to the rest, or by the use of a more flexible clasp arm in relation to the anticipated rotation of the denture under functional forces.
4. Unless guiding planes will positively control the path of removal and will stabilize abutments against rotational movement, retentive clasps should be bilaterally opposed (i.e., buccal retention on one side of the arch should be opposed by buccal retention on the other, or lingual on one side opposed by lingual on the other). In Class II situations, the third abutment may have buccal or lingual retention. In Class III situations, retention may occur bilaterally or may be diametrically opposed.
5. The path of escapement for each retentive clasp terminal must be other than parallel to the path of removal for the prosthesis to require clasp engagement with the resistance to deformation that is retention.
6. The amount of retention should always be the minimum necessary to resist reasonable dislodging forces.
7. Reciprocal elements of the clasp assembly should be located at the junction of the gingival and middle thirds of the crowns of abutment teeth. The terminal end of the retentive arm is optimally placed in the gingival third of the crown, these locations permit better resistance to horizontal and torquing



forces caused by areduction in the effort arm **(Carr *et al* ,2010)** (Figure 1.5).

Figure 1.5 : Simple mechanical laws demonstrate that the nearer stabilizing-reciprocal and retentive elements of direct retainer assemblies are located horizontal to the axis of rotation of the abutment, the less likely it is that physiologic tolerance of the periodontal ligament will be exceeded. The horizontal axis of rotation of the abutment tooth is located somewhere in its root (Carr *et al*., 2010).

1.3 classification of clasps

1.3.1 According to the clasp location on tooth :

1) suprabluge clasps:

(or occlusaly approaching circumferential or encircling clasps) (figure 1.6) is defined as a retainer that encircles a tooth by more than 180°, including opposite angles, and which generally contacts the tooth throughout the extentof the clasp, with at least one terminal located in an undercut area. **(Prakash etal., 2017).**

2) Infrabulge clasps (gingivally approaching or bar clasp):

Gingivally approaching clasp or bar clasp (figure 1.6) is defined as a clasp retainer whose body extends from a major connector or denture base, passing adjacent to the soft tissues and approaching the tooth from a gingivo-occlusal direction **(Prakash et al., 2017).**

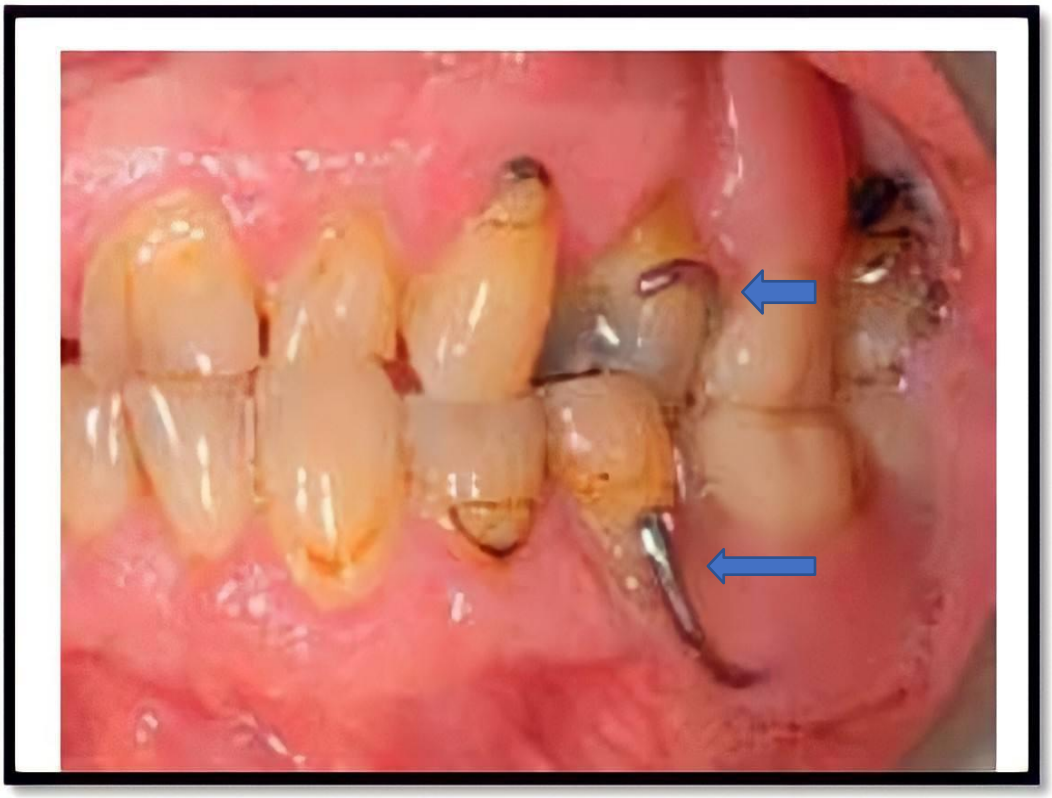


figure 1.6 . Examples of different clasp designs. An occlusally approaching clasp was chosen for UL4 and a gingivally approaching clasp for the LL5 owing to the differing positions of the undercuts and survey lines on these teeth. (lynch,2004)

For cobalt-chromium clasps, only the terminal one-third of the clasp should be engaged in an undercut – something which will determine if a mesial-facing or distal-facing 'three-armed' or 'ring clasp', or a gingivally approaching clasp, will be used. The horizontal depth of the undercut must also be considered: engaging an inappropriate metal in too deep an undercut can lead to difficulties removing a clasp, or lead to strain and permanent deformation of a clasp **(Lynch, 2017).**

Premolars have less Mesiodistal width than molars (about 7 mm), so clasps on premolars won't be so long as they are on molars teeth.

Cr Co alloy is very rigid especially if it is very short So occlusally approaching clasps made of Cr-Co alloy won't be of enough length neither flexibility nor retention when placed on premolars.

For molars we can go for occlusally approaching clasps, for premolars we can go for either gingivally approaching clasps or wrought wire clasps **(Davenport et la., 2001).**

1.3.2 With or without movement accommodation:

1) Clasps Designed Without Movement Accommodation

a) Circumferential Clasp Although a thorough knowledge of the principles of clasp design should lead to a logical application of those principles, it is better when some of the more common clasp designs are considered individually , The circumferential clasp will be considered first as an all- cast clasp.

The circumferential clasp is usually the most logical clasp to use with all tooth-supported partial dentures because of its retentive and stabilizing ability , Only when the retentive undercut may be approached better with a bar clasp arm or when esthetics will be enhanced should the latter be used.

Characteristic and design:

- the simplest clasp (clasp of choice in tooth-borne cases).

- clasp assembly has one retentive arm opposed by a reciprocal arm originating from the rest.
- the retentive arm begins above the height of contour, and curves and tapers to its terminal tip, in the gingival 1/3 of the tooth, well away from the gingiva. (figure 1.7)

- the bracing arm is in the middle 1/3 of the tooth. **(Carr *et al* ,2010)**

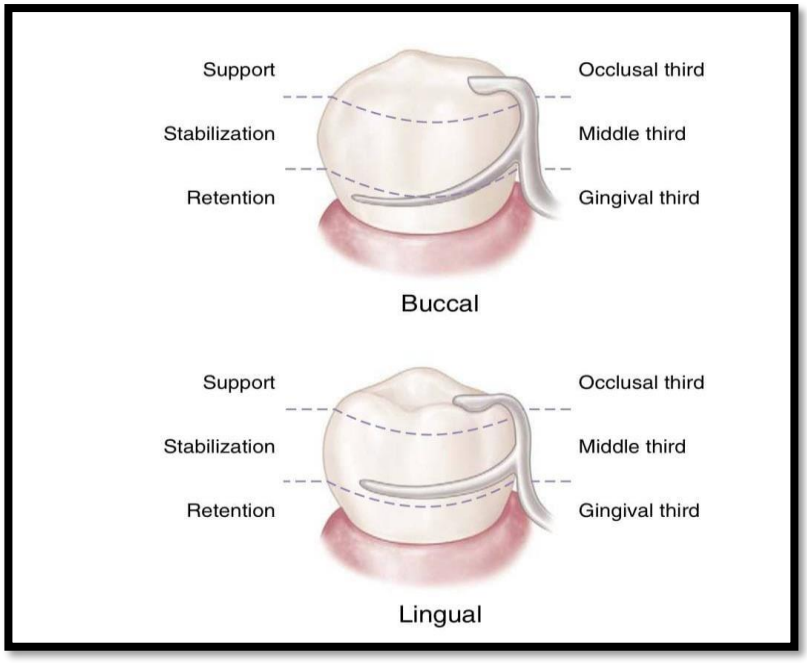


Figure 1.7 Extracoronal circumferential direct retainer)Carr *et al* ,2010)

Advantages:

1. Excellent bracing qualities.
2. Easy to design and construct.
3. Less potential for food accumulation below the clasp compared to bar clasp.

disadvantages:

1. More tooth surface is covered than with a bar clasp arm because of its occlusal origin.
2. more metal may be displayed than with the bar clasp arm.
3. 3.Difficult to adjust.

b) Ring clasp

Characteristic and design:

- Encircles nearly the entire abutment tooth
- Usually used with mesially and lingually tilted mandibular molars
- The undercut is (i.e. adjacent to edentulous span)
- Should always be used with a supporting strut on the non-retentive side with an auxiliary occlusal rest on the opposite side. Omission of the supporting strut will allow the clasp arm to open and close with minimumor no reciprocation.
- Use a cast circumferential clasp with lingual retention and buccal bracing

Disadvantages:

a. Covers a large area of tooth surface, therefore requiringmeticulous hygiene

b. Very difficult to adjust due to the extreme rigidity of the reciprocal arms

c. The lower bracing arm should be at least 1 mm from the free gingival margin and relieved to prevent impingement of the gingival tissues.

Contraindications: excessive tissue undercuts prevent the use of a supporting strut. **(carr et al., 2010)**

c) Embrasure (Double Akers) Clasp:

Used In the fabrication of an unmodified Class II or Class III partial denture, no edentulous spaces are available on the opposite side of the arch to aid in clasping.

Characteristic and design:

- Two rests, two retentive arms, and two bracing arms.
- Double rests with definite shoulders to prevent weakening of clasp arms, separation of teeth and food impaction.

Disadvantages:

- Extensive interproximal reduction is usually required.
- Covers large area of tooth surface - hygiene considerations.

(loney, 2011).

d) “C" clasp (Hair-pin or Reverse action)

Charachteristics and design:

- The retentive area (undercut) is adjacent the occlusal rest.
- The upper arm is a minor a connector givingrise to tapered lower arm.

Advantages:

Allows use of undercut adjacent to edentulous space.

Disadvantages:

a. Almost impossible to adjust.
b. Non-esthetic.
c. Difficult to fabricate so the upper portion of the retentive armclears the opposing. occlusion
d. Covers extensive tooth surface and acts as a food trap.
e. Insufficient flexibility on short crowns due to insufficient clasparm length. **(donovan et al., 2001)**

2) Clasps Designed to Accommodate Functional Movement:

Clasp assemblies that accommodate functional prosthesis movement are designed to address the concern of a Class I lever. The concern is that the distal extension acts as a long "effort arm" across the distal rest "fulcrum" to cause the clasp tip "resistance arm" to engage the tooth undercut. This results in harmful tipping or torquing of the tooth, which is greater with stiff clasps and increased denture base movement. **(carr et al., 2010)**

a) Bar Clasps

Charachteristics and design :

- The bar clasp is a cast clasp that arises from the partial denture framework and approaches the retentive undercut from gingival direction (as opposed to a circumferential clasp that approaches the undercut from the occlusal direction).
- Retentive clasps are identified by shape of retentive terminal,

i.e. T, Y, L, I, U, and S.

- The shape is unimportant as long as the direct retainer is mechanically and functionally stable, covers minimal tooth structure with minimum display (the I bar most often meets these requirements)

Contraindications:

a) deep cervical undercuts - food trap or impingements result
b) severe soft tissue or bony undercuts - food trap or impingements result
c) insufficient vestibular depth for approach arm (requires 4 mm - 3 mm from free gingival margin, 1 mm for thickness of the approach arm)
d) pronounced frenal attachments in area – impingement

The R-P-I Clasp

1. The components of this clasp assembly are:
   "R" - rest (always mesial) , "P" - proximal plate , “I”-I-bar

- The rest is located on the mesio-occlusal surface of a premolar or mesiolingual surface of a canine.
  The minor connector is located in the mesio-lingual embrasure but is not in contact with the adjacent tooth (prevents wedging).
- The proximal plate is located on a guide plane on the distal surface of the tooth.

The plate is approximately l mm. thick and joins the framework at a rightangle.

- The I-bar clasp is located on the buccal surface of the premolar and on the mesiobuccal surface of the canine ,The I-bar originates at the gridwork and approaches the tooth from the gingival direction,The bend in the I-barshould be located at least 3 mm. from the gingival margin, This distance will prevent food entrapment and provide the length for the necessary flexibility in the clasp arm, The clasp is usually cast and is placed just below the height of contour line.

b) Aker clasp (RPA)

It consists of a mesial occlusal rest, proximal plate and a circumferential clasp arm, which arises from the superior portion of the proximal plate and extends around the tooth to engage the mesial undercut.

c) Combination Clasp The combination clasp is similar to the cast circumferential clasp with the exception that the retentive arm is fabricated from around wrought wire (platinum-gold-palladium alloy or chromecobalt alloy). **(Phoenix *et al*, 2003)**

1.4 Functional Requirements of a Clasp

The functional requirements of a clasp include:

- Retention
- Stability
- Support
- Reciprocation
- Encirclement
- Passivity

Each of these functional requirements are provided by various components in a clasp, The clasp and its parts should be designed appro- priately to achieve the functional requirement.

Retention is that quality inherent in the prosthesis which resists the force of gravity, the adhesiveness of foods, and the forces associated with the opening of the jaws **(Gupta et al., 2015).**

Retention is the most important function of the clasp; hence, it is the most important func- tional requirement. The purpose of a clasp is lost if the retention is lost, Retention is provided by the retentive arm of the clasp **(Nallaswamy and Deepak, 2017).**

1.5 length and diameter of the clasp :

Length :

1) increased length increases flexibility (increasing clasp curvature increases length). (figure 1.8)

2) length is measured from the point where the taper begins.

3) length may be increased by using curving rather than straight retentive arms.

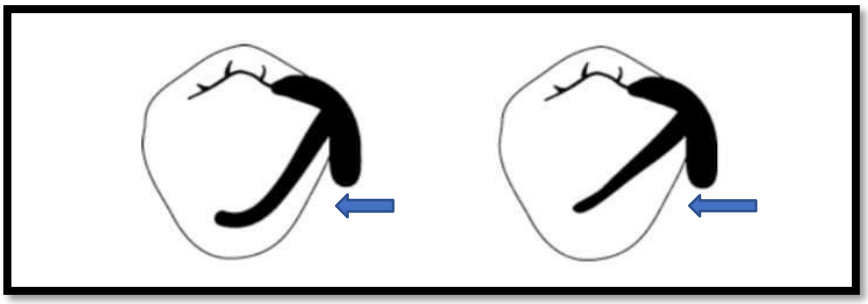


Figure 1.8 : increasing clasp curvature increases length. (loney, 2011)

Diameter

1) diameter is inversely proportional to flexibility.

2) in a uniform taper the average diameter lies midway.

3) if the taper is not uniform a point of flexure will exist at the narrowed area,weakening the clasp arm (possible fracture area)

4) the point of flexure determines flexibility regardless of average diameter **(loney, 2011).**

1.6 Prosthodontic opinion on clasp design

The experts' comments on these principles have been incorporated into the discussions that follow :

1) A clasp should always be supported by a rest

A clasp should be supported to maintain its vertical relationship to the tooth, Without such support the clasp will tend to move gingivally.

2) If an undercut on a tooth, which needs to be clasped for retention, is less than 0.25 mm, then composite resin should be added to the tooth to create atleast this amount of undercut.

The modification of tooth contour with composite resin is a conservative, simple, durable and effective way of creating undercut for clasping where no, or inadequate, undercut exists.

The composite resin should cover a broad area of the tooth surface so that it can be shaped to blend smoothly with the tooth contour .

3) A retentive clasp should be at least 15 mm in length if it is constructed incast cobalt chromium alloy

For the retentive tip of a cobalt chromium clasp to flex 0.25 mm without deforming permanently, it needs to be about 15 mm in length, This length can usually be achieved with an occlusally-approaching clasp on a molar tooth, and a gingivally-approaching clasp on any tooth.

4) Occlusally-approaching retentive clasps should be restricted to molar teeth if constructed in cast cobalt chromium alloy

An occlusally-approaching clasp on a molar tooth will be about 15 mm in length, but on a premolar or canine tooth will be considerably less than this.

5) Retentive clasps should usually be placed lingually on lower molar teeth**.**

6) Retentive clasps should usually be placed buccally on lower premolar or canine teeth.

7) Reciprocation should be provided on a clasped tooth diametrically opposite the retentive clasp ti.

The most effective location for a reciprocating component is:

A) On the clasped tooth

B) Diametrically opposite the retentive tip of the clasp. However, (a) is more important than (b) although the further that the reciprocation is from the ideal position the greater is the potential for tooth or denture movement resulting in reduced retention..

8) A gingivally-approaching clasp should be used if a retentive cast cobalt chromium clasp is required on a premolar or canine tooth, assuming that sulcus anatomy is favourable.

A gingivally-approaching clasp is an appropriate choice under such circumstances as it can be made long enough to achieve adequate flexibility.

9) Rather than making a design statement this section poses a question: 'What is the preferred number of clasps for RPDs restoring each of the Kennedy classes of partially dentate arch?

prosthodontists preferring 2, 3 or 4 clasps for each of the Kennedy classes. For all of the Kennedy classes the use of two clasps is the most popular choice for RPD retention.

Two clasps are advantageous because:

a. Simple denture designs are often better tolerated and minimize tissue coverage.
b. Two clasps usually generate sufficient retention.
c. A pair of clasps creates a clasp axis that can be positioned to bisect the denture and allow indirect retention to be obtained **(Davenport et al., 2001)**

1.7 The Effect of clasp design on gingival health

A comparison has been made of the effects on the gingivae of occlusally and gingivally approaching clasps.

The effect on the gingivae has been assessed by measuring plaque accumulation, crevicular temperature and microbial distribution in patients and students wearing appliances, Habitual and nil oral hygiene regimes have been used to demonstrate changes.

It was concluded that the gingivally approaching clasp is potentially damaging. **(Bazigran et al., 1987).**

While in Periodontally involved tooth – ideally only the terminal third of theocclusally approaching clasp should be below the survey ine. Unfortunately , in most of the cases we can't achieve this, so that more than the terminal third of the clasp will be below the survey line, and this will lead to displacing forces and harmful effect on abutment tooth This is why we prefer Gingivally approaching clasps over occlusally approaching ones when we have Periodontally involved teeth , because in Gingivally approaching clasps only the tip contacts the tooth and this lead to less displacing forces on the abutment tooth **(Davenport et al., 2001).**

The frequency of hygiene recalls should be tailored to the individual patient's needs and ability to keep plaque under control. A very important aspect of recall appointments is prosthetic maintenance. Ill-fitting denturesor malocclusion can alter the function of the RPD and cause undesirable stress and pressure on the remaining teeth and soft tissues **(Yeung et al., 2000).**

Conclusions

1. Cr co clasp has been used for many years and has proved his efficiency.
2. There are many types of clasp that has their own advantages anddisadvantages so the selection of the type will be according to the case.
3. Learning clasp design is very important to have appropriate retention andeventually a good denture for the patients.

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