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:

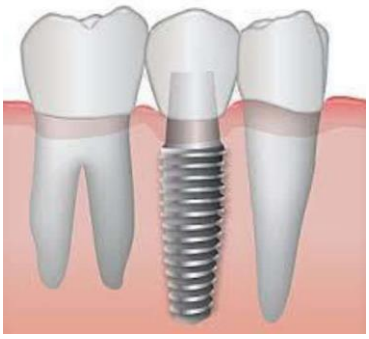
Any dental prosthesis that is luted, screwed, or mechanically attached or otherwise securely retained to natural teeth, tooth roots, and/or dental implants/abutments that furnish the primary support for the dental prosthesis and restoring teeth in a partially edentulous arch; it cannot be removed by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

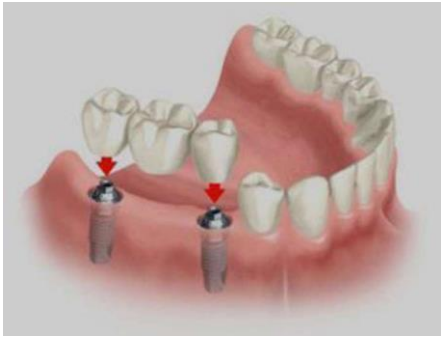
Indications for fixed partial denture:

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.

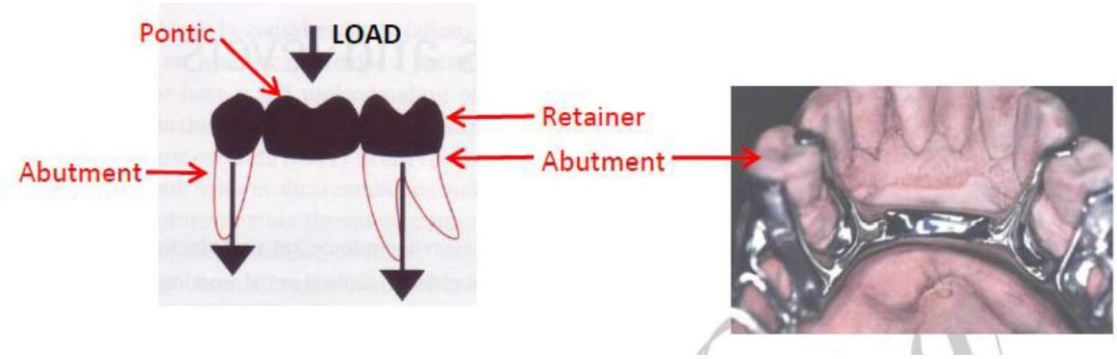
Stability: The quality of a complete or removable partial denture to be firm, steady, or constant, to resist displacement by functional horizontal or rotational stresses.

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.

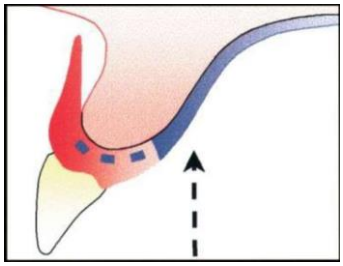


Height of contour: A line encircling a tooth and designating its greatest circumference at a selected axial position determined by a dental surveyor.

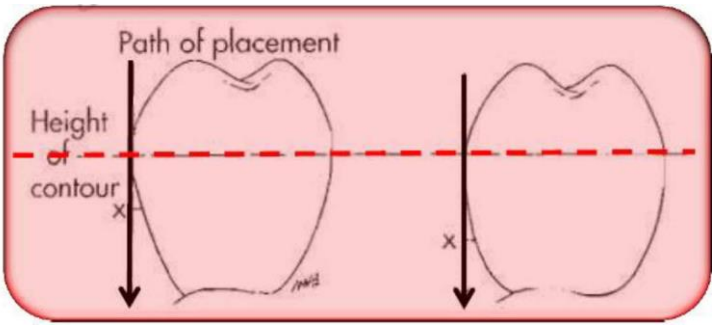
Undercut: The portion of the surface of an object that is below the height of contour in relationship to the path of placement.

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.

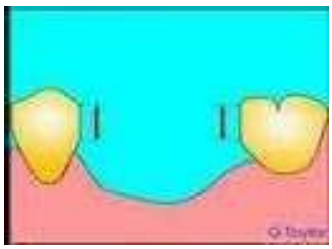


The angle of gingival (cervical) convergence: The angle of gingival convergence is located apical to the height of contour on the abutment tooth; it can be identified by viewing the angle formed by the tooth surface gingival to the survey line and the analyzing rod or undercut gauge of a surveyor as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

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. 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.

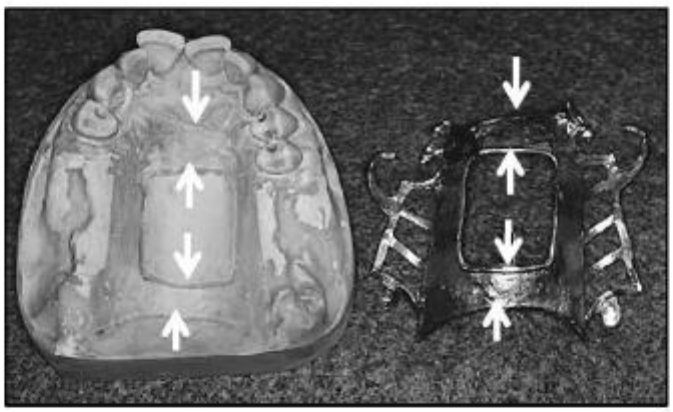


Figure 1: Maxillary major connector bead lines (arrows)

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:

The are six types of maxillary major connectors used in RPD therapy:

1. Single palatal bar
2. Single palatal strap
3. Anterior-posterior palatal bars
4. 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. 2). 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 2: Single palatal bar major connector

2. Single Palatal Strap

The palatal strap consists of a wide band of metal with a thin cross-sectional dimension (Fig. 3). The anteroposterior dimension of a palatal strap major connector should not be less than 8 mm to avoid compromise of its rigidity (Fig. 4).

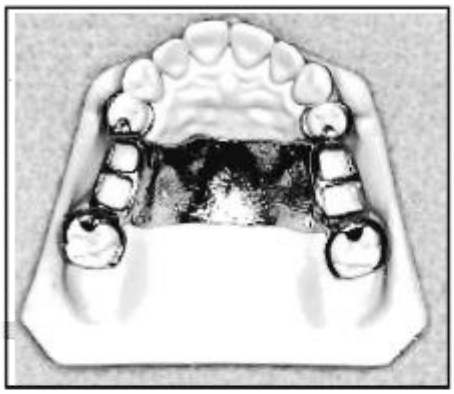


Figure 3: Single palatal strap–type major connector.

Figure 4: The anteroposterior dimension of a palatal strap major connector should never be less than 8 mm.

Disadvantages of the 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.

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

Structurally, this combination of major connectors (Fig. 5) exhibits many of the same disadvantages as the single palatal bar. To be sufficiently rigid and to provide support and stability, these connectors could be too bulky and could interfere with tongue function.

Figure 5: Combination Anterior and Posterior Palatal Bar–type Connectors

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.

The disadvantages of 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.

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. The posterior palatal strap should be flat and a minimum of 8 mm wide (Fig. 6). 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. 7). Each component braces the others against possible torque and flexure. Flexure is practically nonexistent in such a design.

The open area in the palatal region should be at least 20 x 15 mm. Otherwise, another type of major connector should be chosen

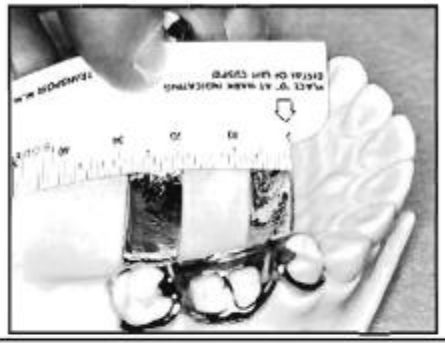


Figure 6: Both the anterior and posterior straps of an anteroposterior palatal strap major connector should be at least 8 mm in width

Figure 7: Anterior-posterior palatal strap–type major connector.

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, whereas the single wide palatal strap is used more frequently in Class III situations. The palatal plate–type or complete coverage connector is used most frequently in Class I situations.

All maxillary major connectors should cross the midline at a right angle rather than on a diagonal. It has been suggested that the tongue will accept symmetrically placed components far more readily than those placed without regard for symmetry.

Characteristics and Location:

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

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 8: Palatal major connector covering two thirds of the 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

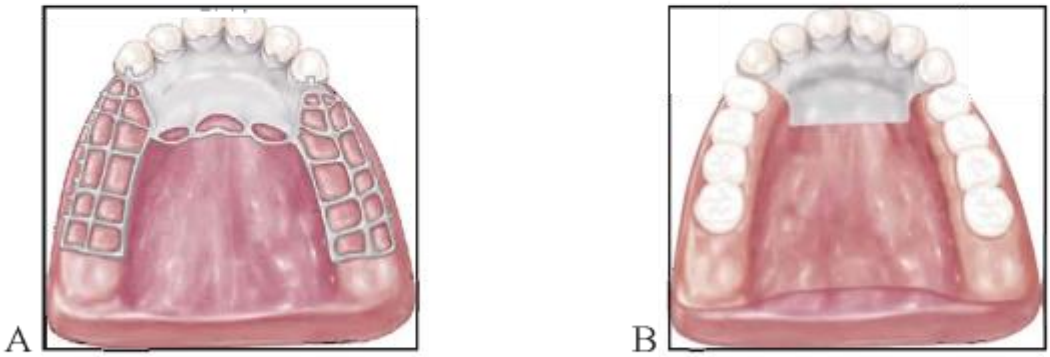


Figure 10: A, Palatal plate major connector with provisions for attaching the full-coverage resin denture base. **B,** Completed removable partial denture with resin base.

5. U-Shaped Palatal Connector (Horseshoe connector)

From both the patient's standpoint and a mechanical standpoint, the U-shaped palatal connector is the least desirable of maxillary major connectors.

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.

Figure (11): U-shaped palatal major connector

In the presence of a prominent median suture line or an inoperable torus, this major connector may offer distinct advantages. The horseshoe connector may be designed to avoid bony prominences without sacrificing vertical support.

The U- shaped Palatal Connector (Fig. 11) 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 tooth supported rests and a wider coverage of the major connector.

Mandibular Major Connectors

Special Structural Requirements

- Unlike maxillary major connectors, the mandibular major connectors often need relief between the rigid metal surfaces and the underlying soft tissues. The Distal extension removable partial denture tends to rotate during function so a moderate amount of relief may be needed. Relief prevents the margins of the major connector from lacerating the sensitive lingual mucosa as a result of this movement.
- 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.

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)
4. Labial bar

1. Lingual Bar

The lingual bar is perhaps the most frequently used mandibular major connector (Fig. 1). Because of its simplicity in design and construction, a lingual bar should be used unless one of the other connectors offers a definite 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 1: lingual bar major connector.

The basic form of a mandibular major connector is a half-pear shape, located above moving tissue but as far below the gingival tissue as possible (Fig. 2). 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.

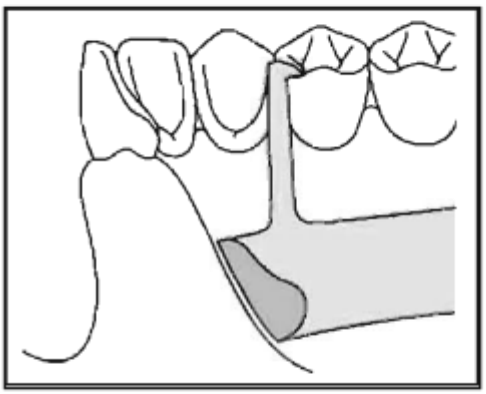


Figure 2: Sagittal section showing half-pear shape of lingual bar.

Indication for use:

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 that may be used to determine the relative height of the floor of the mouth:

At least two clinically acceptable methods may be used to determine the relative height of the floor of the mouth and locate the inferior border of a lingual mandibular major connector. 1) Measure the height of the floor of the mouth in relation to the lingual gingival margins of adjacent teeth with a periodontal probe, as in figure 3. When these measurements are taken, the tip of the patient's tongue should just lightly touch the vermilion border of the upper lip. Recording of these measurements permits their transfer to both diagnostic and master casts. 2) Use an individualized 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.

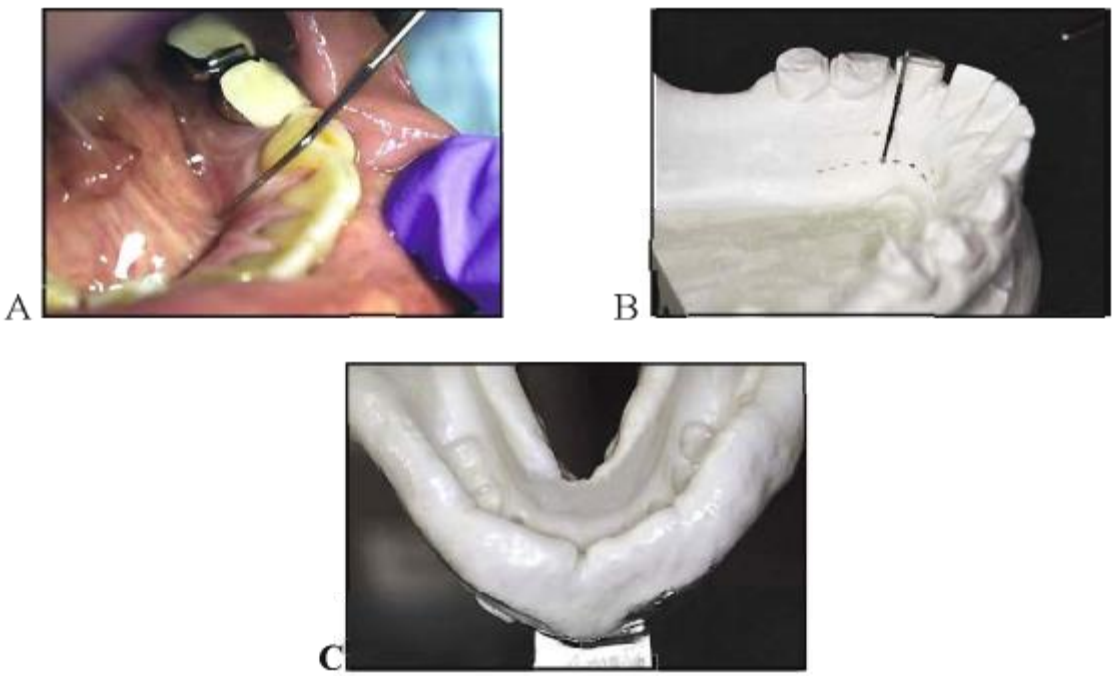


Figure 3: A, Height of floor of the mouth (tongue elevated) in relation to lingual gingival sulci measured with a periodontal probe. **B** Recorded measurements are transferred to a diagnostic cast and then to a master cast after mouth preparations are completed. **C** Impression made with functional 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.4). This thin projection of metal is carried onto the lingual surfaces of the teeth and presents a scalloped appearance.

Figure 4: Lingual plate major connector.

The inferior border of a lingual plate should be positioned as low in the floor of the mouth as possible, 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. 5).

Figure 5: 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.6).

Figure 6: The superior border of a lingual plate major connector should display a scalloped appearance.

The indications for the use of a linguoplate may be listed as follows:

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 as the continuous bar type of major connector (Fig.7).

Figure 7: 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. 8).

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:

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.

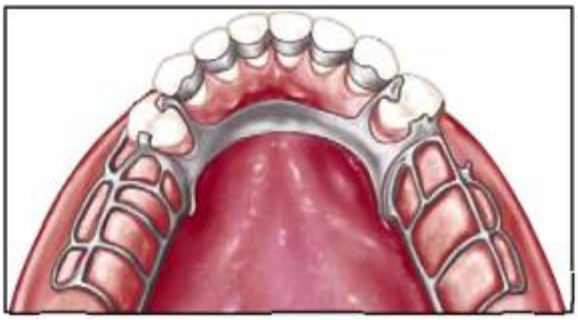


Figure 8: Lingual bar & cingulum bar major connector

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. 9). 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 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.

Figure 9: Labial Bar

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:

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:

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.

Prosthodontics

Types of clasp assemblies:

They are of two types:-

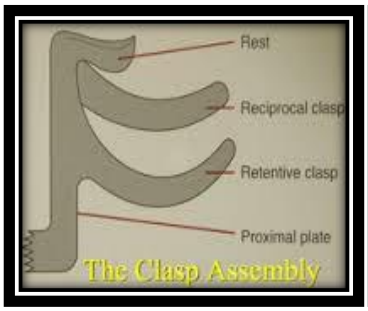
1. **Clasps designed without movement accommodation.**
2. **Clasps designed to accommodate distal extension functional movement.**

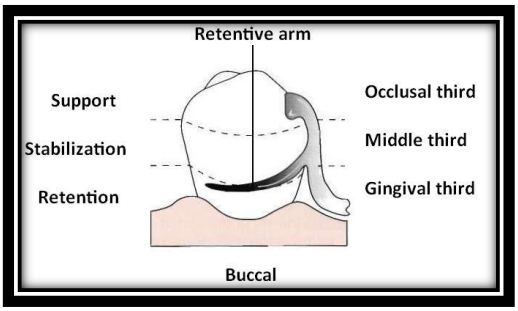
Clasps designed without movement accommodation: It is also named suprabulge clasp or occlusally approach clasp since the clasp approaches the retentive undercut from the occlusal direction.

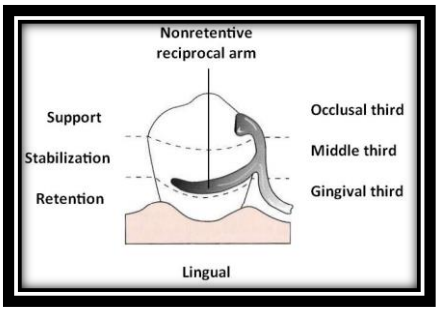
Clasps for tooth-borne partial dentures (Class III and IV) have one function to prevent dislodgment of the prosthesis without damage to the abutment teeth. Since there is little or no rotation caused by tissue ward movement of the edentulous area (as happens in distal extension cases) stress releasing 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.

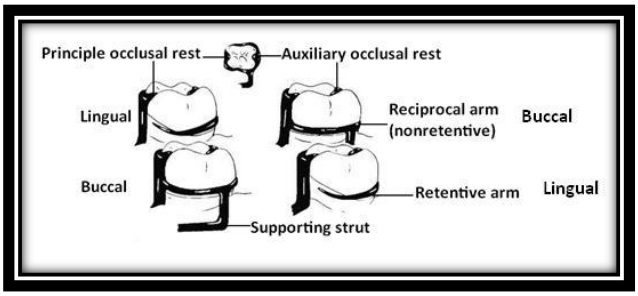
The circumferential type of clasp may be used in several forms:

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

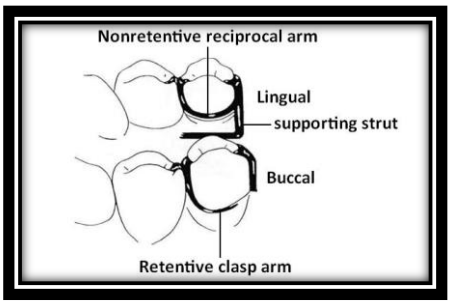
prevented by the presence of a distal rest. In any event, the supporting strut should be regarded as being a minor connector from which the flexible retentive arm originates.

- 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.

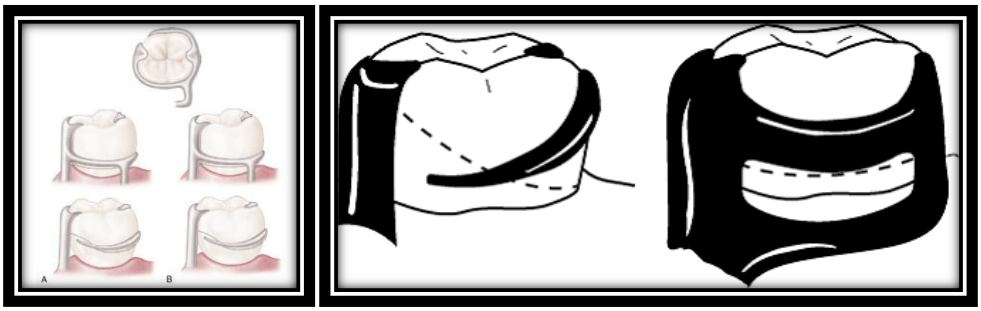


Contraindication:

- 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.



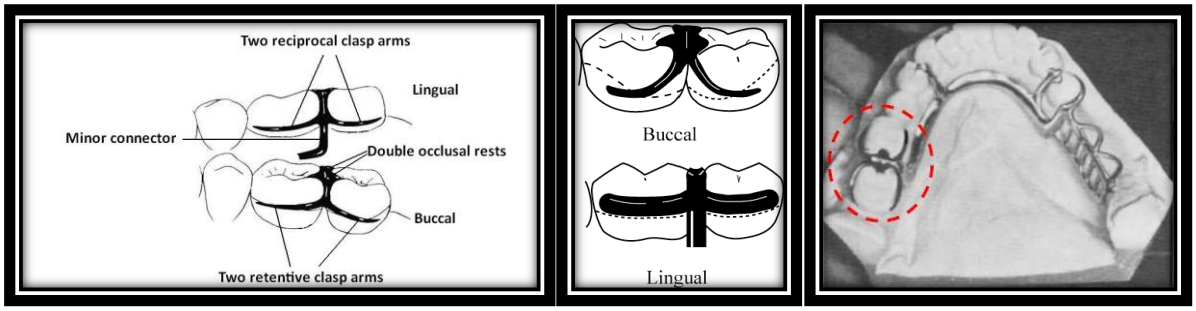
Ring clasp (s) encircling nearly the entire tooth from its point of origin. A Clasp originates on the mesiobuccal surface and encircles the tooth to engage the mesiolingual undercut. B, Clasp originates on the mesiolingual surface and encircles the tooth to engage the mesiobuccal undercut.

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.

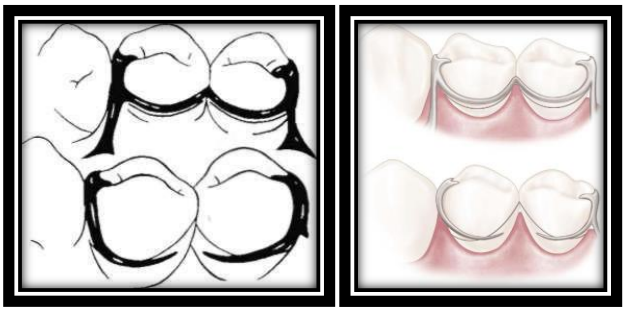
Other less commonly used modifications of the cast circumferential clasp are:

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:

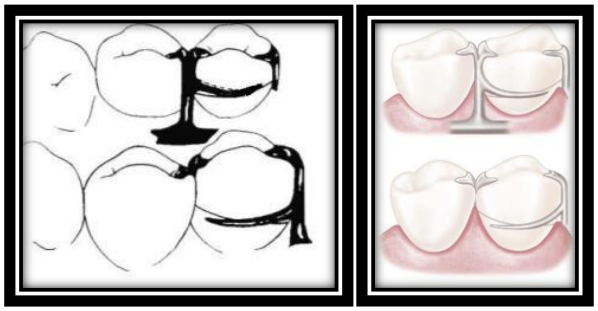
- It is used when additional retention and stabilization are needed, usually on tooth-supported partial dentures.
- It may be used for multiple clasping in instances in which the partial denture replaces an entire half of the dental arch.
- It may be used rather than an embrasure clasp when the only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

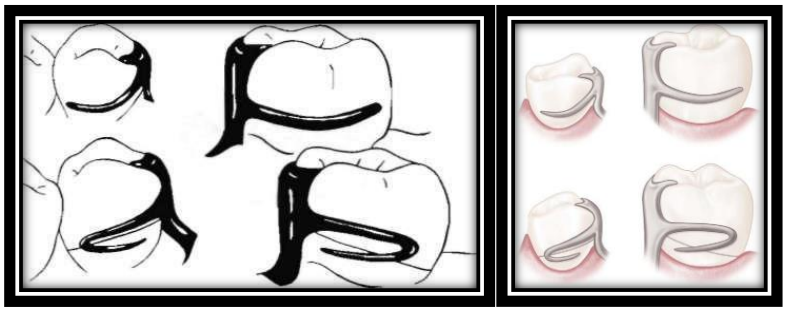


4. Reverse-action clasp (Hairpin):

- 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:

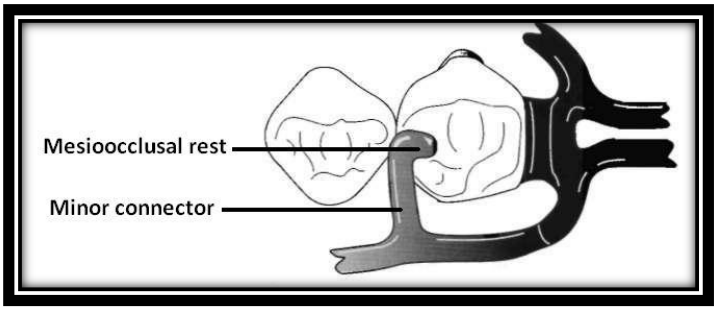
- Change the fulcrum location and subsequently the "resistance arm" engaging effect (mesial rest concept clasp assemblies).
- Minimize the effect of the lever by use of a flexible arm (wrought-wire retentive arm).

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:

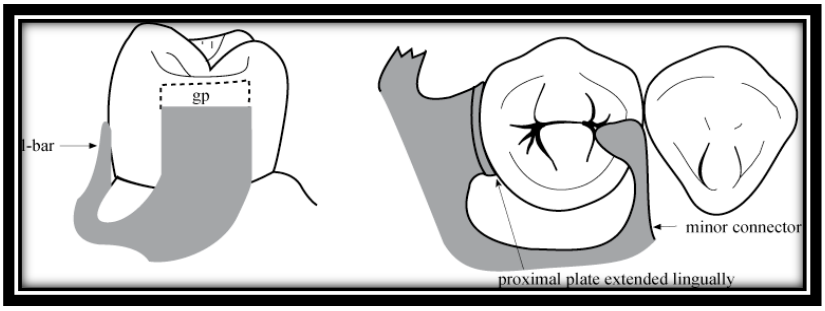
RPI clasps are referring to the: R = Rest always mesial, P = Proximal plate, and I = I-bar. These are component parts of the clasp assembly. Basically, this clasp assembly consists of:

- 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).

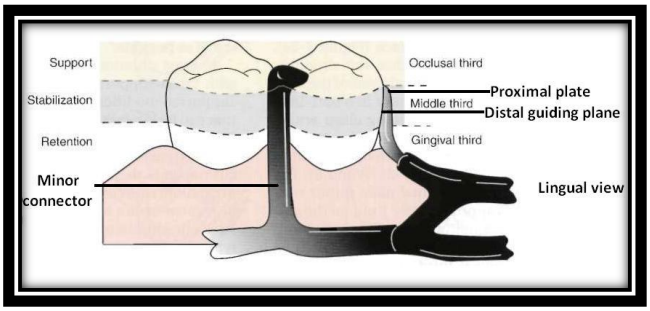


Occlusal view

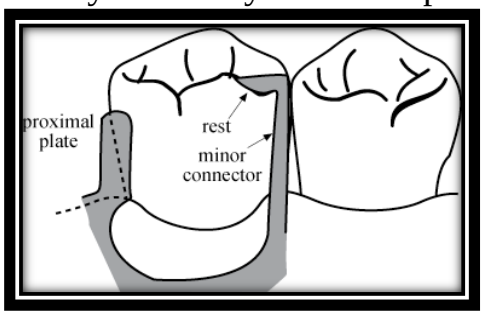
- A distal guiding plane, extending from the marginal ridge to the junction of the middle and gingival thirds of the abutment tooth, is prepared to receive a proximal plate. The buccolingual width of the guiding plane is determined by the proximal contour of the tooth.

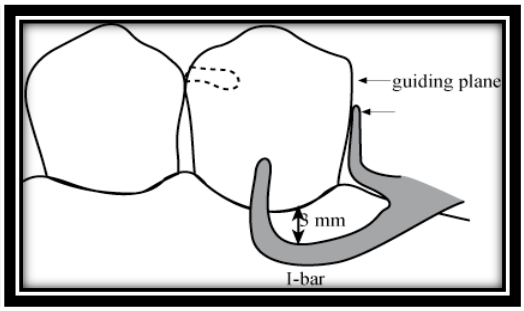


- The proximal plate (essentially a wide minor connector) is located on a guide plane on the distal surface of the tooth. The plate is approximately l mm thick and joins the framework at a right angle.
- The I-bar in conjunction with the minor connector supporting the rest provides the stabilizing and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

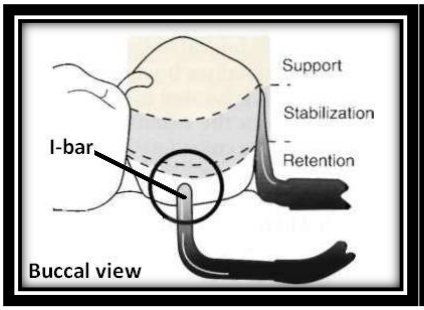


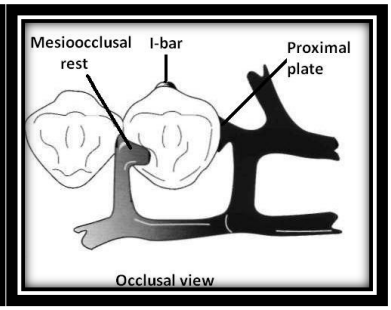
- I-bar should be located in the gingival third of the buccal or labial surface of the abutment in a 0.01-inch (0.25mm) undercut. The whole arm of the I-bar should be tapered to its terminus, with no more than 2 mm of its tip contacting the abutment. The retentive tip contacts the tooth from the undercut 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.



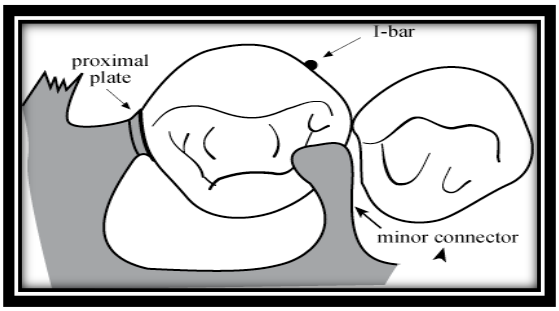


- The clasp is usually cast and is placed just below the height of the contour line.

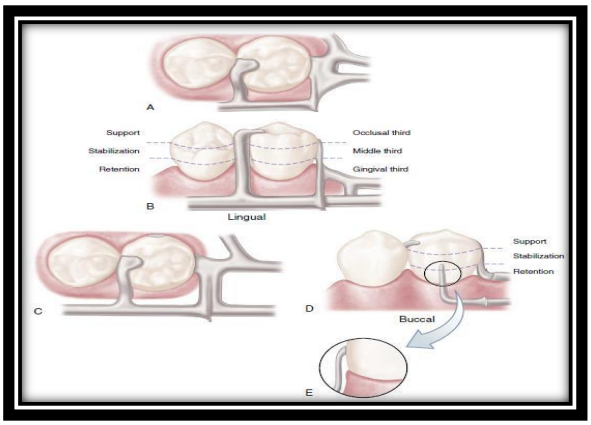




- On the canine, the I-bar is located in the mesiobuccal undercut and is reciprocated directly by the proximal plate.

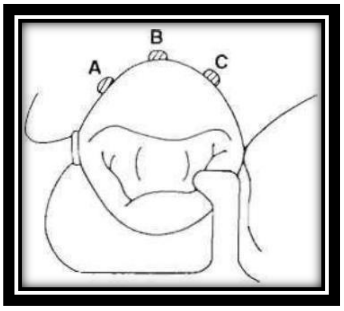


The horizontal portion of the approach arm must be located at least 4 mm from the gingival margin and even farther if possible.



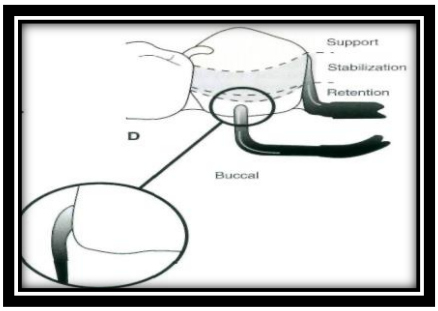
Bar-type clasp assembly:

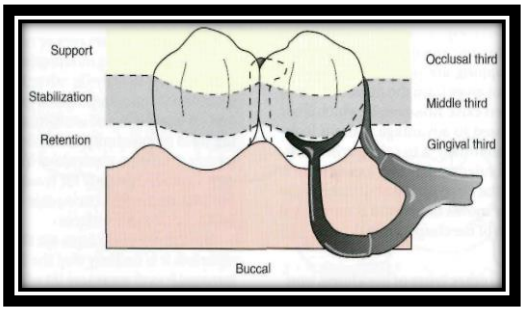
A: Occlusal view. Component parts :(proximal plate minor connector, rest with minor connector, and retentive arm) tripod the abutment to prevent its migration. B: The proximal plate minor connector extends just far enough lingually so that it combines with the mesial minor connector to prevent the lingual 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.



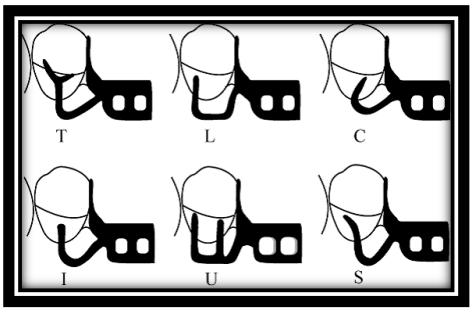
Occlusal view of RPI bar clasp assembly. Placement of l-bar which is depending on the position of proximal plate in relation to guiding plan on proximal tooth surface: (A) On the distobuccal surface. (B) At greatest mesiodistal prominence. (C) On the mesiobuccal surface.

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.



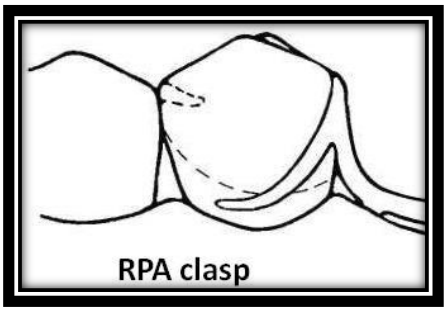
If the abutment teeth demonstrate contraindications for a bar-type clasp a modification should be considered for the RPI system (the RPA clasp; Akers clasp).

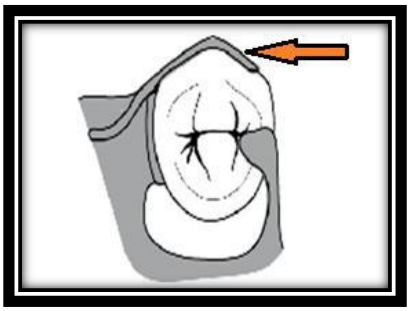
Contraindications:

- 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.

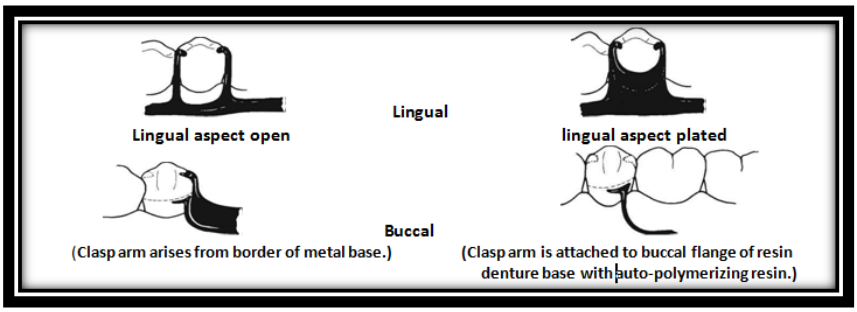




There are several other types of bar clasps; for example:

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.

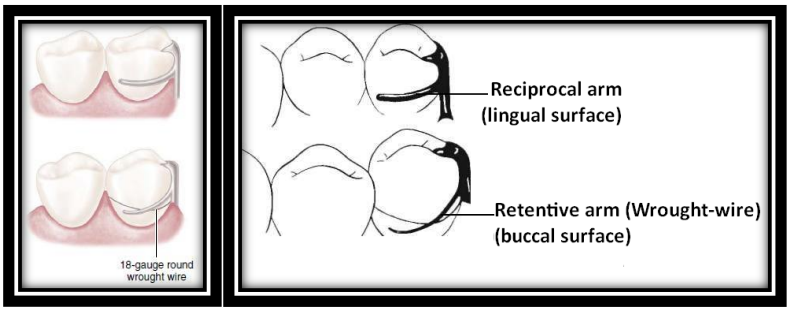


Advantages:

- 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.

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.

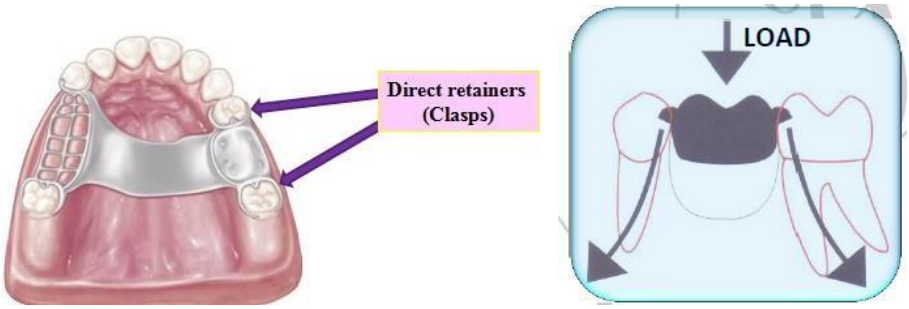
*Removable partial dentures may be classified according to the type of support into:

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:

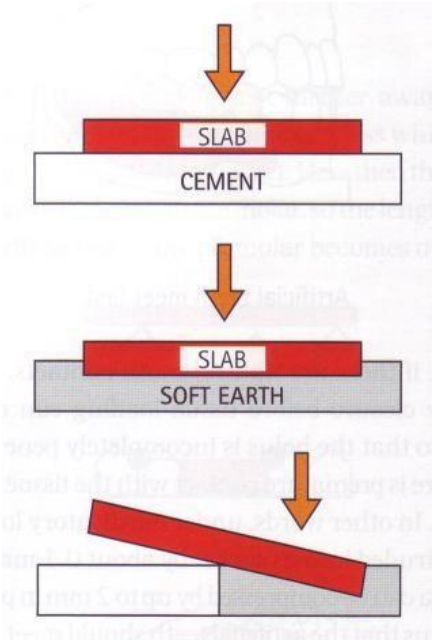
- Natural tooth - supported fixed partial dentures.
- Natural tooth – supported removable partial dentures.
- Implant - supported fixed partial dentures.

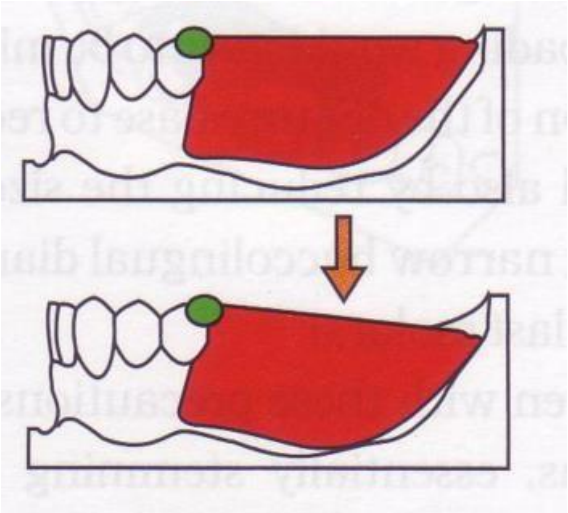
Retention is derived from direct retainers on the abutment teeth, tooth supported RPDs do not move appreciably in function.



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 systemwas further defined and expanded upon by ***Dr. O.C. Applegate*** and ***Dr. Jacques Fiset***.

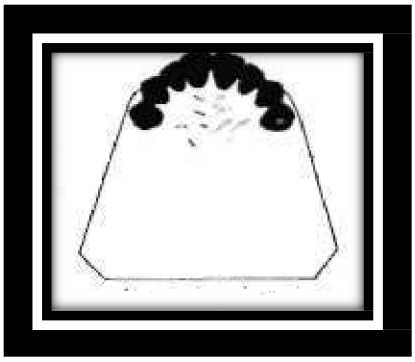
The values of the ***Kennedy – Applegate – Fiset classification system*** *are that:*

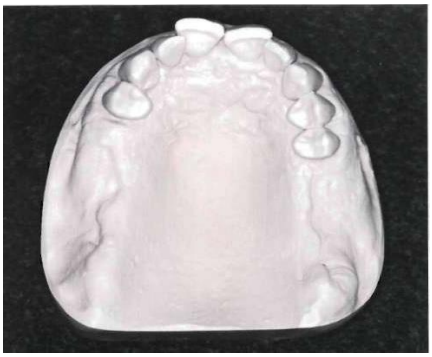
1. It is relatively simple and easy to remember.
2. Extremely comprehensive and very practical.
3. Universally accepted.
4. It permits logical approach to the problem of design.
5. It permits immediate visualization of the partially edentulous arch or RPDs designed for that arch.
6. It indicates the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

Kennedy – Applegate – Fiset classification system

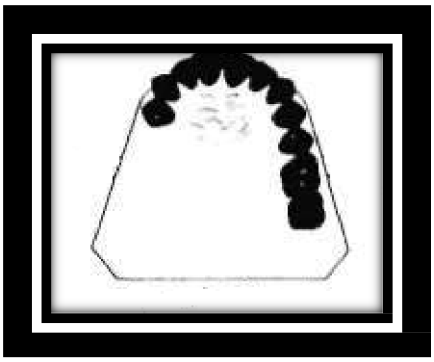
According to this classification system, partially edentulous arches are classified into four basic classes:

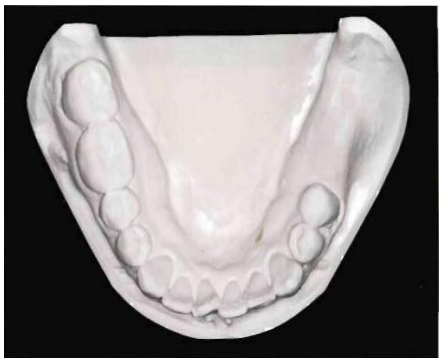
Class I: Bilateral edentulous areas located posterior to the natural teeth.



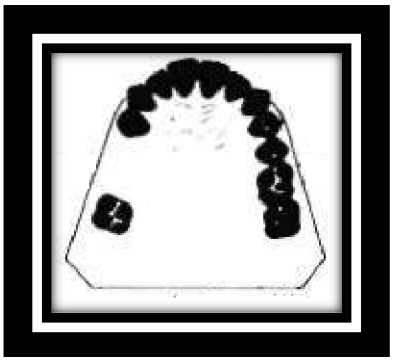


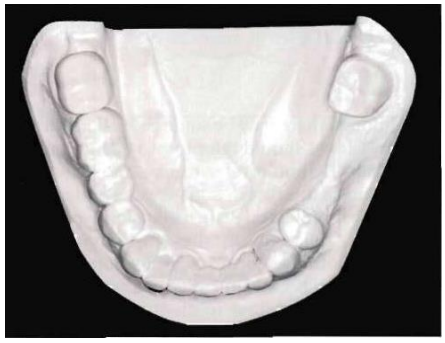
Class II: A unilateral edentulous area located posterior to the remaining natural teeth.



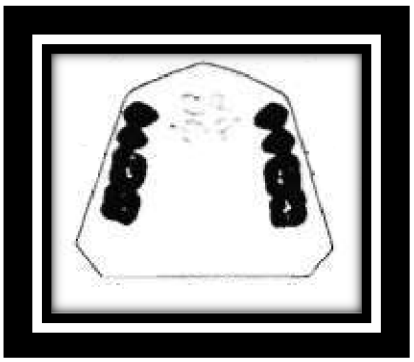


Class III: A unilateral edentulous area with natural teeth remaining both anterior and posterior to it.

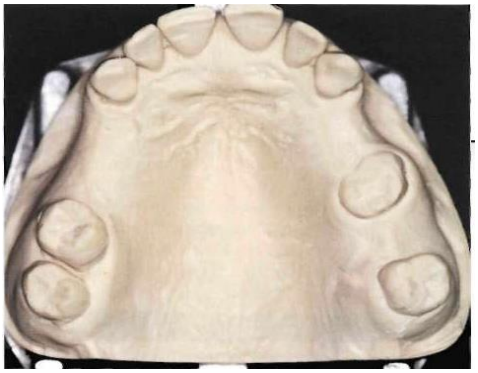




Class IV: A single, but bilateral (crossing the midline), edentulous area located anterior to the remaining natural teeth.



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


Cl IV
Cl II mod 2
Cl I mod 1
Cl III mod 3
Cl III mod 1
Cl I mod 2
Cl IV
Cl II
Cl III mod 5

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

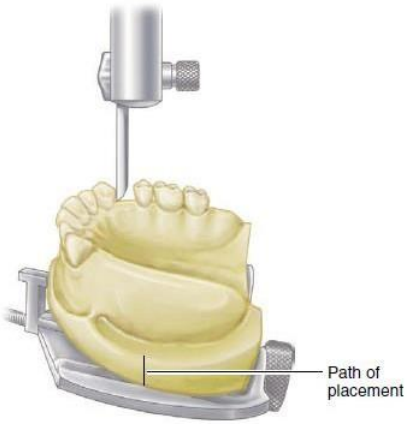
It's the procedure of the locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture.

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.

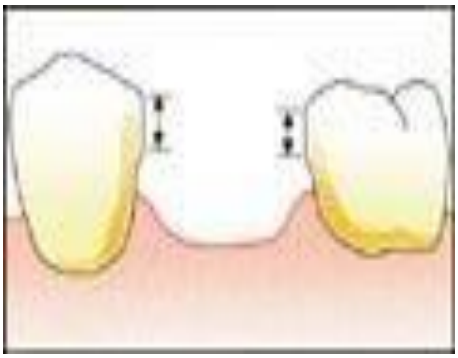


When the restoration (RPD) is properly designed to have positive guiding planes, the patient may place and remove the restoration with ease in only one direction.

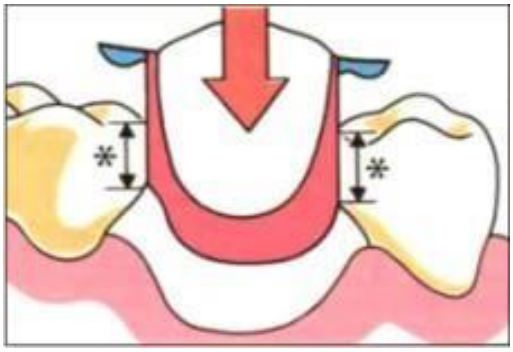
Advantages of single path of placement (insertion):
A. Allows insertion and removal of prosthesis without interference.
B. Help to direct the force along the long axis of the tooth.
C. Provide frictional retention.
D. Minimize torque on the abutment teeth.
E. Cross arch stabilization.
F. Equalize retention.

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.

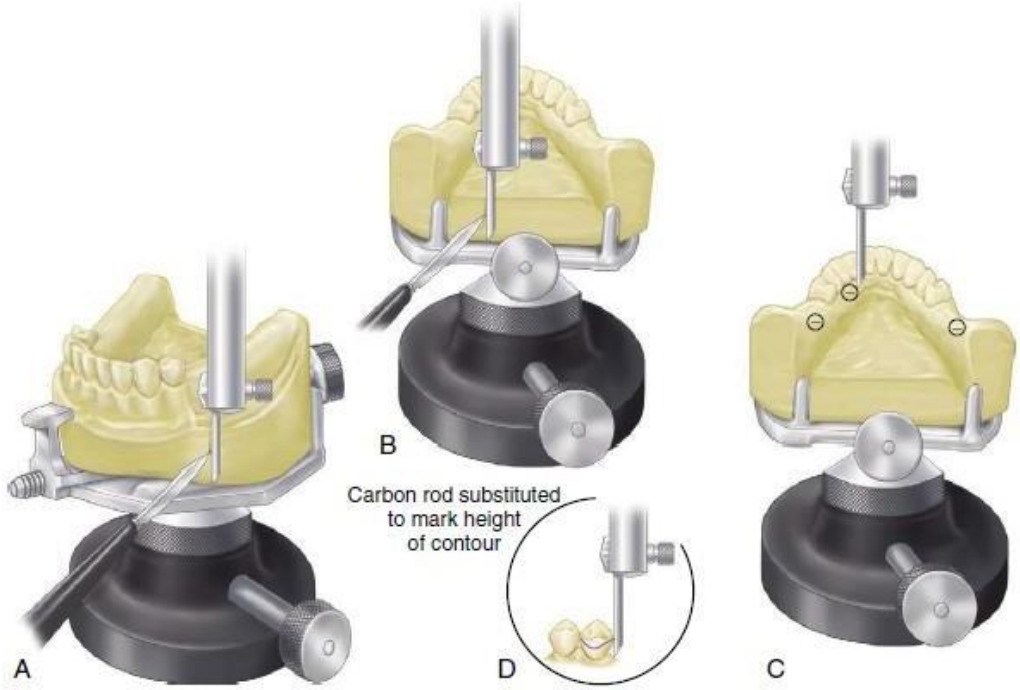
Undercuts could be:

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

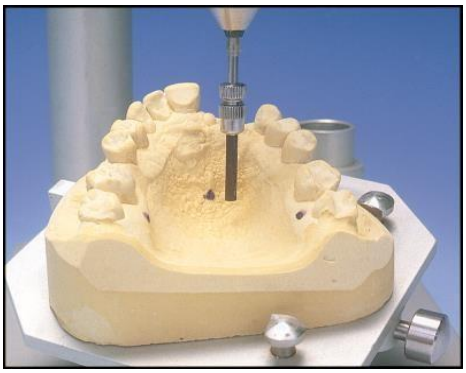
B. Undesirable undercut: other than that used to retain the RPD; in most of the case undesirable undercut interfere with placement and removal of the prosthesis or produces damaging effects on the teeth and underlying structures. Such type of undercut can be eliminated by:

- 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.

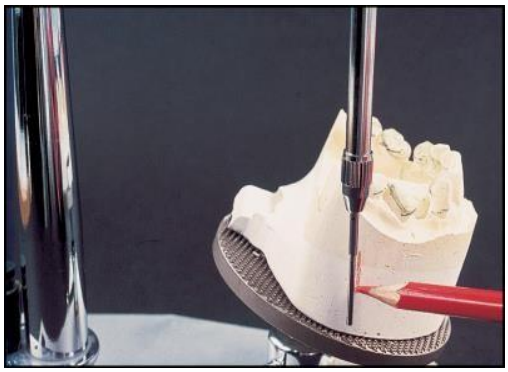
8. To record the cast position in relation to the selected path of placement for future reference. This may be done by locating three dots (tripods) or parallel lines on the cast; three dotes or lines, one anterior and two posterior to permit its reorientation.



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

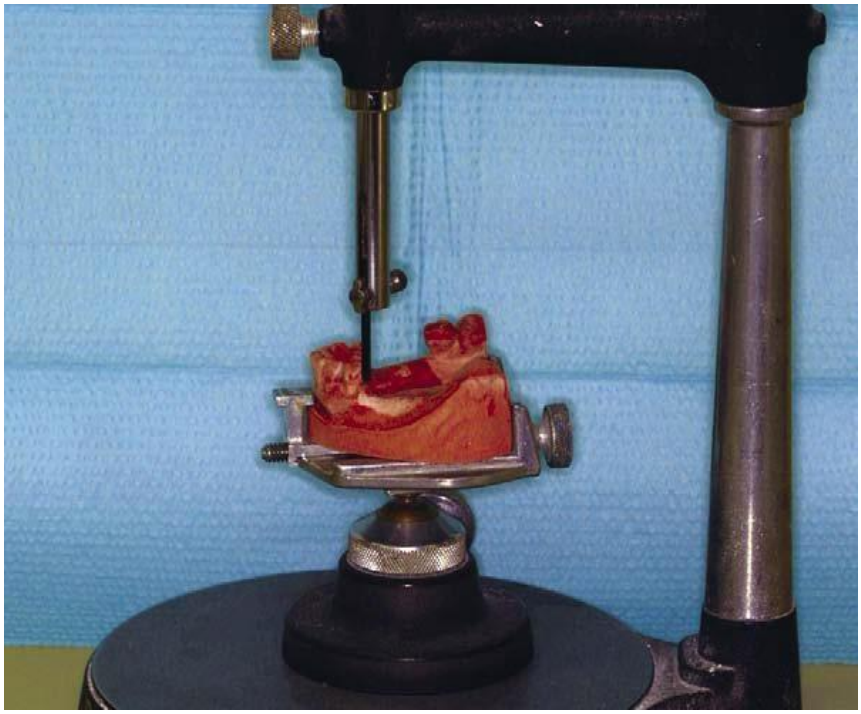
Dental surveyor

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

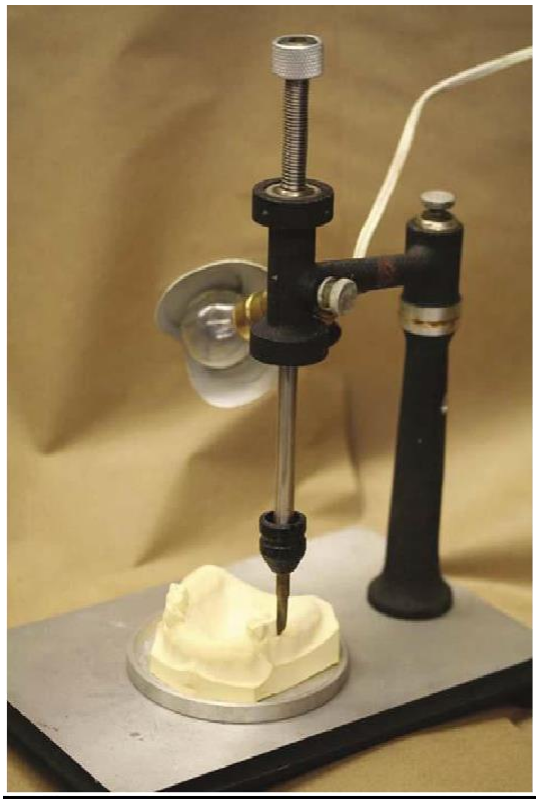
The most widely used surveyors are:

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



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

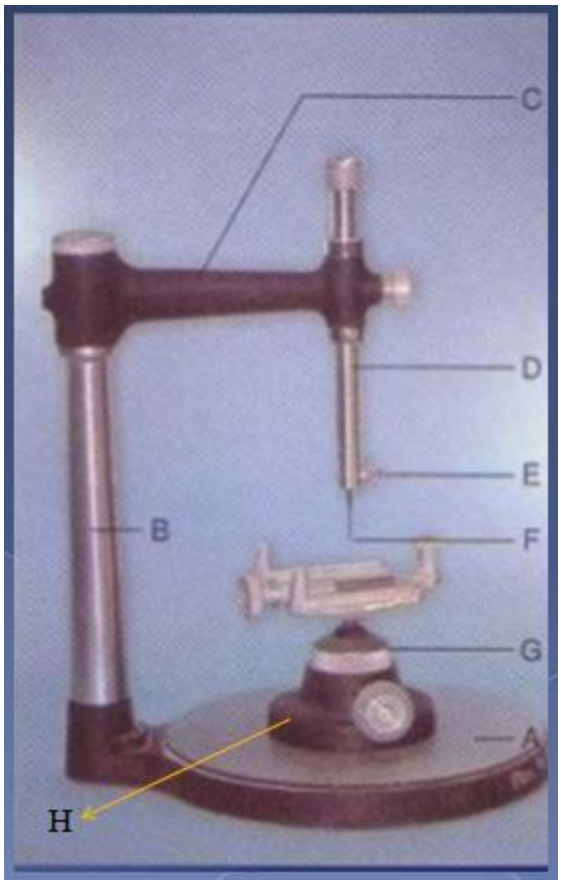
2. ***Jelenko surveyor*** with swiveling horizontal arm and has spring mounted paralleling tool.



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.

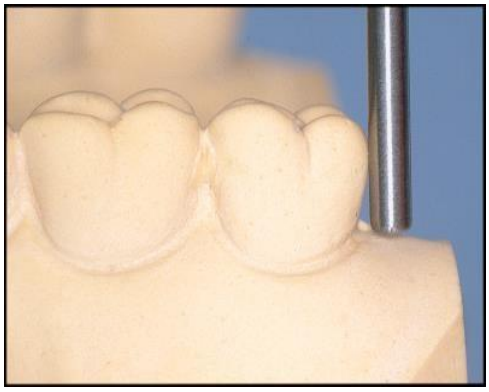
Parts of dental surveyor (Ney type surveyor):

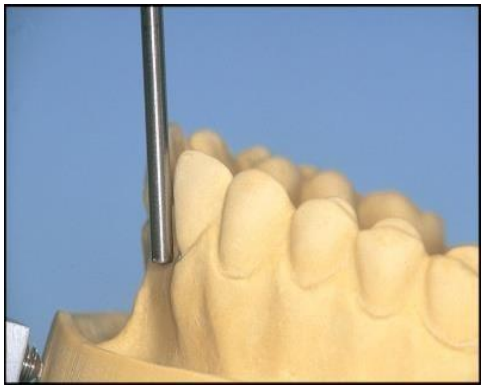
A. **Platform** on which the base is moved.
B. **Vertical arm or upright column** that supports the superstructures.
C. **Horizontal arm** from which surveying tools suspends.
D. **Survey arm.**
E. **Mandrel** for holding special tools.
F. **Tools** which are used for surveying **(in sequence)** include: 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

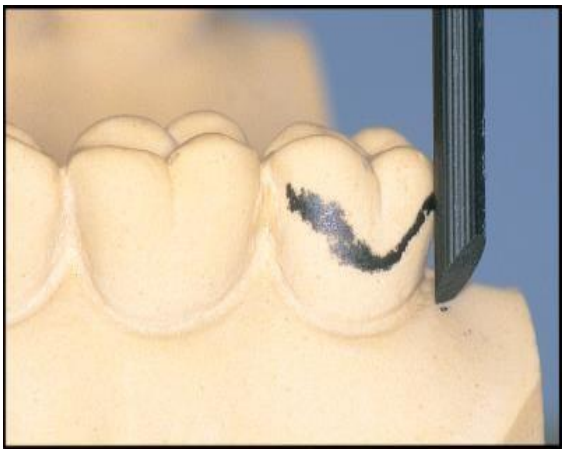
It's a rigid metal rod used for diagnostic purposes in the selection of the path of placement and to determine the undercut areas prior to scribing the height of contour with the carbon marker.



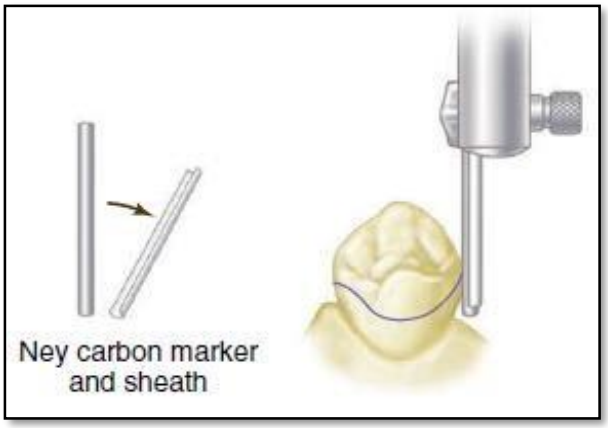


Carbon marker

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

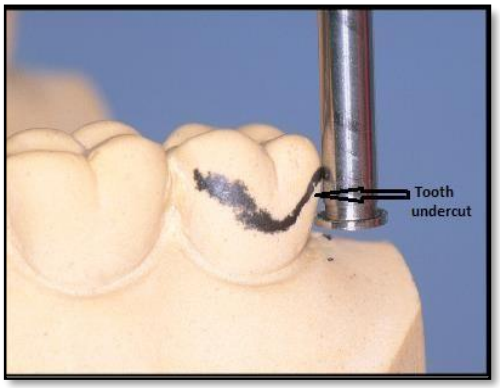


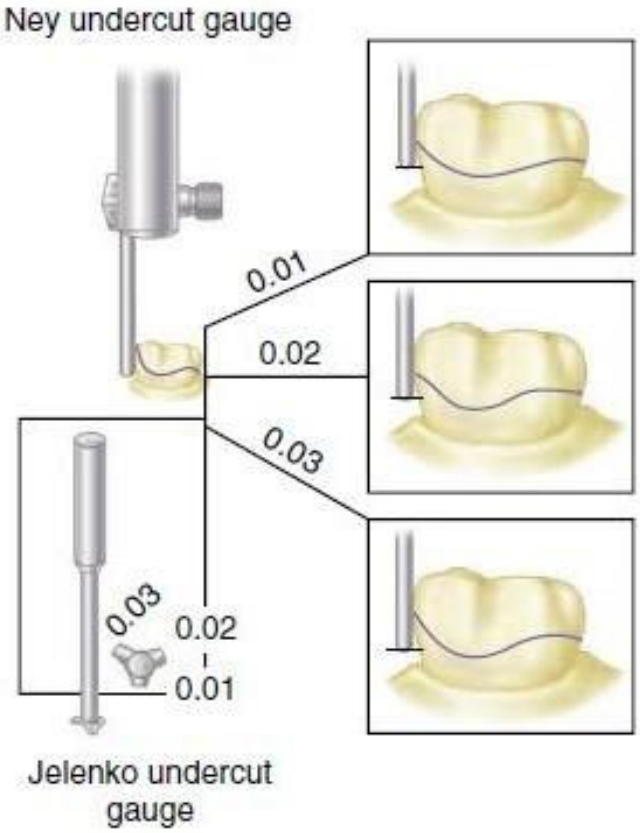
Carbon marker and metal shield



Undercut gauges

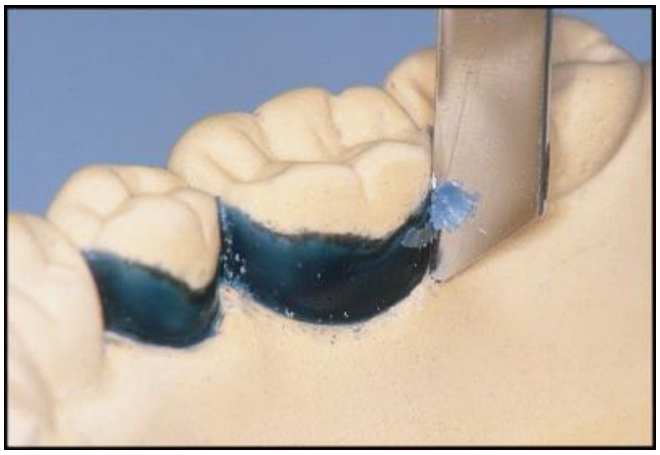
They are used to measure the extent of the undercuts on abutment teeth that are being used for clasp retention, usually there are available in three gauges: 0.01, 0.02, and 0.03 inch. Undercut dimensions can be measured on teeth by bringing the vertical shaft of the gauge in contact with a tooth and 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.

Retention and Removable Partial Denture Retainers

In general a removable partial denture should have these requirements:

1-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.

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

3-Retention: 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:

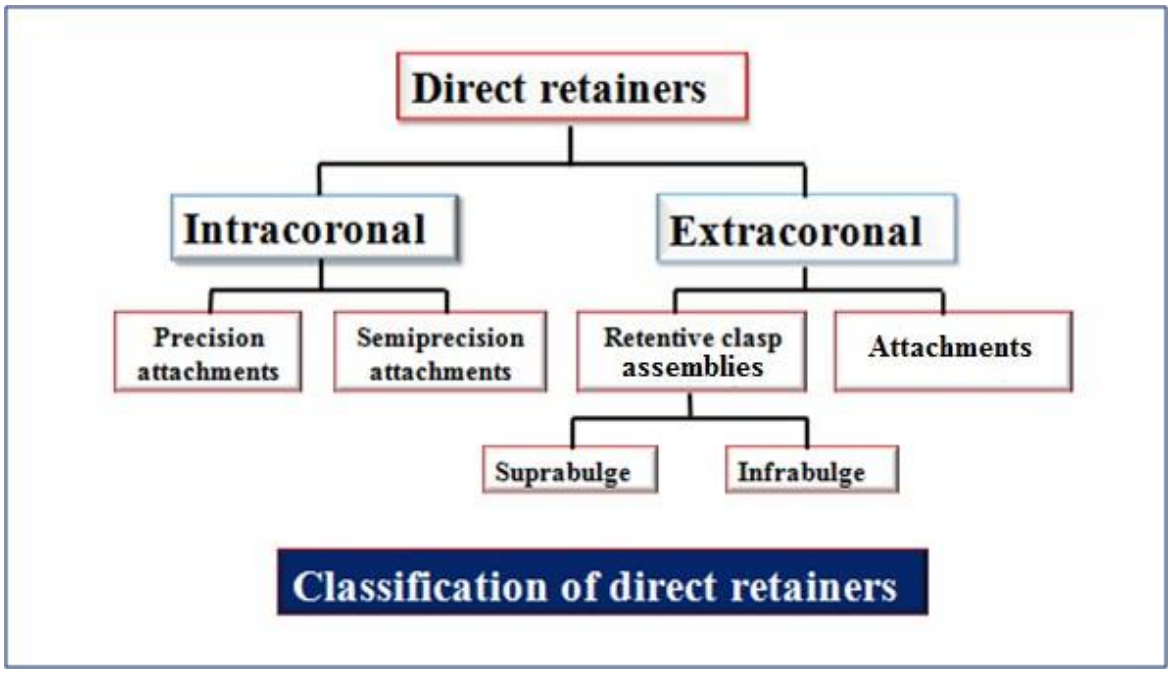
I. Direct retainers.

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.

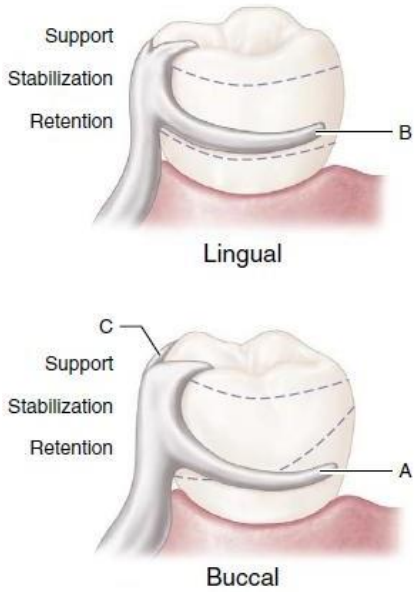


The extracoronal retainer (Clasp type)

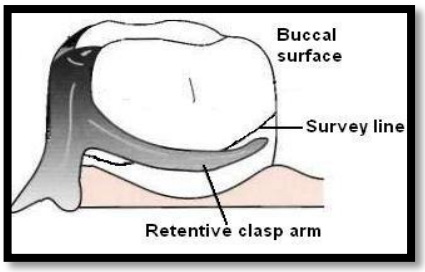
The extracoronal retainer is the most commonly used retainer for removable partial dentures, which uses mechanical resistance to displacement through components placed on the external surfaces of an abutment tooth in an area cervical to survey line or in a depression created for this purpose. Usually a flexible arm is forced to deform, so there will be resistance to removal.

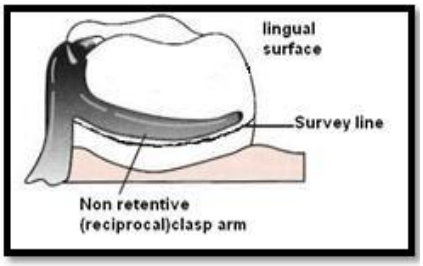
Component parts, Function and position of clasp assembly parts

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 crown.
	Retention	Gingival one third of crown in 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.

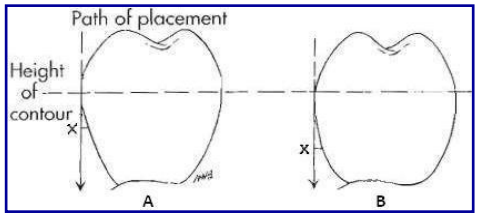




Factors affecting the magnitude of retention

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

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.



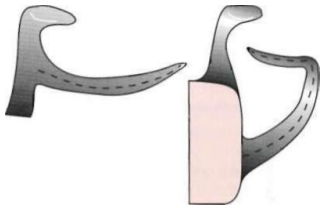
Greater angle of cervical convergence on tooth (A) necessitates placement of clasp terminus, (X), nearer the height of contour than when lesser angle exists, as in (B).

II. Flexibility of the clasp arm

This is influenced by the following factors:

1. Length of clasp arm

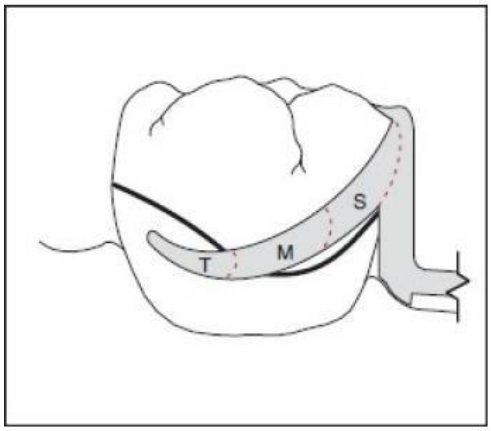
- Increase length of clasp arm increase the flexibility of it (increasing clasp curvature increases length).



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

2. Diameter of clasp

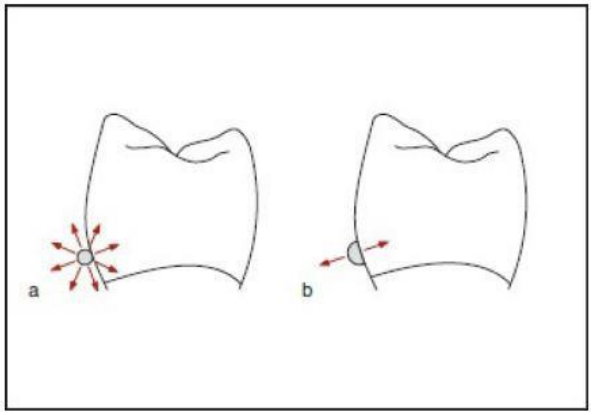
- The greater the average diameter of a clasp arm the less flexible it will be.
- If it's taper is absolutely uniform, the average diameter will be at a point midway between its origin and its terminal end. If its taper is not uniform, a point of flexure and therefore a point of weakness will exist.
- 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 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) is able to 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.
- Wrought wire clasp have greater tensile strength than cast clasps and hence can be used in smaller diameter to provide greater flexibility without fatigue fracture.

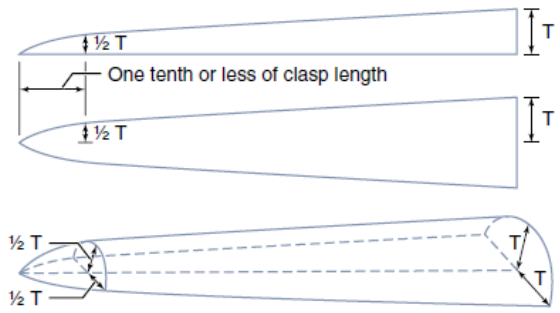
5. Relative uniformity of retention

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.

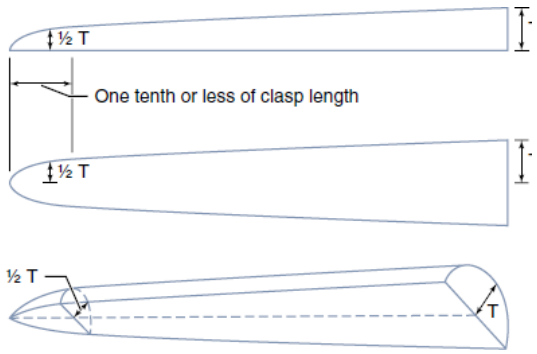
6. Stabilizing-reciprocal cast clasp arm

- 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)

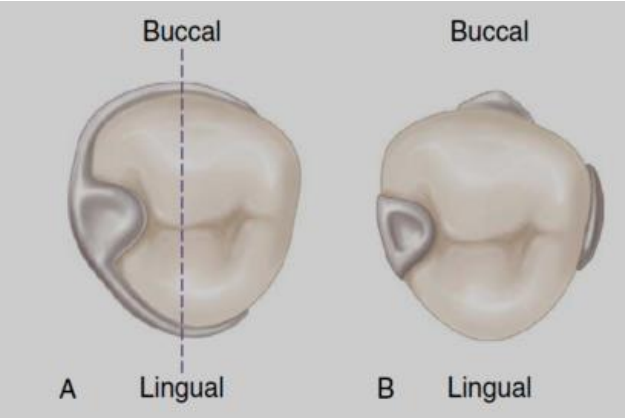


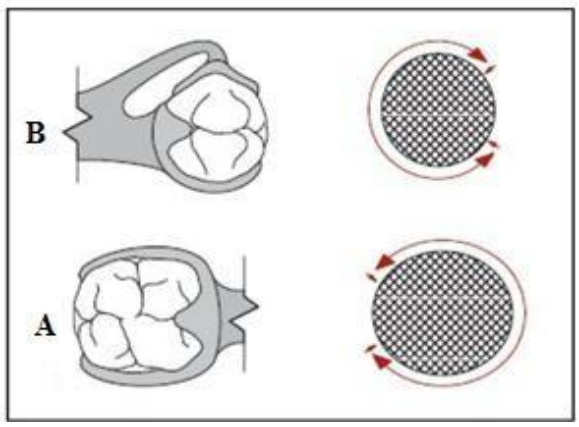
(Cast reciprocal arm)

The basic principles of clasp design

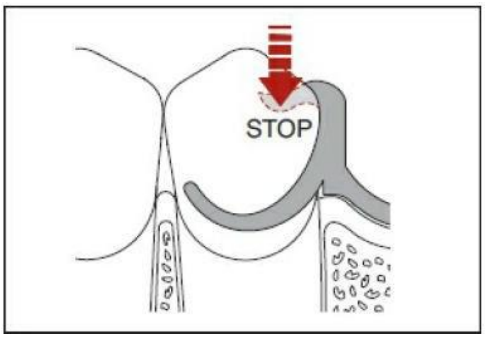
1. Encirclement: The principle of encirclement means that more than 180 degrees in the greatest circumference of the tooth must be engaged by the clasp assembly.

The engagement can be in the form of continuous contact, 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***.



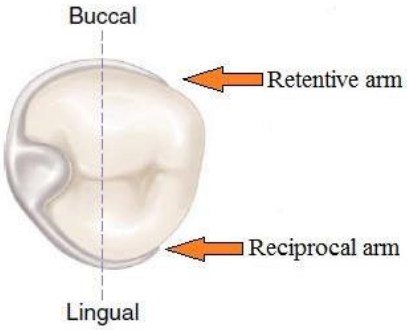


2. ***Support:*** The occlusal rest must be designed to prevent the movement of the clasp arms toward the cervical.



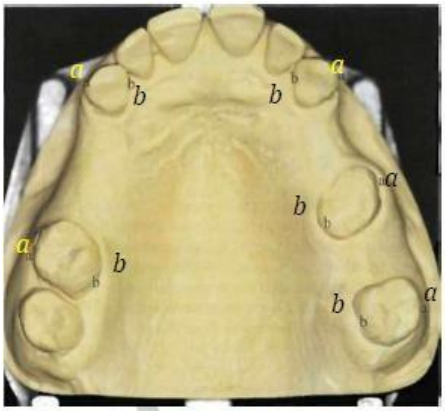
A rest must prevent apical displacement of the prosthesis. If this is not accomplished, the underlying hard and soft tissues may damaged.

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.

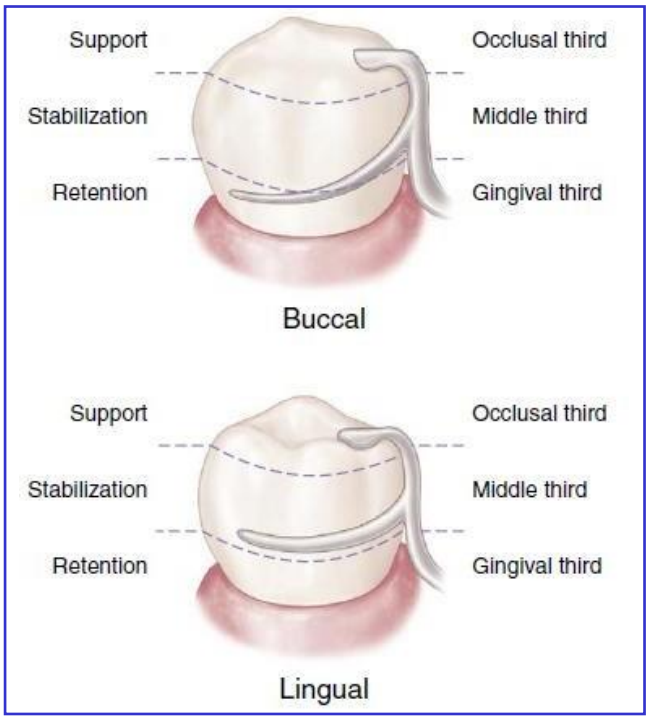
5. Retentive clasps should be bilaterally opposed, i.e., buccal retention on one side of the arch should be opposed by buccal retention on the other, or lingual on one side opposed by lingual on the other.

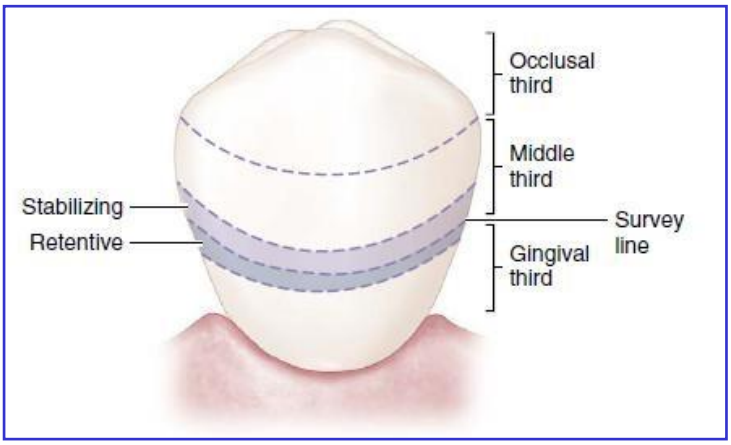


Retentive clasps should be bilaterally opposed. This means using bilateral buccal or bilateral lingual undercuts as shown on this Class III, mod. 2 arch where the retention may be either (a) bilaterally buccal or (b) bilaterally lingual.

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 torqueing 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 resist vertical displacement.

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)

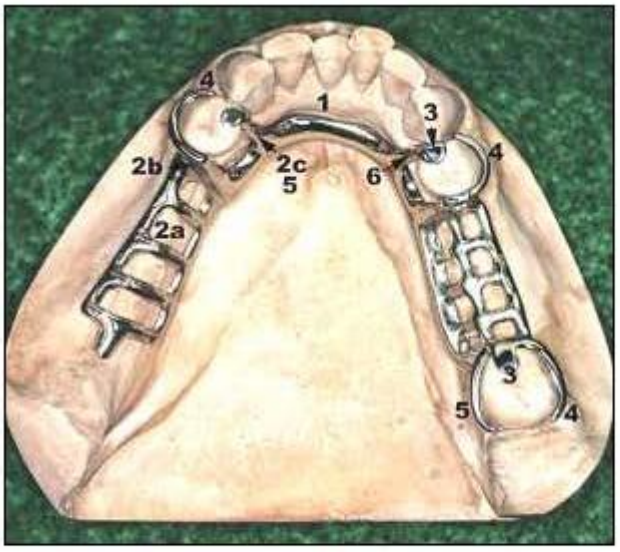


Figure 1: 1, lingual bar major connector; 2a, minor connector by which the resin denture base will be attached; 2b, minor connector, proximal plate, which is part of clasp assembly; 2c, minor connector used to connect rests to major connectors; 3, occlusal rests; 4, direct retainer arm, which is part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

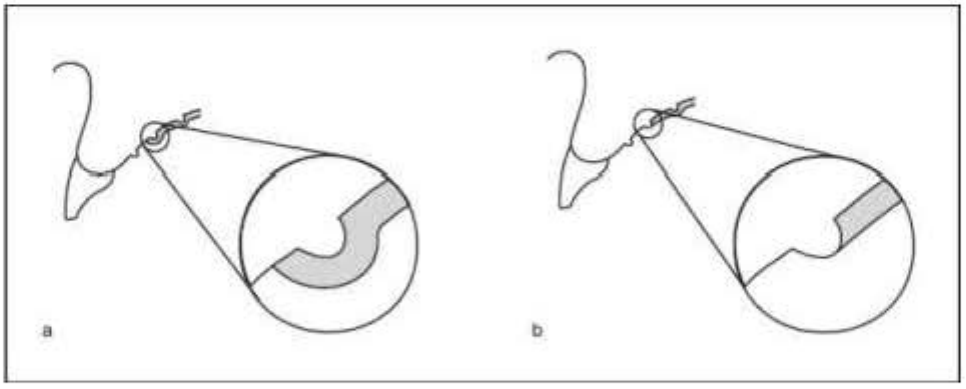


Figure 4: (a) the anterior border of a maxillary major connector should not end on the anterior slope of a prominent ruga. (b) The anterior border of the major connector should be terminated on the posterior slope of a prominent ruga

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).

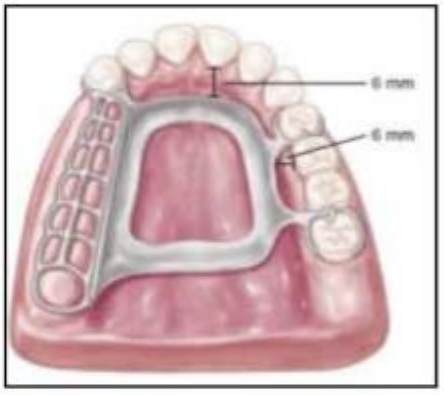


Figure 5: borders of a major connector should be positioned at least 6 mm from the free gingival margins

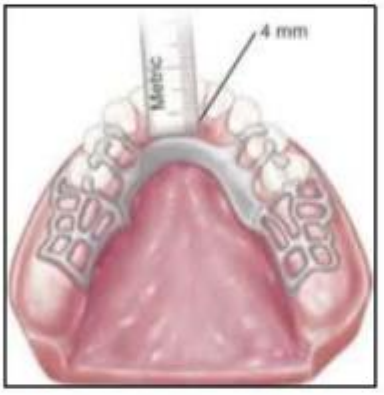


Figure 6: borders of the major connector should be positioned at least 4 mm from the free gingival margins

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

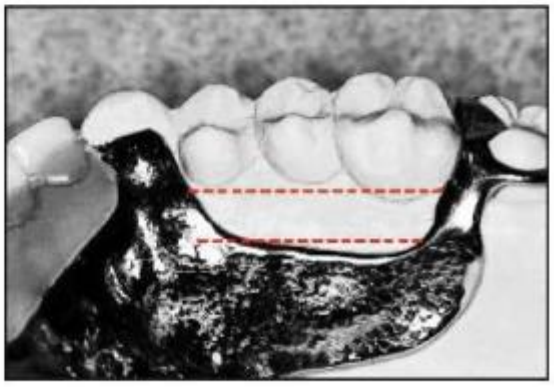


Figure 7: The border s of the major connector should run parallel to the gingival margins of the remaining teeth.

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).

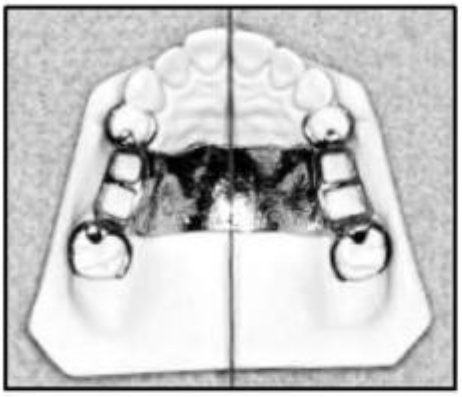


Figure 8: The borders of a maxillary major connector should always cross the palatal midline at 90 degrees.

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.

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. Ocelusal 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 (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).

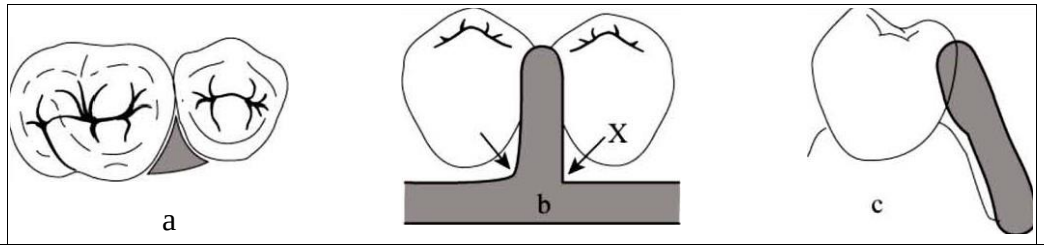


Figure 1: (a). A minor connector should join the major connector at a right angle and cover as small an area of tissue as possible (b). The juncture to the major connector should be rounded (arrow) not sharp (X) unless the juncture includes an acrylic finish line. Relief should be placed on the master

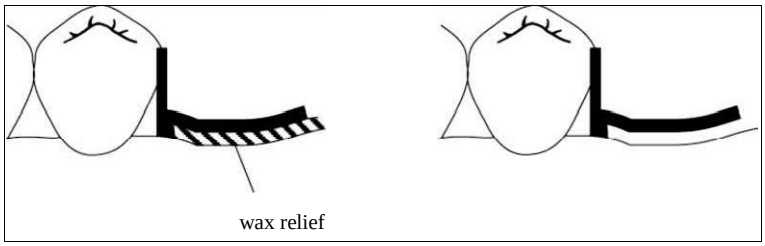
A minor connector should fill the embrasure space so that a smooth surface is presented to the tongue and so that areas where food can be trapped are minimized. Ideally, a minor connector should not contact the teeth gingival to the height of contour. If a minor connector fits tightly against an abutment 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).

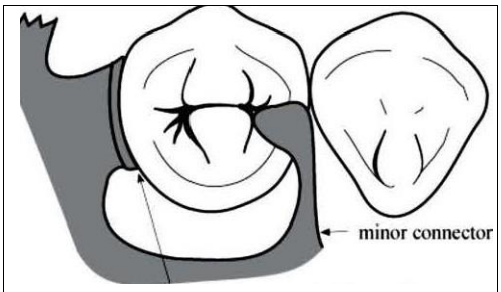
Figure 2: Relief under the minor connector gridwork.



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).



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Tissue Stops

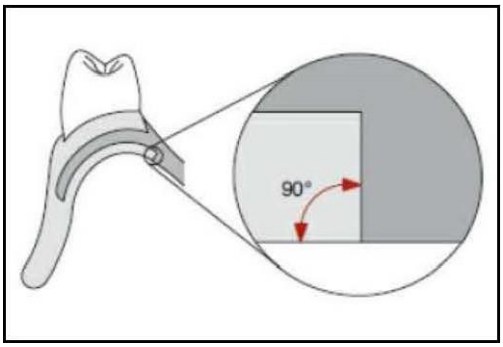
Tissue stops are integral parts of minor connectors designed for retention of acrylic-resin bases. They provide stability to the framework during the stages of transfer and processing. They are particularly useful in preventing distortion of the framework during acrylic-resin processing procedures. Tissue stops can engage buccal and lingual slopes of the residual ridge for stability.

Another integral part of the minor connector designed to retain the acrylic-resin denture base 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.

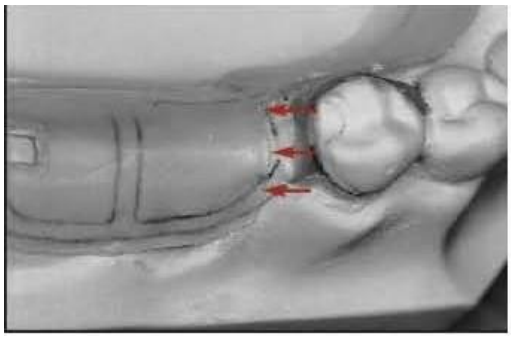
Finishing Lines

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 (4).

Figure 4: The intemal angles of external finish lines should be slightly less than 90 degrees. This results in improved mechanical retention for acrylic resin components.



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 (5).



A

3

5: A. Internal finish lines lt±sult from relief wax placed on the master cast prior to duplication. Arrows indicate the presence of a well-defined veltical wall, l,vhich Viill prothlce an internal finish line. B. Properly contoured relief wax results in a sharply defined internal

The medial extent of the minor cormector 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 su)porting 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 resin on the lingual surface of the affificial teeth. The location ofthe 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.