قسم طب الاسنان

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صناعة اسنان – المرحله الثالثه

Introduction to Removable Partial Dentures

Partial Dentures:

A removable partial denture or a fixed partial denture that restores a partially edentulous arch; a partial denture can be described as a removable partial denture or a fixed partial denture based on the patient's capability to remove or not remove the prosthesis, respectively.

I. Removable Partial Denture (RPD):

A removable denture that replaces some teeth in a partially edentulous arch; the removable partial denture can be readily inserted and removed from the mouth by the patient.

It is either ***acrylic*** type or ***metallic*** type (cobalt/chrome).



Acrylic RPD



Metallic type (cobalt/chrome) RPD

Partial denture construction: The science and techniques of designing and constructing partial dentures.

Removable prosthodontics:

The branch of prosthodontics concerned with the replacement of teeth and contiguous structures for edentulous or partially edentulous patients by artificial substitutes that are readily removable from the mouth by the patient.

Objectives for RPD construction:

1. Restore esthetic (especially for anterior teeth).

2. Restore function (phonetic and mastication) for proper speech, proper occlusion and proper food mastication.

3. To prevent apposing teeth extrusion or migration and tilting of adjacent teeth.
4. To fill empty space or spaces.
5. Prevent disease atrophy by a form of stimulation to the underlying tissue and ridge.
6. For proper muscular balance.
7. To restore the psychological status of the patient.

Causes of teeth loss:

1. Caries (main cause in a young people below 35 years).
2. Periodontal diseases (main cause in old people above 35 years).
3. Trauma or accident (such as receiving a blow or falling down on them).
4. Congenital missing teeth.

Indications of removable partial dentures:

1. Distal extension situations (free end situation).
2. Long span tooth-bounded edentulous area.
3. Need for cross-arch (bilateral) stabilization.
4. Excessive loss of the residual ridge.
5. Unusually sound abutment teeth.
6. If the prognosis of remaining teeth is questionable or reduced periodontal support of remaining teeth (these teeth cannot support fixed prostheses).
7. After recent extraction (need immediate replacement of extracted teeth).
8. Patient younger than 18 years old.
9. Economic consideration.

II. Fixed partial denture:

Any dental prosthesis that is luted, screwed, or mechanically attached or otherwise securely retained to natural teeth, tooth roots, and/or dental implants/abutments that furnish the primary support for the dental prosthesis and restoring teeth in a partially edentulous arch; it cannot be removed by the patient.

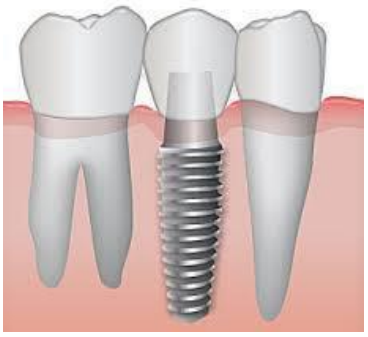


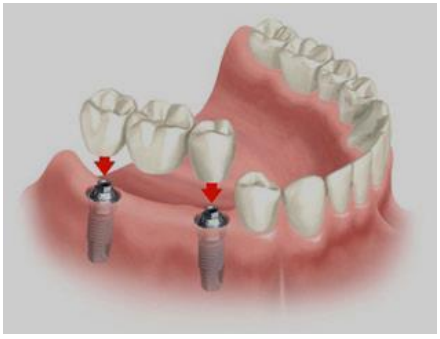
Indications for fixed partial denture:

1. Unilateral bounded edentulous short span.
2. Class IV Kennedy classification with normal loss of bone.
3. Modification area located anteriorly with Class I or with Class II Kennedy classification for simplifies the design of removable partial denture.

III. Dental implant therapy:

A prosthetic device made of alloplastic material(s) implanted into the oral tissues beneath the mucosal and/or periosteal layer and on or within the bone to provide retention and support for a fixed or removable dental prosthesis.





The dental implants are considered adjuncts in fixed and removable therapy. However, not all patients are candidates for dental implant therapy.

Contraindications for dental implant therapy

1. Unfavorable regional anatomy.
2. Uncontrolled systemic disease.
3. Extreme surgical risk.
4. High-dose head and neck radiation.

Terminology and definitions

Denture supporting structures: The tissues (teeth and/or residual ridges) that serve as the foundation for removable partial or complete dentures.

Diagnostic cast: A life-size reproduction of a part or parts of the oral cavity and/or facial structures for the purpose of study and treatment planning.

Support: The foundation area on which a dental prosthesis rests; with respect to dental prostheses, the resistance to forces directed toward the basal tissue or underlying structures.

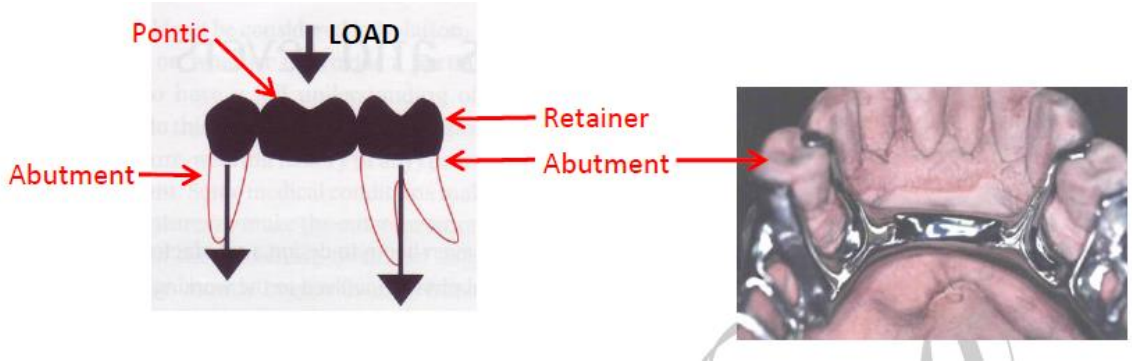
Stability: The quality of a complete or removable partial denture to be firm, steady, or constant, to resist displacement by functional horizontal or rotational stresses.

Retention: That quality inherent in the dental prosthesis acting to resist the forces of dislodgment along the path of placement.
(e. g., the force of gravity, the adhesiveness of foods, or the forces associated with the opening of the jaws).

Support, stability, and retention become more meaningful when they are thought of in terms of providing resistance to movement of a removable partial denture.

Interim, or provisional, denture: A fixed or removable dental prosthesis, or maxillofacial prosthesis designed to enhance esthetics, stabilization, and/or function for a limited period of time, after which it is to be replaced by a definitive dental or maxillofacial prosthesis; often such prostheses are used to assist in determination of the therapeutic effectiveness of a specific treatment plan or the form and function of the planned definitive prosthesis.

Abutment: A tooth, a portion of a tooth, or that portion of a dental implant that serves to support and/or retain a prosthesis.

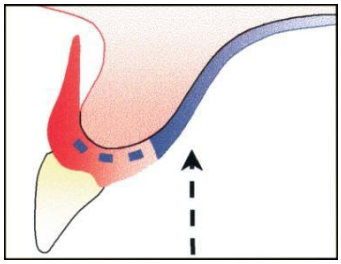


Height of contour: A line encircling a tooth and designating its greatest circumference at a selected axial position determined by a dental surveyor.

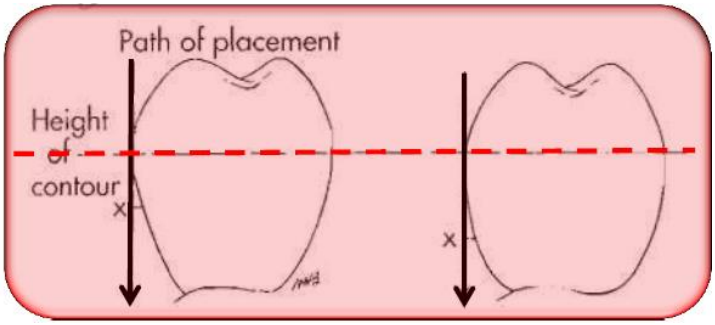
Undercut: The portion of the surface of an object that is below the height of contour in relationship to the path of placement.

When used in reference to an abutment tooth, is that portion of a tooth that lies between the height of contour and the gingiva.

When it is used in reference to other oral structures; the contour of a cross-sectional portion of a residual ridge or dental arch that prevents the insertion of a dental prosthesis.

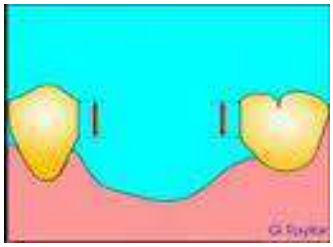


The angle of gingival (cervical) convergence: The angle of gingival convergence is located apical to the height of contour on the abutment tooth; it can be identified by viewing the angle formed by the tooth surface gingival to the survey line and the analyzing rod or undercut gauge of a surveyor as it contacts the height of contour.



Path of insertion (placement): The specific direction in which a prosthesis is placed on the residual alveolar ridge, abutment teeth, dental implant abutment(s), or attachments.

Guiding planes: Two or more vertically parallel surfaces on abutment teeth and/or fixed dental prostheses oriented so as to contribute to the direction of the path of placement and removal of a removable partial denture, maxillofacial prosthesis, and overdenture.



Guiding plane surfaces are parallel to the path of the placement (insertion) and parallel to each other; preferably these surfaces are made parallel to the long axes of abutment teeth.

Bounded edentulous area: It is an edentulous area that is bounded and supported by natural teeth at both ends.

Free-end edentulous area: It is an edentulous area that is bounded and supported by natural teeth at one end.

Extension base or free end extension RPD: It is a removable partial denture that is supported and retained by natural teeth only at one end of the denture base segment and in which a portion of the functional load is carried by the residual ridge, it is tooth - tissue - supported RPD.

Fulcrum line of rotation of a removable partial denture: A theoretical line around which the RPD tends to rotate.

Saddle or denture bases: The part of a denture that rests on the foundation tissues and to which teeth are attached.

Basal seat or denture foundation area: The oral anatomy available to support a denture.

Retainer: Any type of device used for the stabilization or retention of a prosthesis.

Treatment plan: The sequence of procedures planned for the treatment of a patient after diagnosis.

Nesbit prosthesis: Eponym for a unilateral removable partial denture that restores missing teeth on one side of the arch only, without a cross-arch major connector.



Unilateral removable partial denture design

Classification of Partially Edentulous Arches

Need for classification:

1. To formulate a good treatment plan.
2. To anticipate the difficulties common to occur for that particular design.
3. To communicated with a professional about a case.
4. To design the denture according to the occlusal load usually expected for a particular group.

Requirements of an acceptable method of classification:

1. It should permit immediate visualization of the type of partially edentulous arch that is being considered.
2. It should permit immediate differentiation between the tooth-supported and the tooth- and tissue supported removable partial denture.
3. It should be universally acceptable.
4. Serve as a guide to the type of design to be used.

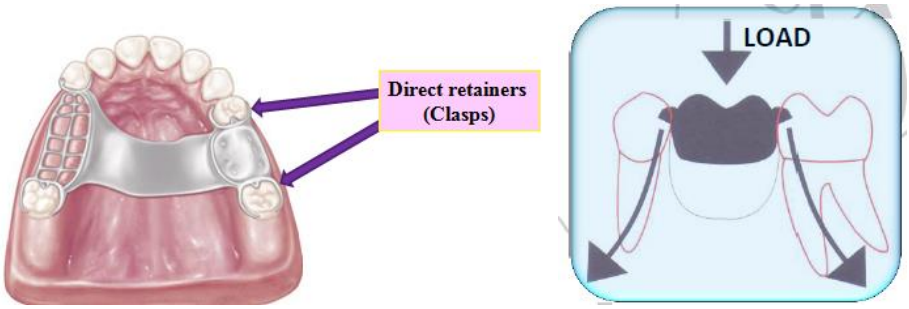
*Removable partial dentures may be classified according to the type of support into:

1. Tooth supported prosthesis: is a prosthesis or part of the prosthesis that depends entirely on the natural teeth (abutments) for support.

For partially edentulous patients the prosthetic options available include:

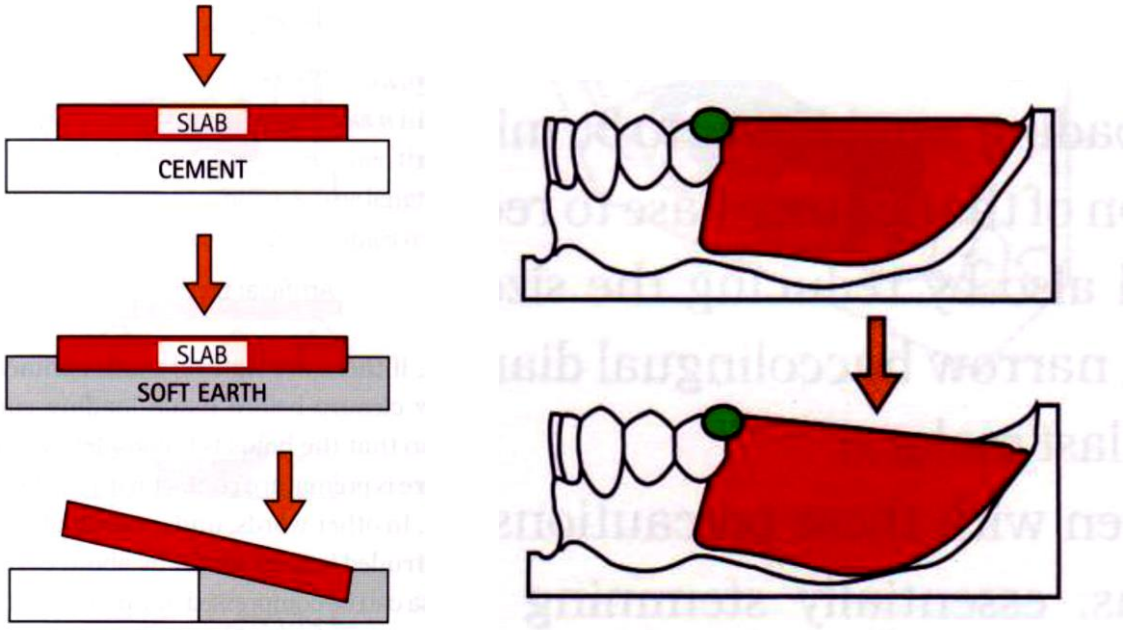
- Natural tooth - supported fixed partial dentures.
- Natural tooth – supported removable partial dentures.
- Implant - supported fixed partial dentures.

Retention is derived from direct retainers on the abutment teeth, tooth supported RPDs do not move appreciably in function.



2. Tooth - tissue supported prosthesis: is a prosthesis or part of the prosthesis that depends on the natural teeth (abutment) as well as the residual ridge and tissue for support. Also called **true partial denture**, it includes a free end extension.

The tooth – tissue supported RPD supported at one end by natural teeth, which essentially do not move, and at the other end by the denture bearing tissues (mucosa overlying bone) which moves because of the resiliency of the mucosa.



3. Tissue supported prosthesis: is one which is supported entirely by mucosa and underlying bone.

Tissue supported RPDs are primarily supported by tissues (mucosa overlying bone) of the denture foundation area. Tissue supported RPDs usually have plastic major connectors and are, therefore, usually interim RPDs. Tissue supported RPDs will move in function because of the resiliency of the mucosa.

Retention for tissue supported RPDs is customarily provided by wrought wire retentive clasp arms on selected natural teeth.

Tissue supported RPDs have the potential to cause soft tissue damage and periodontal attachment loss and accordingly should be used for only a short period of time.



*Removable partial dentures may be classified according to the type of material used into:

1. **Acrylic (Temporary RPDs):** is the RPD made of acrylic and artificial teeth, retentive wires (clasp) may be used for retention.
2. **Cr/Co (Chrome/Cobalt)-metal RPDs (Definitive RPDs):** is the RPD made of metal or alloys and artificial teeth, acrylic may be used as a denture base.

Removable partial dentures may be classified according to the type of treatment:

1. Definitive RPDs:

Definitive RPDs are constructed after extensive diagnosis, treatment planning, and through preparation of the teeth and tissue for the prosthesis. The length of service of definitive RPDs is intended to be many years this meaning the cobalt chromium alloy removable partial dentures.

2. Interim RPDs:

Interim RPDs are usually constructed as part of the preparation of the mouth for definitive RPD, FPD or implant treatment. The length of service of interim RPDs is generally planned to be a year or less, they are frequently referred to as ***temporary RPDs*** example of that is the acrylic removable partial dentures.

* *Classification based on arch configuration:*

The most widely accepted system of classification of RPDs and partially edentulous arches was proposed by ***Dr. Edward Kennedy*** in 1923. It is based on the configuration of the remaining natural teeth and edentulous spaces. This system was further defined and expanded upon by ***Dr. O.C. Applegate*** and ***Dr. Jacques Fiset***.

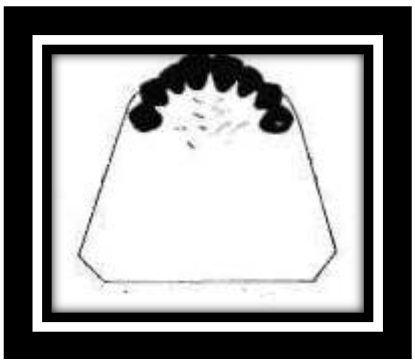
The values of the ***Kennedy – Applegate – Fiset classification system*** *are that:*

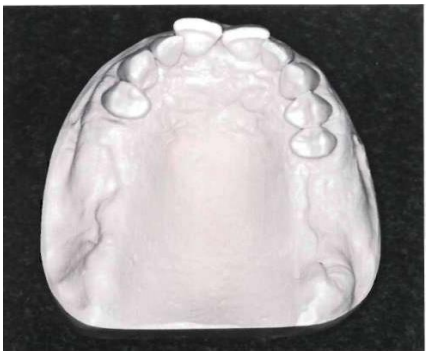
1. It is relatively simple and easy to remember.
2. Extremely comprehensive and very practical.
3. Universally accepted.
4. It permits logical approach to the problem of design.
5. It permits immediate visualization of the partially edentulous arch or RPDs designed for that arch.
6. It indicates the type of support for the RPD, which suggest certain physiological and mechanical principles of treatment and RPD design.

Kennedy – Applegate – Fiset classification system

According to this classification system, partially edentulous arches are classified into four basic classes:

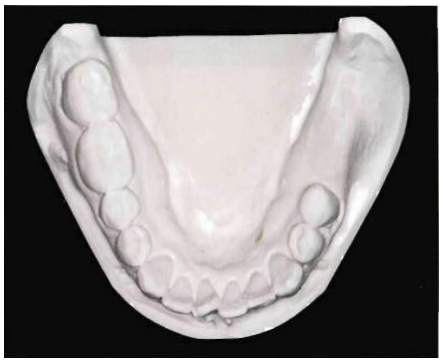
Class I: Bilateral edentulous areas located posterior to the natural teeth.



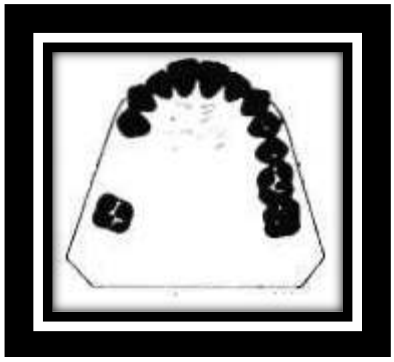


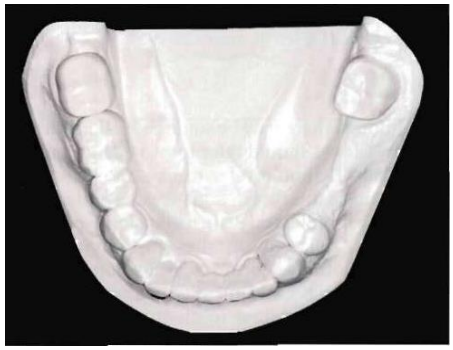
Class II: A unilateral edentulous area located posterior to the remaining natural teeth.



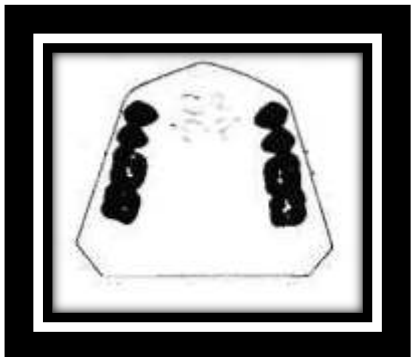


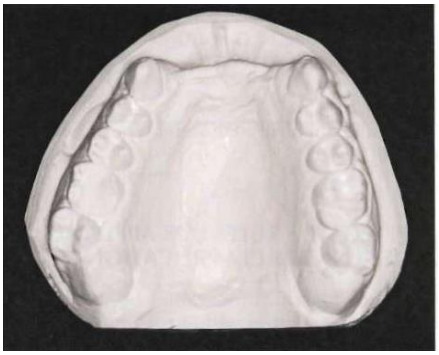
Class III: A unilateral edentulous area with natural teeth remaining both anterior and posterior to it.



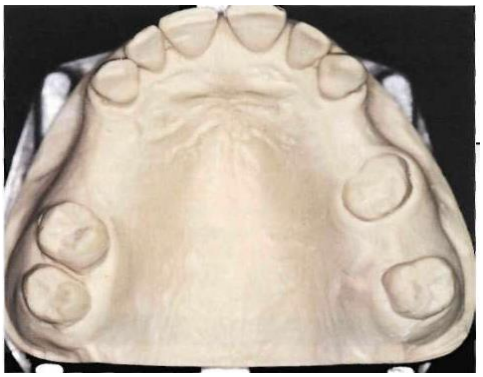


Class IV: A single, but bilateral (crossing the midline), edentulous area located anterior to the remaining natural teeth.





Edentulous areas other than those determining the basic classes were designated as *modification spaces* and written as a number 1, 2, 3… depending on the number of the extra edentulous spans. Example:



Class III, modification 2

Applegate's rules governing the application of the Kennedy classification method:

Rule 1

Classification should follow rather than precede any extractions of teeth that might alter the original classification.

**** Rule 2***

If a third molar is missing and not to be replaced, it is not considered in the classification.

**** Rule 3***

If a third molar is present and is to be used as an abutment, it is considered in the classification.

**** Rule 4***

If a second molar is missing and is not to be replaced, it is not considered in the classification (e. g., if the opposing second molar is likewise missing and is not to be replaced).

**** Rule 5***

The most posterior edentulous area (or areas) always determines the classification.

**** Rule 6***

Edentulous areas other than those determining the classification are referred to as modifications and are designated by their number.

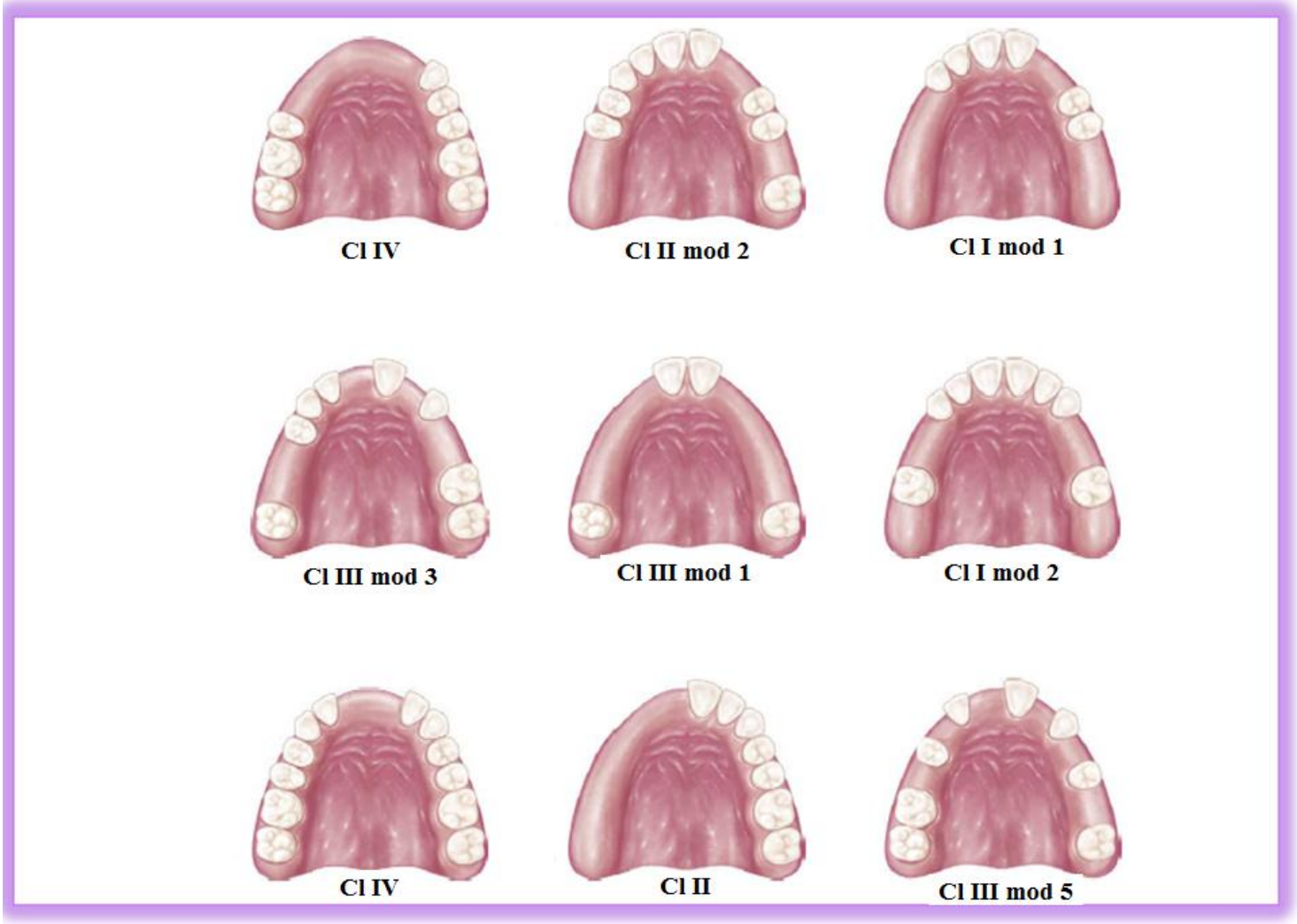
**** Rule 7***

The extent of the modification is not considered, only the number of additional edentulous areas.

****Rule 8***

There can be no modification areas in Class IV arches. (Other edentulous areas lying posterior to the single bilateral areas crossing the midline would instead determine the classification; see Rule 5.)

Examples of different partially edentulous arches cases



Surveying

The ideal requirements for successful removable partial denture are:

1. Be easily inserted and removed by the patient.
2. Resist dislodging forces.
3. It should be aesthetically pleasing.
4. Avoid the creation of undesirable food traps.
5. Minimize plaque retention.

This objective is achieved by a careful evaluation of a patient's study casts. The instrument used to aid the examination of the study casts is called a **dental surveyor** and the procedure is known as **surveying**.

Surveying

It's the determination of the relative parallism of two or more surfaces of the teeth or other parts of the cast of the dental arch.

Survey

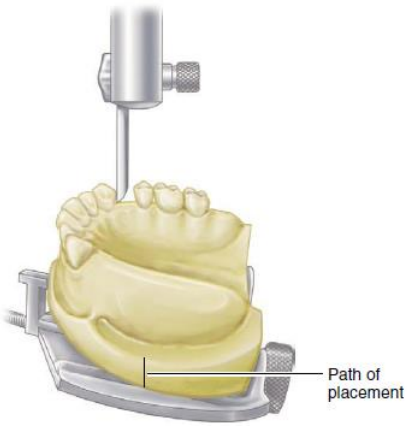
It's the procedure of the locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture.

Objective of surveying

In order to plane those modifications to fabricate a removable partial denture thus can be easily inserted in the mouth and retained in place during function.

Purposes (Objective) of Surveying the Diagnostic Cast

1. To determine the most desirable path of placement that will eliminate or minimize interference to placement and removal.



When the restoration (RPD) is properly designed to have positive guiding planes, the patient may place and remove the restoration with ease in only one direction.

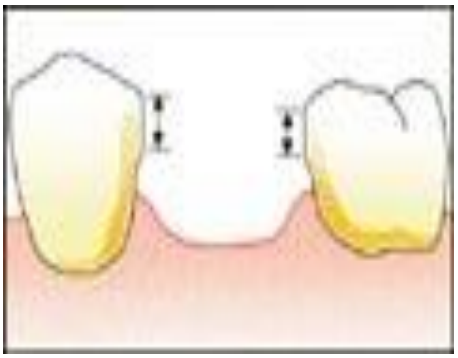
Advantages of single path of placement (insertion):

A. Allows insertion and removal of prosthesis without interference.
B. Help to direct the force along the long axis of the tooth.
C. Provide frictional retention.
D. Minimize torque on the abutment teeth.
E. Cross arch stabilization.
F. Equalize retention.

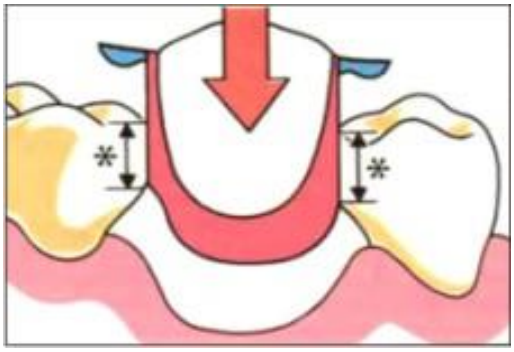
2. To identify proximal tooth surfaces that are, or need to be, made parallel so that they act as guiding planes during placement and removal.

Guiding planes*:* two or more vertically parallel surfaces on abutment teeth and/or fixed dental prostheses oriented so as to contribute to the direction of the path of placement and removal of a removable partial denture, maxillofacial prosthesis, and overdenture. They are:

A. Flat surfaces parallel to the path of insertion.
B. Represent the initial contact of the RPD.
C. Help to stabilize, control and limit the movement of the RPD.



Guiding planes
(Vertically parallel surfaces on abutment teeth)



(The prosthesis during placement)

3. To locate and measure areas of the teeth that may be used for retention.
4. To determine whether tooth and bony areas of interference will need to be eliminated surgically or by selecting a different path of placement.
5. To determine the most suitable path of placement that will permit locating retainers and artificial teeth to the best esthetic advantage.
6. To permit an accurate charting of the mouth preparation to be made.
7. To delineate the height of contour (survey line) on abutment teeth and to locate areas of undesirable tooth undercut those are to be avoided, eliminated, or blocked out.

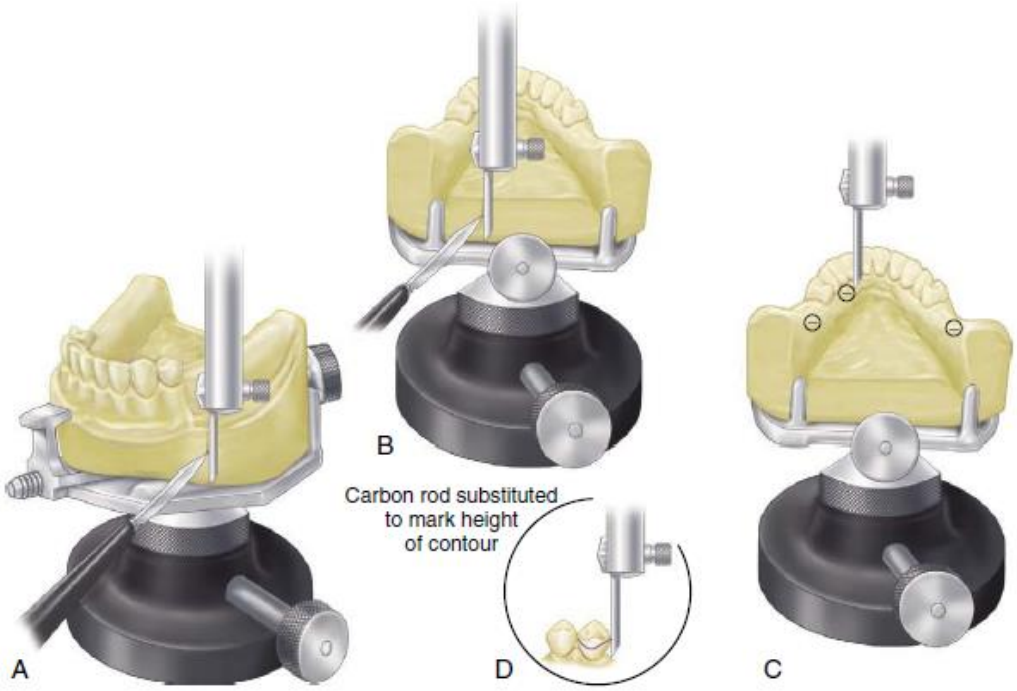
Undercuts could be:

A. Desirable undercut: this is useful in to retain RPD against dislodging forces.

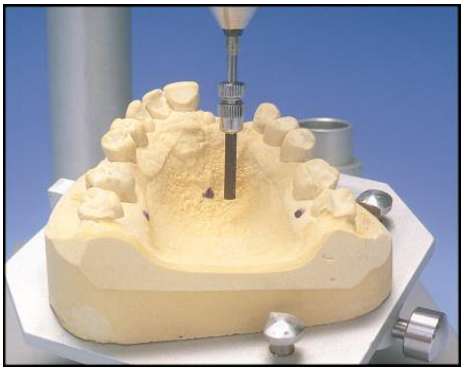
B. Undesirable undercut: other than that used to retain the RPD; in most of the case undesirable undercut interfere with placement and removal of the prosthesis or produces damaging effects on the teeth and underlying structures. Such type of undercut can be eliminated by:

- Block out with wax.
- Preparation and alteration of the tooth surfaces (within a limit).
- Crown restoration, in which the tooth surface can be reshaped to serve RPD functions and requirements.

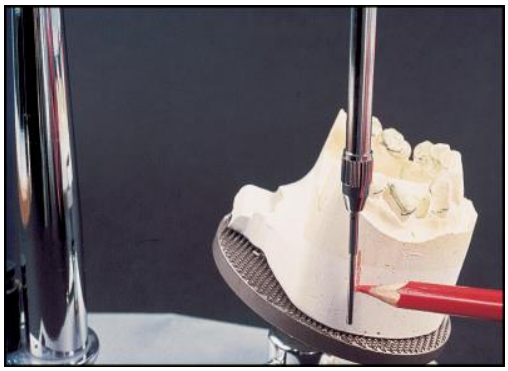
8. To record the cast position in relation to the selected path of placement for future reference. This may be done by locating three dots (tripods) or parallel lines on the cast; three dotes or lines, one anterior and two posterior to permit its reorientation.



A-**B,** The path of placement is determined, and the base of the cast is scored to record its relation to the surveyor for future repositioning. **C,** An alternate method of recording the relation of the cast to the surveyor is known as *tripoding*. A carbon marker is placed in the vertical arm of the surveyor, and the arm is adjusted to the height by which the cast can be contacted in three divergent locations. The vertical arm is locked in position, and the cast is brought into contact with the tip of the carbon marker. Three resultant marks are encircled with colored lead pencil for ease of identification. Reorientation of the cast to the surveyor is accomplished by tilting the cast until the plane created by three marks is at a right angle to the vertical arm of the surveyor. **D,** Height of contour is then delineated by a carbon marker.



Three dots (tripoding)



Parallel lines

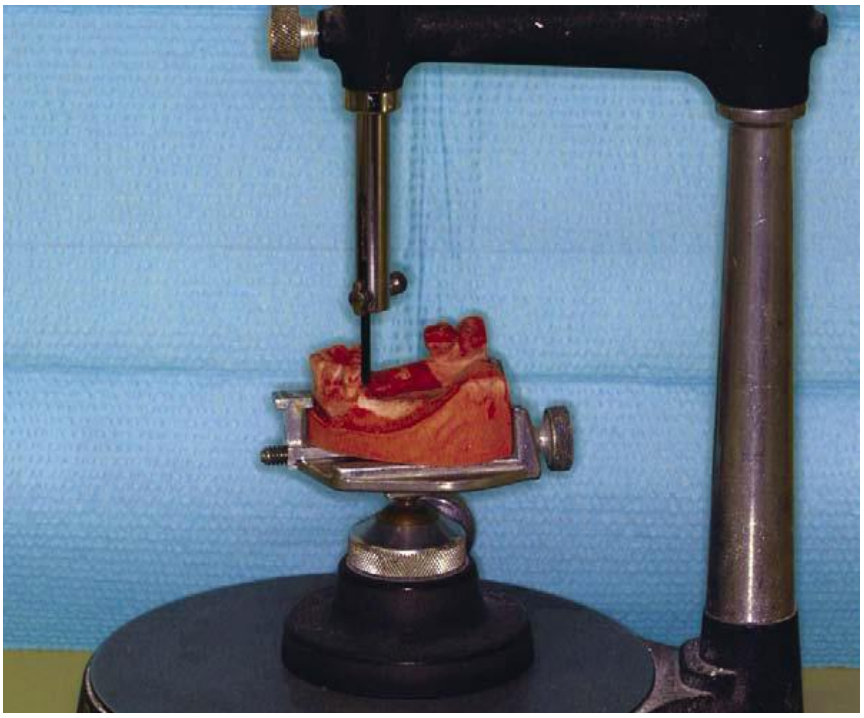
Dental surveyor

It's as an instrument used to determine the relative parallelism of two or more surfaces of the teeth or other parts of the cast of a dental arch.

Types of dental surveyors

The most widely used surveyors are:

1. ***Ney surveyor*** with non swiveling horizontal arm.



The Ney surveyor is widely used because of its simplicity and durability.

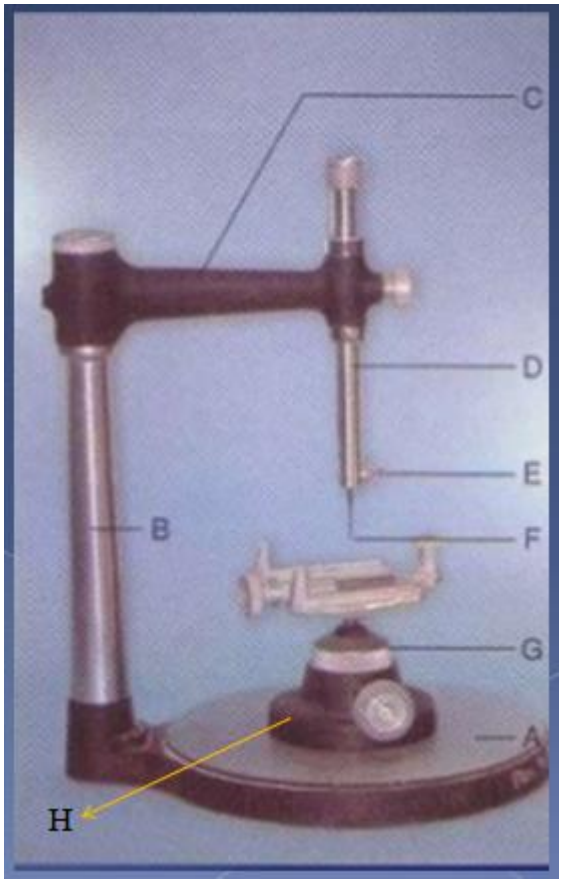
2. *Jelenko surveyor* with swiveling horizontal arm and has spring mounted paralleling tool.



The Jelenko surveyor: Note the spring-mounted paralleling tool and swivel at the top of the vertical arm. The horizontal arm may be fixed in any position by tightening the nut at the top of the vertical arm.

Parts of dental surveyor (Ney type surveyor):

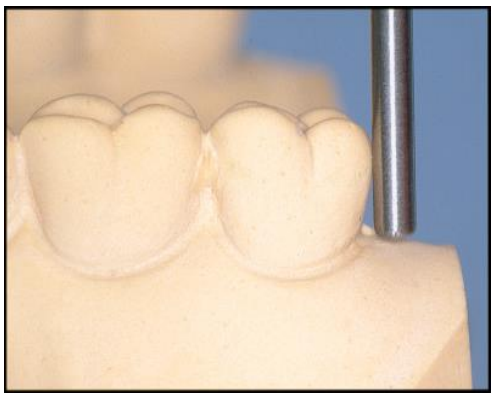
A. Platform on which the base is moved.
B. Vertical arm or upright column that supports the superstructures.
C. Horizontal arm from which surveying tools suspends.
D. Survey arm.
E. Mandrel for holding special tools.
F. Tools which are used for surveying **(in sequence)** include: analyzing rod, carbon marker, undercut gauges, wax trimmer.
G. Table to which the cast is attached.
H. Base on which the table swivels.

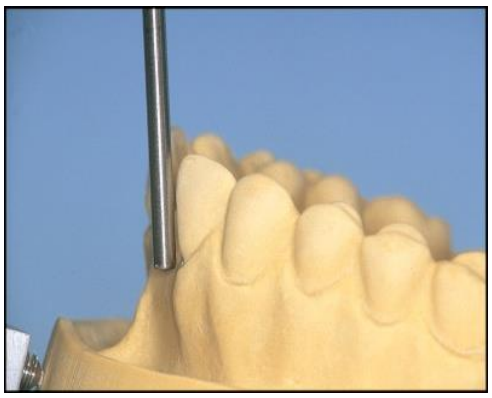


Analyzing rod

It's a rigid metal rod used for diagnostic purposes in the selection of the path of placement and to determine the undercut areas prior to scribing the height of contour with the carbon marker.

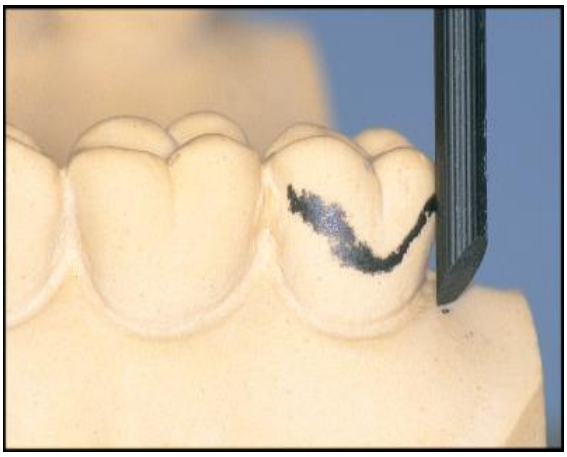






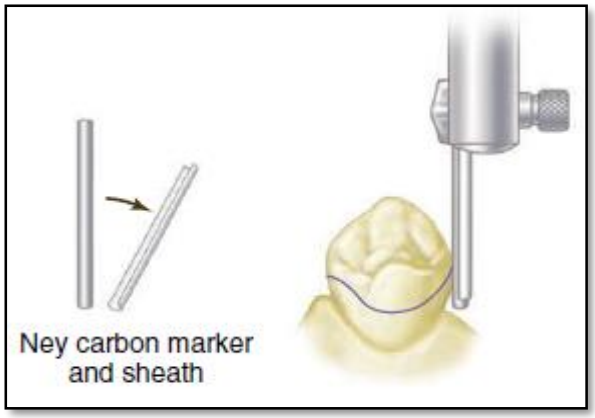
Carbon marker

It's used for the actual marking of the survey lines on the cast. A metal shield is used to protect it from breakage.





Carbon marker and metal shield

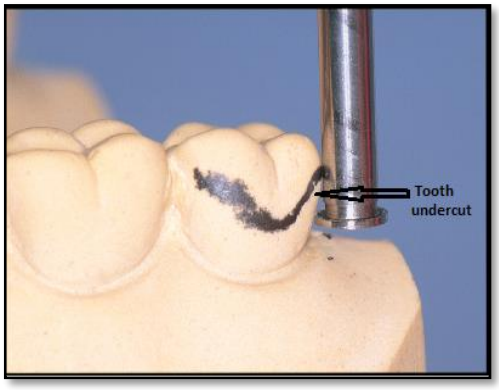


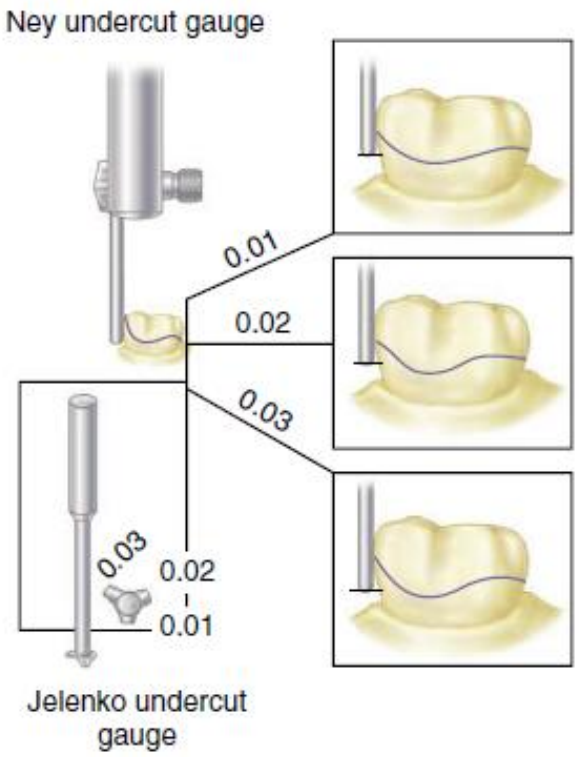


Undercut gauges

They are used to measure the extent of the undercuts on abutment teeth that are being used for clasp retention, usually there are available in three gauges: 0.01, 0.02, and 0.03 inch. Undercut dimensions can be measured on teeth by bringing the vertical shaft of the gauge in contact with a tooth and then moving the surveying arm up or down until there is also contact with the terminal tip.

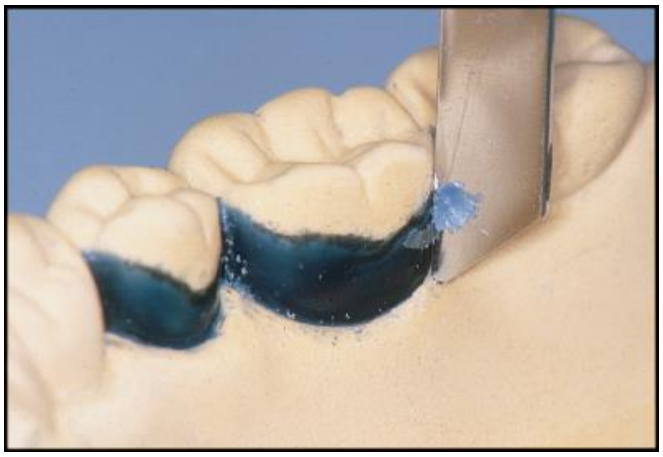






Wax trimmer

It's a knife used for trimming the excess wax which blocks out undesirable undercut in such away to be parallel to each other and to the pre-determined path of insertion.

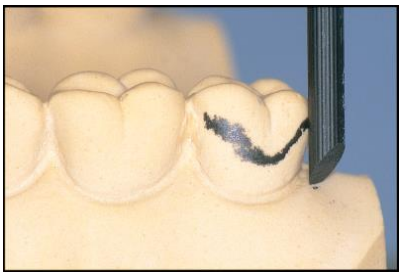




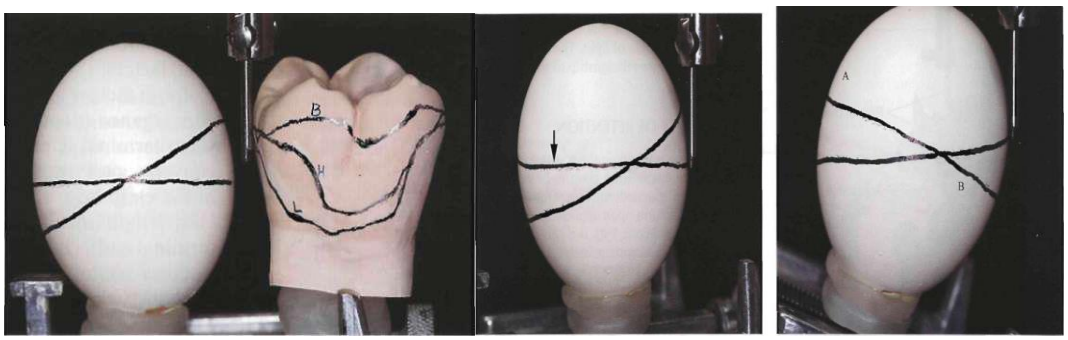
Whenever possible, cast should be surveyed with the occlusal plane parallel to the base of the surveyor so that the path of insertion is vertical to the occlusal plane. Most patients will tend to seat the partial denture under force of occlusion. If the path of insertions is other than vertical to the occlusal plane such seating may deform the clasps.

Principles of surveying

- Surveying a tooth consist of locating accurately the height of its maximum contour in relation to the plane in which the cast is positioned.
- Modifying the proximal tooth surfaces so that the prosthesis goes smooth in place without interferences.
- The fact that the majority of the natural teeth crowns are bulbous in shape (have a suprabulge region), where this suprabulge region could occur anywhere between the occlusal surface and the gingival margin. When a vertical arm is brought into contact with the convex surface, they will contact only at one point that is the point of maximum convexity, where this surface is rotated, and is still in contact with the vertical arm, an imaginary line will be traced at the greatest circumference, when we substituted this vertical analyzing rod with a carbon marker then an actual line will be produced at the level of the maximum tooth bulge, this line is called the survey line.



- The area of a tooth occlusal to the survey line is a non undercut area, while the area gingival to this line is an undercut area. When a tooth is tilted or rotated in relation to the analyzing rod, another survey line will be traced, as a result, the extent of non undercut area and the undercut area are consequently changed. That means the survey line can vary according to the angle formed by contact of the vertical analyzing rod with the tooth surface.



- Alteration of undercut area can be done by anterior or posterior tilting of dental cast. So that the effect of tilting a cast on the surveyor will be:

1. Redistribution of undercuts to the desired areas.
2. Allow a more favorable path of insertion.
3. Allow the use of a desired type of clasp for better function and esthetics.
4. Allow the use of a design to minimize food impaction, food entrapment and plaque accumulation.

Types of undercuts established by surveying

1. Contour: due to natural contour of the tooth.
2. Positional: due to tilting of cast on surveyor.
3. True: an undercut which is present in relation to the analyzing rod and to the path of displacement.
4. False: an undercut which present only in relation to the analyzing rod but not in relation to the path of displacement.

Path of placement (Insertion)

The specific direction in which a prosthesis is placed on the residual alveolar ridge, abutment teeth, dental implant abutment(s), or attachments.

Factors that determine and affect the path of placement (insertion) and removal of the RPD

1. Guiding Planes

Guiding planes are parallel surfaces of abutment teeth that direct the insertion and removal of a partial denture. *The path of insertion should be parallel to the guiding planes*. Proximal tooth surfaces that bear a parallel relationship to one another must either be *found* or be *created* to act as guiding planes.

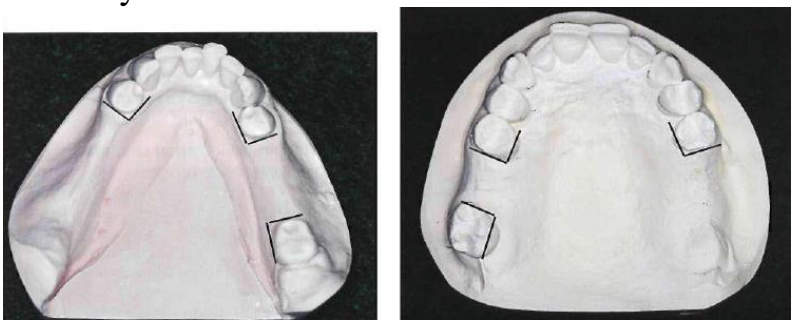
To do so this, proximal plates (part of the RPD contact guiding planes) should, whenever possible, be the ***initial portions of the partial denture to contact the abutments***.

The components of the denture that contact the guiding planes during placement of removable partial denture are:

Tooth surface which act as guiding planes	**Component of the denture which contact this guiding planes**
A- Proximal tooth surface	1. Minor connector that joins the occlusal rests and clasp to the saddle. 2. Proximal plates are used with I-bar or R.P.I. system.
B-Axial or lingual tooth surface	1. Reciprocal clasp arms. 2. Lingual plates that act as reciprocal arm. 3. Minor connector that joins the auxiliary rest to the major connector.

Function of guiding plane:

- The denture can be easily placed and removed by the patient without strain on the teeth contacted or on the denture itself and without damage to the underlying soft tissues.
- Can provide bracing or stabilization when placed in the axial tooth surfaces.
- Ensure clasp assembly function including retention and stabilization.
- The friction forces of contact of prosthesis with the guiding planes wall will contribute significantly to the retention of the RPD.



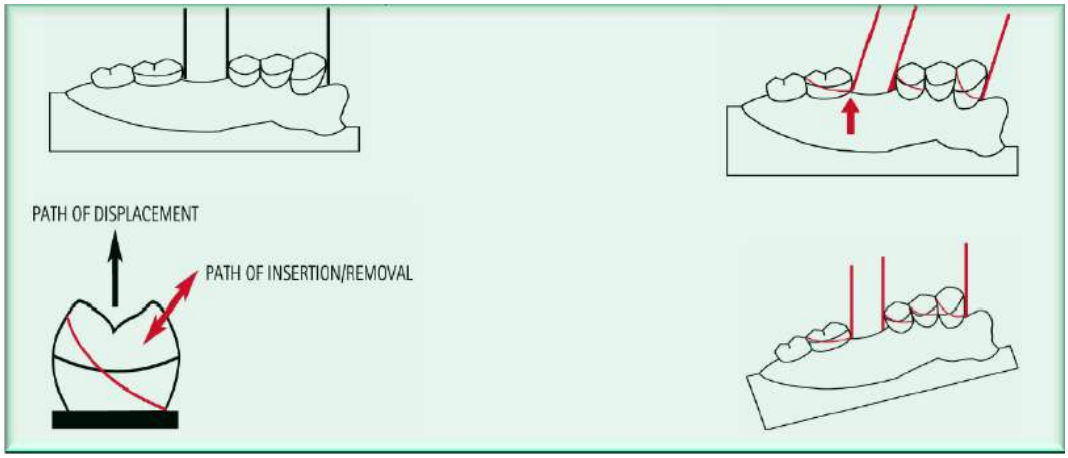
2. Retentive Areas

Retentive areas must exist for a given path of placement and must be contacted by retentive clasp arms that are forced to flex over a convex surface during placement and removal.

Fairly even retention may be obtained by one of two means:

- Change the path of placement to increase or decrease the angle of cervical (Gingival) convergence of opposing retentive surfaces of abutment teeth.
- Alter the flexibility of the clasp arm by changing its design, its size and length, or the material of which it is made.

<u>For a clasp to be retentive</u>; ***its path of escapement*** must be ***other than parallel to the path of removal of the denture itself***; otherwise, it would not be forced to flex and thereby generate the resistance known as retention. Clasp retention therefore depends on the existence of a definite path of placement and removal.



3. Interference

The prosthesis must be designed so that it may be placed and removed without encountering tooth or soft tissue interference (areas of interference like the proximal tooth undercut, maxillary or mandibular lingually or labialy or buccally incline teeth, bony exesistosis and tissue undercuts).

A path of placement may be selected that encounters interference only if the interference can be eliminated:

- During mouth preparations.
- On the master cast by a reasonable amount of blockout.

Interference may be eliminated during mouth preparations by:

- Surgery.
- Extraction of the tooth or teeth.
- Modification of interfering tooth surfaces.
- Or alteration of tooth contours with restorations.

If the interferences cannot be eliminated or minimized, then a different path of insertion must be considered, even if less desirable guiding plane and retentive areas must be selected.

4. Esthetics

A path of insertion should be selected to provide the most esthetic placement of artificial teeth and the least amount of visible metal on the abutment teeth. Retentive areas must be selected to optimize retention purposes with esthetic requirements.

- Metal component must be concealed. Less metal will be displayed (most esthetic location of clasps) if the retentive clasp is placed at a more *distogingival area* of tooth surface made possible either by changing the path of placement selected or by the contour of the restorations.
- Esthetics also may dictate the choice of path selected when missing anterior teeth must be properly positioned in the partial denture. In such situations so that neither the artificial teeth nor the adjacent natural teeth will have to be modified excessively.



(A) The first path of insertion (zero tilt), the less esthetic removable partial denture.
(B) The most esthetic path of insertion, the most esthetic removable partial denture.





CAN YOU NOTICE THE DIFFERENCES WHICH MAKE THE SECOND REMOVABLE DENTURE IS MOST ESTHETIC DENTURE?

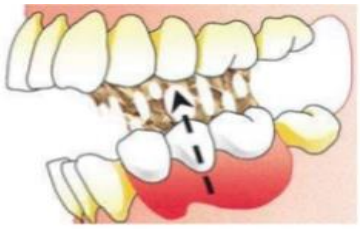
Rules of surveying

1. The undercut areas cannot be created or produced by tilting the cast.

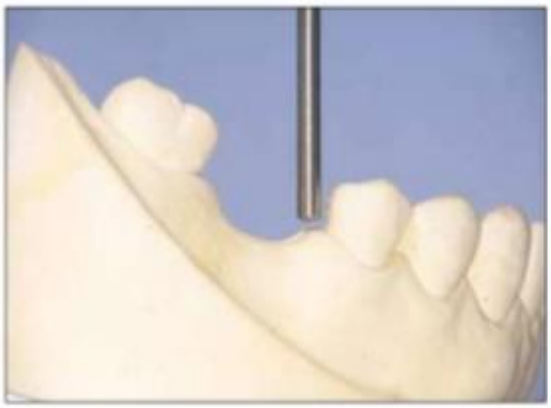
2. All casts are originally surveyed with the occlusal plane is parallel to the base of surveyor; this is what we called ***zero tilt***, in which the retentive undercut must be present on the abutment teeth.

Most patients will tend to seat the partial denture under force of occlusion. If the path of insertion is other than vertical to the occlusal plane such seating may deform the clasps. Also dislodging forces are always directed perpendicular to the occlusal plane.





3. The retentive tip of the clasp must engage the undercut area, which are present when the cast is surveyed in certain position.
4. Wherever possible, the undesirable undercut and area of interference are removed during mouth preparation by recontouring teeth or making necessary restoration.
5. ***Anteroposterior tilt:*** anterior tilt will increase the mesial undercut, while the posterior tilt will increase the distal undercut. Such as in free end extension partial denture tilting the cast anteriorly will decrease or eliminate the distal undercut where the path of insertion will be changed, thus getting rid of undesirable undercut located distally, therefore the tilting of the cast is to minimize or equalize the undesirable undercut.

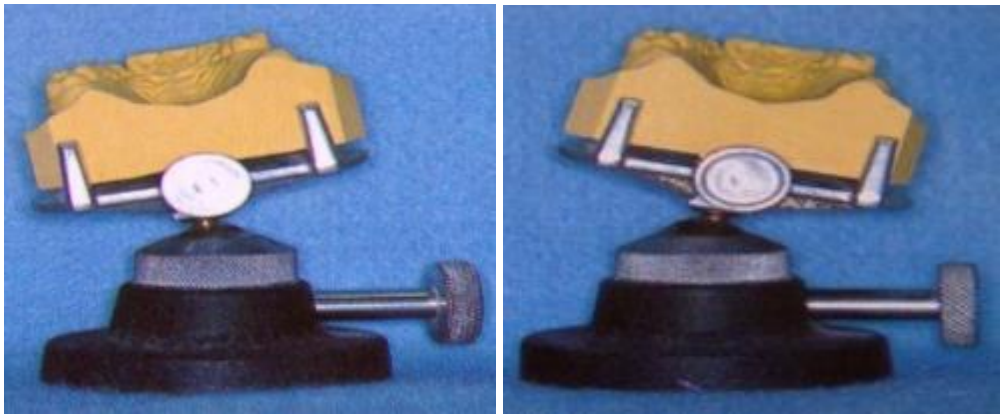


Anterior tilt ('heels up')



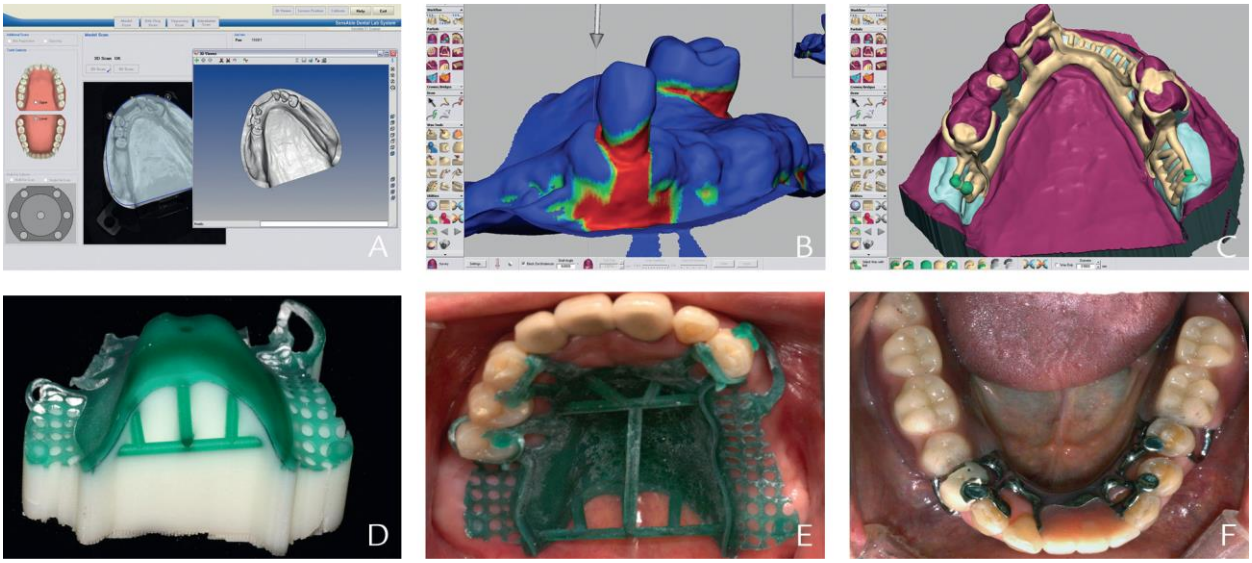
Posterior tilt ('heels down').

6. ***Lateral tilt:*** dealing with retentive undercut situated buccally or lingually on posterior teeth.



Computer aided designing and manufacturing (CAD - CAM) of removable partial dentures: Digital surveying:

The framework of the RPD was designed by setting a surveying axis and computing the undercut to determine an ideal path of insertion and removal (B).



Procedure for digital removable partial denture fabrication. A, Model scanning. B, Electronic surveying. C, Definitive framework design. D, Pattern built with 3-dimensional printer. E. Intraoral view of pattern resin framework. F. Definitive prosthesis.

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Component Parts of a Removable Partial Denture

The removable partial denture consists of seven main components (Fig. 1) and these are essential for the success of the treatment for the partially edentulous patient.

1. Major connectors
2. Minor connectors
3. Rests
4. Direct retainers
5. Reciprocal components (as parts of a clasp assembly)
6. Indirect retainers (if the prosthesis has distal extension bases)
7. One or more bases (each supporting one to several replacement teeth)

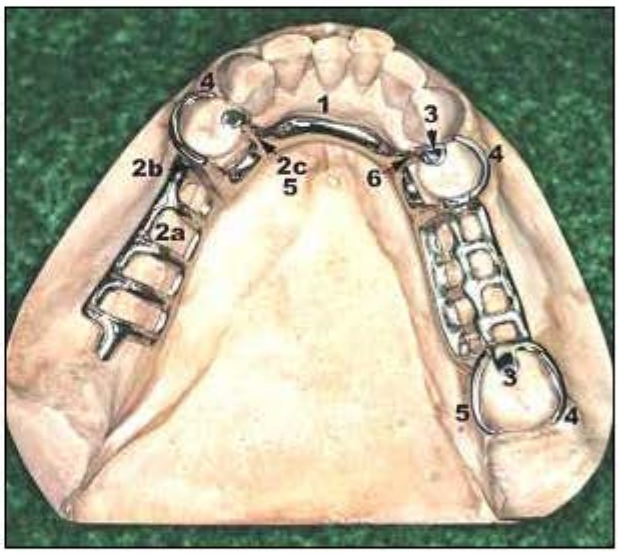


Figure 1: 1, lingual bar major connector; 2a, minor connector by which the resin denture base will be attached; 2b, minor connector, proximal plate, which is part of clasp assembly; 2c, minor connector used to connect rests to major connectors; 3, occlusal rests; 4, direct retainer arm, which is part of the total clasp assembly; 5, stabilizing or reciprocal components of clasp assembly

Major connectors

A major connector is the component of the partial denture that connects the parts of the prosthesis located on one side of the arch with those on the opposite side (Fig. 1). There are several designs for the maxillary and mandibular major connector and each serves for certain purposes (Fig. 2 & 3)



Figure 2: Maxillary major connector



Figure 3: Mandibular major connector

The major connector is that unit of the partial denture to which all other parts are directly or indirectly attached. This component also provides cross arch stability to help resist displacement by functional stresses.

To ***function effectively*** and ***minimize potentially damaging*** effects, all major connectors must:

1. Be rigid.

A flexible major connector may cause severe damage to the hard and soft tissues of the oral cavity. Flexibility allows forces to be concentrated on individual teeth and segments of the residual ridges. This may lead to tooth mobility or tooth loss. The concentration of forces upon small segments of the residual ridges may cause resorption of the hard and soft tissues. This may result in decreased ridge height and decreased support for the associated denture bases.

2. Protect the associated soft tissues.

The Major connector must not permit impingement upon the free gingival margins of the remaining teeth. The marginal gingivae are highly vascular and susceptible to injury from sustained pressure.

3. Provide a means for obtaining indirect retention where indicated.

Removable partial denture that is not supported at each end of an edentulous space tends to rotate about a fulcrum line. The most common method for controlling this movement is through the use of one or more indirect retainers. For practical purposes, indirect retainers will always take the form of rests. When properly positioned, these rests can minimize the rotational movements of prosthesis.

4. Provide a means for placement of one or more denture bases.

Generally, the type of major connector will be dictated by the number and location of edentulous areas. Certain major connectors are indicated for anterior tooth replacement, while others are not. Some major connectors may be selected for tooth-supported removable partial dentures, but not for tooth-tissue-supported applications. In each instance, a major connector must allow appropriate placement of the associated denture base(s).

5. Promote patient comfort.

The edges of a major connector should be contoured to blend with the oral tissues. This is particularly true for major connectors that cross the anterior palate. The anterior border of a maxillary major connector should not end on the anterior slope of a prominent ruga (Fig 4a). The additional thickness produced by metal coverage will create a noticeable prominence on this section of the palate, and may interfere with the patient's comfort and speech. Instead, the anterior border of the major connector should be terminated on the posterior slope of a prominent ruga (Fig 4b).

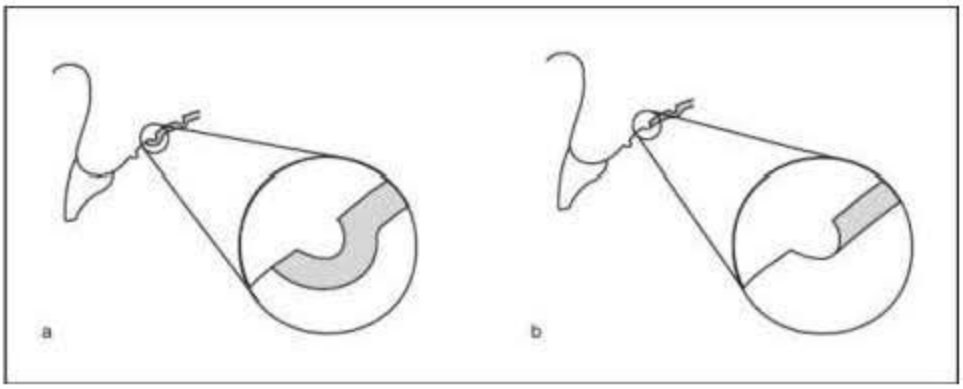


Figure 4: (a) the anterior border of a maxillary major connector should not end on the anterior slope of a prominent ruga. (b) The anterior border of the major connector should be terminated on the posterior slope of a prominent ruga

The major connector is a component part of the removable partial denture, as mentioned earlier. The ***chief functions of a major connector*** are to 1) unify the major parts of the prosthesis, 2) distribute the occlusal force throughout the arch to selected teeth and tissue, 3) cross-arch stabilization to minimize the torque to the teeth. It is through the major

connector that other components of the partial denture become unified and effective.

Major connectors should be ***designed and located*** with the following guidelines in mind:

1. Major connectors should be free of movable tissue.
2. Impingement of gingival tissue should be avoided.
   It is recommended that the borders of the maxillary major connector be located a minimum of 6 mm away from and parallel to the gingival margins (Fig. 5). As for the mandibular major connector, there should be a minimum of 4 mm below the gingival margin (Fig. 6).

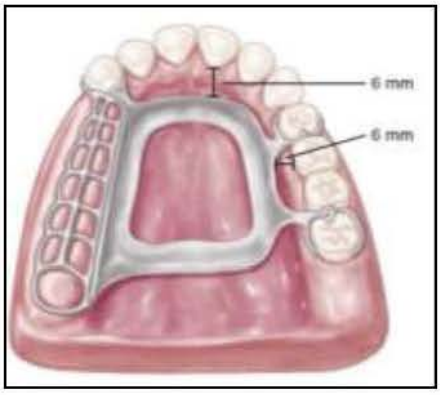


Figure 5: borders of a major connector should be positioned at least 6 mm from the free gingival margins

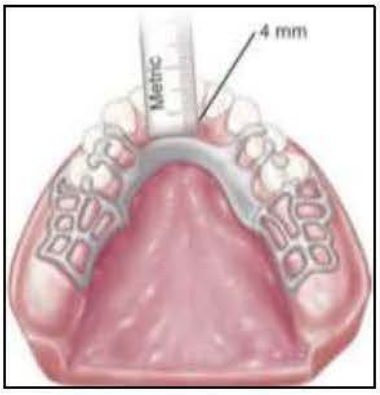


Figure 6: borders of the major connector should be positioned at least 4 mm from the free gingival margins

3. The borders of the major connector should run parallel to the gingival margins of the remaining teeth (Fig. 7).

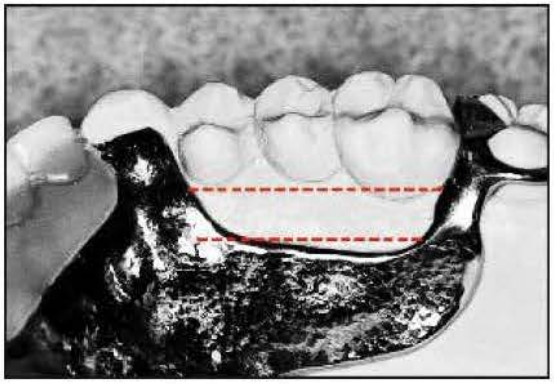


Figure 7: The border s of the major connector should run parallel to the gingival margins of the remaining teeth.

4. The major connector should be as a symmetrical as possible. In addition, the borders of a maxillary major connector should cross the palatal midline at right angles not obliquely (Fig. 8).

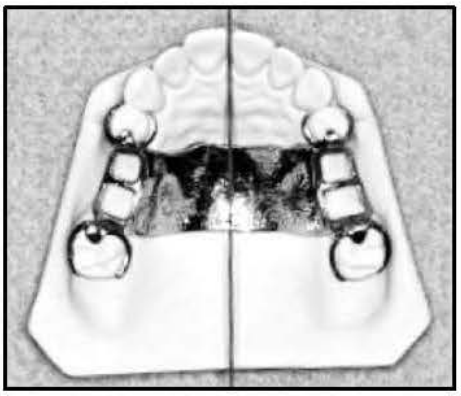


Figure 8: The borders of a maxillary major connector should always cross the palatal midline at 90 degrees.

5. Bony and soft tissue prominences should be avoided during placement and removal (Fig. 9).



Figure 9: Coverage of tori should be avoided if possible. The tissues covering tori are extremely thin and susceptible to irritation.

6. The major connector should show smooth, rounded contours (Fig. 10). Sharp angles and corners may cause patient discomfort and produce areas of stress concentration within a removable partial denture framework. Areas of stress concentration may lead to structural fatigue and prosthesis fracture.

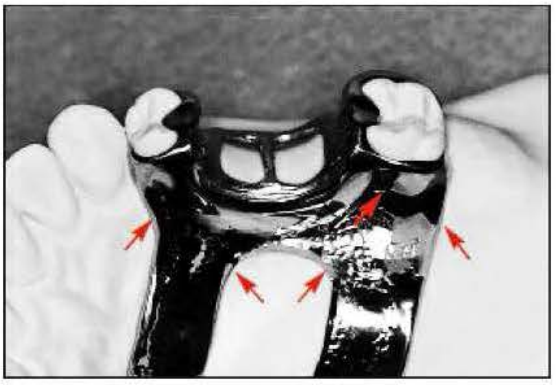


Figure 10: All major connectors should exhibit smooth, rounded contours (arrows).

7. Relief should be provided beneath a major connector to prevent its settling into areas of possible interference, such as an elevated median palatal suture.
8. Major connectors should be located and/or relieved to prevent impingement of tissue that occurs because the distal extension denture rotates in function in the mandible.

Characteristics of major connectors that contribute to the ***maintenance of health of the oral environment and the wellbeing of the patient*** may be listed as follows:

1. Made from an alloy compatible with oral tissue.
2. Rigid and provide cross-arch stability through the principle of broad distribution of stress.
3. Do not interfere with and are not irritating to the tongue.
4. Do not substantially alter the natural contour of the lingual surface of the mandibular alveolar ridge or of the palatal vault.
5. Do not impinge on oral tissue when the restoration is placed, removed, or rotated in function.
6. Cover no more tissue than is absolutely necessary.
7. Do not contribute to retention or trapping of food particles.
8. Have support from other elements of the framework to minimize rotation tendencies in function.
9. Contribute to the support of the prosthesis.

Maxillary Major Connectors

Special Structural Requirements for Maxillary Major Connectors:

Beading: All maxillary major connectors should display minor elevations at those borders that contact the palatal soft tissues (Fig. 1). The elevations are termed ***bead lines*** and are intended to slightly displace the adjacent soft tissues. This displacement produces a 1) mechanical seal and prevents food particles from collecting under the major connector. In addition, 2) these elevations provide excellent visual finish lines for technicians who finish and polish removable partial denture frameworks.

Bead lines are created by carving shallow channels on the surface of a maxillary master cast before duplication in investment material (Fig. 2). These lines are best prepared with a small spoon excavator or round bur rotating at slow speed. Each channel should have a width and depth of 0.5 to 1.0 mm. The depth of the beading should be reduced in areas of thin tissue coverage such as the midpalatine raphe or a palatal torus.



Figure 2: Bead lines are created by carving shallow channels on maxillary master cast.

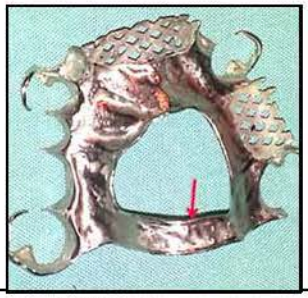


Figure 1: Maxillary major connector bead lines (arrows)

Relief should not be used under a maxillary major connector except in the presence of a palatal torus or a prominent median suture line. The intimate contact between the palatal soft tissues and the metal connector enhances the retention and stability of the denture.

Types of Maxillary Major Connector:

1. Single palatal bar
2. Single palatal strap
3. Anterior-posterior palatal bars

4. Horseshoe (U-shaped palatal connector)
5. Combination anterior and posterior palatal strap–type connector
6. Palatal plate-type connector

1. Single Palatal Bar

The palatal bar is a narrow half oval with its thickest point at the center (Fig. 3). If used, the palatal bar should be limited to short-span Class III applications (replacing one or two teeth on each side of the arch). In addition, the palatal bar should not be placed anterior to the second premolar position; otherwise, its bulk may produce noticeable discomfort and alteration of speech.



Figure 3: Single palatal bar major connector

Disadvantages of the single palatal bar. To provide the necessary rigidity, a palatal bar major connector must be bulky. Consequently, patients find the palatal bar uncomfortable. Moreover, because of its narrow anteroposterior width, a palatal bar derives little vertical support from the bony palate. As a result, a palatal bar major connector must derive nearly all of its support from rests on the remaining teeth.

2. Single Palatal Strap

The palatal strap consists of a wide band of metal with a thin cross-sectional dimension (Fig. 4). The anteroposterior dimension of a palatal strap major connector should not be less than 8 mm to avoid compromise of its rigidity (Fig. 5).

Figure 4: Single palatal strap–type major connector.



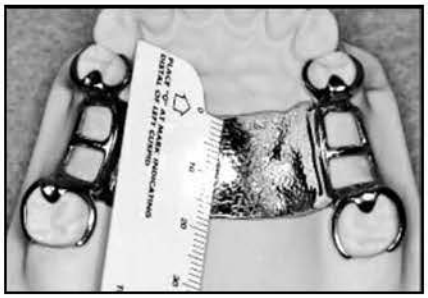


Figure 5: The anteroposterior dimension of a palatal strap major connector should never be less than 8 mm.

Advantages of the single palatal strap. Because the palatal strap is located in two or more planes, it offers great resistance to bending and twisting forces. This theory is similar to the "L beam" principle used in building construction. Simply stated, forces transmitted on different planes are responded more easily.

Because the palatal strap is inherently strong, it can be kept relatively thin. Since this configuration offers little interference with normal tongue action, palatal strap major connectors are well accepted by patients. In addition, the increased tissue coverage helps distribute applied stresses over a larger area.

Disadvantages of the single palatal strap: In some cases, a patient may complain of excessive palatal coverage. Frequently, this complaint can be traced to improper positioning of the strap borders. Therefore, the anterior border of the major connector should be positioned posterior to the palatal rugae if possible. If this is not possible, the anterior border should be terminated on the posterior slopes of prominent rugae. The posterior border of the major connector should be positioned anterior to the junction of the hard and soft palates.

The increased soft tissue coverage associated with a wide palatal strap also may predispose the patient to papillary hyperplasia. This condition is seen when the partial denture is worn 24 hours a day and normally is accompanied by poor oral hygiene. In many cases, the occurrence of papillary hyperplasia may be traced to inadequate patient instruction. Therefore, it is essential that each removable partial denture patient be provided with thorough oral and written instructions regarding the wear, care, and cleaning of oral prostheses.

Note: To differentiate between a palatal bar and a palatal strap, a palatal connector component less than 8 mm in width is referred to as a bar.

3. Combination Anterior and Posterior Palatal Bar–type Connectors

The anteroposterior palatal bar displays characteristics of palatal bar and palatal strap major connectors (Fig. 6).

The anterior bar is relatively flat. Its cross-sectional shape is similar to that of a palatal strap. Borders of the anterior bar are positioned on the appropriate slopes of prominent rugae, thereby allowing it to blend with the contours of the anterior palate.

The posterior bar is a half oval, similar to the palatal bar major connector. The two bars are joined by flat longitudinal elements on each side of the palate. This configuration gives the effect of a circle and is considerably more rigid than any of the individual elements. The two bars, lying in different planes, produce a structurally strong L-beam effect.



Figure 6: Combination Anterior and Posterior Palatal Bar–type Connectors

Advantages of the anteroposterior palatal bar. As previously noted, the main advantage of an anteroposterior palatal bar is its rigidity. The anteroposterior palatal bar minimizes soft tissue coverage, yet provides exceptional resistance to deformation.

Disadvantages of the anteroposterior palatal bar. The anteroposterior palatal bar is frequently uncomfortable. The bulk and contour of the connector may be bothersome to the tongue and may interfere with phonetics. Moreover, because of its limited contact with the palatal tissues, the anteroposterior palatal bar derives little support from the bony palate. Consequently, its use may be contraindicated in patients with reduced periodontal support.

As a general rule, the anteroposterior palatal bar should not be considered the first choice for a maxillary major connector. It should be selected only after other choices have been considered and eliminated.

3. Combination Anterior and Posterior Palatal Strap–type Connector

The anterior-posterior palatal strap provides maximum rigidity and minimum bulk. It may be used in almost any maxillary partial denture design. This major connector is particularly indicated when numerous teeth are to be replaced, or when a palatine torus is present.

Each strap should be at least 8 mm in width and relatively thin in cross section (Fig. 7). Borders of the major connector should be kept 6 mm from the free gingival margins or should extend onto the lingual surfaces of the remaining teeth. Palatal borders should exhibit smooth, gentle curves.

When anterior teeth are not being replaced, the anterior strap should be in the farthest posterior position possible. Appropriate placement promotes patient comfort and minimizes interference with speech. The posterior strap also should be in a posterior position, but should not contact the tissues of the movable soft palate. The open area in the palatal region should be at least 20 x 15 mm. Otherwise, another type of major connector should be chosen (e.g., wide palatal strap, complete palate, modified complete palate).

The posterior palatal strap should be flat and a minimum of 8 mm wide (Fig. 7). Posterior palatal connectors should be located as far posterior as possible to avoid interference with the tongue but anterior to the junction of the hard and soft palates. The only condition that prevents their use is an inoperable maxillary torus that extends posterior to the soft palate.

The strength of this major connector design lies in the fact that the anterior and posterior components are joined together by longitudinal connectors on either side, which form a square or rectangular frame (Fig. 8). Each component braces the others against possible torque and flexure. Flexure is practically nonexistent in such a design.

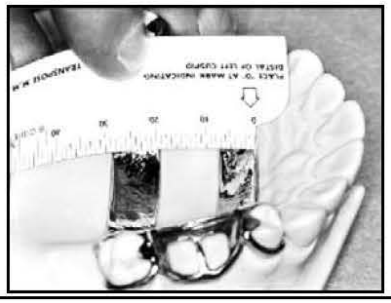


Figure 7: Both the anterior and posterior straps should be at least 8 mm in width.

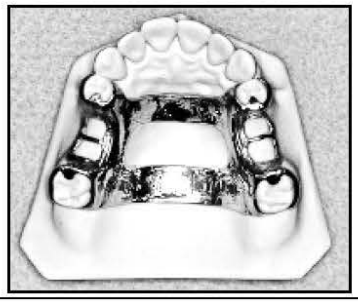


Figure 8: Anterior-posterior palatal strap–type major connector.

Advantages of the anteroposterior palatal strap. The anteroposterior palatal strap is a rigid connector that derives good support from the tissues of the hard palate despite its open design. The wavy contour of the metal over the rugae adds strength to the connector and allows the metal to be made relatively thin (< 1 mm). The structural encirclement produced by the anterior and posterior straps contributes to the rigidity of the connector. The shape of this connector

also provides a definite L-beam effect, thereby increasing the resistance to flexure.

Disadvantages of the anteroposterior palatal strap. Even though the metal over the rugae area may be thinner than in some other major connectors, interference with phonetics may occur in some patients. In addition, the extensive length of borders may cause irritation to the tongue.

Characteristics and Location of Anteroposterior Palatal Strap:

1. Rectangle shaped and open in center portion.
2. Relatively broad (8 to 10 mm) anterior and posterior palatal straps.
3. Narrow lateral palatal straps (7 to 9 mm) parallel to curve of arch; minimum of 6 mm from gingival crevices of remaining teeth.
4. Anterior palatal strap: anterior border not placed farther anteriorly than anterior rests and never closer than 6 mm to lingual gingival crevices; follows the valleys of the rugae at right angles to the median palatal suture. Posterior border, if in rugae area, follows valleys of rugae at right angles to the median palatal suture.
5. Posterior palatal connector: posterior border located at junction of hard and soft palates and at right angles to median palatal suture and extended to hamular notch area(s) on distal extension side(s).
6. Anatomic replica or matte surface.

4. Palatal Plate–type Connector (Complete palate)

The complete palate provides the ultimate rigidity and support. It also provides the greatest amount of tissue coverage. Hence, the need for maximum support and rigidity should be determined before this connector is selected. As noted for other types of major connectors, the anterior border of a complete palate must be kept 6 mm from the marginal gingivae, or it must cover the cingula of the anterior teeth (Fig. 9).

Advantages of the complete palate. Complete palatal coverage is advantageous when all posterior teeth are to be replaced. Complete palatal coverage also may be indicated when the remaining teeth are periodontally compromised. In such applications, the vertical support provided by a complete palate can be extremely beneficial. Complete palatal coverage permits distribution of applied forces to the remaining teeth, as well as to the palatal tissues.

When minimal ridge height is available, a complete palate can provide additional stabilization for the prosthesis. Undesirable lateral or horizontal forces may be dissipated by intimate contact between the major connector and the underlying soft tissues.

A cast metal palate can be produced as a uniformly thin plate that reproduces the anatomic contours of the palate. As a result, the complete palate generally is comfortable and exerts little or no effect upon phonetics. In addition, the coverage of multiple palatal planes provides an L-beam effect and makes the complete palate an extremely rigid major connector.

An all-metal connector also enhances thermal conductivity. This characteristic permit stimulation of the underlying soft tissues and may contribute to long-term tissue health. This advantage is diminished when acrylic resin is used.

Metal also exhibits a less porous surface than that of commonly used acrylic resins. Consequently, the surface of a metal framework is more resistant to colonization by potentially harmful microorganisms such as Candida albicans.

Disadvantages of the complete palate. Because of the extensive tissue coverage, adverse soft tissue reactions may occur in conjunction with complete palate major connectors. These reactions generally are characterized by soft tissue hyperplasia and accompanied by poor oral hygiene and prolonged periods of denture wear.

Occasionally, problems with phonetics may be encountered. This may be related to the extensive soft tissue coverage exhibited by complete palate major connectors.

The complete palatal plate is particularly indicated when maximum tissue support is required. In particular it should be the major connector of choice in long distal extension cases or where six or less anterior teeth remain. It should be selected where the primary abutments are periodontally involved, requiring maximum stress distribution. Where the edentulous areas are covered with flabby tissue or where there is a shallow palatal vault this connector also provides greater stability and stress distributing characteristics. The full palatal plate is usually not used in the presence of torus palatinus.

The words palatal plate are used to designate any thin, broad, contoured palatal coverage used as a maxillary major connector and covering one half or

more of the hard palate (Fig. 8). This type is also named anatomic replica palatal major connector.



Figure 9: Palatal major connector; on left, covering two thirds of the palate. On the right, covering whole palate.

The palatal plate may be used: 1) As a plate of varying width that covers the area between two or more edentulous areas, as a partial (Fig.8) or complete cast plate that extends posterior to the junction of the hard and soft palates (Fig. 9). Or 2) As an anterior palatal connector with a provision for extending an acrylic resin denture base in a posterior direction and this can be used when future relining is anticipated (Fig. 10).

The palatal plate should be located anterior to the posterior palatal seal area. The maxillary complete denture's typical posterior palatal seal is not necessary with a maxillary partial denture's palatal plate because of the accuracy and stability of the cast metal.



Figure 9: Complete coverage palatal major connector



A



B

Figure 10: A, Palatal plate major connector with provisions for attaching the full-coverage resin denture base. **B,** Completed removable partial denture with resin base.

5. U-Shaped Palatal Connector (Horseshoe connector)

The horseshoe connector consists of a thin band of metal running along the lingual surfaces of the remaining teeth and extending onto the palatal tissues for 6 to 8 mm (Fig. 11).

The medial borders of this connector should be placed at the junction of the horizontal and vertical slopes of the palate. Rigidity can be increased by extending the borders slightly onto the horizontal surfaces of the hard palate.

The connector should display symmetry and should extend to the same height on both sides. All borders of the connector should be gently curved and smooth. From both the patient's standpoint and a mechanical standpoint, the U-shaped palatal connector is the least desirable of maxillary major connectors.

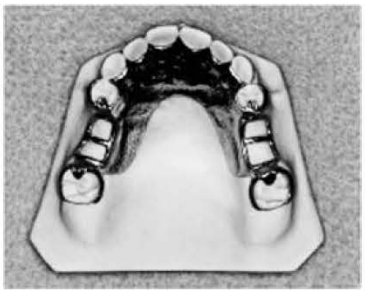


Figure (11): U-shaped palatal major connector

Disadvantages of the horseshoe connector. When vertical force is applied to one or both ends of a horseshoe major connector, there is a tendency for the connector to flex or deform (Fig. 12). Therefore, it is a poor choice for distal extension partial dentures. For the same reason, this is not a good connector when cross-arch stabilization is required. The horseshoe connector displays limited resistance to flexing, and noticeable movement can occur at the open end. This may result in the concentration of forces and damage to the associated abutments.

To avoid the tendency to flex, the metal crossing the anterior palate must be thicker than that used in most other major connectors. This places the greatest bulk of metal in an area that is critical to patient comfort and phonetics.

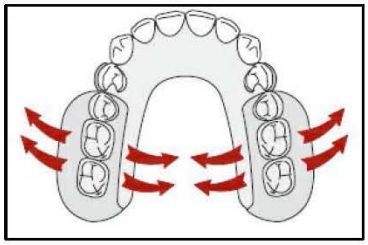


Figure (12): A horseshoe major connector has a tendency to flex or deform when a load is placed. Therefore, it is a poor choice for most maxillary applications.

The U- shaped Palatal Connector should never be used arbitrarily and may be indicated when a large inoperable palatal torus exists, and occasionally when several anterior teeth are to be replaced. The following are the principal **objections** to use of the U-shaped connector that may lead to failure of many maxillary partial dentures:

1. Its lack of rigidity can allow lateral flexure under occlusal forces, which may induce torque or direct lateral force to abutment teeth.
2. Doesn't provide good support and may impinge underlying tissue when subjected to occlusal loading.
3. Increase in thickness, at the rugae area, to enhance rigidity may interfere with the freedom of the tongue.

A U-shaped major connector may be made more rigid with multiple teeth supported rests and a wider coverage of the major connector.

Review of indications for maxillary major connectors

1. The combination anterior-posterior connector design may be used with any Kennedy class of partially edentulous arch. It is used most frequently in Classes II and IV.
2. The single palatal strap is used more frequently in Class III situations.
3. If the periodontal support of the remaining teeth is weak, more of the palate should be covered. A wide palatal strap or a complete palate is indicated.
4. The palatal plate–type or complete coverage connector is used most frequently in Class I situations.
5. When anterior teeth must be replaced, an anteroposterior palatal strap, complete palate, or horseshoe major connector may be used. The final selection must be based on modifying factors such as number and location of missing posterior teeth, periodontal support of remaining teeth, type of opposing occlusion, and present of torus.
6. If a torus is present and is not to be removed, an anteroposterior palatal strap, or horseshoe major connector may be used. Final selection must be based on modifying factors e.g. size, position, extension of torus.

Mandibular Major Connectors

Special Structural Requirements

- In general, mandibular major connectors are long and relatively narrow. Therefore, special consideration must be given to the design of such connectors. Mandibular connectors must be rigid without being so bulky that they compromise patient comfort. Furthermore, mandibular major connectors must not impinge upon the movable floor of the mouth, the associated frena, or mandibular tori.
- Unlike maxillary major connectors, for which relief is infrequently required, mandibular major connectors often permit relief between the rigid metal surfaces and the underlying soft tissues. The amount of relief is dependent upon several factors. For an entirely tooth-supported prosthesis, little or no relief is needed because the denture does not tend to move in function. For a distal extension removable partial denture, however, a moderate amount of relief may be indicated because this type of prosthesis tends to rotate during function. Relief prevents the margins of the major connector from lacerating the sensitive lingual mucosa as a result of this movement.

  The slope of the anterior ridge also influences the amount of relief needed (Fig. 1). If the soft tissues are vertical, or nearly so, only minimal relief is required. Tissues that slope toward the tongue require the greatest amount of relief because any movement of the connector will bring it into contact with the adjacent soft tissues. If the anterior ridge is undercut, sufficient space may be created when the technician blocks out the undercut area.
- Bead lines are not used in combination with mandibular major connectors. Contact with the mucosa of the mandibular arch may cause irritation, ulceration, and patient discomfort.

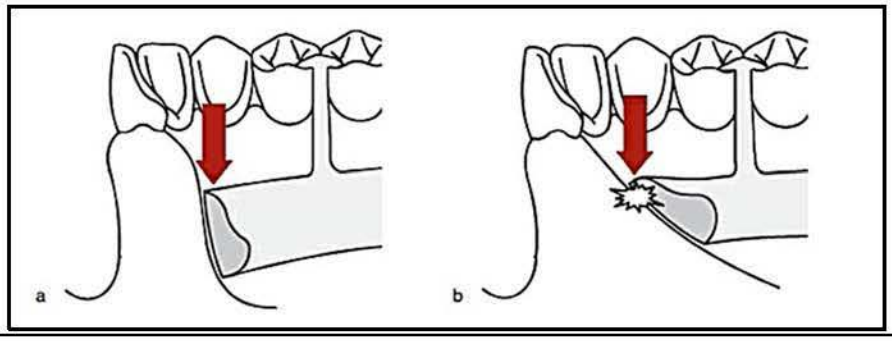


Figure 1: Slope of the anterior ridge also influences the amount of relief needed. (a) If the lingual soft tissues are vertical, or nearly vertical, minimal relief may be used. (b) Tissues that slope toward the tongue require the greatest amount of relief because any movement of the major connector will bring it into contact with the adjacent soft tissues.

Types of Mandibular major connectors

The following is a list of the different types of mandibular major connectors:

1. Lingual bar
2. Lingual plate (Linguoplate)
3. Double lingual bar (Lingual bar with cingulum bar, Kennedy bar)
4. Labial bar

Lingual bar and lingual plate major connectors are used in the majority of removable partial denture applications. Double lingual bar and labial bar major connectors are used for special applications in which lingual bars and lingual plates are contraindicated.

1. Lingual Bar

The lingual bar is possibly the most frequently used mandibular major connector (Fig. 2). Because of its simplicity in design and construction, a lingual bar should be used unless one of the other connectors offers a certain advantage. A lingual bar is indicated for all tooth-supported removable partial dentures unless there is insufficient space between the marginal gingivae and the floor of the mouth.

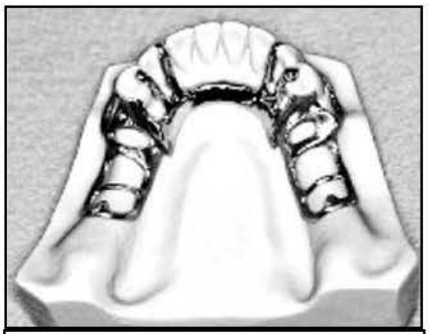


Figure 2: lingual bar major connector.

When viewed in cross section, a lingual bar is half-pear shaped. The broadest portion of the bar is located at its inferior border, nearest the floor of the mouth (Fig. 3). The bar should not have sharp margins that irritate the tongue. The superior border should be tapered toward the gingival tissue and the greatest bulk should be at the inferior border which should be slightly rounded, resulting in a contour that has a half-pear shape. A rounded border will not impinge on the lingual tissue when the denture bases rotate inferiorly under occlusal loads. The inferior border of a lingual mandibular major connector must be located free from the floor of the mouth.

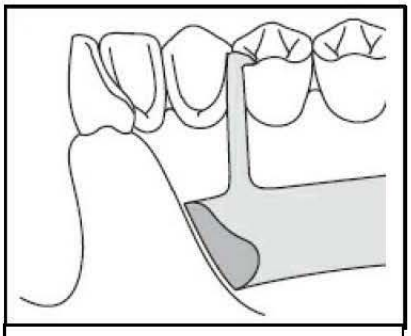


Figure 3: Sagittal section showing half-pear shape of lingual bar.

Indication for the Use of lingual Bar.

The lingual bar should be used for mandibular RPD where sufficient space exists, more than 8mm between the slightly elevated alveolar lingual sulcus and the lingual gingival tissue.

Methods for Determination the Height of the Floor of the Mouth.

In a clinical situation, the available space may be determined using a periodontal probe. The patient should be instructed to elevate and protrude the tongue so that its tip touches the vermilion border of the upper lip. This activates the floor of the mouth and raises the tissues to the height that occurs during function. While the patient maintains this position, a periodontal probe can be positioned gently in the oral cavity (Fig 4-A). The tip of the probe should rest on the floor of the mouth, and readings should be taken at the most apical portion of each gingival margin. Then, these readings should be transferred to the diagnostic cast or master cast (Fig 4-B). The lingual bar should be located in the most apical position the movable soft tissues will allow.

Another method may be by the using of a customized impression tray for which lingual borders are 3 mm short of the elevated floor of the mouth, and then use an impression material that will permit the impression to be accurately molded as the patient licks the lips.

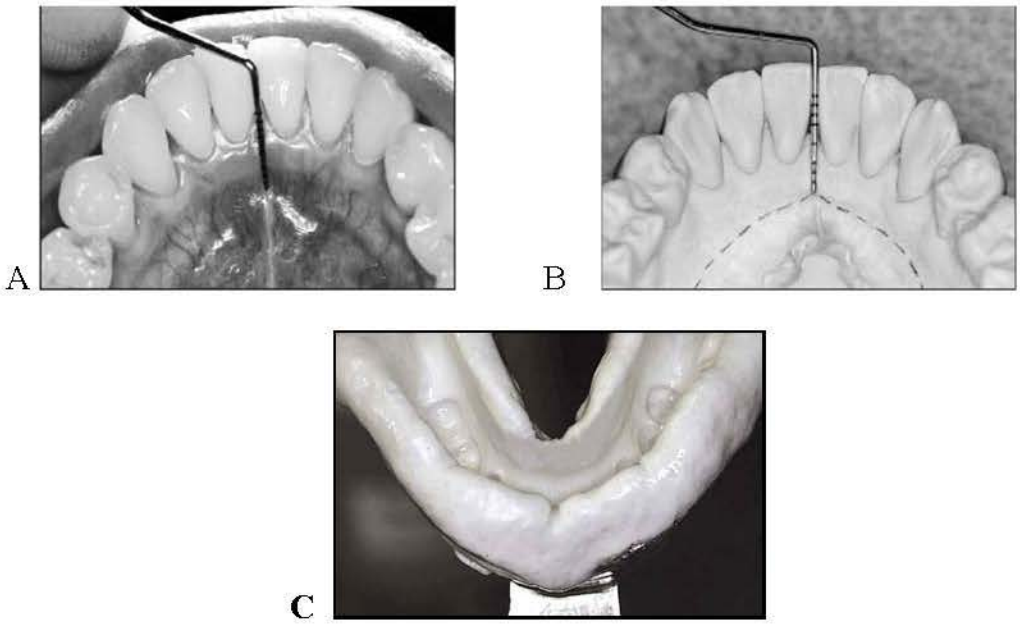


Figure 4: Methods for determination the height of the floor of the mouth. **A**, Height of floor of the mouth (tongue elevated) in relation to lingual gingival sulci measured with a periodontal probe. **B** Recorded measurements are transferred to a diagnostic cast and then to a master cast after mouth preparations are completed. **C** Impression made with functional movement of the tongue to demonstrate maximum shortening of the floor of the mouth.

2. Linguoplate (lingual plate)

The structure of a lingual plate is basically that of a half pear shaped lingual bar with a thin, solid piece of metal extending from its superior border (Fig.5). This thin projection of metal is carried onto the lingual surfaces of the teeth and presents a scalloped appearance.

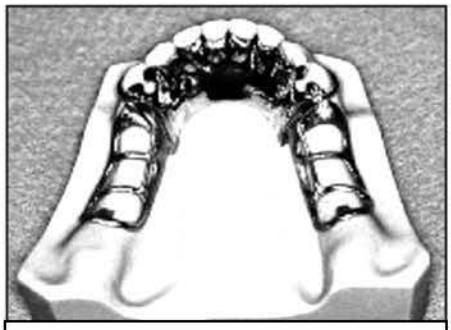


Figure 5: Lingual plate major connector.

The inferior border of a lingual plate should be positioned as low as possible in the floor of the mouth, but should not interfere with the functional movements of the tongue and soft tissues. The superior border of a lingual plate must be contoured to intimately contact the lingual surfaces of the teeth above the cingula (Fig. 6).

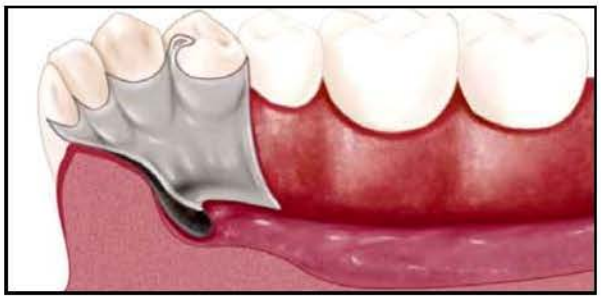


Figure 6: Sagittal section through the linguoplate demonstrating a basic half-pear–shaped inferior border with the metallic apron extending superiorly.

In addition, the lingual plate must completely close the interproximal spaces to the level of the contact points. Sealing these spaces from the lingual aspect prevents food from being packed into these areas. As a result of this contouring, the lingual plate should display a scalloped appearance (Fig.7).



Figure 7: The superior border of a lingual plate major connector should display a scalloped appearance.

Indications for the use of a linguoplate.

1. When the lingual frenum is high or the space available for a lingual bar is limited (less than 8 mm).
2. In Class I situations in which the residual ridges have undergone excessive vertical resorption.
3. For stabilizing periodontally weakened teeth, splinting with a linguoplate can be of some value when used with definite rests on sound adjacent teeth.
4. When the future replacement of one or more incisor teeth will be facilitated by the addition of retention loops to an existing linguoplate.
5. In the presence of mandibular tori.

The lingual plate has a main disadvantage, because of its extensive coverage, which may contribute to decalcification of enamel surfaces and irritation of the gingival tissues in patients with poor oral hygiene.

The linguoplate does not in itself serve as an indirect retainer. When indirect retention is required, definite rests must be provided for this purpose. Both the linguoplate and the cingulum bar ideally should have a terminal rest at each end, regardless of the need for indirect retention. However, when indirect retainers are necessary, these rests may also serve as terminal rests for the linguoplate.

Sometimes a linguoplate is indicated as the major connector of choice even though the anterior teeth are quite spaced and the patient strenuously objects to metal showing through the spaces. The linguoplate can then be constructed so that the metal will not show through the spaced anterior teeth. This is a modification of the linguoplate and is named "***interrupted linguoplate***" *or* "**step backs**". To accomplish this, the superior border of a lingual plate should cover the cingulum of the individual tooth. The border should extend toward the contact area of the tooth and then turn apically, following the line angle to the level of the gingiva. The rigidity of the major connector is not greatly altered. However, such a design may be as much of a food trap (Fig.8).



Figure8: Interrupted linguoplate or "step backs".

3. Double lingual bar (Lingual bar with cingulum bar or Kennedy bar).

The connector consists of a lingual bar plus a secondary bar resting above the cingula of the anterior teeth. The upper and lower components of a double lingual bar are not joined by a continuous sheet of metal. As a result, the lingual surfaces of the teeth and the interproximal soft tissues are largely exposed (Fig. 9).

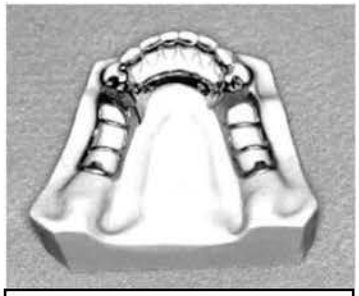


Figure 9: Double lingual

The lower component of this major connector should display the same structural characteristics as does a lingual bar. The upper bar should

be half oval in cross section. This bar should be 2 to 3 mm in height and 1 mm thick. The upper bar should not run straight across the lingual surfaces of the teeth but should present a scalloped appearance. The two bars should be joined by rigid minor connectors at each end. Rests should be placed at each end of the upper bar and should be located no farther posterior than the mesial fossae of the first premolars. Placement of these rests is intended to prevent the bar from moving inferiorly and causing orthodontic movement of the remaining anterior teeth.

The secondary bar supposedly acts as an indirect retainer and performs a role in the horizontal stabilization of periodontally involved teeth. The performance of these functions is questionable. Additionally, this major connector can create a food trap between the two bars. *The use of this type of connector is not encouraged.*

Indications for Use of Double lingual bar:

1. When a linguoplate is indicated but the axial alignment of anterior teeth is such that excessive blockout of interproximal undercuts would be required.

2. When wide diastemata exist between mandibular anterior teeth and a linguoplate would objectionably display metal in a frontal view.

The disadvantage of this type of major connector is the tendency of the upper bar to trap debris especially with crowding of the mandibular anterior teeth. This can be minimized by accurate impressions and good adaptation of the upper bar to the anterior teeth. Also, the double lingual bar may irritate the tongue and annoy the patient due to the multiple borders and the thickness of the upper bar. Thus, a modified lingual plate major connector may be preferred.

4. Labial Bar

As its name suggests, a labial bar runs across the mucosa on the facial surface of the mandibular arch (Fig. 10). Like other mandibular major connectors, a labial bar displays a half-pear shape when viewed in cross section. But, because of its placement on the external curvature of the mandible, a labial



Figure 10: Labial Bar

bar is longer than a corresponding lingual bar, double lingual bar or lingual plate. To ensure rigidity, the height and thickness of a labial bar must be greater than those described for a lingual bar.

In only few situations when the extreme lingual inclination of the remaining lower premolar and incisor teeth prevent the use of a lingual bar major connector. With the use of conservative mouth preparations in the form of recontouring and block out, a lingual major connector can almost always be used. Lingually inclined teeth sometimes may have to be reshaped by means of crowns. Although the use of a labial major connector may be necessary in rare instances, this should be avoided by resorting to necessary mouth preparations rather than by accepting a condition that is otherwise correctable.

The same applies to the use of a labial bar when a mandibular torus interferes with placement of a lingual bar. Unless surgery is definitely contraindicated, interfering mandibular tori should be removed so that the use of a labial bar connector may be avoided.

Indications for Use of the Labial Bar.

1. When lingual inclinations of remaining mandibular premolar and incisor teeth cannot be corrected, preventing placement of a conventional lingual bar connector.

2. When severe lingual tori cannot be removed and prevent the use of a lingual bar or lingual plate major connector.

3. When severe and abrupt lingual tissue undercuts make it impractical to use a lingual bar or a lingual plate major connector.

Characteristics and Location of the Labial Bar.

1. Half-pear shaped with bulkiest portion inferiorly located on the labial and buccal aspects of the mandible.

2. Superior border tapered to soft tissue.

3. Superior border located at least 4 mm inferior to labial and buccal gingival margins and farther if possible.

4. Inferior border located in the labial-buccal vestibule at the junction of attached (immobile) and unattached (mobile) mucosa.

A labial bar can be used in association with the linguoplate as a modification for the linguoplate. This concept is incorporated in the Swing-Lock design, which consists of a labial or buccal bar that is connected to the linguoplate major connector by a hinge at one end and a latch at the other end, as shown in figure 10.

Support is provided by multiple rests on the remaining natural teeth. Stabilization and reciprocation are provided by a linguoplate that contacts the remaining teeth and are supplemented by the labial bar with its retentive struts. Retention is provided by a bar type of retentive clasp with arms projecting from the labial or buccal bar and contacting the infra-bulge areas on the labial surfaces of the teeth.



Figure 10: The Swing-Lock removable partial

Use of the Swing-Lock concept would seem primarily indicated when the following conditions are present:

1) Missing key abutments,

2) Unfavorable tooth contours,

3) Unfavorable soft tissue contours, &

4) Teeth with questionable prognoses.

Contraindications to the use of this hinged labial bar concept are poor oral hygiene or lack of motivation for plaque control by the patient, the presence of a shallow buccal or labial vestibule, & a high frenal attachment.

Review of Indications for Mandibular Major Connectors

- For a tooth-supported removable partial denture, the lingual bar generally is the mandibular major connector of choice.
- When there is insufficient room between the floor of the mouth and the gingival margins (< 8 mm), a lingual plate should be used. This major connector also is indicated for patients with large inoperable tori and patients with high lingual frenum attachments.
- When the anterior teeth have reduced periodontal support and require stabilization, a lingual plate is recommended.
- When the anterior teeth exhibit reduced periodontal support and large interproximal spaces, a modified lingual plate (ie, step-back design) or double lingual bar should be used.
- When a removable partial denture will replace all mandibular posterior teeth, a lingual plate should be used.
- A labial bar is rarely indicated.

  You have to correct the condition by extraction of severely malpositioned teeth, orthodontic correction of lingually inclined teeth, placement of crowns, or surgical intervention to remove tori.

Minor Connector

Minor connectors are those components that serve as the connecting link between the major connector or the base of a removable partial denture and the other components of the prosthesis, such as the clasp assembly, indirect retainers, occlusal rests, or cingulum rests.
In many instances, a minor connector may be continuous with some other part of the denture. For example, an occlusal rest at one end of a linguoplate is actually the terminus of a minor connector, even though that minor connector is continuous with the linguoplate. Similarly the portion of a partial denture framework that supports the clasp and the occlusal rest is a minor connector, which joins the major connector with the clasp proper. Those portions of a removable partial denture framework that retain the denture bases are also minor connectors.

Functions of Minor Connector

In addition to joining denture parts, the minor connector serves two other purposes.

1. Transfers functional stress to the abutment teeth.

   This is a prosthesis-to-abutment function of the minor connector. Occlusal forces applied to the artificial teeth are transmitted through the base to the underlying ridge tissue if that base is primarily tissue supported. Occlusal forces applied to the artificial teeth are also transferred to abutment teeth through occlusal rests. The minor connectors arising from a rigid major connector make possible this transfer of functional stress throughout the dental arch.

2. Transfers the effects of the retainers, rests, and stabilizing components throughout the prosthesis.

   This is an abutment- to-prosthesis function of the minor connector. Thus, forces applied on one portion of the denture may be resisted by other components placed elsewhere in the arch for that purpose. A stabilizing component on one side of the arch may be placed to resist horizontal forces that originate on the opposite side. This is possible only because of the transferring effect of the minor connector, which supports that stabilizing component, and the rigidity of the major connector.

Form and Location of Minor Connectors

Like the major connector, the minor connector must have sufficient bulk to be rigid; otherwise, the transfer of functional stresses to the supporting teeth and tissue will not be effective. At the same time, the bulk of the minor connector should not be objectionable.

Basic Types of Minor Connectors

A. **Minor connectors placed into embrasures between two adjacent teeth.**

   These connectors should be somewhat triangular shaped in cross section to minimize intrusion into the tongue or vestibular spaces, while still providing adequate bulk for rigidity as shown in the Figure (1).

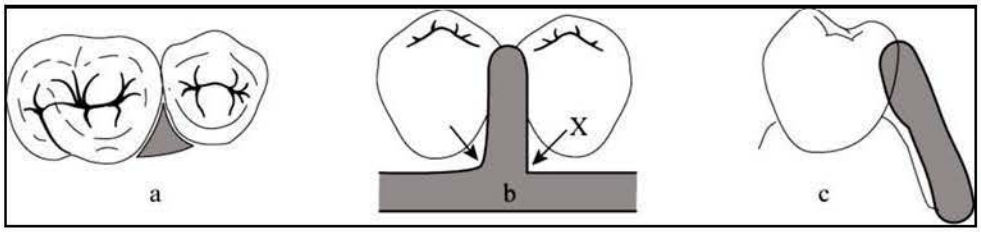


Figure 1: (a). A minor connector should join the major connector at a right angle and cover as small an area of tissue as possible (b). The juncture to the major connector should be rounded (arrow) not sharp (X) unless the juncture includes an acrylic finish line. Relief should be placed on the master

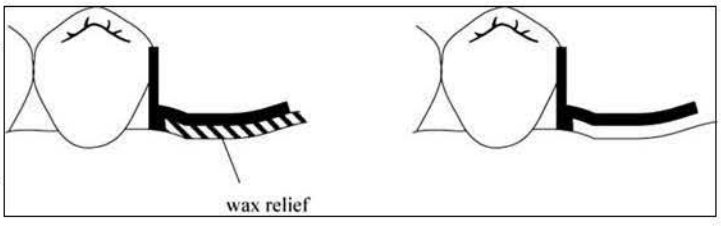
A minor connector should fill the embrasure space so that a smooth surface is presented to the tongue and so that areas where food can be trapped are minimized. Ideally, a minor connector should not contact the teeth gingival to the height of contour. If a minor connector fits tightly against an abutment below the height of contour, a wedging force may be created during functional movements of the framework. This wedging can result in increased tooth mobility. Alternatively, it may be difficult to seat or unseat the framework.

B. Gridwork minor connectors that connect the denture base and teeth to the major connector.

These minor connectors are adjacent edentulous spaces and usually connect the major connector to a clasp assembly as well. Gridworks can be an open lattice work or mesh type. The mesh type tends to be flatter, with more potential rigidity. Conversely the mesh has been shown provide less retention for the acrylic if the openings are insufficiently large. The lattice type has superior retentive potential, but can interfere with the setting of teeth, if the struts are made too thick or poorly positioned. Both types are acceptable if correctly designed.

Adequate mechanical retention of the denture base resin is gained by providing relief under the minor connector gridwork to allow the acrylic resin to flow under the gridwork. To allow for this space, relief wax is placed on the cast in the edentulous areas prior to making a refractory cast (for fabricating the framework). Usually, one thickness of baseplate wax is sufficient (about 1 mm of relief). After the framework has been waxed and cast on the refractory model and returned to the master cast, the space provided by the relief wax is available for the mechanical retention of the acrylic resin, Figure (2).

Figure 2: Relief under the minor connector gridwork.



Minor connectors originating from the gridwork in an edentulous area usually take the form of vertical metal plates (**proximal plates**) that make broad contact with prepared guiding planes. These proximal plates may or may not terminate in an occlusal rest, depending on the partial denture design. The plate is shifted slightly towards the lingual to increase rigidity, enhance reciprocation and improve esthetics, Figure (3).

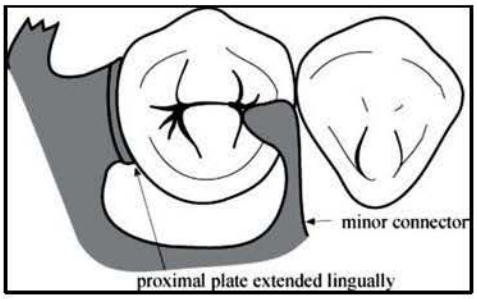


Figure 3: Minor connectors originating from the gridwork in an edentulous area (Proximal plates).

Tissue Stops

Tissue stops are integral parts of minor connectors. Mandibular distal extension gridworks should have a "tissue stop" at their posterior limit. This is an extension of the metal through the relief wax providing direct contact with the ridge. They provide stability to the framework during the stages of transfer and processing. They are particularly useful in preventing distortion of the framework during acrylic-resin processing procedures.

Another integral part of the minor connector is similar to a tissue stop but serves a different purpose. It is located distal to the terminal abutment and is a continuation of the minor connector contacting the guiding plane. Its purpose is to establish a definitive finishing index tissue stop for the acrylic-resin base after processing. Relief under the gridwork should not be started immediately adjacent to the abutment tooth but should begin 1.5 - 2 mm from the abutment tooth. This will create a metal to tissue contact immediately adjacent to the tooth. A metal surface is preferable since it wears less, and is less porous, thus facilitating hygiene, Figure (4).

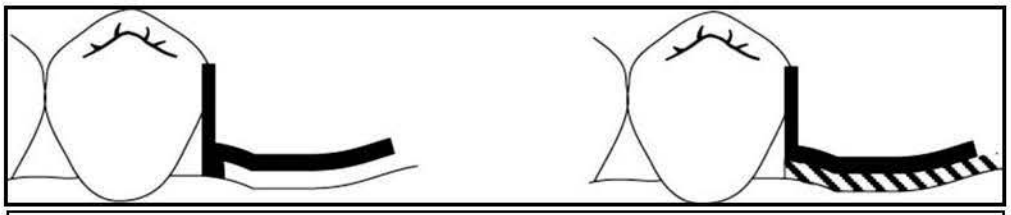


Figure 4: Metal immediately adjacent to tooth on the left, Incorrect (acrylic of base is adjacent tooth) on the right.

Finishing Lines

The finishing line junction with the major connector should take the form of an angle not greater than 90 degrees, therefore being somewhat undercut, Figure (5). This provides for maximum bulk of the acrylic resin denture base at the metal junction, to prevent the creation of thin, weak, feather edges which can easily fracture or distort, Figure (6).

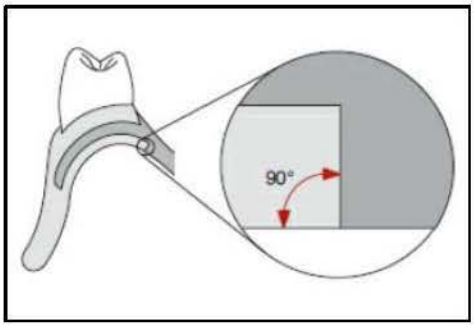


Figure 5: The internal angles of external finish lines should be slightly less than 90 degrees. This results in improved mechanical retention for acrylic resin components.

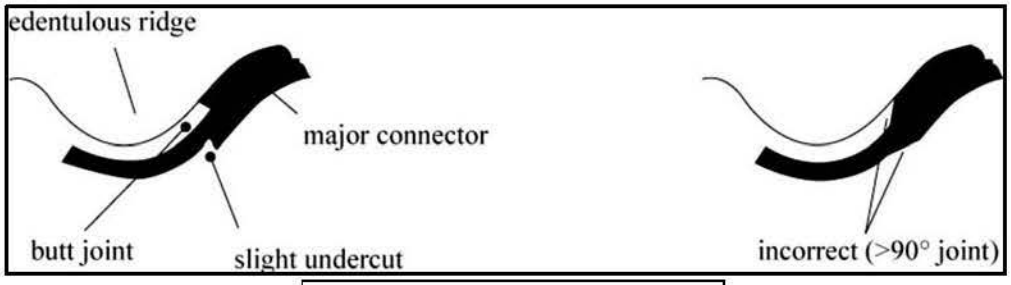
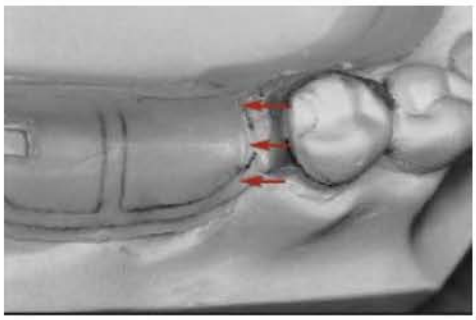


Figure 6: Finishing line junction.

Therefore, resin metal joints should be created only at the external surfaces. These interfaces are referred to as finish lines. If they are located on the outer surfaces of major connectors, they are called external finish lines. If they are positioned on the inner or tissue surfaces, they are termed internal finish lines, Figure (7).



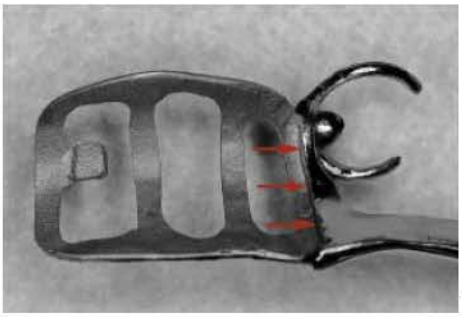


Figure 7: A. Internal finish lines result from relief wax placed on the master cast prior to duplication. Arrows indicate the presence of a well-defined vertical wall, which will produce an internal finish line. B. Properly contoured relief wax results in a sharply defined internal

The medial extent of the minor connector depends on the lateral extent of the major palatal connector. If the finishing line is located too far medially, the natural contour of the palate will be altered by the thickness of the junction and the acrylic resin supporting the artificial teeth. If, on the other hand, the finishing line is located too far buccally, it will be most difficult to create a natural contour of the acrylic resin on the lingual surface of the artificial teeth. The location of the finishing line at the junction of the major and minor connectors should be based on restoration of the natural palatal shape, with consideration given to the location of the replacement teeth, Figure (8).

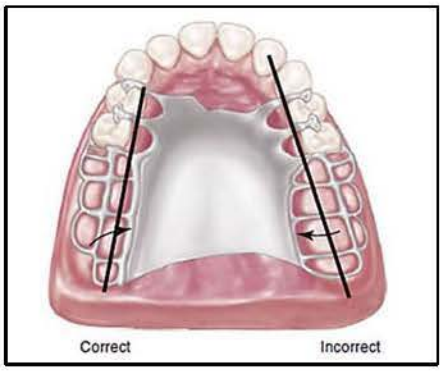


Figure 8: Junction of the major connector and the minor connector at palatal finishing lines should be located 2 mm medial from an imaginary line that would contact the lingual surfaces of missing posterior teeth. The finish line on the right is too far toward midline of the palate. The natural contours of the palate will be altered.

Gridwork Minor Connector Design

The length of the gridwork minor connector for the mandibular distal extension base should extend posteriorly about two-thirds the length of the edentulous ridge of the distal extension in CL I & II cases, Figure (9). For the maxillary distal extension base, gridwork minor connector should extend the entire length of the distal extension in CL I & II cases, Figure (10).

Figure 9: Length of the gridwork minor connector.

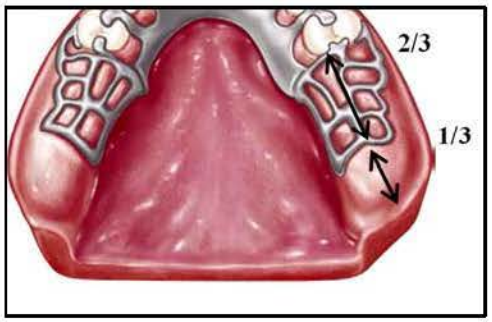




Figure 10: Length of the gridwork minor connector. Note the extension of the finishing line to the area of the pterygomaxillary notch provides a butt-type joint for attachment of the border portion of the resin base through the pterygomaxillary notch (Circle).

Rests and Rest Seats

The component of a partial denture on a tooth surface that provides vertical support is called a ***rest***. The prepared surface of an abutment to receive the rest is called the ***rest seat***. The topography of any rest should restore the topography of the tooth that existed before the rest seat was prepared.

The relationship between a rest and a rest seat must be such that forces transmitted from the prosthesis to an abutment are directed apically down the long axis of the tooth. In this manner, stress can be absorbed by the fibers of the periodontal ligament without damaging the ligament or the supporting bone.

A rest that is part of a retentive clasp assembly is referred to as a ***primary rest***. The main purpose of a primary rest is to prevent vertical movement of a prosthesis toward the tissues and also helps transmit forces to the supporting teeth. A rest that is responsible for additional support or indirect retention is called an ***auxiliary rest*** or ***secondary rest***.

The purposes of the rest in general are:

1. Provide vertical support for the partial denture.
2. Directs and distributes occlusal loads to abutment teeth.
3. Maintains the components in their planned positions.
4. Maintains occlusal relationship by preventing settling of the denture.
5. Prevents impingement of soft tissue.
6. In addition, a rest may be used to close a small space between teeth, thereby restoring continuity of the arch and preventing food impaction.

Rests are designated by the surface of the tooth prepared to receive them. Thus, they are named as follows:

A. Occlusal Rest:

   1. Occlusal rest (conventional)
   2. Extended occlusal rest
   3. Interproximal occlusal rest
   4. Internal occlusal rest

B. Lingual Rest (Cingulum Rest)
C. Incisal Rest
D. Implants as a Rest

A. Occlusal Rest

This rest is associated with the posterior teeth; molars & premolars. The Form of the ***Occlusal Rest and Rest Seat*** should be as follows:

1. The outline form of an occlusal rest seat should be a rounded triangular shape with the apex toward the center of the occlusal surface (Fig. 1).
2. It should be as long as it is wide, and the base of the triangular shape (at the marginal ridge) should be at least 2.5 mm for both molars and premolars.
3. The marginal ridge of the abutment tooth at the site of the rest seat must be lowered to 1.5 mm to permit a sufficient bulk of metal for strength and rigidity of the rest and the minor connector. The most common mistake in occlusal rest seat preparation is insufficient reduction of the marginal ridge.
4. The floor of the occlusal rest seat should be apical to the marginal ridge and the occlusal surface and should be concave, or spoon shaped.
5. When viewed in cross section, the deepest part of an occlusal rest seat should be located near the center of the mesial or distal fossa. From its depth, the floor of the rest seat should rise gently toward the marginal ridge (Fig. 1).
6. The angle formed by the occlusal rest and the vertical minor connector from which it originates should be less than 90 degrees (Fig. 1). An angle greater than 90 degrees fails to transmit occlusal forces along the vertical axis of the abutment tooth. This also permits slippage of the prosthesis away from the abutment, with possible orthodontic tooth movement.

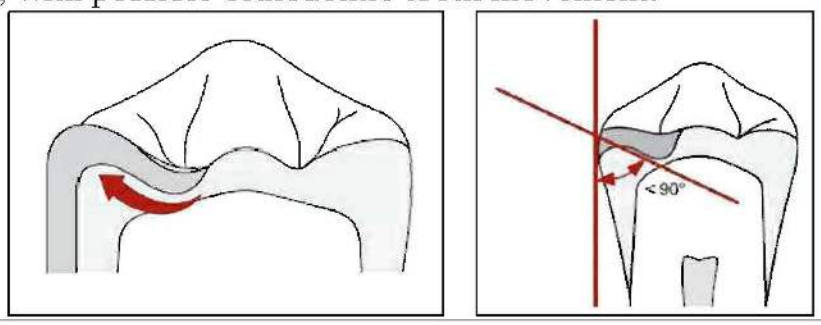


Figure 1: The deepest part should be should near the center of the mesial or distal fossa and should be inclined apically from the lowered marginal ridge with an angle less than 90 degrees.

When occlusal rest seats are prepared next to an edentulous space the morphology follows the conventional form (Fig. 2). On the other hand, when a single occlusal rest seat is prepared next to an adjacent tooth (Fig. 3) the lingual line angle is flared more to provide additional space for the minor connector.

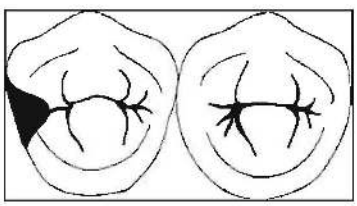


Figure 2: Occlusal rest seat prepared next to an edentulous space

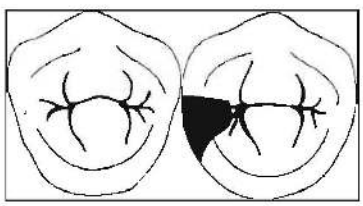


Figure 3: Single occlusal rest seat prepared next to an adjacent tooth

Extended Occlusal Rest

An extended occlusal rest should be used in situations in which the most posterior abutment is a mesially tipped molar, to minimize further tipping of the abutment and to ensure that the forces are directed down the long axis of the abutment. This rest should extend more than one-half the mesio-distal width of the tooth (Fig. 4).



Figure 4: Extended occlusal rest seat on the mandibular first molar.

Interproximal Occlusal Rest

The rest seats of this rest are prepared as individual occlusal rest seats (Fig. 5), with the exception that the preparations must be extended farther lingually and additional tooth structure is removed in the marginal areas to provide at least 1.5 mm of room for the embrasure clasps. The rest seats are flared more dramatically to the facial and the lingual line angles to provide additional space for the retentive arms and minor connector. The lingual interproximal area requires only minor preparation. Creation of a vertical groove must be avoided to prevent a torqueing effect on the abutments by the minor connector. This is especially true for RPDs with distal extension bases.

The advantages of such occlusal rests are: 1) Prevent interproximal wedging by the framework. 2) The joined rests shunt food away from contact points.





Figure 5: Preparations of interproximal occlusal rest extending lingually.

Internal Occlusal Rests

They are used for a partial denture that is totally tooth supported for both occlusal support and horizontal stabilization (Fig. 6). They must be used in association with a crown on the abutment tooth. An internal occlusal rest should not be confused with an internal attachment.

The main advantages of the internal rest are:

1) The clasp arm buccally is not visible. Retention is provided by a lingual clasp arm.
2) Permits the location of the rest seat in a more favorable position in relation to the tipping axis (horizontal) of the abutment.



Figure 6: Maxillary tooth-supported removable partial denture utilizing internal occlusal rests.

Occlusal Rest Seat Preparation

Occlusal rest seats should have smooth gentle curves and any sharp angles, walls, and ledges must be avoided. Any portion of the rest seat that restricts movement of the rest may transmit undesirable horizontal forces to the tooth.

Rest seat preparations should be made in sound enamel and should follow preparation of proximal tooth surfaces that are necessary to provide proximal guiding planes and eliminate undesirable undercuts.

Occlusal rest seats in sound enamel may be prepared with burs and polishing points that leave the enamel surface as smooth as the original enamel. The larger round bur is used first to lower the marginal ridge and to establish the outline form of the rest seat. A slightly smaller round bur then is used to deepen the floor of the occlusal rest seat and form the desired spoon shape.

The anatomy and depth of the rest seat preparation can be evaluated by using sheet wax. A small piece is firmly pressed into the rest seat and the patient is asked to occlude on the wax while the wax is in the rest seat. The surface of the wax is inspected to determine the anatomy of the rest seat preparation. The depth of the rest seat is determined by carefully measuring the thickness of the wax. Any corrections can be accompanied and the process can be repeated.

The preparation is smoothed by a polishing point of suitable size and shape. Fluoride gel should be applied to abutment teeth following enamel recontouring.

Occlusal Rests on Amalgam Restorations

It is always better to place an occlusal rest on sound enamel or cast restoration. Sometimes a conservative amalgam restoration may be used to support removable partial denture, but advantages and disadvantages of such treatment should be carefully considered.

As for a large amalgam restoration, it is easier to place an occlusal rest on a large amalgam restoration because an amalgam restoration costs less than a crown. However, the disadvantages are greater than the benefits so this is not advisable.

The flow characteristics and poor tensile characteristics of amalgam increase the possibility of restoration failure. Amalgam alloys tend to deform when a sustained load is applied and this may result in fracture of the material and failure of the restoration. In addition, future replacement of a defective restoration under an existing removable partial denture is difficult, and the results are not always good. Retreatment may need restoration of the abutment and a construction of a new removable partial denture.

Occlusal Rest on Crowns

All-ceramic restorations should not be used to support removable partial dentures, via rests, because of the undesirable physical characteristics of ceramics. Ceramic materials are relatively strong in compression, but weak in tension and any wedging or elongation of a ceramic surface often lead to fracture. If the rests bind against the walls of the rest seat, this will result in a wedging effect and create tensile forces that cause fracture of the ceramic. Also, the interaction between a ceramic rest seat and the associated metal rest is not desirable because of the different material properties.

Metal-ceramic restorations can be used but it is recommended that rest seats be constructed entirely in metal. The metal borders should extend at least 1 mm beyond the borders of the rest (in all directions).

Occlusal rest seat preparations in existing restorations (crown) may be widened to compensate for shallowness, but the floor of the rest seat should still be slightly inclined apically from the marginal ridge. When this is not possible, a secondary occlusal rest should be used on the opposite side of the tooth to prevent slipping of the primary rest.

Occlusal rest seats that will be located in new restorations, crowns, and inlays should be known when the tooth is prepared so that sufficient clearance may be provided for the rest seat within the preparation (Fig. 7).

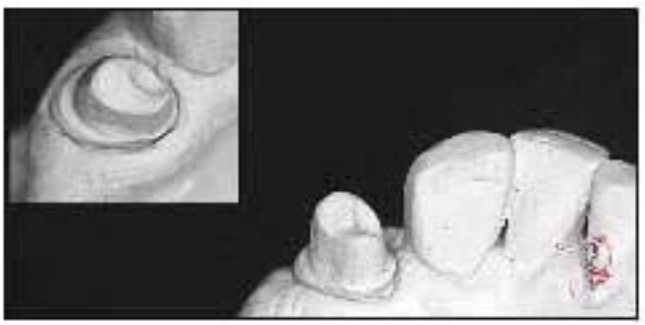


Figure 7: Adequate occlusal reduction to accommodate the depth of the rest seat in the abutment crown.

B. Lingual Rests (Cingulum Rest)

An occlusal rest seat on a posterior tooth is preferred over a cingulum or incisal rest seat on an anterior tooth. Because of its size and position, an occlusal rest seat permits forces to be directed along the long axis of the tooth in a better manner. Posterior teeth also present large divergent roots that can withstand more loading than the small conical roots of anterior teeth.

There are situations where a lingual rest is used because an anterior tooth may be the only abutment available for occlusal support of the denture. Also, an anterior tooth may be used as an indirect retainer or an auxiliary rest. In such cases a canine is preferred over an incisor for this purpose due to the greater root length, root surface area, and crown morphology.

Lingual rests are used primarily on maxillary canines. The normal crown morphology of a maxillary canine permits preparation of a satisfactory rest seat with minimal tooth reduction. Lingual rests are not usually placed on mandibular canines because of the lack of sufficient enamel thickness for appropriate preparation of the rest seat. Also, mandibular canines do not have a prominent cingulum and appropriate depth for a rest seat may expose the underlying dentine.

When a canine is not present, multiple rests over several incisor teeth are preferable to distribute the stresses over a number of teeth because a single incisor doesn't provide adequate support.

The preparation of an anterior tooth to receive a lingual rest is accomplished in two ways:

First method: A slightly rounded V-shape prepared on the lingual surface at the junction of the gingival and the middle one third of the tooth (Fig. 8). The apex of the V is directed incisally. The mesio-distal length of the preparation should be a minimum of 2.5 to 3 mm, labio-lingual width about 2 mm, and incisal-apical depth a minimum of 1.5 mm. This preparation of the tooth starts with an inverted cone shaped bur and progresses to a smaller tapered bur with a round end to complete the preparation.

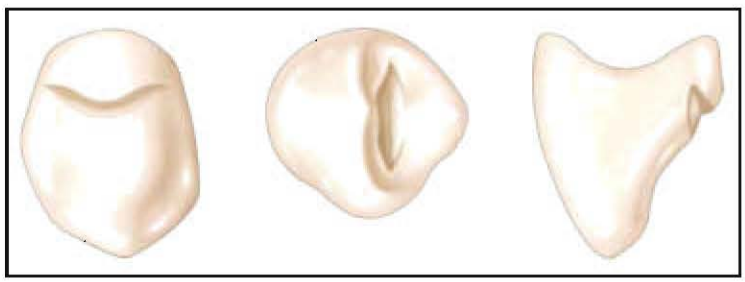


Figure 8: Three views of lingual rest seat prepared in enamel of the maxillary canine.

Second method: A ball type of rest may be used in a prepared seat (Fig. 9). Round rest seats are occasionally prepared on the mesial side of the canine when the use of a typical cingulum rest is contraindicated (i.e. large restoration, lack of clearance with

the opposing teeth, poorly developed cingulum). The seats of these rests are prepared in the same manner as that of the occlusal rest seats.



Figure 9: Ball type rest seat on canine.

There are several modifications to lingual rest seats prepared in natural teeth:

1. Lingual (Cingulum) Rest Seat in a New Cast-Metal or Metal Ceramic Restoration Cast Restoration (Crown)

The most satisfactory lingual rest from the standpoint of support is one that is placed on a prepared rest seat in a cast restoration (crown). When a fixed restoration is to be placed on an anterior abutment, a cingulum rest seat should be incorporated into the wax pattern. This rest seat should exhibit ideal contours and should direct forces along the long axis of the abutment.

2. Cast Alloy Rest Seat Forms

Also, individually cast alloy rest seat forms are used on teeth with unacceptable lingual contours using minimal tooth preparation. They are attached to lingual surfaces by the use of composite resin cements (Fig. 10).

A limited area on the lingual surface of the abutment is prepared to a depth of 0.5 to 0.7 mm. This minimizes tooth reduction and permits the surface of the casting to be positioned at the level of the adjacent tooth structure. Two or three circular indentations are then prepared within the borders of the tooth reduction. The indentations assist in placement of the restoration and also provide vertical support for the cast. The casting is cemented using an appropriate luting agent.

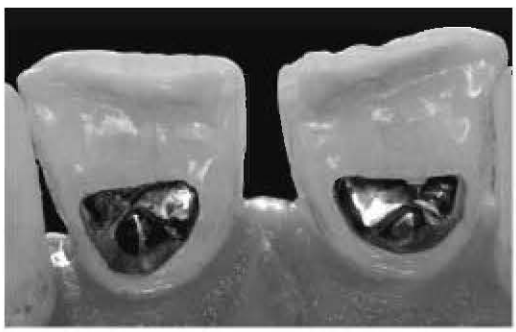


Figure 10: cast alloy lingual rest seat on mandibular canine.

3. Bonded Composite Cingulum Rest Seats

Bonded composite cingulum rest seats with composite resin have also been successfully used as a conservative approach to forming rest seats (Fig. 11).

This is accomplished by bonding composite resin to the lingual surface of the tooth, then shaping the resin in the manner described for rest seats prepared in enamel. The disadvantage of these rest seats is that they are susceptible to wear and may lose their effectiveness over a relatively short period. Thus, they are not always desired.



Figure 11: Composite resin rest seat.

4. An Alternative Cingulum Rest Seat

The alternative cingulum rest seat may be described as a crescent-shaped depression located in the middle and gingival thirds of the crown (Fig 12). This type can be used for mandibular canines with insufficient enamel that prevents preparation of conventional cingulum rest seats.

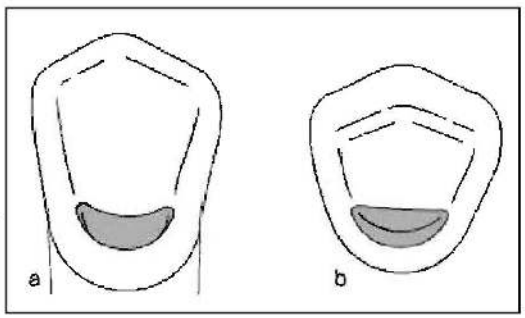


Figure 12: Alternative Cingulum Rest Seat.

Attempts to create adequate depth often result in exposure of the underlying dentin. Therefore, the alternative cingulum rest seat should be used very carefully.

C. Incisal Rests and Rest Seats

An incisal rest seat is usually placed on the disto-incisal angle for esthetic purposes, but the mesio-incisal may also be used (Fig. 13). It is predominantly used as an auxiliary rest or an indirect retainer.

An incisal rest is inferior to a lingual rest. 1) Esthetically, the metal of the rest shows at the incisal edge, 2) mechanically the lingual rest is placed nearer to the center of rotation of the tooth and has fewer tendencies to tip the tooth, 3) may interfere with

occlusion, and 4) has a higher possibility for breakage and distortion. Although, it may be used successfully for selected patients when the abutment is sound and when a cast restoration is not otherwise indicated.

Incisal rest seats are commonly used on mandibular canines, but may be used on other anterior teeth as well. The placement of incisal rest seats on incisors should be considered a last resort because of the esthetic and mechanical compromises that must be made.

The incisal rest seat is prepared in the form of a rounded notch at the incisal edge of the teeth, with the deepest portion of the preparation apical to the incisal edge. The rest seat should be approximately 2.5 mm wide and 1.5 mm deep so that the rest will be strong without having to exceed the natural contour of the incisal edge.

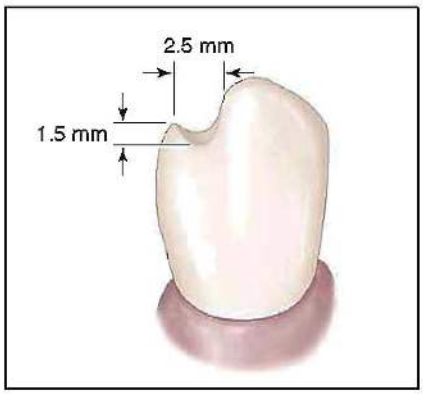


Figure 13: Incisal rest seat preparation and dimensions.

D. Implants as a Rest

Implants can serve as a rest, since they resist tissue-ward movement and are useful for retentive needs as well. Their use allows a low profile connection (i.e., close to the ridge), and less torque to the implant.

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Prosthodontics

Retention and Removable Partial Denture Retainers

In general, a removable partial denture should have these requirements :

Support: The support derived from the abutment teeth through the use of rests and from the residual ridge through the use of well-fitting bases .

Stability: Removable partial denture must be stable against horizontal movement through the use of rigid components like the reciprocal arm of the circumferential clasp and minor connector. The removable partial denture must also be stable against rotational movements through the use of rigid connectors and indirect retainers.

Retention: Retention is the quality of the removable partial denture that resists forces acting to dislodge components away from the supporting tissues. Sufficient retention is provided by two means. Primary retention for removable partial denture is accomplished mechanically by placing retaining elements (direct retainers) on the abutment teeth. Secondary retention is provided by the intimate relationship of the minor connector contact with the guiding planes, denture bases, and major connectors (maxillary) with the underlying tissue. The latter (secondary retention) is similar to the retention of complete denture. It is proportionate to the accuracy of the impression registration, the accuracy of the fit of the denture bases, and the total involved area of contact.

Retainers can be divided into:

I. Direct retainers .

II. Indirect retainers.

Direct retainers

A direct retainer: is any unit of a removable dental prosthesis that engages an abutment tooth to resist displacement of the prosthesis away from basal seat tissue.

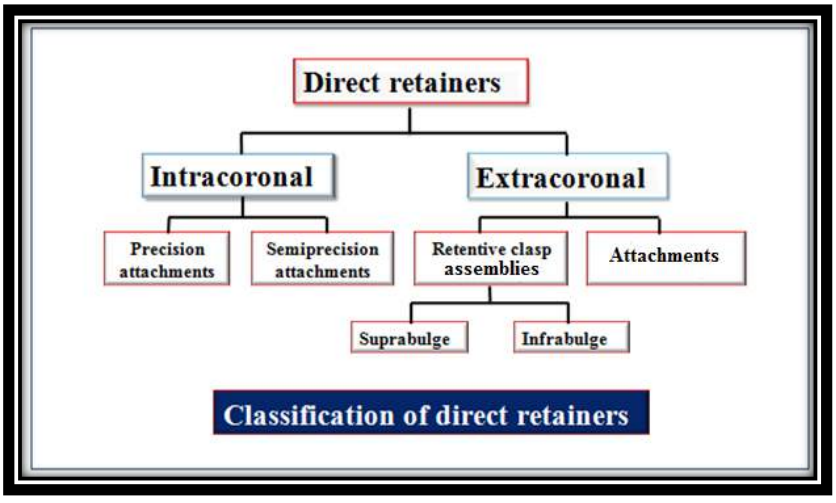
The direct retainer's ability to resist this movement is greatly influenced by the stability and support of the prosthesis provided by major and minor connectors, rests, and tissue bases.

There are basically two types of direct retainers:

1. Intracoronal in conjunction with the fabrication of a single crown or fixed bridge. Precision or semi-precision attachments are usually premanufactured and either machined or cast in the laboratory.

There is a male-female union between the abutment tooth and the RPD framework. The primary advantage of using attachments as direct retainers is esthetics as the retentive clasp arm is eliminated from the design. A disadvantage of using these attachments is they can be costly, they are difficult to use, and they require more maintenance than a conventional clasp design.

2. Conventional extra coronal cast clasp, where the retention is usually provided by a flexible arm that flexes over the area of greatest contour into an area of lesser contour. This is usually called a clasp.



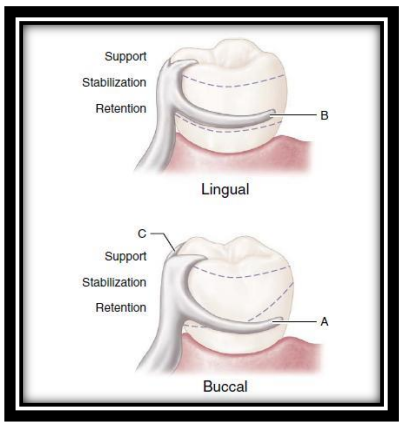
The extra coronal retainer (Clasp type): Most mechanical retention is derived from the use of direct retainers (clasp assemblies) utilizing tooth undercuts.

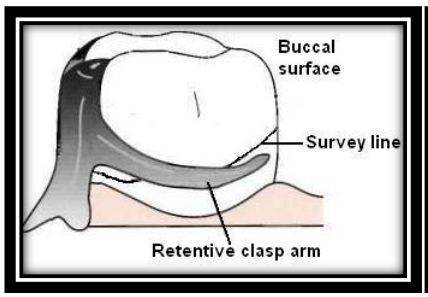
The extra coronal retainer is the most commonly used retainer for removable partial dentures, which uses mechanical resistance to displacement through components placed on

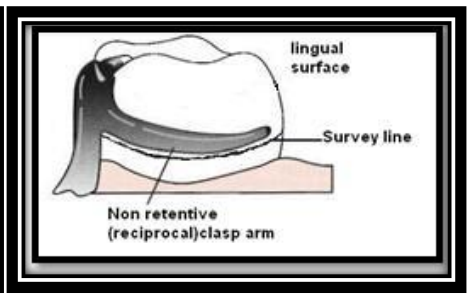
the external surfaces of an abutment tooth in an area cervical to survey line or in a depression created for this purpose. Usually, a flexible arm is forced to deform, so there will be resistance to removal.

Component parts, Function, and position of clasp assembly parts

Component Part	Function	Location
Rest	**Support**	Occlusal, lingual and incisal rests.
Minor connector	**Stabilization**	Proximal surfaces extending from a prepared marginal ridge to the junction of the middle and gingival one-third of abutment crown.
Clasp arms	**Stabilization (Reciprocation)**	Middle one-third of the crown.
	Retention	Gingival one-third of the crown in the measured undercut.







Extracoronal circumferential direct retainer Assembly consists of: (A) the buccal retentive arm; (B) the rigid lingual stabilizing (reciprocal) arm; and (C) the supporting occlusal rest. The terminal portion of the retentive arm is flexible and engages measured undercut. Assembly remains passive until activated by placement or removal of the restoration, or when subjected to masticatory forces that tend to dislodge the denture base.

No single component of a clasp assembly is solely responsible for prosthesis retention. Rather, it is the effective design and accurate construction that make the removable partial denture retentive. Each part contributes to some critical features. For example :

1. The retentive arm must be designed so that only the clasp terminus engages the prescribed undercut .
2. The accompanying rest must provide support so the clasp terminus is maintained in an optimal location .
3. The minor connector must be sufficiently rigid to ensure proper stability and function of parts of the clasp assembly.
4. The reciprocal element must contact the abutment slightly before the retentive element contacts the tooth to protect the abutment from destructive lateral forces.
5. Components must provide sufficient encirclement; otherwise, retention will be lost.
6. Indirect retainers must resist forces acting to dislodge the prosthesis from its fully seated position.

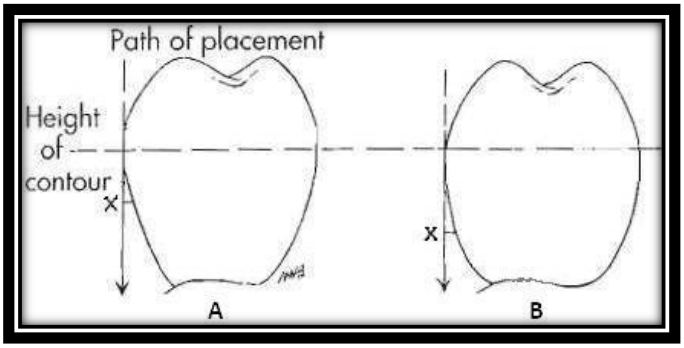
Factors affecting the magnitude of retention: Clasp retention is based on resistance to the deformation of the metal. For a clasp to be retentive, it must be placed in an undercut area of the tooth, it is forced to deform upon application of a vertical dislodging force. The amount of retention depends on various factors.

I. Size of and distance into the angle of cervical (gingival) convergence and how far into the angle of convergence the clasp terminal is placed: To be retentive, a tooth must have an angle of convergence cervical to the height of contour. When it is surveyed, any single tooth will have a height of contour or an area of greatest convexity. Any areas cervical to the height of contour may be used for the placement of retentive clasp components, whereas areas occlusal to the height of contour may be used for the placement of nonretentive, stabilizing, or reciprocating components. So, only flexible components may be placed gingivally to the height of contour because rigid elements would not flex over the height of contour or contact the tooth in the undercut area.

The location and depth of a tooth undercut available for retention are therefore only relative to the path of placement and removal of the partial denture. The most suitable path of placement is generally considered to be the path of placement that will require the least

amount of mouth preparation necessary to place the components of the partial denture in their ideal position.

When the angle of convergence between two abutments differs, uniformity of retention can be obtained by placing the clasp arms into the same degree of undercut (i.e. both 0.01"). A guiding principle of partial denture design is that retention should be uniform in magnitude and bilaterally opposed amongst abutments.

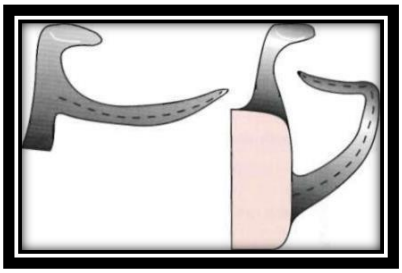


The greater angle of cervical convergence on the tooth (A) necessitates placement of clasp terminus, (X), nearer the height of contour than when a lesser angle exists, as in (B).

II. The flexibility of the clasp arm: This is influenced by the following factors:

1. **Length of clasp arm:**

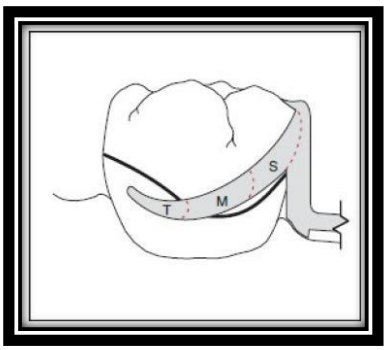
- Increase the length of the clasp arm increase the flexibility of it, all other factors being equal, (increasing clasp curvature increases length).



- The length of the clasp arm is measured from the point where the taper begins.
- The length of the clasp arm may be increased by using curving rather than straight retentive arms.

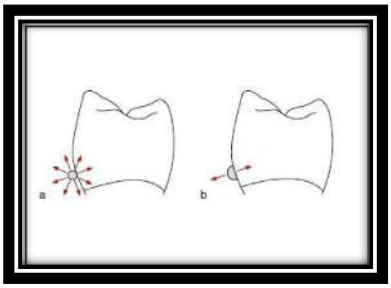
2. **The diameter of clasp:**

- The greater the average diameter of a clasp arm the less flexible it will be .
- If it's taper is absolutely uniform, the average diameter will be at a point midway between its origin and its terminal end. If its taper is not uniform, a point of flexure and therefore a point of weakness will exist .
- The clasp should always taper from the body to the tip, being thicker where the body is attached to the denture base metal or acrylic and thinnest at the end of the arm.



The rigid clasp shoulder (S) originates from the minor connector and projects across the axial surface of the abutment. The relatively flexible midsection of the clasp arm (M) continues along the abutment surface and approaches the height of the contour. The flexible clasp terminus (T) crosses apical to the height of contour, contacting the abutment on a surface undercut relative to the path of prosthesis insertion and removal.

3. Cross-sectional form of the clasp arm: Flexibility may exist in any form, but it is limited to only one direction in the case of the half-round form (bidirectional flexure). The only universally flexible form (omnidirectional flexure) is the round form, which is practically impossible to obtain by casting and polishing.



When viewed in cross-section, a round clasp (a) can flex in all directions, while a half-round clasp (b) is restricted to bidirectional flexure.

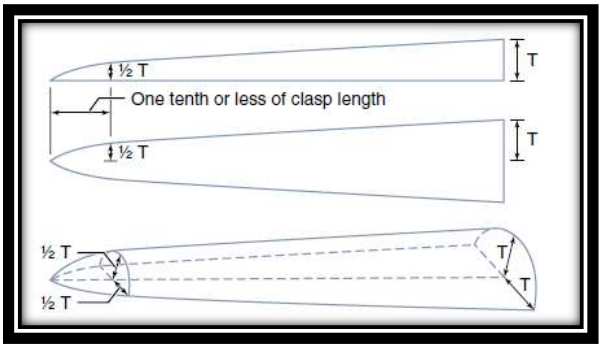
4. Clasp material:

- Whereas all cast alloys used in partial denture construction possess flexibility; their flexibility is proportionate to their bulk.
- Greater rigidity with less bulk is possible through the use of chromium-cobalt alloys.
- Gold clasps are not as flexible or adjustable as wrought wire.
- Cast gold alloys may have greater resiliency than doing cast chromium- cobalt alloys.
- Wrought wire clasp has greater tensile strength than cast clasps and hence can be used in a smaller diameter to provide greater flexibility without fatigue fracture.

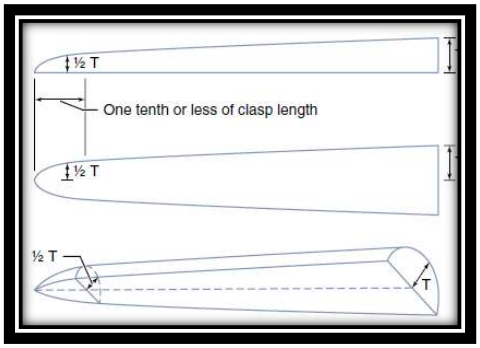
5. The relative uniformity of retention: Having reviewed the factors inherent to a determination of the amount of retention from individual clasps, it is important to consider coordination of relative retention between various clasps in a single prosthesis.

6. Stabilizing-reciprocal cast clasp arm:

- When the direct retainer becomes active, the framework must be stabilized against horizontal movement. This stabilization is derived from either cross-arch framework contacts or a stabilizing or reciprocal clasp in the same clasp assembly.
- To provide true reciprocation, the reciprocal clasp must be in contact during the entire period of retentive clasp deformation. This is best provided with lingual- palatal, guide-plane surfaces.
- Its average diameter must be greater than the average diameter of the opposing retentive arm to increase desired rigidity.



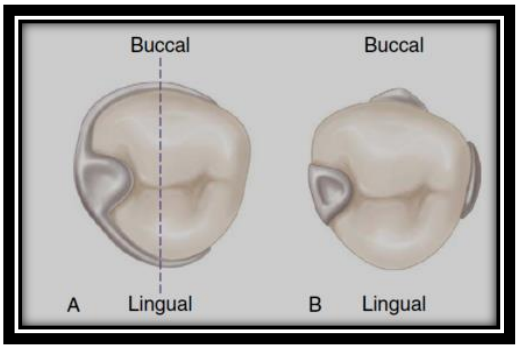
(Cast retentive arm)

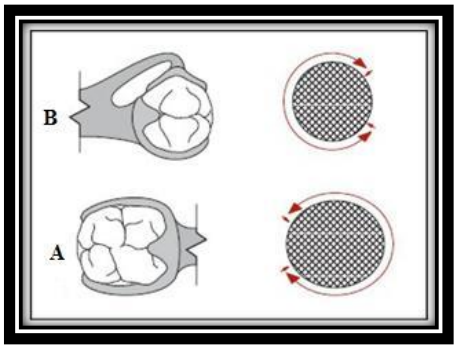


(Cast reciprocal arm)

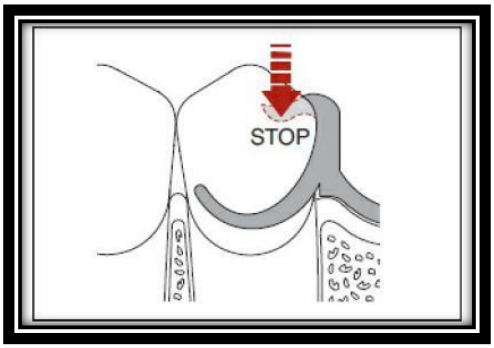
The basic principles of clasp design:

1. **Encirclement:** The principle of encirclement means that more than 180 degrees in the greatest circumference of the tooth must be engaged by the clasp assembly. The engagement can be in the form of continuous contacts, such as in a circumferential clasp (A), or discontinuous contact, such as in the use of a bar clasp (B). 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.



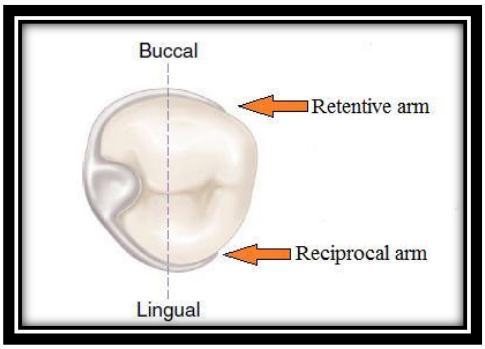


2. Support: The occlusal rest must be designed to prevent the movement of the clasp arms toward the cervical.

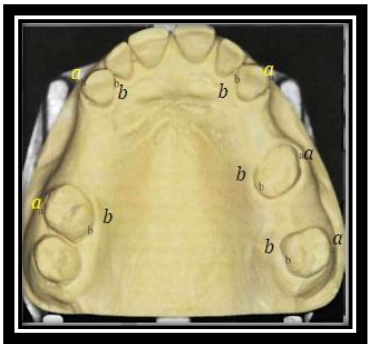


A rest must prevent the apical displacement of the prosthesis. If this is not accomplished, the underlying hard and soft tissues may be damaged.

3. **Reciprocation:** 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.



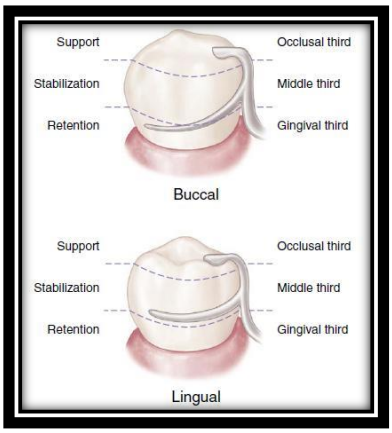
4. **Clasp retainers:** on abutment teeth adjacent to distal extension bases should be designed so that they will prevent direct transmission of tipping and rotational forces to the abutment. In effect, they must act as stress breakers either by their design or by their construction.
5. **Retentive clasps:** 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.

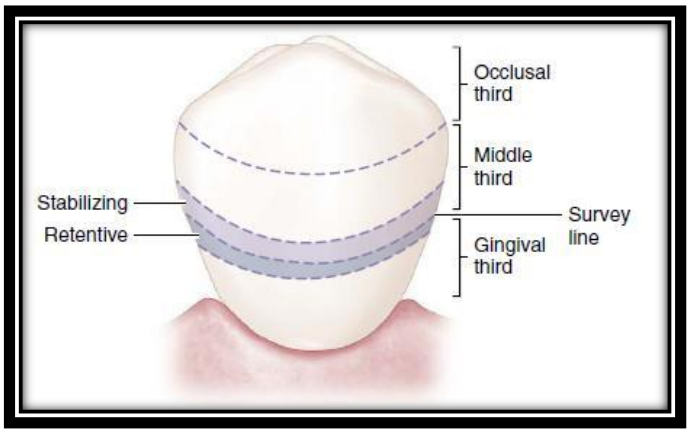


Retentive clasps should be bilaterally opposed. This means using bilateral buccal or bilateral lingual undercuts as shown on this Class III, mod. 2 arches where the retention may be either (a) bilaterally buccal or (b) bilaterally lingual.

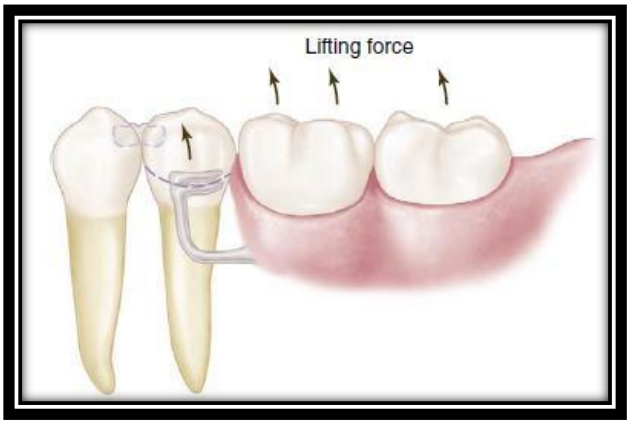
6. The amount of retention should always be the minimum necessary to resist reasonable dislodging forces.
7. Reciprocal elements of the clasp assembly should be located at the junction of the gingival and middle thirds of the crowns of abutment teeth. The terminal end of the retentive arm is optimally placed in the gingival third of the crown. These locations

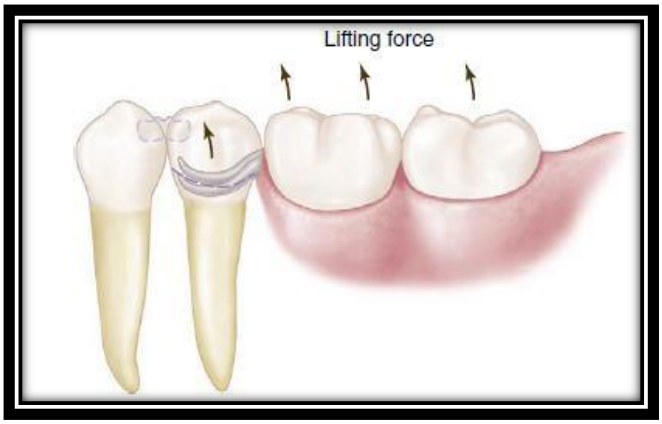
permit better resistance to horizontal and torquing forces because of a reduction in the effort arm.





8. **Passivity:** When the clasp is in its place on the tooth surface, it should be at rest, the retentive tip of the clasp arm must be passive and remain in contact with the tooth ready to resist vertical dislodging force, so when a dislodging force is applied the clasp arm should immediately become active to engage tooth surface to resist vertical displacement.





Prosthodontics

Types of clasp assemblies:

They are of two types:-

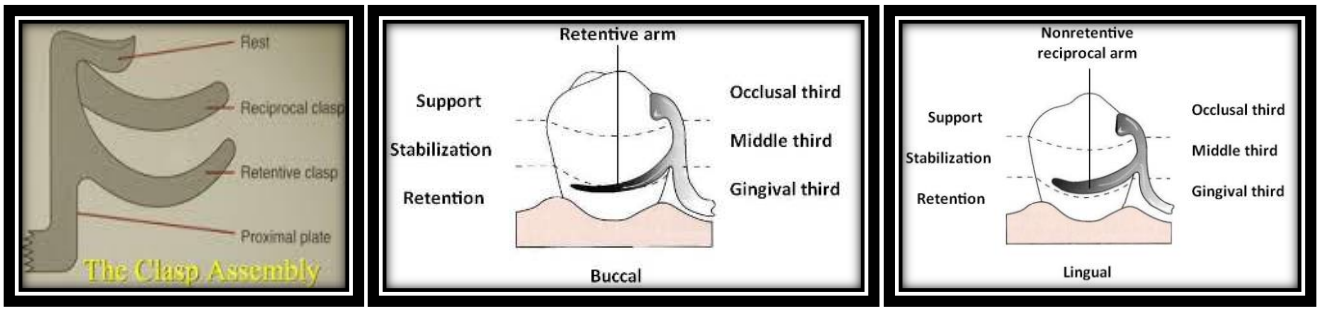
1. **Clasps designed without movement accommodation.**
2. **Clasps designed to accommodate distal extension functional movement.**

Clasps designed without movement accommodation: It is also named suprabulge clasp or occlusally approach clasp since the clasp approaches the retentive undercut from the occlusal direction.

Clasps for tooth-borne partial dentures (Class III and IV) have one function to prevent dislodgment of the prosthesis without damage to the abutment teeth. Since there is little or no rotation caused by tissue ward movement of the edentulous area (as happens in distal extension cases) stress releasing properties are usually not required. These clasps can also be used in modification spaces for tooth and tissue supported removable partial dentures (Class I and II).

Circumferential (Circle or Akers) clasp:

- The circumferential clasp will be considered first as an all-cast clasp and it is the simplest one.
- The basic form of the circumferential clasp is a buccal and lingual arm originating from a common body (principle occlusal rest and minor connector).
- The circumferential clasp has only one retentive clasp arm, opposed by a nonretentive reciprocal arm on the opposite side.
- It approaches the undercut area from an occlusal direction so it is called (occlusally approaching clasp) since it is coming to the undercut area from above the bulge area so-called (suprabulge clasp) and since it is pulling the tooth during action also called pull clasp and also called Aker clasp.
- 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 gingival.
- The bracing (nonretentive reciprocal) arm is in the middle 1/3 of the tooth, and is broader occlusal – gingivally, does not taper and is either entirely above the height of contour or completely on a prepared guiding plane – it should never be designed into an undercut, as it is a rigid element.
- Support is provided by occlusal rest; stabilization is provided by occlusal rest, proximal minor connector, lingual clasp arm and rigid portion of buccal retentive clasp arm occlusal to the height of contour; retention is realized by the retentive terminal of buccal clasp arm; reciprocation is provided by nonflexible lingual clasp arm. Clasp Assembly engages more than 180 degrees of abutment tooth's circumferences.



Indications:

- It is a most logical clasp to use with all tooth-supported partial dentures because of its retentive and stabilizing ability.
- On free end extension when minimal undercut is utilized.

Contraindication:

- When the retentive undercut may be approached better with a bar clasp arm.
- When esthetics will be enhanced by using bar clasp arm.

Advantages:

- Excellent bracing qualities.
- Easy to design and construct.
- Less potential for food accumulation below the clasp compared to bar clasps.

Disadvantages:

- More tooth surface is covered than with a bar clasp arm because of its occlusal origin.
- On some tooth surfaces, particularly the buccal surface of mandibular teeth and the lingual surfaces of maxillary teeth, its occlusal approach may increase the width of the occlusal surface of the tooth.
- In the mandibular arch, more metal may be displayed than with the bar clasp arm.
- Its half-round form prevents adjustment to increase or decrease retention. True adjustment is impossible with most cast clasps.

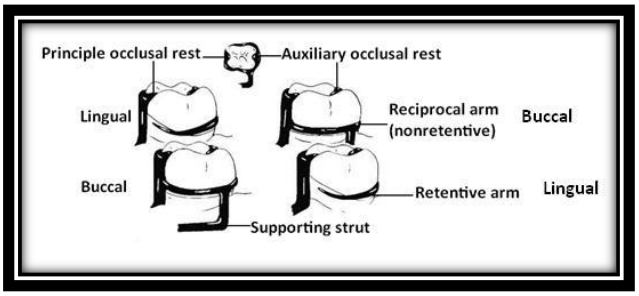
The circumferential type of clasp may be used in several forms:

1. Ring-type clasp:

- Ring clasp, which encircles nearly all of a tooth from its point of origin.
- Usually used with mesially and lingually tilted mandibular molars or the undercut is on the same side as the rest seat (i.e. adjacent to edentulous span).
- The clasp should never be used as an unsupported ring because if it is free to open and close as a ring, it cannot provide either reciprocation or stabilization. Instead, the ring-type clasp should always be used with a supporting strut on the nonretentive side, with or without an auxiliary occlusal rest on the opposite marginal ridge. The advantage of an auxiliary rest is that further movement of a mesially inclined tooth is

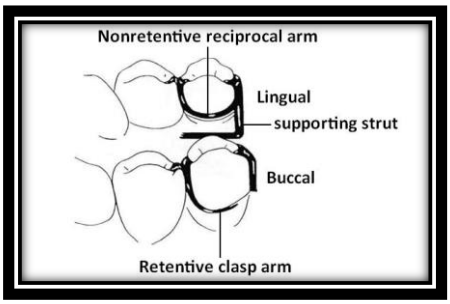
prevented by the presence of a distal rest. In any event, the supporting strut should be regarded as being a minor connector from which the flexible retentive arm originates.

- Reciprocation comes from the rigid portion of the clasp lying between the supporting strut and the principal occlusal rest.
- The ring-type clasp should be used on protected abutments whenever possible because it covers such a large area of the tooth surface.



Indications:

- It is used when a proximal undercut cannot be approached by other means. For example, when a mesiolingual undercut on a lower molar abutment (isolated lower molar such as in Class II modification one) cannot be approached directly because of its proximity to the occlusal rest area and cannot be approached with a bar clasp arm because of lingual inclination of the tooth.
- It may be used in reverse on an abutment located anterior to a tooth-bounded edentulous space when a distobuccal or distolingual undercut cannot be approached directly from the occlusal rest area and/or tissue undercuts prevent its approach from a gingival direction with a bar clasp arm.

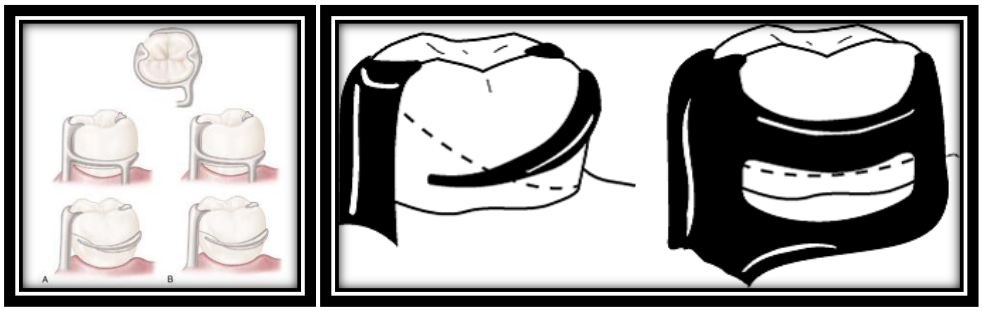


Contraindication:

- Excessive tissue undercuts prevent the use of a supporting strut.

Advantages:

a. Excellent bracing (with supporting strut).
b. Allow the use of an available undercut adjacent to the edentulous area.



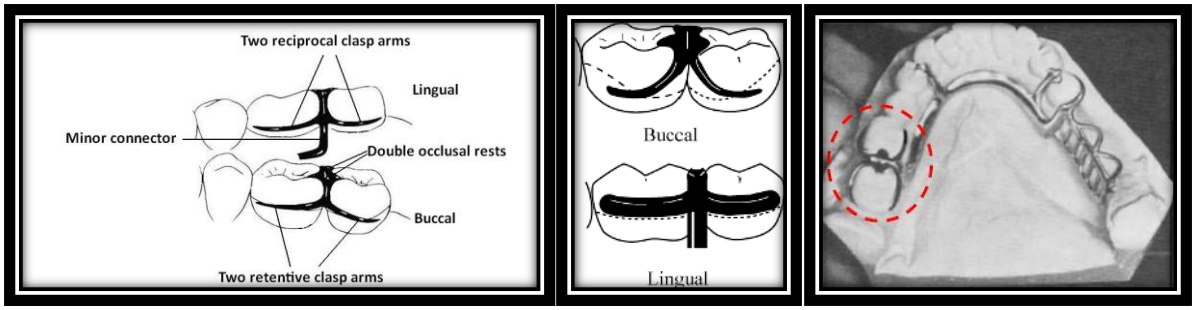
Ring clasp (s) encircling nearly the entire tooth from its point of origin. A Clasp originates on the mesiobuccal surface and encircles the tooth to engage the mesiolingual undercut. B, Clasp originates on the mesiolingual surface and encircles the tooth to engage the mesiobuccal undercut.

Disadvantages:

- Covers a large area of the tooth surface, therefore requiring meticulous hygiene.
- Very difficult to adjust due to the extreme rigidity of the reciprocal arms.
- The lower bracing arm should be at least 1mm from the free gingival margin and relieved to prevent impingement of the gingival tissues.

2. Embrasure (double Akers) clasp:

- The embrasure clasp always should be used with double occlusal rests, even when definite proximal shoulders can be established. This is done to avoid interproximal wedging by the prosthesis, which could cause separation of the abutment teeth and result in food impaction and clasp displacement.
- In addition to providing support, occlusal rests also serve to shunt food away from contact areas.
- Embrasure clasps should have two retentive clasp arms and two reciprocal clasp arms, either bilaterally or diagonally opposed.



Example of use of embrasure clasp for a Class II partially edentulous arch: Embrasure clasp on two left molar abutments were used in the absence of posterior modification space.

Indications:

Used in a quadrant where no edentulous area exists, In an unmodified Class II or Class III partial denture, where there are no edentulous spaces on the opposite side of the arch to aid in clasping.



Occlusal and proximal surfaces of adjacent molar and premolar prepared for embrasure clasp. Note that rest seat preparations are extended both buccally and lingually to accommodate retentive and reciprocal clasp arms.

Disadvantages:

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

Other less commonly used modifications of the cast circumferential clasp are:

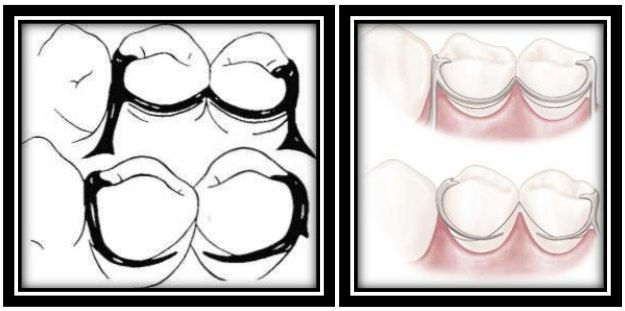
1. Back action clasp:

- The back-action clasp is a modification of the ring clasp.
- It is used on premolar abutment anterior to edentulous space.
- The undercut can usually be approached just as well using a conventional circumferential clasp, with less tooth coverage and less display of metal.
- Its use is difficult to justify.



2. Multiple clasps:

The multiple clasps are simply two opposing circumferential clasps joined at the terminal end of the two reciprocal arms.



Indications:

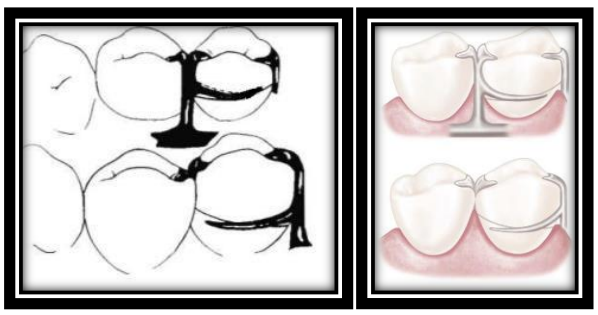
- It is used when additional retention and stabilization are needed, usually on tooth-supported partial dentures.
- It may be used for multiple clasping in instances in which the partial denture replaces an entire half of the dental arch.
- It may be used rather than an embrasure clasp when the only available retentive areas are adjacent to each other.

Disadvantage:

- Its disadvantage is that two embrasure approaches are necessary rather than a single common embrasure for both clasps.

3. Half-and-half Clasp:

- It is consists of a circumferential retentive arm arising from one direction and a reciprocal arm arising from another.
- The second arm must arise from a second minor connector, and this arm is used with or without an auxiliary occlusal rest.
- Its design was originally intended to provide dual retention, a principle that should be applied only to unilateral partial denture design.
- Reciprocation arising from a second minor connector usually can be accomplished with a short bar or with an auxiliary occlusal rest, thereby avoiding so much tooth coverage.
- There is little justification for the use of the half-and-half clasp in bilateral extension base partial dentures.

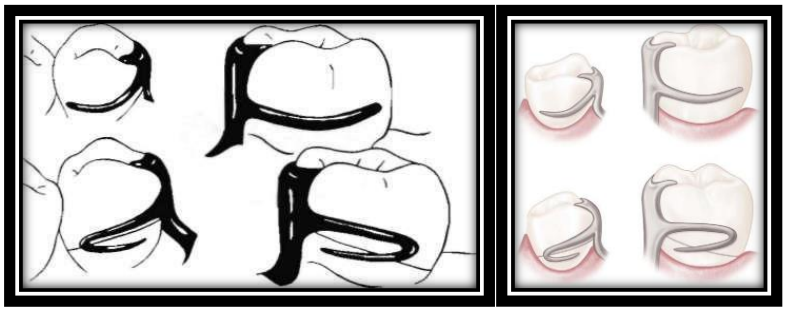


4. Reverse-action clasp (Hairpin):

- Ring clasp or bar clasp originating on the opposite side of the tooth can be used with the same result getting from reverse- action clasp.
- The upper part of the arm of this clasp should be considered a minor connector, giving rise to the tapered lower part of the arm. Therefore only the lower part of the arm should be flexible. With the retentive portion beginning beyond the turn, only the lower part of the arm should flex over the height of the contour to engage a retentive undercut.
- The bend that connects the upper and lower parts of the arm should be rounded to prevent stress accumulation and fracture of the arm at the bend.

Advantage:

- Clasp arm is designed to permit engaging a proximal undercut (undercut adjacent to edentulous space) from an occlusal approach.



Disadvantages:

- Esthetically objectionable when using an anterior abutment.
- The clasp covers a considerable tooth surface and may trap debris.
- Almost impossible to adjust.
- Difficult to fabricate.
- Insufficient flexibility on short crowns due to insufficient clasp arm length.

Indications:

- When a proximal undercut must be used on a posterior abutment and when tissue undercuts, tilted teeth or high tissue attachments prevent the use of a bar clasp arm.
- When lingual undercuts may prevent the placement of a supporting strut (of ring clasp) without tongue interference.
- May be used on abutments of tooth-supported dentures when proximal undercut lies below the point of origin of the clasp.

Disadvantages of circumferential clasps in summary:

- A large amount of tooth surface is covered by clasp assembly.
- It alters the gross morphology of the clinical crown.

Clasps designed to accommodate distal extension functional movement:

Two strategies are adapted to either:

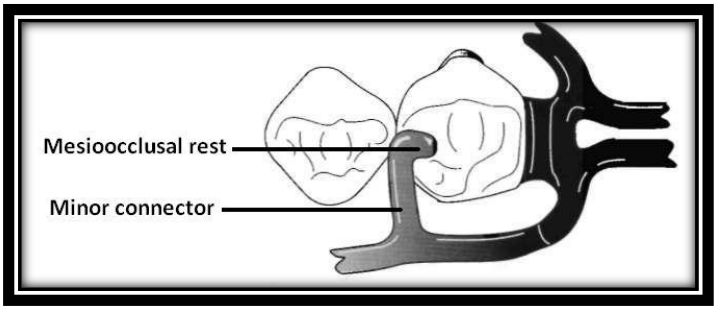
- Change the fulcrum location and subsequently the "resistance arm" engaging effect (mesial rest concept clasp assemblies).
- Minimize the effect of the lever by use of a flexible arm (wrought-wire retentive arm).

Change the fulcrum location and subsequently the "resistance arm" engaging effect: Mesial rest concept clasps assemblies (RPI, RPA, and Bar clasp): These are proposed to accomplish movement accommodation by changing the fulcrum location to prevent harmful tipping or torquing of the abutment tooth and prevent more denture base movement. This is concept includes RPI and RPA clasps.

RPI clasp:

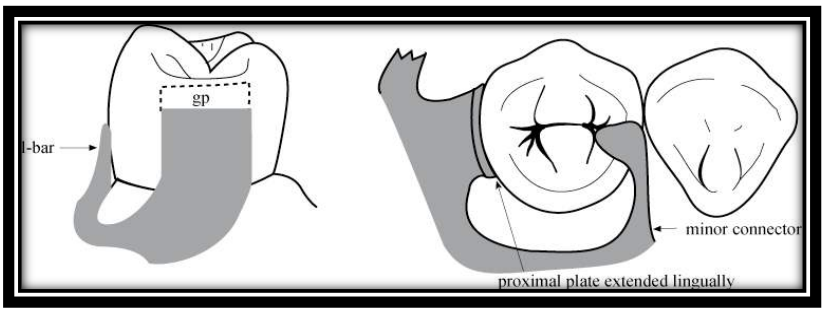
RPI clasps are referring to the: R = Rest always mesial, P = Proximal plate, and I = I-bar. These are component parts of the clasp assembly. Basically, this clasp assembly consists of:

- A mesioocclusal rest of a premolar or mesiolingual surface of a canine with the minor connector placed into the mesiolingual embrasure, but not contacting the adjacent tooth (prevents wedging).

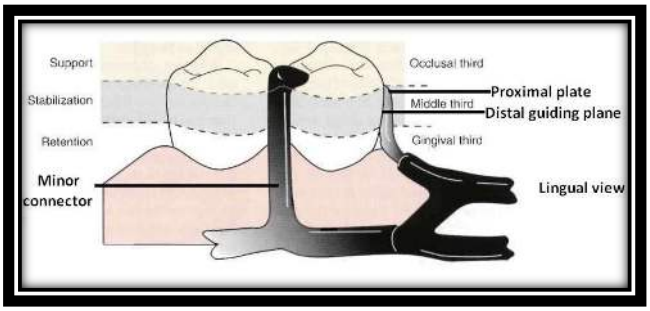


Occlusal view

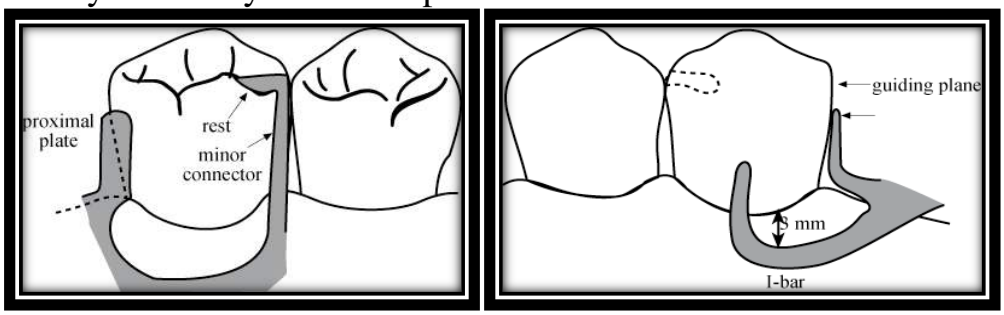
- A distal guiding plane, extending from the marginal ridge to the junction of the middle and gingival thirds of the abutment tooth, is prepared to receive a proximal plate. The buccolingual width of the guiding plane is determined by the proximal contour of the tooth.



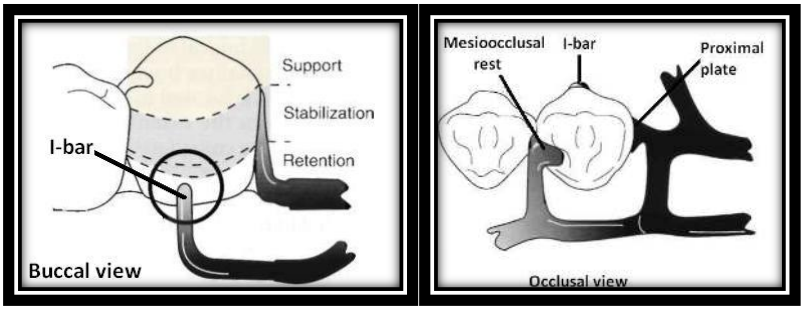
- The proximal plate (essentially a wide minor connector) is located on a guide plane on the distal surface of the tooth. The plate is approximately 1 mm thick and joins the framework at a right angle.
- The I-bar in conjunction with the minor connector supporting the rest provides the stabilizing and reciprocal aspects of the clasp assembly.



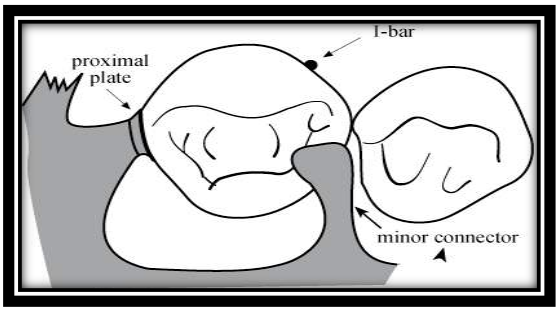
- I-bar should be located in the gingival third of the buccal or labial surface of the abutment in a 0.01-inch (0.25mm) undercut. The whole arm of the I-bar should be tapered to its terminus, with no more than 2 mm of its tip contacting the abutment. The retentive tip contacts the tooth from the undercut to the height of the contour. This area of contact along with the rest and proximal plate contact provides stabilization through the encirclement. The bend in the I-bar should 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.



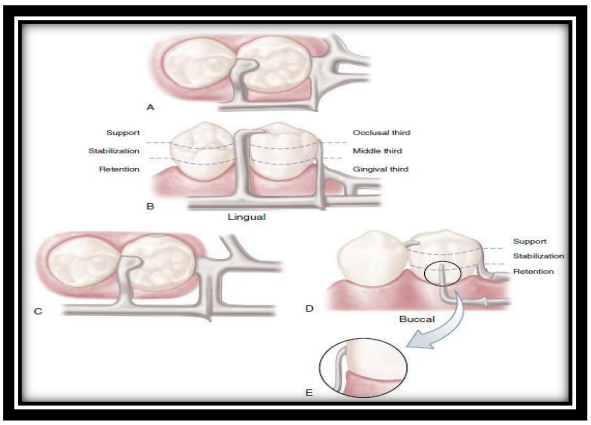
- The clasp is usually cast and is placed just below the height of the contour line.



- On the canine, the I-bar is located in the mesiobuccal undercut and is reciprocated directly by the proximal plate.

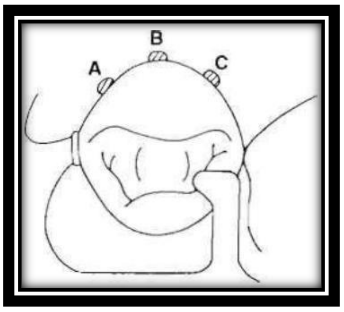


The horizontal portion of the approach arm must be located at least 4 mm from the gingival margin and even farther if possible.



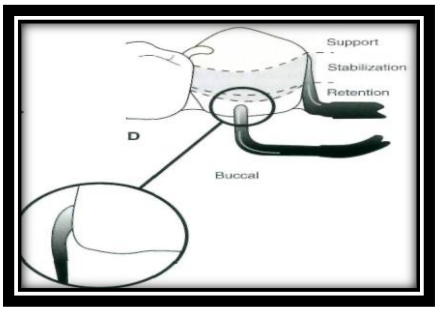
Bar-type clasp assembly:

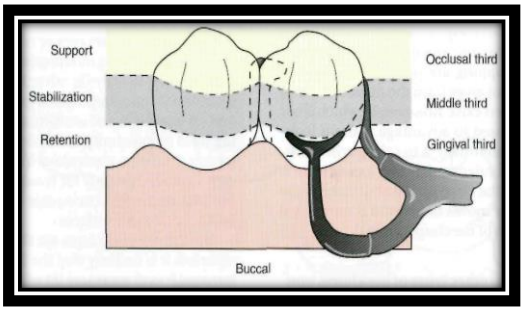
A: Occlusal view. Component parts :(proximal plate minor connector, rest with minor connector, and retentive arm) tripod the abutment to prevent its migration. B: The proximal plate minor connector extends just far enough lingually so that it combines with the mesial minor connector to prevent the lingual migration of the abutment. C: On narrow or tapered abutments (mandibular first premolars), the proximal plate should be designed to be as narrow as possible but still sufficiently wide to prevent lingual migration. D: I-bar retainer located at the greatest prominence of the tooth in the gingival third. E: Mesial view of I-bar illustrating the retentive tip relationship to the undercut and a region superior to the height of contour, which serves stabilization function in the encirclement.



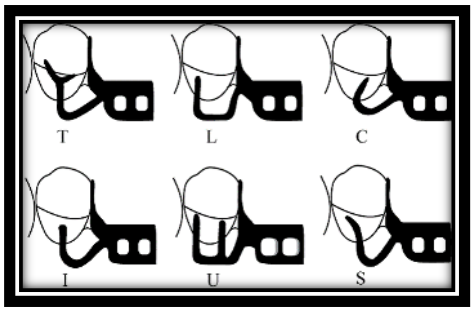
Occlusal view of RPI bar clasp assembly. Placement of l-bar which is depending on the position of proximal plate in relation to guiding plan on proximal tooth surface: (A) On the distobuccal surface. (B) At greatest mesiodistal prominence. (C) On the mesiobuccal surface.

The bar clasp arm arises from the denture framework or a metal base and approaches the retentive undercut from a gingival direction.





The bar clasp arm has been classified by the shape of the retentive terminal. Thus it has been identified as T, Y, L, I, U and S. I shape bar is preferred than other shapes because this shape being biologically and mechanically sound.



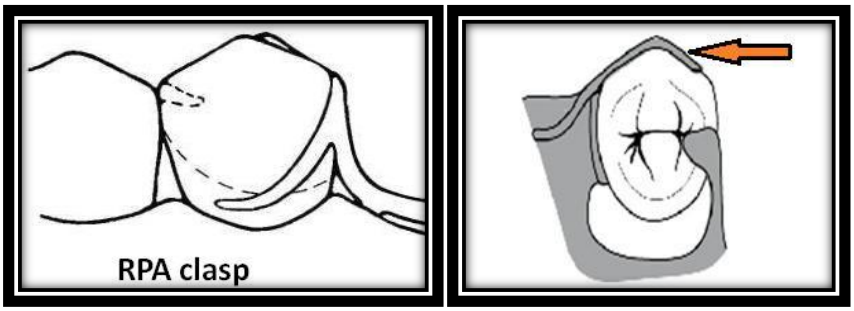
If the abutment teeth demonstrate contraindications for a bar-type clasp a modification should be considered for the RPI system (the RPA clasp; Akers clasp).

Contraindications:

- Deep cervical undercuts - food trap or impingements result.
- Severe soft tissue or bony undercuts - food trap or impingements result.
- Insufficient vestibular depth for approach arm, because this reduces the advantageous length of the arm and made the clasp too close to the gingival margin it (requires 4 - 3 mm from the free gingival margin, 1 mm for the thickness of the approach arm).
- Pronounced frenal attachments area – impingement.
- The excessive buccal or lingual tilt of the abutment tooth.

RPA clasp; Akers clasp:

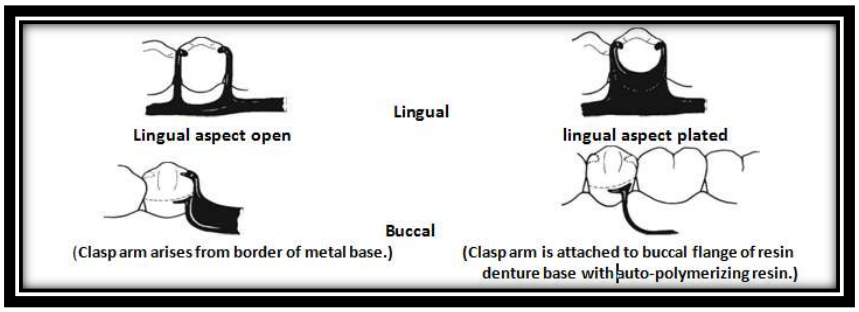
This clasp assembly is similar to the RPI design (consists of a mesial occlusal rest, proximal plate, except a wrought wire circumferential clasp (Akers) is used instead of the I-bar. This clasp arises from the proximal plate and terminates in the mesiobuccal undercut. It is used when there is insufficient vestibule depth or when a severe tissue undercut exists.



There are several other types of bar clasps; for example:

Infrabulge clasp:

It is designed so that the bar arm arises from the border of the denture base, either as an extension of a cast base or attached to the border of a resin base. It is made more flexible than the usual bar clasp arm.

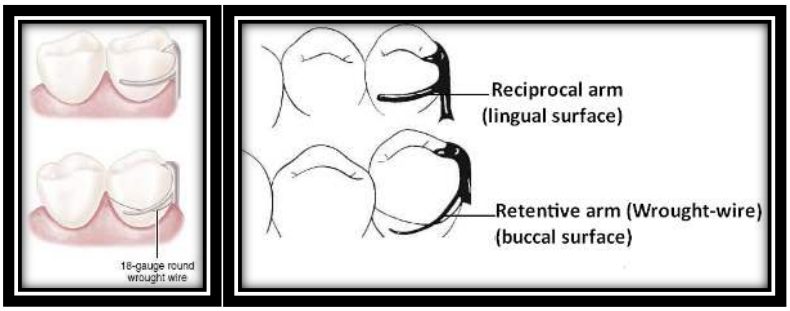


Advantages:

- Its interproximal location, which may be used to esthetic advantage. And Increased retention without tipping action on the abutment.
- Less chance of accidental distortion resulting from its proximity to the denture border.
- Minimize the effect of the lever by use of a flexible arm (wrought- wire retentive arm).

Combination clasp:

- Another strategy to reduce the effect of the Class I lever in distal extension situations is to use a flexible component in the "resistance arm," which is the strategy employed in the combination clasp. The combination clasp consists of a wrought-wire retentive clasp arm (round, uniformly tapered 18-gauge platinum-gold-palladium alloy or chrome- cobalt alloy wrought- wire) and a cast reciprocal clasp arm.
- The retentive arm (wrought-wire) is almost always circumferential, but it also may be used in the manner of a bar, originating gingivally from the denture base.
- The cast reciprocal arm may be in the form of a bar clasp arm, it is usually a circumferential arm.



Advantages:

- The flexibility.
- The adjustability.
- The esthetic appearance of the wrought-wire retentive arm over other retentive circumferential clasp arms).
- Minimum of tooth surface covered because of its line contact with the tooth, rather than having the surface contact of a cast clasp arm.
- A less likely occurrence of fatigue failures.

Disadvantages:

- It involves extra steps in fabrication, particularly when high-fusing chromium alloys are used.
- It may be distorted by careless handling on the part of the patient.
- Because it is bent by hand, it may be less accurately adapted to the tooth and therefore provide less stabilization in the suprabulge portion.
- It may distort with function and not engage the tooth.

Indications:

- When maximum flexibility is desirable, such as on an abutment tooth adjacent to a distal extension base where only a mesial undercut exists on the abutment or a weak abutment or where a large tissue undercut, contraindicates a bar- type direct retainer.
- It may be used for its adjustability when precise retentive requirements are unpredictable and later adjustment to increase or decrease retention may be necessary.
- When esthetic required overcast clasps, because wrought -wire is round, light is reflected in such a manner that the display of metal is less noticeable than with the broader surfaces of a cast clasp.

The various types of cast circumferential clasps may be used in combination with bar clasp arms. Circumferential and bar clasp arms may be made either flexible (retentive) or rigid (reciprocal) in any combination as long as each retentive clasp arm is opposed by a rigid reciprocal component.

Internal Attachments & Stress Breakers

Internal Attachments & Precision Attachments

An internal attachment (intracoronal direct retainer) is a type of precision attachment located within the normal contours of an abutment and functions to retain and stabilize a removable partial denture.

Usually the internal attachment consists of two components (Fig. 1). The first component, ***matrix***, is a metal receptacle (holder) contained within the normal clinical contours of a fixed restoration. The second component, ***patrix***, is attached to the corresponding removable partial denture.

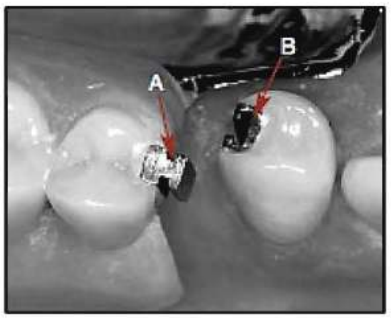


Figure 1: Internal attachment demonstrating the patrix (A) and the matrix (B).

Internal attachments (intracoronal direct retainers) may be subdivided into two categories based on the method of fabrication and tolerance of fit between components. If components are fabricated in metal using high-precision manufacturing techniques, they are considered ***precision internal attachments***. These attachments usually exhibit long, parallel walls and excellent surface adaptation that fit together with tolerances of about 10 microns. These are ready-made attachments made by specialized companies and are more preferable from any fabricated by the dental technician due to the alloys used and precision in make them.

The second category shows a less intimate fit between matrix and patrix components. These are termed ***semi-precision internal attachments***. Components usually originate as wax or plastic patterns, which are subsequently cast in metal. Unlike precision attachments, semi-precision attachments often display gently tapering walls. These are fabricated by dental technicians as a cast dovetail fitting into a counterpart holder in the abutment crown.

Internal attachments differ from ***internal occlusal rests*** because they use a securing device for retention without a visible clasp. Also, internal attachments provide horizontal stabilization similar to that of internal occlusal rests, but additional extracoronal stabilization is usually desirable.

The internal attachment has two major advantages over the extracoronal attachment:

1. Elimination of visible retentive and support components.
2. Better vertical support through a rest seat located more favorably in relation to the horizontal axis of the abutment tooth.

Some of the ***disadvantages*** of internal attachments include the following:

1. They require prepared abutments and castings.
2. They require somewhat complicated clinical and laboratory procedures.
3. They eventually wear, with progressive loss of frictional resistance to denture removal.
4. They are difficult to repair and replace.
5. They are effective in proportion to their length and are therefore least effective on short teeth.
6. They are difficult to place completely within the circumference of an abutment tooth because of the size of the pulp.
7. They are considered more costly.

Internal attachments do not permit horizontal movement. Thus, all horizontal, tipping, and rotational movements of the prosthesis are transmitted directly to the abutment teeth. Therefore, internal attachments should not be used in combination with tissue-supported distal extension denture bases unless some form of stress-breaker is used between the movable base and the rigid attachment. Although stress breakers may be used, they do have some disadvantages and their use adds to the cost of the partial denture.

Precision Attachments

A precision attachment is "an interlocking device, one component of which is fixed to an abutment or abutments, and the other is integrated into a removable partial denture to stabilize and/or retain it." **(GPT-9)**

There are many types of precision attachments for partial dentures that ***cannot*** be classified as primarily of the intracoronal or extracoronal type. Neither can they be

classified as relying primarily on frictional resistance or placement of an element in an undercut to prevent displacement of the denture. However, all of these use some type of retentive means, located intracoronally or extracoronally, for providing retention without visible clasp retention.

Intracoronal direct retainers (internal attachments) of the locking or dovetail type are not recommended for distal extension removable partial dentures because of excessive leverages often associated with these attachments that may generate torque and tipping stresses on the abutment.

The non-locking type of the intracoronal direct retainers can be used in many cases of Class I and Class II partially edentulous situations. However, unless the cross-arch axis of rotation is common to the bilaterally placed attachments, torque on the abutments may be experienced.

Some indications for precision attachments are as follows:

1. Esthetics zone.
2. Nonparallel abutments present.
3. Improved retention.
4. As stress breaker in free end saddles and bridges.
5. Intracoronal attachments as effective direct retainers for removable partial dentures.
6. As a connector for sectional dentures.
7. To lock a connector joining saddles in the opposite side of the arch.
8. To retain hybrid dentures.

Some of the contraindications for precision attachments are as follows:

1. Along one precise path of insertion, the patient must possess an average degree of manual skill.
2. Patients with severe periodontitis.
3. Patients with abnormally high caries rate.
4. Where there is inadequate space (teeth that are very narrow faciolingually).

The ***main types of precision attachments*** are as follows:

1. Internal attachments (intracoronal direct retainer):

These attachments are in the form of key and keyway (Fig. 2) and they are incorporated entirely within the cast crown. They are mainly used in connecting a fixed prosthesis

with a removable partial denture. Stern attachment & Ney attachment are examples of such types of attachments.

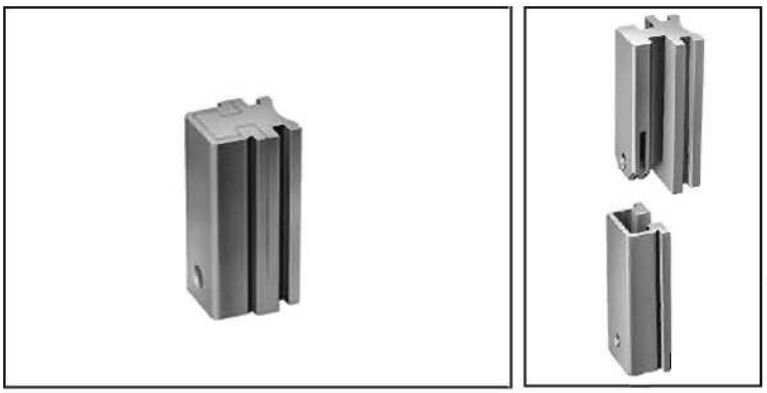


Figure 2: Stern attachment

2. Extracoronal attachments:

They are situated external to the crown and can provide stability and retention for removable prostheses. These are less rigid attachments that can be used with distal extension partial dentures. The main disadvantage with extracoronal attachments is that more space is required within the removable partial denture as they are bulky. Examples of these attachments include the Dalbo (Fig. 3) and Ceka attachments.

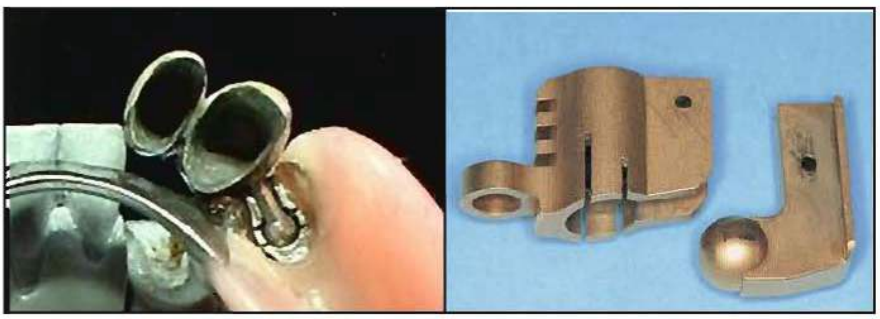


Figure 3: Dalbo extracoronal precision attachment incorporated in the denture (left). Male and female components (right).

3. Stud or anchor attachments:

These attachments are either intra-radicular or extra-radicular. Such attachments can be made in rigid form for bounded saddle situations and in resilient forms for free end saddles. Stud attachments consist of a post like male secured to the diaphragm of coping female which engages the male post. Retention is obtained by frictional fit or snap like action. One of their advantages is that the crown root ratio is improved with low profile stud attachments. Zest anchor (Fig. 4), Rotherman, and Gerber (Fig. 5) are examples of stud attachments.

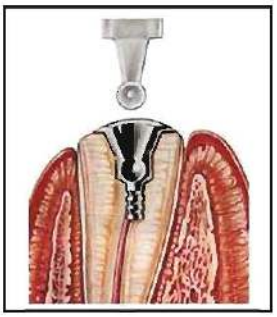


Figure 4: Zest anchor attachment.



Figure 5: Gerber attachment.

In general, for distal extension partial dentures it is recommended that the intracoronal attachment is used in cases where the periodontal condition of the distal abutment is good. On the other hand, the extracoronal attachment is used with fairly good alveolar ridges and with periodontally weaker abutments.

4. Bar attachments:

Used for splinting groups of teeth and for overdenture retention and stabilization (Fig. 6). They consist of a precision attachment bar and channel clips. Examples are Ackerman, Dolder, and Hader bar. The main disadvantage of bar attachments is that they cannot be used with reduced interocclusal space.



Figure 6: precision attachment bar and channel clips.

Ackerman Bar is probably the most versatile and popular factory-made bar. There are two types of bar: round and egg shaped. One advantage of the round bar is that it can be bent in all directions and can be constructed to follow not only the antero-posterior relationship but also the vertical changes in the arch. The egg-shaped bar has extra rigidity making bending more difficult. Retention is achieved through engagement of the clips with the undercuts of the bar.

Dolder Bar is also available in two types; (1) Pear shaped which allows a degree of resilience of movement between it and the sleeve and (2) Parallel bar which allows no movement. Dolder bar units are tooth supported and non-rotational and are indicated where numerous attachments are present (four in three planes). Friction between the

walls provides retention. In Dolder bar units paralleling of bars is more important which is provided with a special paralleling mandrill.

Selection of an Attachment for a Removable Partial Denture

1. The first decision that must be made is whether to use an intracoronal or extracoronal attachment.
2. The second decision to be made is whether to use a resilient or a non-resilient type.
3. The third consideration is that the largest attachment can be used within the given space should be chosen to gain maximum stability, retention, and strength for the prosthesis.

Stress-Breakers (Stress Equalizers)

Distal extension partial dentures should be designed in a manner to prevent the damaging effect of the rigid connection between the denture base and the abutment teeth. This rigid connection is through the rigid major and minor connectors. The stress on the abutment teeth and residual ridge is minimized through the use:

1. Denture bases constructed from functional impressions.
2. Broad coverage of the denture base.
3. Harmonious occlusion
4. Correct choice of the direct retainers.

Types of stress breakers:

1. Types of clasp assemblies used for distal extensions because of their stress-breaking design.

Cast retentive clasp arms that engage undercuts on the abutment teeth in such a manner that tissue-ward movement of the extension base transmits only minimum leverage to the abutment and this is represented by the RPI & RPA systems. Or tapered wrought-wire retentive clasp arms should be used because of their greater flexibility such as the combination clasp assembly. The tapered, round wrought-wire clasp arm acts somewhat as a stress-breaker between the denture base and the abutment tooth by reducing the effects of denture base movement on the tooth through its flexibility.

2. Stress breakers that separate the actions of the direct retainers from the movement of the denture base through independent movement of the denture base (or its supporting framework) and the direct retainers

This form of stress-breaker is also referred to as a stress equalizer and an example is the split bar major connector (Fig. 7), which is a commonly used stress breaker.

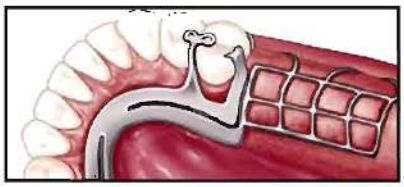


Figure 7: Split bar major connector.

All stress-breakers effectively disperse damaging vertical stresses to the abutment teeth, which is the main purpose of their use. However, this is achieved with the following disadvantages:

1. Reduced horizontal stability
2. Excessive ridge resorption
3. Tissue impingement
4. Inefficient mastication

It is the rigid nature of the conventional removable partial denture that allows satisfaction of all requirements for support, stability, and retention without overemphasis on only one principle to the damage of the oral tissues.

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