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# Removable Partial Denture Manual

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2011



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## Introduction to Removable Partial Dentures

### A. Definitions

1. **Partial denture:** A prosthesis that replaces one or more, but not all of the natural teeth and supporting structures. It is supported by the teeth and/or the mucosa. It may be fixed (i.e. a bridge) or removable.
2. **Removable partial denture (RPD):** A partial denture that can be removed and replaced in the mouth by the patient.
3. **Interim denture** (provisional; temporary): A denture used for a short interval of time to provide:
  - a. esthetics, mastication, occlusal support and convenience.
  - b. conditioning of the patient to accept the final prosthesis.
4. **Retention:** Resistance to removal from the tissues or teeth
5. **Stability:** Resistance to movement in a horizontal direction (anterior-posteriorly or medio-laterally)
6. **Support:** Resistance to movement towards the tissues or teeth
7. **Abutment:** A tooth that supports a partial denture.
8. **Retainer:** A component of a partial denture that provides both retention and support for the partial denture

### B. Treatment Objectives

1. preserve remaining teeth and supporting structures
2. restore esthetics and phonetics
3. restore and/or improve mastication
4. restore health, comfort and quality of life

### C. Alternatives to RPD's (Treatment Options - Important for Informed Consent)

1. No Treatment (Shortened Dental Arch)
  - Most patients can function with a shortened dental arch (SDA)
  - Requires anterior teeth + 4 occlusal units (symmetric loss) or 6 occlusal units (asymmetric loss) for acceptable function (opposing PM = 1 unit, opposing molars = 2 units)
  - RPD doesn't usually improve function if minimal occlusal units present
2. Fixed partial denture – requires abutments at opposite ends of edentulous space, more expensive than RPD, must grind down abutments, flexes and can fail if too long.
3. Implant supported prosthesis – most costly, closest replacement to natural dentition, less costly over long term
4. Complete denture (if few teeth left, with poor prognosis); if replacement of missing teeth is very complex or costly

### D. Indications for RPD's

1. lengthy edentulous span (too long for a fixed prosthesis)
2. no posterior abutment for a fixed prosthesis
3. excessive alveolar bone loss (esthetic problem)

4. poor prognosis for complete dentures due to residual ridge morphology
5. reduced periodontal support of remaining teeth (won't support a fixed prosthesis)
6. cross-arch stabilization of teeth
7. need for immediate replacement of extracted teeth
8. cost/patient desire considerations

### **Treatment Sequence for Partial Dentures**

If an RPD is part of planned Treatment:

#### **PLAN THE RPD BEFORE BEGINNING ANY OTHER TREATMENT**

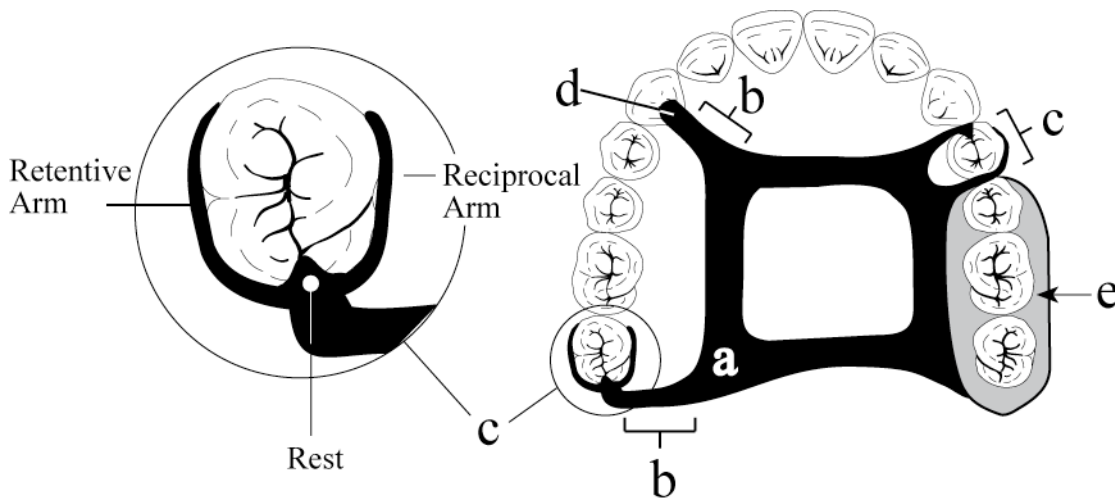
- Survey, tripod, heights of contour
- Draw design on surveyed cast
- **Design approved** before any treatment started:
  - Affects direct restorations
  - Can influence need for/preparations for crowns
  - Insures RPD can be completed successfully
  - NO EXCEPTIONS

#### **CLINICAL STEPS**

1. Diagnosis, Treatment Plan, Hygiene
2. Diagnostic Casts
3. **Draw design & list abutment modifications on Prosthesis Design page**
4. Instructor Approval
5. Complete Phase 1 treatment
6. Abutment modifications
7. Preliminary impression to check abutment modifications
8. Crown or Fixed partial denture's for removable partial denture abutments (if necessary)
9. Final Framework Impression (must include hamular notches/retromolar pads for distal extension removable partial dentures)
10. Make two casts
11. Draw design on 2nd cast
12. Instructor approval/corrections
13. Complete RPD Framework Prescription (instructor signature required)
  - a. Second poured cast with design sent to Lab with 1st pour
14. Inspect wax-up
15. Framework Adjustment
16. Altered Cast impression, if needed
17. Try-in with teeth in wax
18. Process, deliver to patient

## E. Components of a Partial Denture

- a. **Major Connector:** The unit of a removable partial denture that connects the parts of one side of the dental arch to those of the other side. Its principal functions are to provide unification and rigidity to the denture.
- b. **Minor Connector:** A unit of a partial denture that connects other components (i.e. direct retainer, indirect retainer, denture base, etc.) to the major connector. The principle functions of minor connectors are to provide unification and rigidity to the denture.
- c. **Direct Retainer:** A unit of a partial denture that provides retention against dislodging forces. A direct retainer is commonly called a 'clasp' or 'clasp unit' and is composed of four elements, a **rest**, a **retentive arm**, a **reciprocal arm** and a **minor connector**.
- d. **Indirect Retainer:** A unit of a Class I or II partial denture that prevents or resists movement or **rotation** of the base(s) away from the residual ridge. The indirect retainer is usually composed of one component, a **rest**.
- e. **Denture Base:** The unit of a partial denture that covers the residual ridges and supports the denture teeth.





## F. Classification

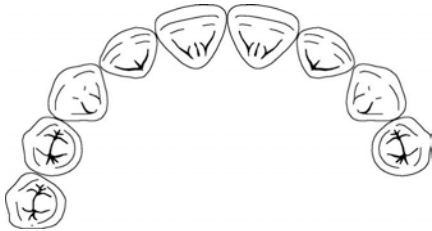
### The Need for Classification

There may be over 65,000 possible combinations of teeth and edentulous spaces. A classification system facilitates communication between dentists. Since there are several methods of classifying partial dentures, the use of non-standard classifications could lead to confusion. Therefore, the Kennedy system has been adopted by most dentists.

### Kennedy Classification

In 1923, Kennedy devised a system that became popular due to its simplicity and ease of application. A tremendous number of possible combinations can be reduced to four simple groups.

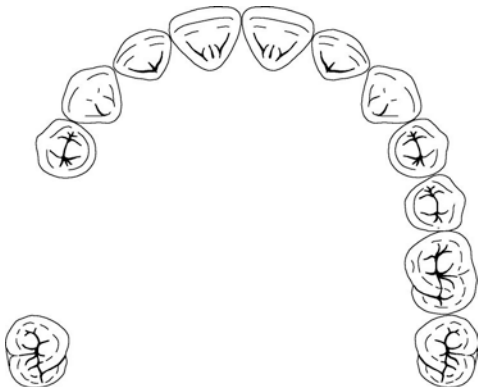
**Class I - bilateral** edentulous areas located posterior to all remaining teeth.



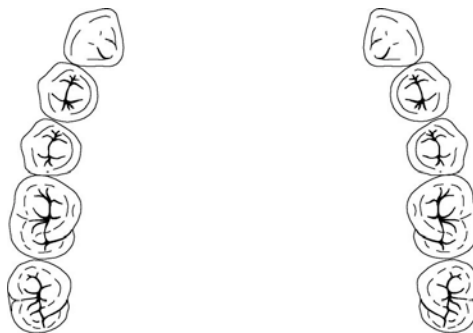
**Class II - unilateral** edentulous area located posterior to all remaining teeth.



**Class III - unilateral** edentulous area **bounded** by anterior and posterior natural teeth.



**Class IV - a single, but bilateral** (crossing the midline) edentulous area located **anterior** to remaining teeth.



### **Applegate's Rules for Applying the Kennedy Classification**

- Rule 1: Classification should follow rather than precede extraction.
- Rule 2: If the 3rd molar is missing and not to be replaced, it is not considered in the classification.
- Rule 3: If the 3rd molar is present and to be used as an abutment, it is considered in the classification.
- Rule 4: If the second molar is missing and not be replaced, it is not considered in the classification.
- Rule 5: The most posterior edentulous area determines the classification.
- Rule 6: Edentulous areas other than those determining classification are called modification spaces.
- Rule 7: The extent of the modification is not considered, only the number.
- Rule 8: There is no modification space in Class IV.

## **Anatomy Tour for Complete and Partial Dentures**

Identify the following structures, and answer the corresponding questions regarding anatomy that is important in the fabrication of complete and partial dentures. The tour does not provide a comprehensive overview of all critical anatomy, but a sample of structures that are easily visible in the dentate mouth and on casts. Use your instructor as a resource.

### **LIPS:**

#### ☐ **Vermilion Border**

- When a denture provides insufficient lip support (teeth set too far palatally), the vermillion border becomes narrow, or disappears, adversely affecting appearance.
- Note the width and fullness of the vermillion border of your partner(s), so you have some idea of the normal shape and contour of these tissues.

☐ Height, maxillary \_\_\_\_\_ mm, mandibular \_\_\_\_\_ mm

#### ☐ **Philtrum**

- If denture teeth are set too far facially, the maxillary lip is stretched so that the depression of the philtrum is lost. This looks unnatural. Note the normal appearance of the philtrum on several of your colleagues. The appearance varies.

#### ☐ **Nasolabial Angle**

- The angle measured between the columella of the nose and the philtrum of the lip.
- Normally, approximately 90° as viewed in profile.

☐ Estimate your partner's nasolabial angle \_\_\_\_\_°

#### ☐ **Tissue of the Upper Lip**

- Gather the loose tissue of the upper lip between your thumb and index finger, so you have some idea of the tension of the tissue or support of the lip on a dentate individual.
- If a denture is too "full", no tissue can be gathered without struggling.
- If there is insufficient denture support, a large portion of the lip can be gathered

### **CHEEKS:**

#### ☐ **Masseter Muscle**

- Have a partner clench while you palpate this muscle externally and internally
  - What happens internally, when the muscles are active? \_\_\_\_\_
  - What aspect of a denture base will be affected by this structure? \_\_\_\_\_
  - Will this muscle be active when you make an open mouth impression? \_\_\_\_\_
  - How will you record its contours for your denture base? \_\_\_\_\_
  - Who has the most pronounced masseter in your group? \_\_\_\_\_

**RESIDUAL RIDGES** (Identify on casts, and corresponding portions of dentures)

If ridges are severely resorbed, inform the patient, so they know denture fabrication and retention will be difficult.

- ☐ Maxillary
- ☐ Mandibular

**VESTIBULES** (Identify on casts and corresponding portions of dentures)

If vestibules are short, inform the patient, so they know denture fabrication and retention will be difficult.

- ☐ Maxillary Buccal
- ☐ Mandibular Buccal
- ☐ Mandibular Lingual

**MAXILLA:**☐ **Maxillary Tuberosities**

These will be more easily observed in edentulous patients (identify, then **see casts**)

What influence will these structures have on dentures:

- a) if they are oversized? \_\_\_\_\_
- b) if they are severely resorbed? \_\_\_\_\_
- c) if they are severely undercut? i. \_\_\_\_\_  
ii. \_\_\_\_\_

☐ **Incisive Papilla**

Important landmark for setting of teeth (midline of papilla to labial of incisor  $\approx 10\text{mm}$ )

On a partner, note the position and size of the papilla in relation to the teeth:

- a. How far anterior to the incisive papilla are the central incisors? \_\_\_\_\_mm
- b. What is the mediolateral relation of the incisive papilla to the midline of the maxillary teeth \_\_\_\_\_

☐ **“Hamular” Notch**

The posterior border of a complete denture and some partial dentures must pass through this notch, between the bony tuberosity and hamulus. Denture border must terminate on “soft displaceable tissue”, to provide comfort and retention. In some patients the notch is posterior to where the depression in the soft tissue appears.

- ☐ Use the head of your mirror to palpate the notch & mark with an indelible marker.

☐ **Posterior Border of the Hard Palate**

- What significance is this border for maxillary complete and partial dentures?

\_\_\_\_\_

☐ **Soft Palate**

☐ ***Vibrating Line***

Critical posterior border of complete dentures and some partial dentures. The junction of movable and immovable portions of the soft palate. If the denture terminates posterior to this, movements of the soft palate cause it to dislodge and drop. If the denture terminates anterior to this, on the hard palate, no seal is created, the denture is unretentive and often uncomfortable.

☐ Within a group of six students:

- ☐ Have an instructor demonstrate how to find and mark the vibrating line on one student, using an indelible stick
- ☐ Have an instructor draw an indelible line at an incorrect position on one of the two students and a correct position on the other, and guess which one is correct.
- ☐ Locate and draw the vibrating line on the remaining students, check with instructor.

☐ ***Fovea Palatini***

Bilateral indentations near the midline of the soft palate. Close to the vibrating line in many individuals, but not accurate enough for using as a landmark for the posterior border of the denture

☐ ***Median Palatine Raphe (midline palatine suture)***

- a. A bony midline structure, that can be raised and may require relief when covered by a denture. Covered with thin mucosa and can ulcerate easily if impinged upon.
  - b. Occasionally a torus palatinus may be present, creating similar, often more pronounced problems.
- ☐ Identify who has the most prominent raphe/torus \_\_\_\_\_

**MANDIBLE:**

☐ ***Pear Shaped Pad***

A soft pad containing glandular tissue, with an inverted pear shape, which is the posterior terminus of the mandibular complete dentures and Class I & II partial dentures. The pear shaped pad is usually created from scarring after extractions, and is therefore more easily seen in edentulous casts.

- ☐ Identify the retromolar area or pad on a partner, and have an instructor check.
- ☐ Identify the pear shaped pad on the distributed cast

☐ ***Buccal Shelf***

The primary denture bearing area of a mandibular denture.

Between extraction sites of molars and the external oblique ridge. Does not tend to resorb much.

- ☐ Identify on a partner.

☐ **Anterior Border of the Ramus**

- Do not extend dentures **posterior** to the pear shaped pad onto this structure, or discomfort will result

☐ **External Oblique Ridge**

- Do not extend dentures **laterally** from the buccal shelf onto this structure or discomfort will result

☐ **Mylohyoid Ridge (Internal Oblique Ridge)**

- Origin of the mylohyoid muscle, largest muscle in the floor of the mouth, which influences the length of the flange of the lingual flange of a denture.
  - Can be quite prominent, and/or sharp, requiring relief in the final denture, particularly toward the posterior.
  - ☐ Identify, palpate and indicate the colleague with the most prominent mylohyoid ridge
- 

☐ **Lingual Tori**

Raised bony structures that may require relief when covered by a denture. Covered with thin mucosa and can ulcerate easily if impinged upon

☐ **Genial Tubercles (no demo)**

- Attachment for the genioglossus muscle in the midline of the lingual vestibule.
- When the residual ridge is highly resorbed the tubercles may be higher than the ridge and present problems for comfort.

**FRENA** (singular = frenum):

- Frena must be relieved in a denture to allow for movement, without impingement.
- If frena are very prominent, adequate relief can weaken a denture.
- If too much relief is provided, retention is lost.
- Frena can be displaced easily with viscous impression materials such as alginate, so it is important to check their prominence intraorally.

- ☐ Pull the cheeks and lips of a colleague to see how frena change shape.

- ☐ Note the shape, size and direction of the following and look on the distributed denture for corresponding areas to these frena:

☐ maxillary labial

☐ mandibular labial

☐ lingual

- these are narrow in shape

☐ maxillary buccal

☐ mandibular buccal

- these are broader in shape

- ☐ Who has the most prominent frena in your group? \_\_\_\_\_

## OTHER STRUCTURES:

### ☐ Pterygo-Mandibular Raphe

- Connects from the hamulus to the mylohyoid ridge.
- Rarely significant, but when prominent, it can cause pain, or loosening of the denture, requiring a relief “groove ” by the hamular notch
- ☐ Have partner open wide as possible -identify raphe.
- ☐ Is it prominent? \_\_\_\_\_

### ☐ Retrozygomal Fossae (Space)

- Palpate the zygomatic process in the buccal vestibule just buccal to the first maxillary molar.
- The vestibular space posteriorly is the retrozygomal fossae.
- It is commonly incompletely captured in preliminary impressions without a syringe technique - this leads to a short flange and non-retentive denture.

### ☐ Coronoid Process

- Place mirror head lateral to tuberosity, have partner move mandible to opposite side.
- Note binding or pain during this excursion.
- This gives some indication of the width of the space available for a denture flange.
- If the flange is made too thick, it will cause pain and sometimes dislodgment.

## **Irreversible Hydrocolloid Preliminary Impressions**

### **Selection of a stock tray:**

1. A space of 5 -7 mm should exist between the tray and the tissues to provide bulk for strength and accuracy of the material.
2. The tray should be just short of the labial vestibule and slightly beyond the vibrating line
3. Compound may be placed on peripheries of stock tray to extend borders if needed. Extension should be made only to provide coverage of critical anatomy, not for the purpose of displacing or distorting the vestibular tissues, which should be registered accurately to obtain a peripheral seal on a denture.

### **Handling the Material:**

1. Pre-measure material – do not take containers to your operatory. Do not handle containers with contaminated gloves/hands. This makes infection control easier.
2. Do not leave containers open in a humid environment - humidity and high temperatures can cause deterioration of the powder.
3. Do not mix in a bowl contaminated with dental stone - gypsum can cause acceleration of the alginate. Conversely alginate contamination of a bowl used to mix stone can diminish the strength of the cast or model produced. Keep separate bowls and spatulas for alginate and stone.

### **Measuring and Mixing alginate**

1. Fluff the powder before measuring, making sure there are no large voids in the scoop. Do not tap the scoop more than once or twice, since this will compact the powder, and result in a thicker mix.
2. Measuring by weight is more accurate than by volume.
3. Ratio of 1 scoop powder : 1 measure water.
4. 3 scoops of powder is sufficient for most arches.
5. For adjusting the setting time, regulate water temperature rather than the water/powder ratio, which can affect strength of the impression.
6. Mix for up to 45 seconds, until a smooth creamy consistency is reached. No lumps or powder should remain visible in the mix.

### **Making the impression**

1. Lightly dry the teeth and mucosa. Don't desiccate the teeth or the alginate may stick to them.
2. Wipe alginate onto the occlusal surfaces of any teeth.
3. When seating the tray, don't bottom out on the teeth or the residual ridge, as this will result in distortions of the tissue or movement of the teeth.
4. Wait to remove the impression until the material is firm (approximately one minute after initial set).
5. Pull the lip up to allow air to break the seal with the tissues. This will make the impression easier to remove. Several drops of water placed in the vestibule can also aid in breaking the seal. Remove rapidly, to prevent significant permanent deformation.



6. Wrap the impression in a damp towel (completely wet, then wring out to eliminate dripping water), then pour within 12 minutes to avoid significant distortion.
7. If the impression is placed on a firm surface, the alginate may distort if it is unsupported by the tray and in contact with the supporting surface. Support the impression by the handle or the tray, rather than unsupported portions of the impression, until the preliminary cast has been poured and the stone has set.

### **Evaluating Irreversible Hydrocolloid Impressions**

1. The alginate should be properly mixed, smooth and creamy.
2. The tray should be centered over ridge.
3. No significant contact should occur between the tray with soft tissues or teeth.
4. No-large voids in the impression.
5. All critical anatomy should be recorded (hamular notches, retromolar pads, etc.).

### **Pouring a Model**

1. Weigh the powder for the stone, measure water for the corresponding amount of powder
2. Vacuum mix the stone (this takes less time to spatulate than hand mixing and it results in a stronger cast)
3. Use a two-pour technique - pour stone into the impression first, then wait for the cast to set before inverting the model to add a base to the cast. This produces casts with superior surface strength.

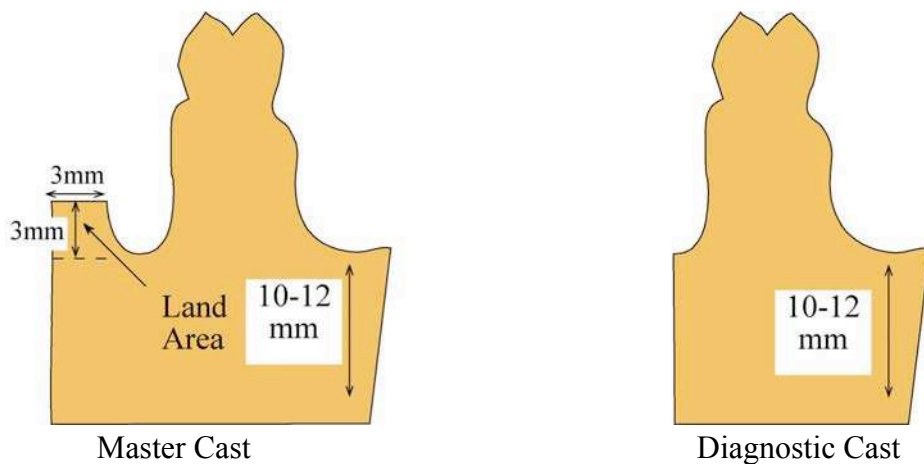
### **Two-Pour Technique**

1. Rinse the alginate impression. Spray all surfaces with disinfectant solution and seal for 10 minutes.
2. Use the vibrator and flow the stone into the impression slowly, watching the stone fill all the indentations of the impression. Modulate speed of pouring the impression by tilting the tray back and forth. If the stone mixture fills the impression too quickly, air will get trapped in undercuts and voids will be incorporated into the cast. To delay the filling of the impression, tilt the impression in the opposite direction of the flow of the stone, reduce the speed of the vibrator, or press the impression less firmly against the vibrator.
3. Leave some rough areas or projections above on the exposed surface of the stone to help attach the base that will be attached after this first pour has set.
4. Let the stone set to a firm consistency (approximately 30 minutes). This will ensure that the surface of the cast has superior strength due to the heavier and denser stone particles settling toward the incisal and occlusal surfaces.
5. Make a patty of stone and invert the alginate impression with the set first pour onto the base. Adapt the new stone to the existing stone, but be careful not to cover any areas of the tray. Otherwise it may be difficult to remove the tray without damaging the cast.
6. Trim excess stone from the base with the spatula while the stone is still soft.
7. Separate the alginate impression from the stone cast after 30 minutes.

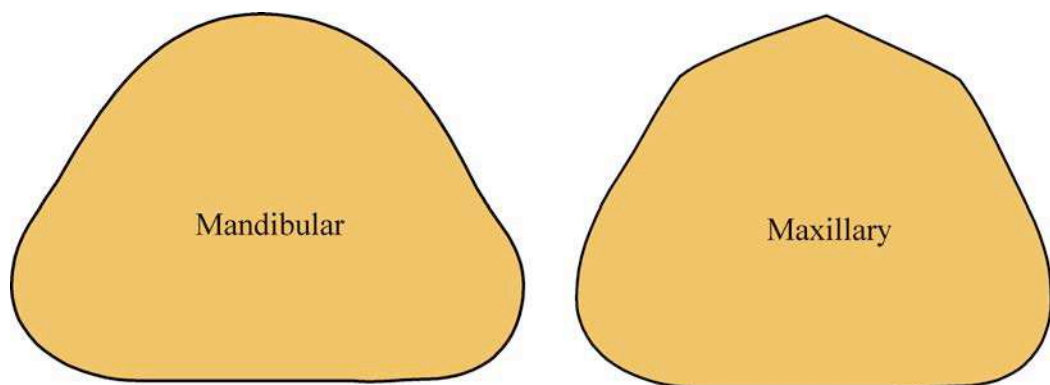
## Trimming

1. Make sure the model is moist during trimming, so that debris from the trimmer does not attach to the cast. Soak the model by immersing it in slurry water, or by allowing just the base of cast to contact clear tap water. Prolonged immersion in tap water can lead to erosion of the cast.
2. Cast should be minimum of 10-12mm (.5 inch) in thinnest part
3. Trim the base on the model trimmer parallel to ridges.
4. Leave the mucous membrane reflection intact for making a custom tray
5. The casts should have the following contours and dimensions:

Cross Section through Casts



For Master casts, impressions are boxed and trimmed with a 3mm wide by 3mm deep land area to aid in processing of acrylic. For diagnostic casts used for making custom trays, the land area should be omitted so that the tray material is easier to trim and remove from the cast

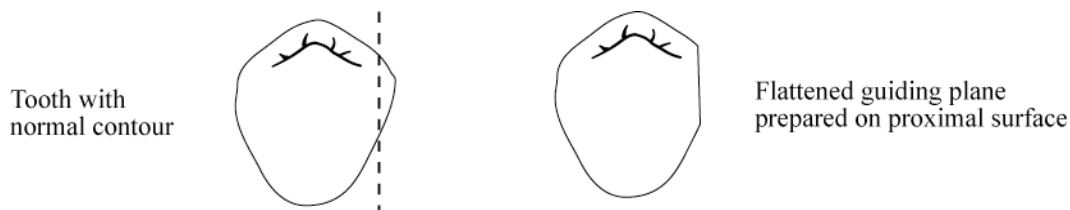


Outline of Bases for Trimmed Casts  
Follow the contour of the ridges, with rounded angles

## Surveying, Path of Insertion, Guiding Planes

A path of insertion (or removal) is the path along which a prosthesis is placed (or removed) intraorally. A removable partial denture is usually fabricated to have a **single** path of insertion or removal from the mouth. A single path of insertion is advantageous because it:

1. **equalizes retention** on all abutments
2. provides bracing and cross-arch stabilization of teeth
3. minimizes torquing forces of the partial denture
4. allows the partial denture to be removed without encountering interferences
5. directs forces along the long axes of the teeth
6. provides frictional retention from contact of parallel surfaces on the teeth



In order to provide a single path of insertion for a partial denture, some axial surfaces of **abutments** must be prepared so that they parallel the path of insertion. These parallel surfaces are called **guiding planes**.

Guiding planes are prepared wherever rigid components of a partial denture contact abutment teeth. Specifically, guiding planes should usually be prepared for:

1. Proximal plates
2. Bracing arms
3. Rigid portions of retentive clasps

The **dental surveyor** is a diagnostic instrument used to select the most favorable path of insertion and aid in the preparation of guiding planes. It is an essential instrument in designing removable partial dentures. The act of using a surveyor is referred to as **surveying**.

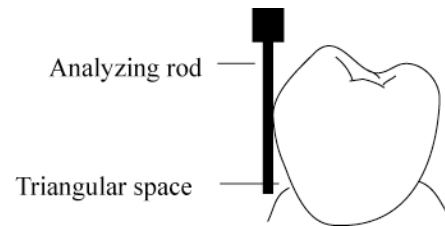
### Other Uses of a Surveyor:

1. Locating **soft tissue undercuts**, which can influence the extent of the denture base, the type of direct retainers and the path of insertion selected.
2. **Contouring wax patterns** for fixed restorations that will be partial denture abutments.
3. **Machining parallel surfaces** on cast restorations.
4. **Blocking out undesirable undercuts** on master casts.
5. **Placing intracoronal retainers** (precision attachments).
6. **Recording the cast position** in relation to the selected path of insertion (**tripoding**).

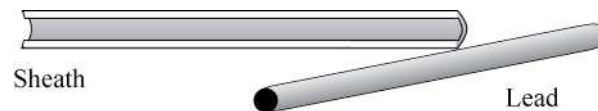
## Parts of a Surveyor:

1. **Surveying Table (Cast Holder):** The part of the surveyor to which a cast can be attached. Through the use of a ball and socket joint it allows the cast to be oriented at various tilts and to be fixed along one of these planes.
2. **Surveying Arm:** A vertical arm used to analyze the parallelism of various axial cast surfaces. It contains a holder so that several surveying tools may be attached and used.
3. **Surveying Tools:**

- a. **Analyzing Rod** - A thin straight metal rod used to analyze contours and undercuts. This is the principal tool used in surveying. The side of analyzing rod is brought into contact with surfaces of the proposed abutment teeth to analyze their axial inclinations. This rod is easily bent and once bent is difficult to straighten. Use it carefully.



- b. **Carbon Marker** - Rods similar to pencil leads which can be used to mark the location of the height of contour on a dental cast. Some surveyors use a protective sheath to prevent or reduce breakage of the carbon markers.



- c. **Metal Gauges** - Metal rods with terminal ledges or lips of various widths (the most commonly used are 0.01" and 0.02"). 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 lip.

When vertical shaft of .02" undercut gauge contacts tooth simultaneously as the terminal lip, a .02" undercut is present.



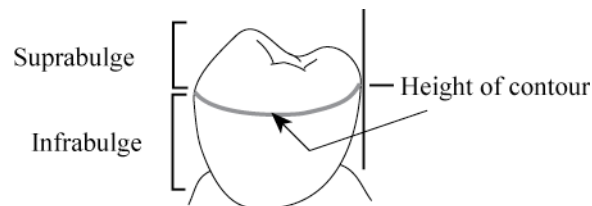
- d. **Wax Trimmer** - A tool with a straight sharp edge, which parallels the surveying arm. It is used to contour waxed crowns for partial denture abutments, or to place blackout for a partial denture framework. It is used with a dragging or shaving motion to remove thin layers.



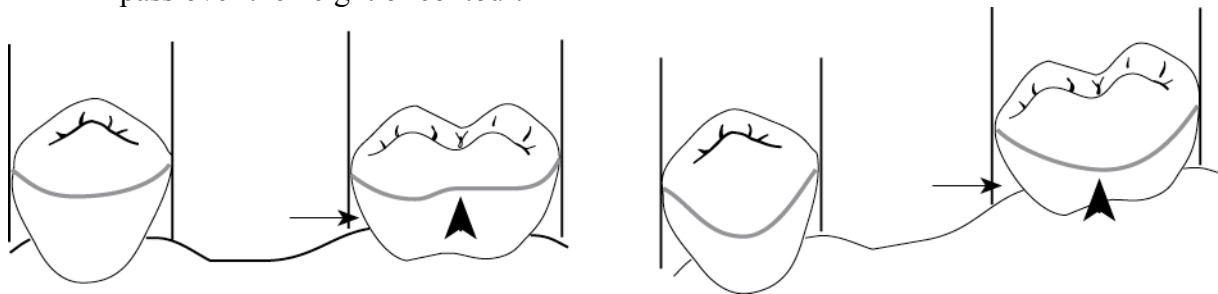
## Selecting the Path of Insertion of a Removable Partial Denture

A path of insertion is selected to provide the best **combination** of retentive undercuts and parallel surfaces for ALL ABUTMENTS. Use the following steps to do so:

- STEP 1 Place the cast on the surveyor table and orient the plane of occlusion **relatively horizontal**. The final tilt of the cast for the ideal path of insertion is seldom more than  $10^\circ$  from this position.
- STEP 2 Place the analyzing rod against the axial surface of a proposed abutment teeth (any tooth adjacent an edentulous space). The tip of the rod should be at the level of the free gingival margin. The point where the tooth touches the analyzing rod is greatest convexity (bulge) of a tooth and is called the **height of contour**.



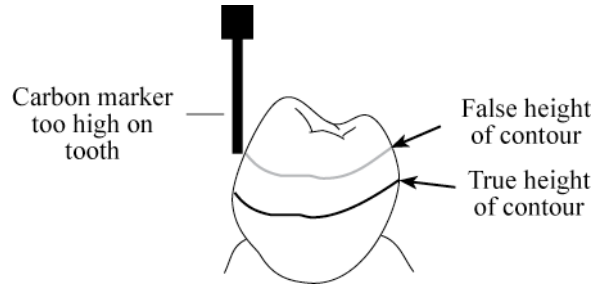
The position of the height of contour can be changed by tilting the cast. The area on a tooth occlusal to the height of contour is called the **suprabulge area**. All portions of a direct retainer that are rigid or semi-rigid must be located in this area. The area gingival to the height of contour is an undercut and is called the **infrabulge area**. The retentive portions of direct retainers are located in this area, since they can flex to pass over the height of contour.



Note that when cast is tilted and the surveying arm remains vertical, the height of contour (large arrows) changes, as does the distance of the analyzing rod to the tooth (small arrows)

- STEP 3 Tilt the cast to gain maximum parallelism of axial surfaces of all of the proposed abutments. Maximum parallelism is present when the heights of contour of all teeth and **all surfaces** are **as close as possible** to the same position occluso-gingival. An additional check for maximum parallelism is that **equal amounts of undercut** are present on all abutments and all abutment surfaces. Check the mesial and distal tooth surfaces while tilting the cast anterior-posteriorly (A-P). While maintaining the same A-P tilt check facial and lingual parallelism. Lock the tilt of the cast when maximum parallelism is achieved.
- STEP 4 Use an undercut gauge to check for adequate and **relatively equal retentive, undercuts** for retentive arms on all abutments. Alter the tilt of cast if required.

- STEP 5 Change the tilt of the cast if there are any major **soft tissue interferences** (i.e. mandibular tori, residual ridge undercuts), or if the selected path of insertion will cause an **esthetic problem** (i.e. clasp would have to be placed too far incisally on the facial surface of an anterior tooth, as when the height of contour or required depth of undercut is too close to the incisal or occlusal surface).
- STEP 6 Lock the diagnostic cast in position on the surveying table and **mark the heights of contour** on the denture abutments and soft tissues with the carbon marker. When marking the heights of contour, ensure that the carbon tip **follows close to the free gingival margin** so that you do not register a false height of contour.



**The heights should be relatively equal occluso-gingivally.**

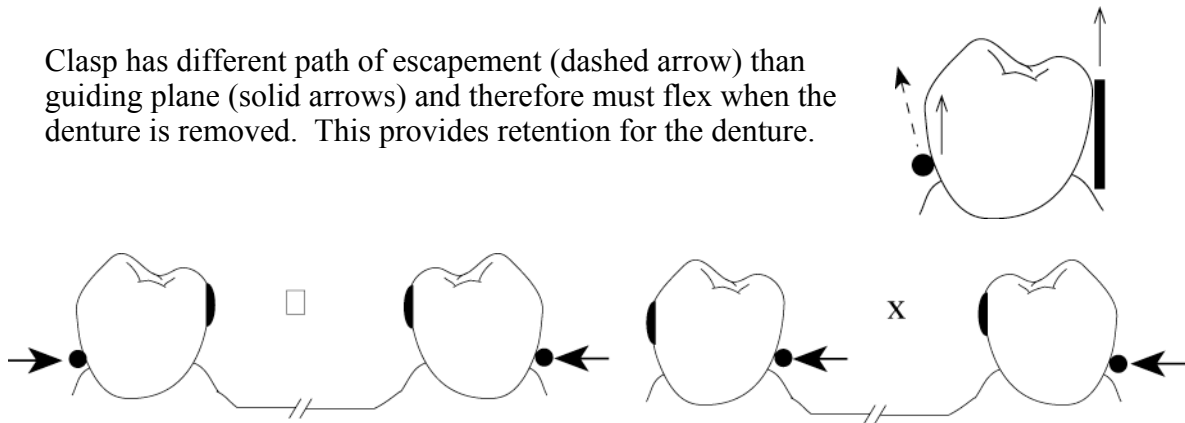
- STEP 7 **Tripod** the diagnostic cast so that the selected path of insertion may be easily found for future reference.

### The Optimal Path of Insertion

The optimal path of insertion of a partial denture is determined by:

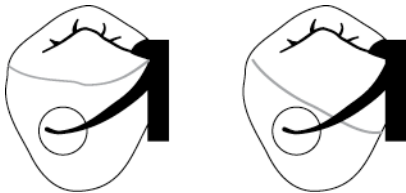
- A. **Retentive undercuts** - equalized on all abutments.

Clasp has different path of escapement (dashed arrow) than guiding plane (solid arrows) and therefore must flex when the denture is removed. This provides retention for the denture.



Retentive clasps(•) oppose each other when correctly designed (left). Retention at each principle abutment should balance that of the tooth on the opposite side of the arch (i.e. equal in magnitude and opposite in relative location).

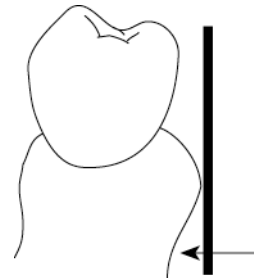
- B. **Interferences** - A path of insertion must be selected so that the prosthesis may be inserted and removed without encountering tooth or soft tissue interferences. Tooth interferences are usually encountered where rigid elements of the partial denture would require placement in areas of undercut. Since rigid elements do not flex, such a partial denture will not seat. Tooth interferences are often encountered in the bucco- or linguo-occluso-proximal point angles, where the height of contour is high and where rigid portions of the clasp assemblies must be placed.



Since only the terminal end of the retentive arm flexes (circled area), the clasp on the left will lock on the cast. The rigid portion of the clasp will not release from the undercut. The clasp on the right will release since only the flexible tip is in the undercut.

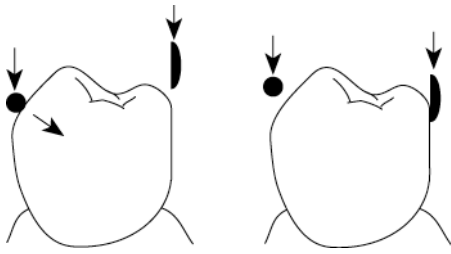
When soft tissue undercuts exist (i.e. mandibular tori, residual ridge undercuts), the rigid denture base can cause abrasion, irritation and /or ulceration as it is forced over the tissue. As such, a path of insertion that involves interferences should only be selected if the interferences can be eliminated by tooth preparation or reasonable blockout of the master cast. If the interferences cannot be eliminated or minimized, then a different path of insertion must be considered, even if less desirable guiding plane and retentive areas must be selected.

Soft tissue undercuts require that the tissue be impinged upon as the major connector or denture base passes over it. If a large undercut is blocked out, the connector or base will be remote from the tissue and collect food and debris.



- C. **Esthetics.** A path of insertion should be selected to provide the most esthetic placement of artificial teeth and the least amount of visible metal on the abutment teeth. Ensure that the retentive undercut and the height of contour are not placed too far occlusally, so that the retentive clasp and that anterior proximal plates are close to the gingival contours making these components as inconspicuous as possible.
- D. **Guiding planes.** Guiding planes are flat surfaces prepared on abutment teeth. Flat, rigid elements of the partial denture (**bracing elements** and **proximal plate** minor connectors) fit against these surfaces to ensure that a partial denture seats along one path of insertion.

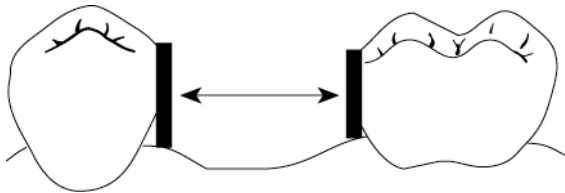
Guiding planes are used to control and limit the directions of movement of a removable partial denture as it is being inserted, removed or while it is in function. To do this, bracing elements or proximal plates should, whenever possible, be the **initial portions of the partial denture to contact the abutments**. In this way, the teeth are stabilized from the potential moving forces as retentive elements of direct retainers flex over the heights of contour into the retentive undercuts.



When the retentive arm (•) contacts the tooth first, it can cause movement of the tooth since the tooth is not stabilized to resist displacement. When the rigid bracing or reciprocal arm contacts first, it braces the tooth so the retentive arm cannot displace it.

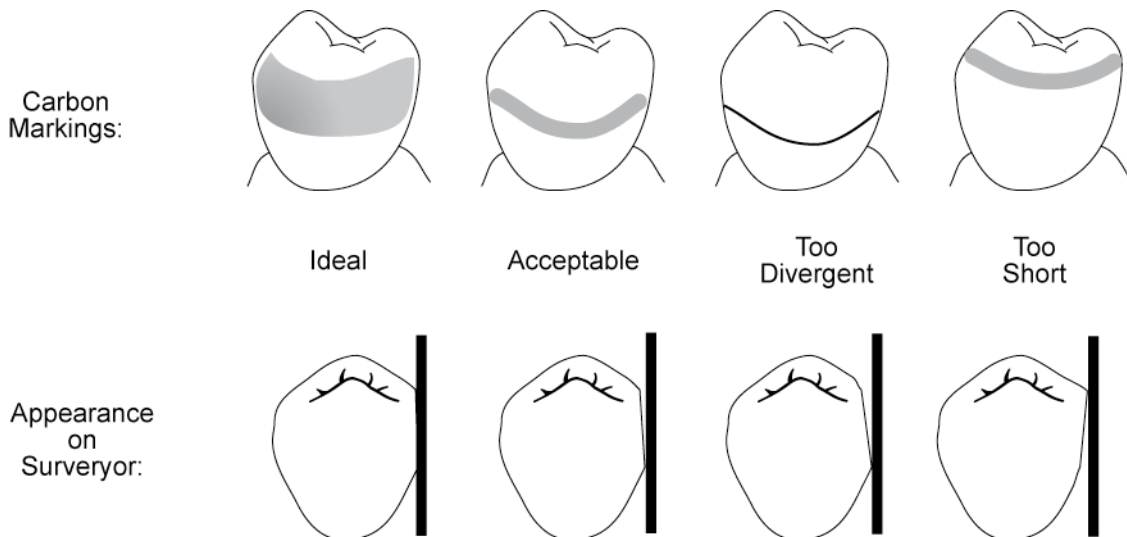
Guiding planes are most effective when they:

- are **parallel**
- include **more than one common axial surface** (e.g. proximal and lingual surfaces)
- are **directly opposed** by another guiding plane (e.g. facing guiding planes in a modification space)
- are placed on **several teeth**
- cover a **large surface area** (long and/or broad)



These guiding planes are parallel, include more than one common axial surface (i.e. distal of premolar, mesial of molar), directly oppose one another and are fairly long. They will be very effective.

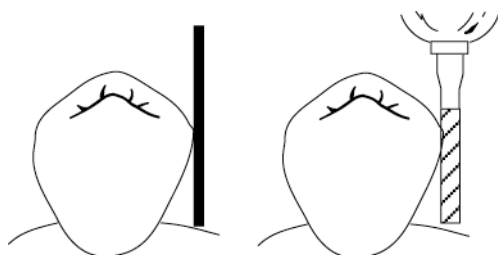
When marked with a carbon marker, well-prepared guiding planes appear as wide survey lines:





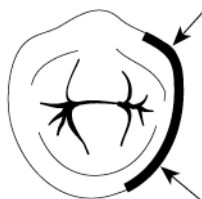
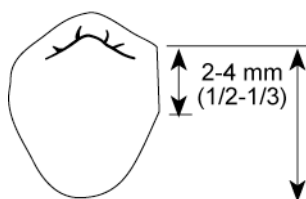
### Selection and Preparation of Guiding Planes:

- a. A path of insertion is selected.
- b. The number and position of guiding planes is selected.
- c. With the diagnostic cast as a guide, parallel surfaces are prepared intraorally with straight cylindrical burs (#1156 or #557L or equivalent cylindrical bur). The surveyed cast should be nearby for comparison, so that the bur can be placed in the same relationship to the tooth as the analyzing rod makes with the diagnostic cast.



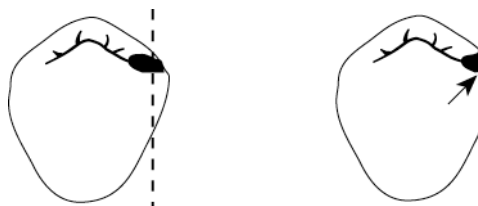
The bur should be placed at the same angulation as the surveying rod. The triangular space below the height of contour should appear to be the same.

- d. Guiding planes should be at least **1/2 to 1/3 of the axial height** of the tooth (generally a minimum of 2 mm in height). Use a light sweeping stroke continuing past the bucco- and the linguo proximal line angles. Reduction should **follow the bucco-lingual curvature** of the tooth, rather than slicing straight across the tooth. Guide planes for distal-extension cases should be *slightly* shorter to avoid torquing of the abutment teeth. **Lingual guiding planes** for bracing or reciprocal arms should be 2-4 mm and ideally be located in the **middle third of the crown**, occluso-gingivally. Use a good finger rest to establish parallel planes.



Prepare past the facio- and linguo-proximal line angles

- e. If tooth surfaces selected for guiding planes are already parallel to the path of insertion, little if any tooth modification may be necessary.
- f. The prepared surfaces are polished rubber wheels or points.
- g. Guiding planes are the first features prepared intraorally. If occlusal rest seats are prepared initially, placement of a proximal guiding plane will remove some of the rest seat preparation, and result in a narrowed rest with a sharp occluso-proximal angle.



## The Effects of Guiding Planes on Retention and Stability

### 1. Guiding Planes Maintain Retention

Retention is gained by the flexible retentive tip of the clasp engaging an undercut of an abutment. Retentive undercuts exist only in relation to a fixed plane. If an undercut is found on a diagnostic cast, and the cast is tilted in another direction, the undercut can be eliminated. Likewise, in the mouth, if the partial denture does not have a single path of insertion (as dictated by guiding planes) the prosthesis could be rotated so that the retentive undercuts would be eliminated. The denture could then be easily displaced.



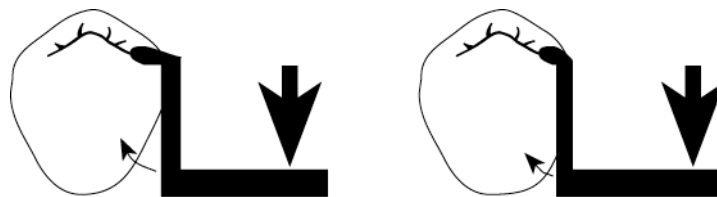
Point contact of the reciprocal arm allows rotation of the partial denture and release of the retentive arm (left and middle). A broad flat plane does not (right).

### 2. Guiding Planes Minimize the Need for Retention

The use of too many clasps or the use of clasps with large undercuts can impair the health of the periodontium. Frictional retention from parallel guide planes minimizes the retention required from direct retainers.

### 3. Guiding Planes Stabilize Teeth

Guiding planes with intimate, firm and continual contact with the prosthesis are effective in stabilizing teeth. Stability can be important if there is mobility due to periodontal bone loss. This effect is **most pronounced in Class III** partial dentures. In **Class I and II** partial dentures, stability is compromised by the lack of posterior abutments. These dentures **tend to rotate more** and produce a torquing force, if the principal abutments are locked into the denture. Slightly shorter guiding planes are used in distal extension cases to minimize this torquing action.



Loading of a Class I denture base causes rotation around the rest seat. A short guiding plane allows rotation into the gingival relief area. A long guiding plane has no area to move and thus immediately torques the tooth.

## Alteration of Other Axial Contours

While guiding plane surfaces are the most common axial tooth preparations made for removable partial dentures, other axial preparations may also be required. These include:

### A. Lowering Height of Contours

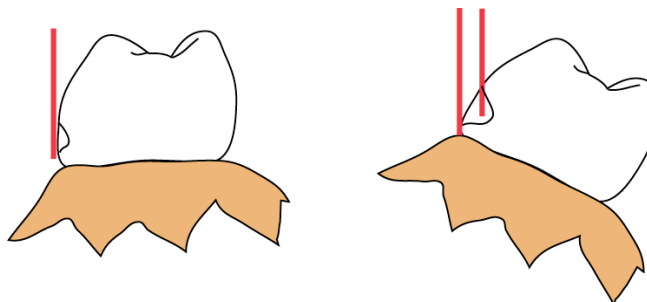
1. Lowering height of contours to eliminate tooth interferences in areas where rigid frameworks elements will be placed (such as rigid portions of retentive arms).
2. Lowering height of contours to improve esthetics (e.g. to allow retentive arms to be placed more gingivally to reduce clasp display).

When preparing axial contours for these situations, the heights of contour are most quickly lowered by placing the bur parallel to the path of insertion.

### B. Raising Height of Contours

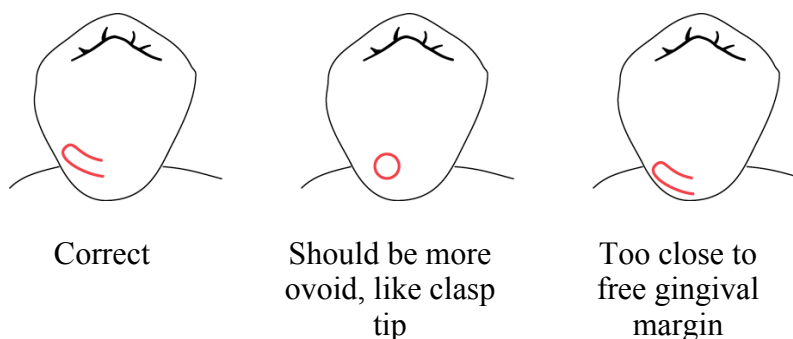
The only time that a height of contour would be raised would be when there is no retentive undercut present or when the undercut is so far gingival that the retentive tip would either impinge on the free gingival margin or cause a hygiene problem due to its proximity to the free gingival margin. In general, the inferior portion of the retentive undercut should be *at least* 1mm above the free gingival margin. Raising the height of contour is only feasible when the axial surface is parallel or slightly divergent to the path of insertion. If the surface is grossly divergent from the path of insertion, then raising the height of contour may be impossible.

The tooth on the right is grossly divergent from the path of insertion, so that excessive preparation is required just to gain the appropriate undercut. Dentin, or in extreme cases, the pulp could be exposed. Minimal preparation will be required on the tooth on the left since its long axis is close to the path of insertion.



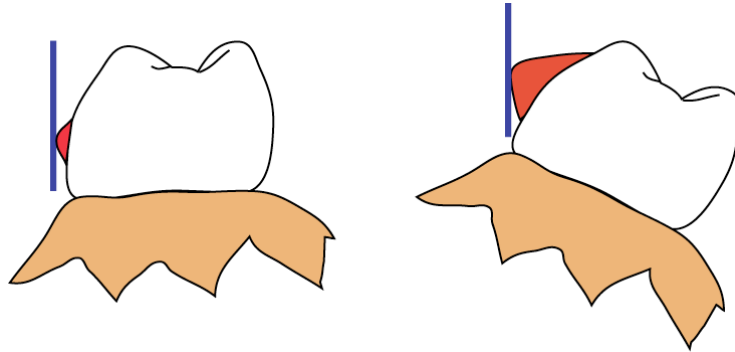
Raising the height of contour for retentive undercuts can be accomplished by:

1. Preparing a retentive undercut. Prepare an ovoid undercut with the inferior border at least 1 mm from the free gingival margin, using a round or chamfer diamond bur.



2. Place composite resin above the position of the retentive tip, using rubber dam isolation. Place a Mylar matrix to separate the tooth from adjacent teeth. Clean the tooth with flour of pumice, etch, apply bonding agent and place the composite with plastic instrument. Place and contour the material as indicated below. Ensure there is adequate undercut only in the area needed, even after polishing.

If the tooth is very divergent from the path of insertion, the composite will have to be grossly over contoured (right), which is not advisable for hygienic reasons. Changing the path of insertion or uprighting the tooth orthodontically may be preferable alternatives.



### 3. Combination of Preparing an Undercut and Placing Composite Resin

This is most commonly done when the tooth is more divergent from the path of insertion than usual. When possible, it is preferable to prepare retention in enamel rather than place a resin bonded undercut. Preparation in enamel, when feasible, is less time consuming, less expensive and probably more hygienic over an extended period of time.

## Summary of Removable Partial Denture Abutment Modifications

After a path of insertion is selected and a partial denture design has been formulated, tooth preparations are made according to the following sequence.

1. Prepare guiding planes along the path of insertion for:
  - a. Proximal plates
  - b. Bracing arms
  - c. Rigid portions of retentive clasps
2. Lower heights of contour to eliminate interferences and improve esthetics.
3. Raise heights of contour for retentive arm tips by preparation and/or placement of composite resin.
4. Rest seat preparations or placement of bonded composite rest seats.

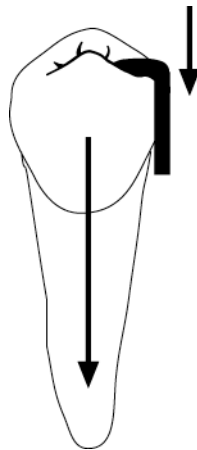
## Rests and Rest Seats

### A. Definitions

- i. **Rest:** A rigid component of a removable partial denture which rests in a recessed preparation on the occlusal, lingual or incisal surface of a tooth to provide vertical support for the denture. Although a rest is a component of a direct retainer (retentive unit, clasp assembly), the rest itself is classified as a supporting element due to the nature of its function.
  - a. **Occlusal rest** - a rest placed on the occlusal surface of a bicuspid or molar.
  - b. **Lingual (cingulum) rest** - A rest placed on the cingulum of an anterior tooth (usually the canine). Rests may also be placed on the lingual of posterior teeth by creating a ledge of the tooth surface (prescribed for surveyed crowns).
  - c. **Incisal rest** - A rest placed on an anterior tooth at the incisal edge.
  - d. **Intracoronaral (precision) rest** - A rest consisting of precision manufactured attachments that are placed within the coronal contours of a crown or retainer.
- ii. **Rest Seat:** A portion of a tooth selected and prepared to receive an occlusal, incisal or lingual rest.

### B. Functions of Rests

1. To direct forces along the long axis of the abutment tooth.
2. To prevent the denture base from moving cervically and impinging gingival tissue.



3. To maintain a planned clasp-tooth relationship.
4. To prevent extrusion of abutment teeth.
5. To provide positive reference seats in rebasing and/or impression procedures.
6. To serve as an indirect retainer by preventing rotation of the partial denture (Class I or II RPD's only).

### C. Preparation of Rest Seats

Rests seats should be prepared using light pressure with a high-speed handpiece with or without water spray. Since minimal preparation is usually performed, minimal heat is generated. Good visibility is required so that water coolant can be eliminated.

Since preparations are usually entirely in enamel it is best to avoid anesthesia so the patient can inform the dentist when sensitivity is felt.

Occlusal rest seats can be prepared with medium round burs (#2 and primarily the #4 sizes).or diamonds (e.g. 801-016, 38006-135)

Guiding planes and cingulum rest seats can be prepared with a long, medium diameter cylindrical bur or diamond (e.g. #57L; 8837K-014).

### D. Rest Seat Form

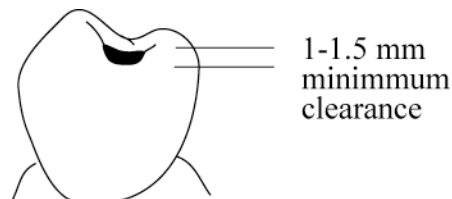
Rest seats should have a smooth flowing outline form (i.e. no sharp line angles).

#### 1. Occlusal Rest Seats

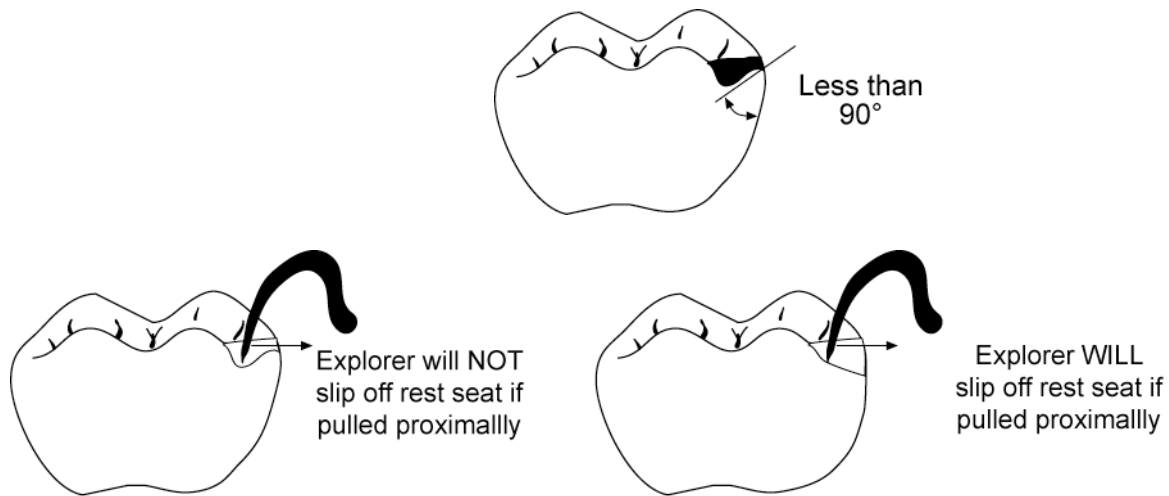
- (a) The outline of an occlusal rest seat is a **rounded triangular shape** with its apex nearest to the centre of the tooth.
- (b) The base of the triangular shape is at the marginal ridge and should be approximately **one third the bucco-lingual width** of the tooth.



- (c) The marginal ridge must be **lowered** and **rounded** to permit a sufficient bulk of metal to prevent fracture of the rest from the minor connector (**1 to 1.5 mm**)



- (d) The floor of the rest seat should be **inclined towards the centre** of the tooth, so that the angle formed by the rest and the minor connector should be **less than 90°**. This helps to direct the occlusal forces along the long axis of the tooth.

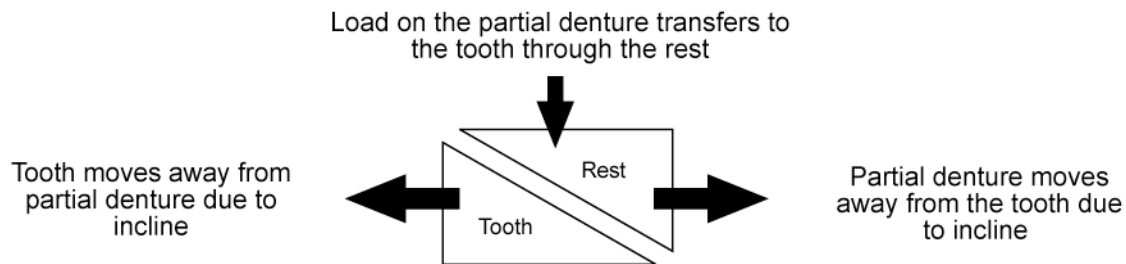


'Positive' Rest Seat  
( $< 90^\circ$ )

Rest Seat not 'Positive'  
( $> 90^\circ$ )

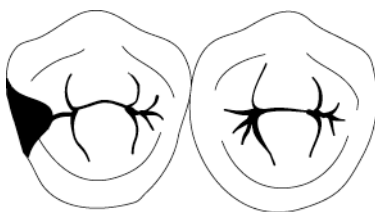
A clinician can test to see if a rest seat is 'positive' (i.e.  $< 90^\circ$ ) by trying to slide an explorer tip off the rest seat.

An angle of **more than 90°** fails to transmit the occlusal forces along the long axis of the tooth and **permits movement** of the clasp assembly away from the abutment and **orthodontic movement** of the tooth.

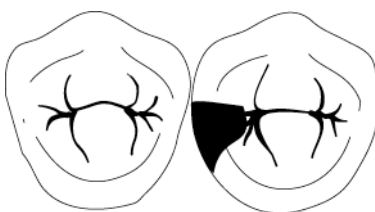


- (e) The floor of the rest seat should be **concave or spoon shaped** to create a ball-and-socket type of joint. This will prevent horizontal stresses and torque on the abutment tooth.

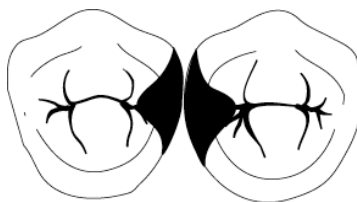
When occlusal rest seats are prepared next to an edentulous space the morphology follows conventional form.



When a single occlusal rest seat is prepared next to an adjacent tooth the form is modified. The rest seat is not flared to the facial line angle. Instead, the lingual line angle is flared more dramatically to provide additional space for the minor connector.



When embrasure occlusal rest seats are prepared on adjacent teeth, the form is also modified. Additional tooth structure is removed in the marginal areas to provide at least 1.5 mm of room for the embrasure clasps. The rest seats are flared more dramatically to the facial and the lingual line angles to provide additional space for the retentive arms and minor connector. Inadequate clearance in these areas will result in occlusal interferences with the opposing teeth and/or inadequate thickness and strength of framework. Care must be taken to ensure all line angles are smoothed.



## 2. Lingual Rest Seats

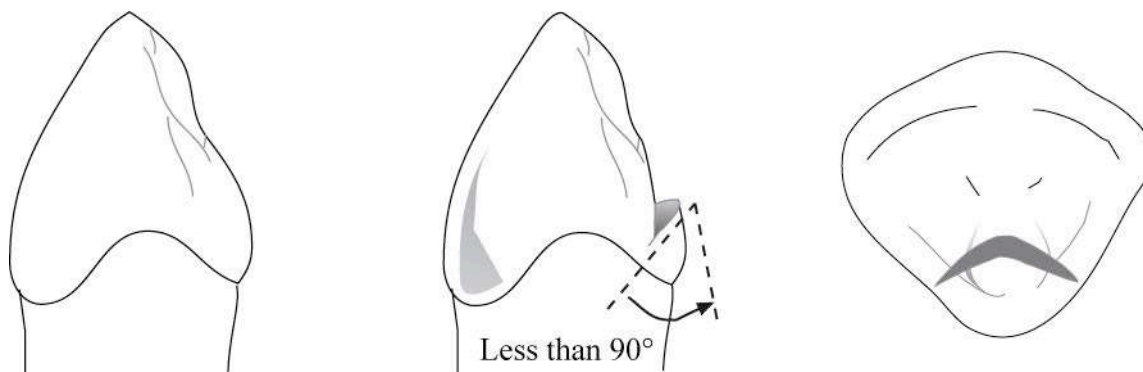
Lingual or cingulum rests on anterior teeth are often utilized when no posterior teeth are present or when indirect retention is necessary. The anterior tooth most readily adaptable to a cingulum rest is the canine, due to its well-developed cingulum. When a canine is not available, the cingulum of an incisor may be used. In some instances, multiple rests spread over the cingula of several teeth may be required, in order to minimize stress on the teeth. Root form, root length, inclination of the tooth, and the crown-root ratio must be considered in the planning for the use of such rests.

### Cingulum Rest Seat Form

- a. The rest seat, from the lingual aspect assumes the form of a broad inverted "V" maintaining the natural contour often seen in the canine cingulum. From the incisal view the rest seat is broadest at the central aspect of the canine (approximately 1 mm). The proximal view demonstrates the correct angulation of the floor of the rest seat ( $< 90^\circ$ ). The borders of the rest seat are slightly rounded to avoid sharp line angles in its preparation. As with occlusal rest seats, a preparation will test as 'positive' if an explorer tip does not slip off the rest seat when pulled lingually from the base of the rest seat.

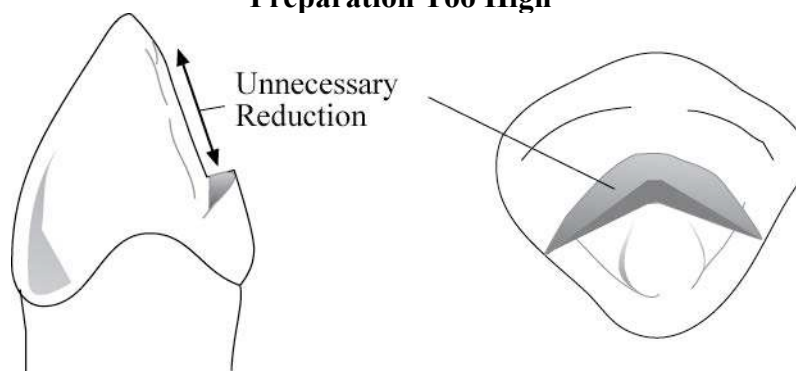


### Correct Preparation



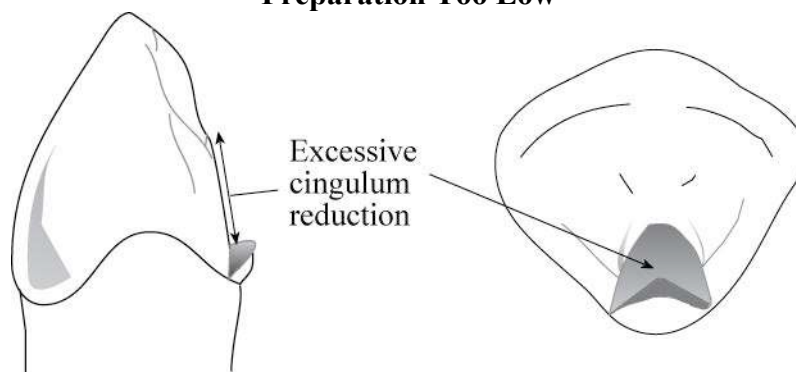
The cingulum rest seat should be prepared in the bulk of the cingulum to minimize tooth reduction. The cavosurface should be less than 90° to prevent orthodontic movements of the tooth.

### Preparation Too High



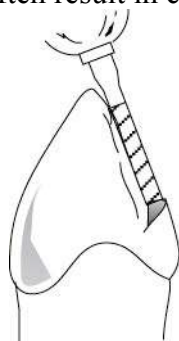
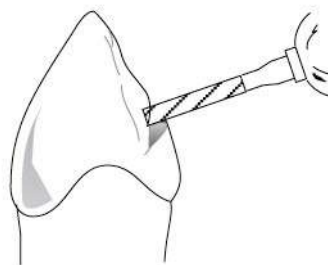
If the preparation is started too high above the cingulum proper, much of the lingual surface of the tooth above the cingulum will need to be reduced, in order to obtain sufficient width for support. On maxillary anteriors, this may also cause the rest to interfere with the opposing tooth.

### Preparation Too Low

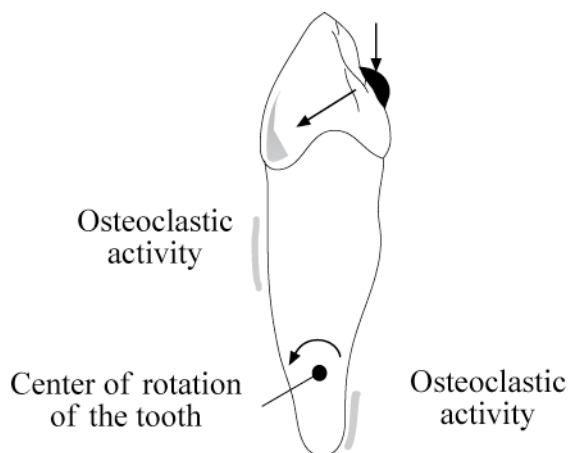


If the preparation is started too low, much of the cingulum will need to be reduced, in order to obtain sufficient width for support. Enamel is thinner in this area, and preparation could result in dentinal exposure, resulting in sensitivity. If correction of the outline form or depth is required, there will be little tooth structure remaining to make such changes.

- b. Care must be taken not to create an enamel undercut that would interfere with the placement of the denture. A medium or large diameter cylindrical fissure bur should be utilized approaching along the long axis of the tooth. Approach from a horizontal direction will often result in creation of an undercut incisal to the rest seat.

**Correct****Incorrect**

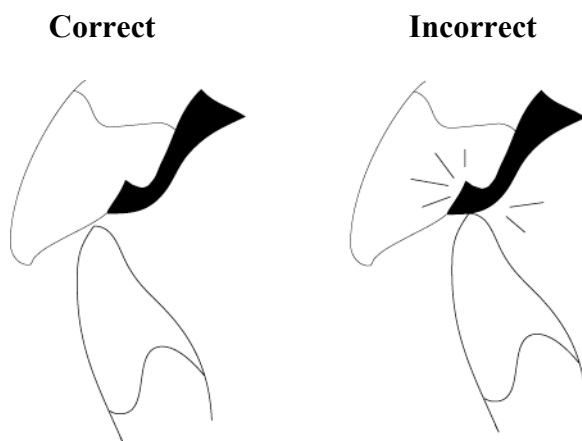
A rest placed on an unprepared cingulum results in force being applied in a labial direction. Orthodontic movement will occur with osteoclastic activity around the centre of rotation of the root. A rest seat prepared in the cingulum of the tooth results in the forces being directed along the long axis of the tooth.



The following factors should be considered prior to the preparation of a cingulum rest seat on a natural tooth:

1. The prominence and shape of the natural cingulum. Cingulum rest seats must be placed in sound tooth structure or restorations. Where the ideal position of the rest seat would be upon an amalgam restoration it is advisable to select a different tooth surface or replace the restoration with an onlay or crown, since the flow characteristics and relatively low yield strength of the material make the possibility of fracture high. Where the cingulum is not prominent or when preparation might encroach upon the pulp, other means of securing a lingual rest seat must be considered (i.e. selection of a different tooth, use of a composite bonded rest seat, onlay, crown etc.)

2. The interocclusal relationship of a maxillary tooth with the incisal edge of the opposing mandibular tooth when the former will be prepared for a cingulum rest. When a deep vertical overlap exists, care must be taken to ensure that the mandibular tooth does not prematurely contact the area of the planned metal framework. Mounted diagnostic casts should be used to assess this relationship, by drawing a line on the lingual surface of the maxillary abutment, where the mandibular tooth touches when the models are in contact with each other. The cingulum rest seat preparation should be 1.5-2.0 mm below this line to allow for adequate framework strength.

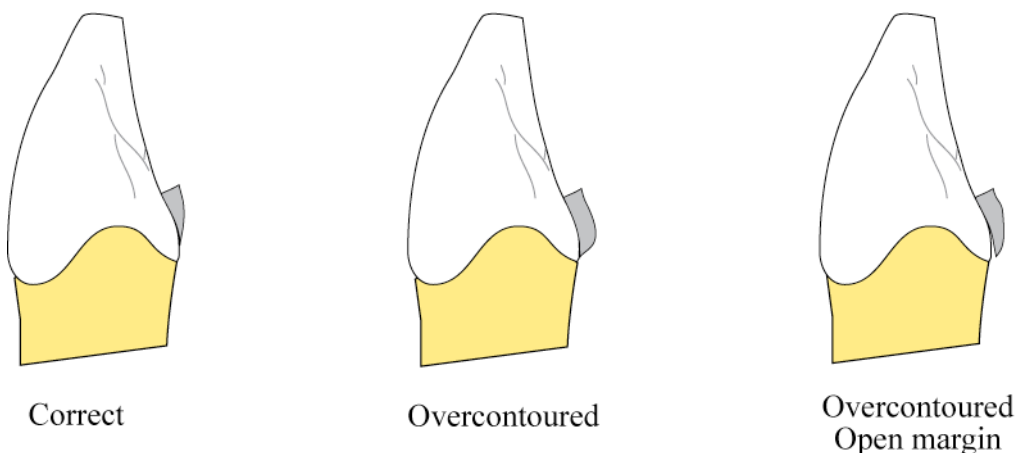


### **Composite Buildups for Cingulum Rests:**

When a cingulum is poorly developed, with insufficient bulk for preparation for a cingulum rest seat, a rest seat can be made using composite resin. Research has demonstrated that these "bonded rest seats" can provide acceptable strength and longevity.

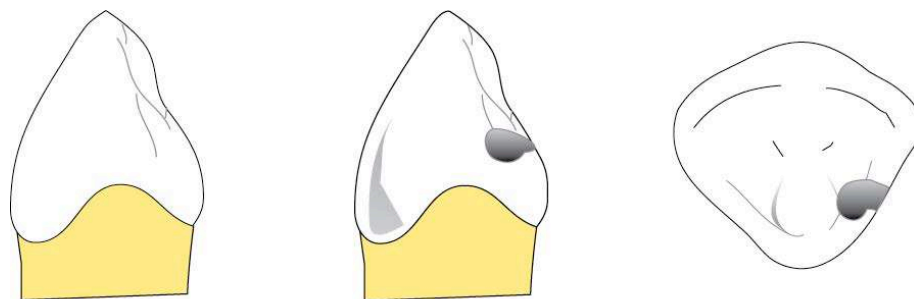
The cervical portion of the buildup should have a flat emergence profile (not over contoured) with bulk increasing toward the incisal. Enamel should be pumiced, rinsed, etched, bonded, in a relatively dry, isolated environment. Care must be taken to ensure the cervical composite is well adapted and that most of the form is finalized prior to curing. The bonded rest seat should be smooth and well polished, with no sharp line angles.

### **Composite Bonded Rest Seat Form**



### Round Lingual Rest Seat Form

Round rest seats are occasionally prepared on the mesial of the canine teeth when the use of a typical cingulum rest is contraindicated (i.e. large restoration, lack of clearance with the opposing teeth, poorly developed cingulum). These rest seats are prepared spoon shaped, similar to an occlusal rest seat, with reduction of the mesial marginal ridge. However, preparation is more difficult due to the incline of the lingual surface of the canine and more tooth structure must often be removed. Round lingual rest seats can be easily incorporated into crowns where there is usually sufficient linguo-proximal reduction, without the problem regarding exposure of dentin. Use care to **ensure that no undercuts are prepared** in relation to the path of insertion if a round bur is used.

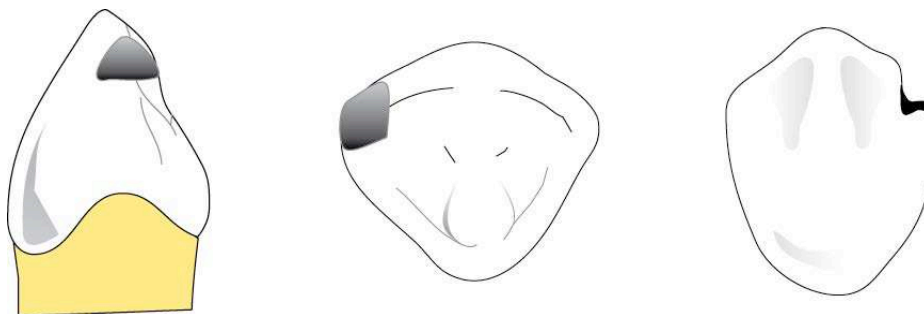


### 3. Incisal Rests

Incisal rests are inferior to lingual rests both mechanically and esthetically. Normally they should not be used unless it is impossible to place a lingual rest seat or a composite bonded rest seat.

- a. An incisal rest seat is usually placed on the mesio- or disto-incisal angle of the incisor teeth with the deepest portion towards the centre of the tooth. It is predominantly used as an auxiliary rest or an indirect retainer.
- b. It is usually used on the mandibular incisor where the lower lip can cover, as much as possible, the metal of the rest that shows at the incisal edge.

Mechanically, a lingual rest is preferable to an incisal rest, because the lingual rest is placed nearer to the center of rotation of the tooth and therefore, will have less tendency to tip the tooth.



## **Major Connectors**

### **Definition**

The unit of a removable partial denture that connects the various parts of the denture. Its principal functions are to provide unification and rigidity to the denture.

### **Functions of a Major Connector**

#### **1. Unification**

A major connector unites all other components of a partial denture so that the partial denture acts as one unit.

#### **2. Stress Distribution**

By unifying all elements of a partial denture the major connector can distribute functional loads to all abutment teeth, so that no one abutment is subjected to extreme loading. Unification of the direct retainers with the denture bases aids in distributing forces between both the teeth and the mucosa. This is particularly important in Class I and II partial dentures. In some maxillary cases a major connector with broad palatal contact is selected. In these situations the broad base offers additional support, distributing stress over a larger area.

#### **3. Cross-Arch Stabilization (Counterleverage)**

By uniting one side of the arch to the other bracing elements on one side of the arch can aid in providing stability to the other. This can aid in dissipating twisting and torquing forces.

### **Requirements of a Major Connector**

#### **1. Rigidity**

Rigidity is necessary to ensure that the partial denture functions as one unit. If the denture flexes, stress distribution and cross arch stabilization can be compromised since different portions of the denture can move independent of the others. A major connector can be made more rigid by:

- a. using a more rigid alloy (Chrome-cobalt > gold alloys; cast > wrought metal)
- b. using a 1/2 round or 1/2 pear shaped bars (more rigid than flat bars)
- c. increasing the bulk as the length increases
- d. corrugating lingual-plate or rugae areas.

#### **2. Non-Interference with the Soft Tissues**

Major connectors should not enter into undercut areas unless tissue impingement can be avoided by changing the selected path of insertion or by using minor undercut blockout. In addition, connectors should not end on the crest of rugae or at the free gingival margin. If terminated in these areas, it is possible that movement of the connector could cause tissue

impingement that could compromise blood flow. Major connectors should be placed **as far**

**from the free gingival margin as possible and practical.** Where it is necessary to cross the gingival margin (i.e. with a minor connector), it should be done abruptly and perpendicular to the margin. In addition, a small amount of relief is used over the area where crossing occurs, in order to minimize impingement.

Other areas of potential tissue impingement are the various hard structures such as the mid-palatal suture or mandibular tori. Where it is necessary to cross these areas, relief should be used so that the connector does not fulcrum on them during movement.

Soft tissue movements during function must also be allowed. Of particular importance are the mandibular lingual frenum and the maxillary movable soft palate. **Before a partial denture design is finalized, the clinician should make a careful examination of the mouth to ensure the selected major connector will not interfere with any of these anatomical structures.**

### 3. Food Impaction

This can be minimized by locating the margins of the connectors at the prescribed distance from the free gingival margin and by taking care that the presence of minor connectors, clasp arms and major connectors does not create "traps" or large concavities where food can collect.

### 4. Unobtrusive

The margins of the major connector should have a smooth transition from connector to tissue so as to minimize the obtrusiveness. All line angles and edges should be smooth and rounded. Borders should not be placed in locations where they might interfere with speech. Bulk should be reduced enough so as not to interfere with speech or appearance, yet thick enough to ensure rigidity.

## I. Mandibular Major Connectors

### A. Lingual Bar

This is the most commonly used mandibular major connector. It should be used whenever possible unless there are advantages that can be obtained from another connector. Such situations are rare.

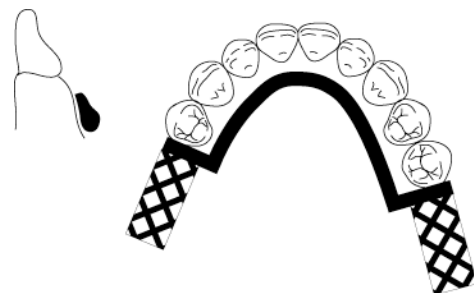
#### 1. Shape

- flat on tissue side
- convex or tear-drop on tongue side

(1/2 pear shape, with thin edge toward teeth)

#### 2. Size

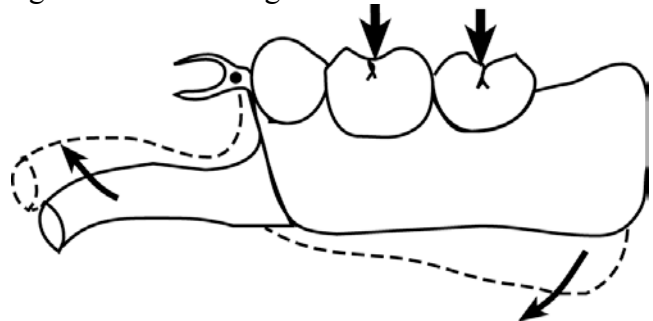
- occluso-gingival width = 4 to 6 mm.
- thickness = 1.5 to 2 mm.



### 3. Position

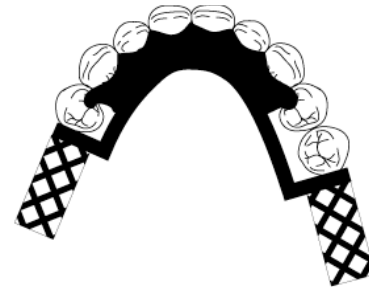
- The inferior border should be as low as the lingual frenum and tissue reflections of the floor of the mouth will permit, as **determined by observing functional movements of the tongue**.
- The superior border should be **1.5-2.0 mm or more below the free gingival margin**. For hygienic reasons the superior border should still be kept as far from the gingival margin as possible.
- In distal extension cases there will be some tissue-ward movement of the lingual bar as the denture base moves during function. If bone loss occurs over the edentulous ridges, this movement can become more pronounced and this will cause the lingual bar to impinge upon the lingual tissues. To eliminate the lingual bar from impinging the soft tissues, a wax spacer (relief) of one thickness of 30 gauge wax is placed under the major connector when it is being waxed for casting.

Note the anterior portion of the major connector moves forward as the posterior portion is loaded and rotates around the rest. If relief is not provided, impingement occurs.



### B. Lingual Plate (Linguoplate)

The lingual plate consists of a lingual bar plus an extension over the cingula of anterior teeth. This mandibular major connector should only be considered in those rare instances where a lingual bar cannot be used. Most often, this occurs when there is a high floor of the mouth, a prominent lingual frenum or lingual tori that would be impinged upon by a lingual bar, if it was made with adequate height and distance from the free gingival margin.



The lingual plate has also been advocated for extensive distal extension cases with severe vertical resorption of ridges (i.e. little resistance to horizontal rotational tendencies). In these cases the major connector could provide some additional stability. The lingual plate has been advocated for use to reduce heavy calculus formation or to stabilize mobile anterior teeth. However, the plate usually does not reduce mobility, other than stabilizing the teeth during function. Mobility *per se* is not a problem unless it is increasing (i.e. pathological process continuing). Since mobility is often related to periodontal bone loss and since the plate complicates hygiene by closing the lingual opening of the embrasure spaces, this connector actually may be contraindicated when mobile teeth are present. When large diastemas are present, the lingual plate may show through the embrasure spaces.

A vertical stop or rest area must be prepared at each end of the anterior segments of the lingual plate. This prevents excessive forces being directed facially by movements of the distal extension

base. Any areas where the connector crosses the gingival tissue must be relieved to prevent impingement caused by the movement of the lingual plate.

### C. Continuous Bar Retainer (Kennedy Bar, Double Lingual Bar)

The connector consists of a lingual bar plus a secondary bar resting above the cingula of the 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.**



### D. Labial Bar

Where extreme lingual inclination of the remaining teeth is present and no reasonable way exists to use a lingual bar without interfering with tongue movements, a labial bar may be used. It is essentially similar to the lingual bar and the same rules apply for its use. Indications for it are extremely rare. The swing-lock design is a variation of the labial bar.

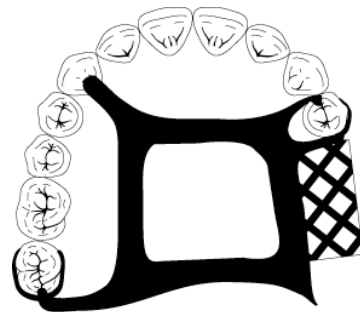


## II. Maxillary Major Connectors

Major connectors in the upper arch should terminate 4.0 mm or more from the gingival crest tissues.

### A. Anterior-Posterior Palatal Strap

The anterior-posterior palatal strap provides maximum rigidity and minimum bulk. The strength of this connector lies in the fact that the anterior and posterior sections are joined together by longitudinal connectors on either side. Each component braces the other against possible torque and flexure. It can be used in most maxillary partial denture designs and is **especially useful in cases with a torus palatinus.**

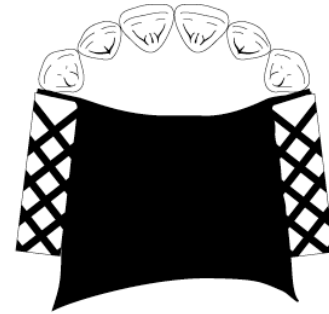


A variation of the double palatal strap is the anterior-posterior palatal **bar** connector where the palatal connector elements are narrower antero-posteriorly. Due to the narrowness of the elements, the bars must have greater bulk for rigidity, and thus the design is more objectionable to the patient. In addition, strap connectors provide greater distribution of stresses to the palatal tissues since a greater surface area is contacted.



## B. Full Palatal Plate

The full 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 full palatal connector should be fabricated of a uniformly thin metal plate with accurate anatomic reproduction of the rugae configuration (improves strength and rigidity). It should cover the same area as a complete denture posteriorly. The large surface area of contact with the mucosa improves the potential for retention.

Connectors of this type are generally of cast metal. However an acrylic resin plate may be used in interim prostheses.

## C. Palatal Strap (or Bar)

This type of connector can be wide (**strap**) or narrow (**bar**) depending upon its location or the need for strength or support of the denture. The palatal **bar** should only be used in tooth supported cases where no other connector can be used. It is usually objectionable due to its bulk. It should never be used in cases involving distal extensions or replacement of anterior teeth since it must be made to bulky for rigidity.



The palatal strap is similar, but with a broader area of contact, providing better stabilization and stress distributing properties with minimum bulk. Therefore it is preferable to the palatal bar for posterior tooth supported cases. However, other connectors should be chosen if there is a large torus or if many teeth are being replaced.

Relief may be required over bony midline areas in some instances to prevent fulcruming over the overlying soft tissue. In these cases one thickness of 28 gauge wax relief should be placed over the midline.

**D. Anterior Palatal Plate (U-Shaped Or "Horse-Shoe" Palatal Connector)**

From a biomechanical standpoint **the palatal horseshoe is a poor connector and should never be used unless absolutely necessary.** To be rigid, the horseshoe connector must have bulk in the rugae area where the tongue requires freedom. Without sufficient bulk the U-shaped design becomes flexible and allows movement posteriorly. In distal extension partial dentures where posterior tooth support is nonexistent, movement is particularly noticeable and is traumatic to the residual ridge causing continual irritation during function.



The anterior palatal plate should only be prescribed where the torus palatinus prohibits the use of other connectors.

## Minor Connectors

### Definition

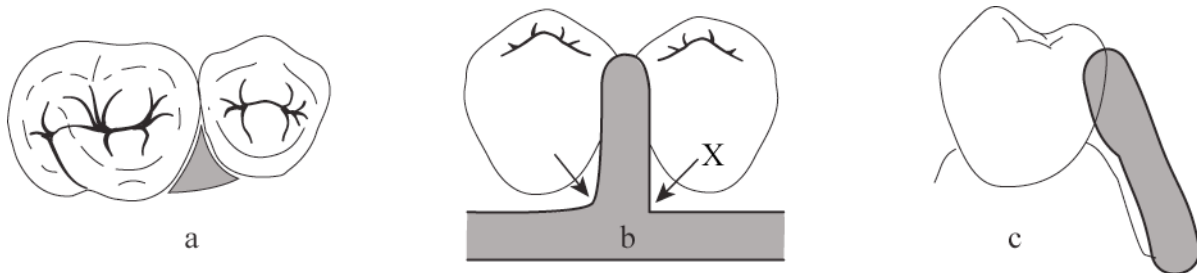
A unit of a partial denture which connects other components (e.g. direct retainer, indirect retainer, denture base, etc.) to the major connector.

### Functions

1. Provide unification and rigidity
2. Provide stress distribution by transferring stresses from the major connector to other parts of the partial denture and from the partial denture to the abutment teeth
3. Act as bracing elements through contact with guiding planes opposing the retentive arms.
4. Maintain a path of insertion via contact with guiding planes

### 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 (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 cast so that the minor connector does not lie directly on the soft tissue (c).



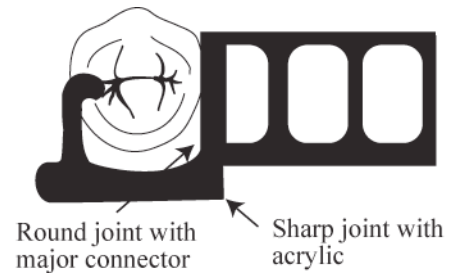
A minor connector should fill the embrasure space so that a smooth surface is presented to the tongue and so that areas where food can be trapped are minimized. Ideally, a minor connector should not contact the teeth gingival to the height of contour. If a minor connector fits tightly against an abutment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

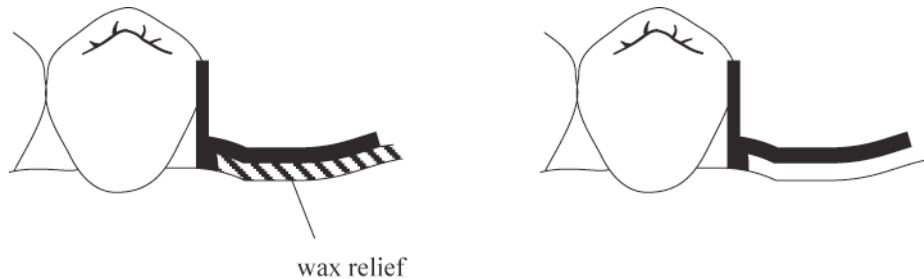
### Mesh Gridwork



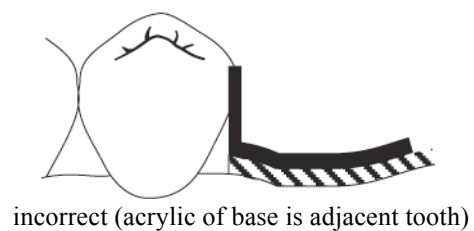
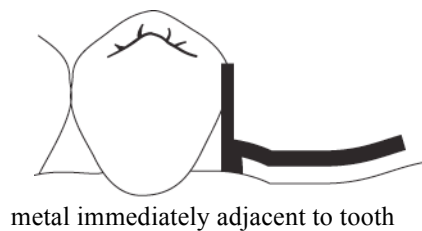
### Lattice Gridwork



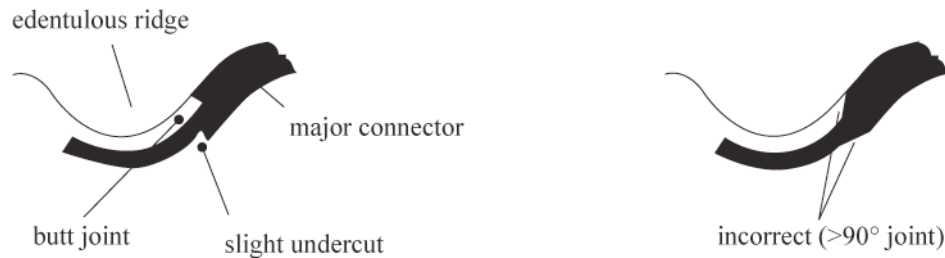
Adequate mechanical retention of the denture base resin is gained by providing relief under the minor connector gridwork to allow the acrylic resin to flow under the gridwork. To allow for this space, relief wax is placed on the cast in the edentulous areas prior to making a refractory cast (for fabricating 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.



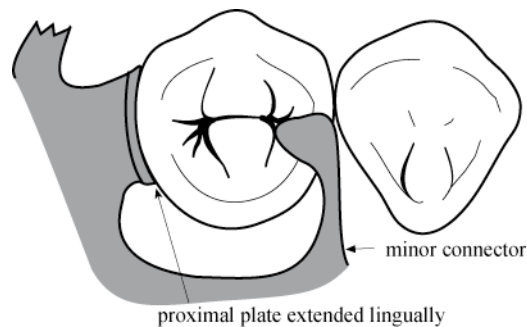
**Relief under the gridwork should not be started immediately adjacent to the abutment tooth but should begin 1.5 - 2 mm from the abutment tooth.** This will create a metal to tissue contact immediately adjacent to the tooth. A metal surface is preferable since it wears less, and is less porous, thus facilitating hygiene.



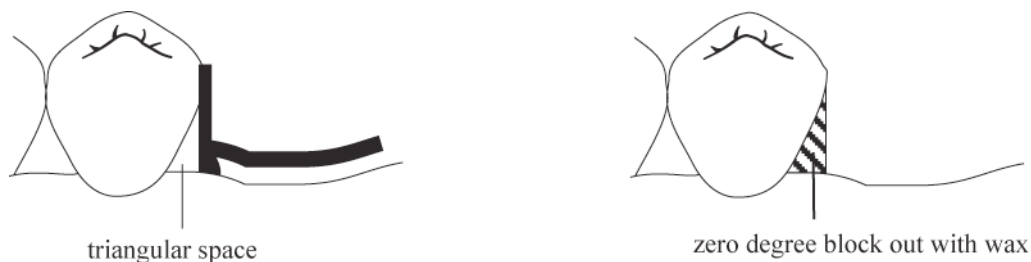
The junction of gridworks to the major connector should be in the form of a butt joint with a slight undercut in the metal. The angle formed by the metal at this juncture must not be greater than 90 degrees. This provides for maximum bulk of the acrylic resin denture base at the metal junction, to prevent the creation of thin, weak, feather edges which can easily fracture or distort.



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.

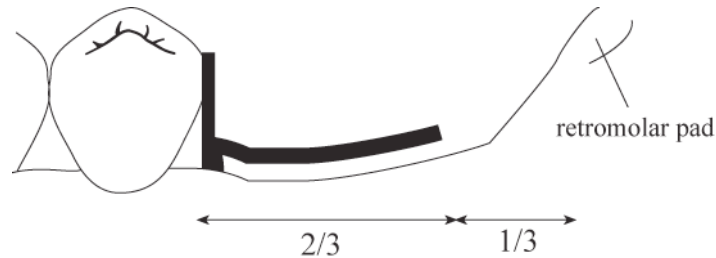


When the guiding plate type of minor connector makes contact with proximal guiding planes, there is often a triangular space below the guiding plane (an undercut). Because the minor connector must be rigid, it must not be allowed to contact the tooth in this undercut area. Therefore, the technician will artificially **block out** these undercuts prior to waxing and casting the framework to ensure the casting will not be placed below the height of contour. Blockout wax is placed in these area and trimmed parallel with the path of insertion using the wax trimmer in a surveyor, and the cast is duplicated in refractory material, before the framework design is placed on the cast. Because this blockout does not deviate in inclination from the selected path of insertion, it is referred to as a **zero degree blockout**. Instructions to the laboratory should note "Use zero degree blockout".

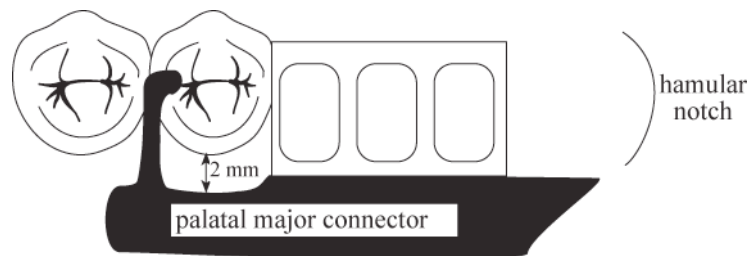


## Gridwork Design

The gridwork on a mandibular distal extension should extend about  $\frac{2}{3}$  of the way from abutment tooth to retromolar pad but not on the ascending portion of the ridge mesial to the pad.



Maxillary distal extension gridworks should extend at least  $\frac{2}{3}$  of the length of the ridge to the hamular notch. However, the junction or finishing line of the maxillary major connector should extend fully to point to the hamular notch area so that the acrylic resin base can be extended into this area and provide a smooth transition from the connector to the base. The junction of maxillary major connector with the gridwork should be approximately 2 mm medial to an imaginary line along the lingual surfaces of the replacement denture teeth. This ensures a bulk of acrylic surrounding the replacement denture teeth to provide adequate bond to the denture base.

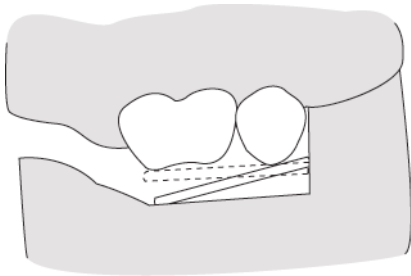
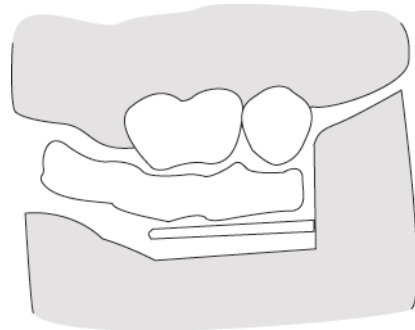


Mandibular distal extension gridworks should have a "tissue stop" at their posterior limit. This is an extension of the metal through the relief wax providing direct contact with the ridge.



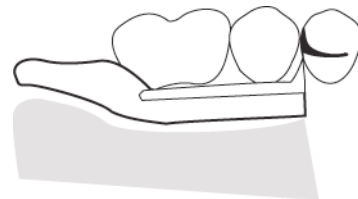
When the denture is flaked for processing, only the gridwork is left exposed after the wax removal. If there is no “tissue stop”, the framework can be bent or displaced during the pressure packing of the mold with stiff doughy acrylic resin. If this occurs, the framework could resume its normal shape after deflasking, and the denture would subsequently lift off the tissue. Rocking of the denture base and clasp apparatus would result, and the occlusion would be high. A tissue stop, in theory, prevents framework deformation and its consequences.

The denture teeth are embedded in investment in one half of the processing flask, the framework is embedded in the other, with acrylic resin in between (note the absence of a tissue stop).



Closure of the flask under hydraulic pressure can cause distortion of the framework, pushing it tissueward.

Placement of the finished denture in the mouth (note lack of tissue contact due to rebound of the distorted framework).



## Direct and Indirect Retainers

### I. Retention

Retention is the ability of a removable partial denture to resist dislodging forces during function. Retention depends upon several factors:

- a. adhesion, cohesion, interfacial surface tension and atmospheric pressure
- b. gravity
- c. frictional retention (guiding planes, bracing elements)
- e. indirect retention
- f. direction of dislodging force relative to the path of placement.
- g. mechanical retention

### Mechanical Retention

Mechanical retention is obtained by placing portions of the partial denture into tooth or soft tissue undercuts. Maximizing the other retentive factors can minimize the need for mechanical retention.

Most mechanical retention is derived from the use of direct retainers (clasp assemblies) utilizing tooth undercuts. There are two classes of mechanical retainers: intracoronal and extracoronal.

**Intracoronal retainers** (precision attachments) are mechanical devices set into the casting of a full crown. These are generally reserved for removable partial denture therapy that requires exceptional effort in producing ideal esthetics. There are many contraindications and disadvantages to precision attachments.

**Extracoronal retainers** engage an external surface of an abutment in a natural undercut or in a prepared depression. There are two main classes of clasps: 1) those that approach the undercut from above the height of contour (suprabulge retainers) and 2) those that approach the undercut from below (infrabulge retainers).

### II. Extra-Coronal Direct Retainers

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

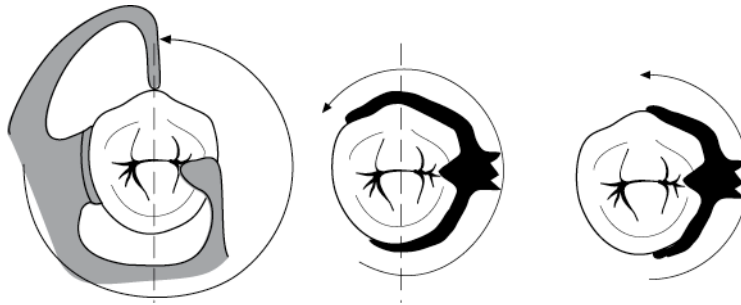
Retention is derived by placing a clasp arm into an undercut area so that it is forced to deform upon vertical dislodgment. Resistance of the clasp to deformation generates retention. Resistance is proportionate to the flexibility of the clasp arm. Non-flexible portions of clasp arms must be placed occlusal to the height of contour (**suprabulge area**).



## Requirements of Direct Retainers

All clasp assemblies should meet the following requirements:

1. **Support** - resistance to gingival displacement (occlusal rests)
2. **Reciprocity** - resistance to orthodontic movement of teeth using reciprocal arms or elements placed against guiding planes. During placement and removal of the partial denture the retentive arm flexes over the height of contour and generates energy. At this point the rigid reciprocal arm should contact the guiding plane and prevent orthodontic movement from taking place.
3. **Stability** - resistance to lateral movement (reciprocal arms, minor connectors)
4. **Retention** - retentive arms located in undercuts on the abutments
5. **Encirclement of greater than 180°** of the tooth - prevents the prosthesis from moving away from the tooth

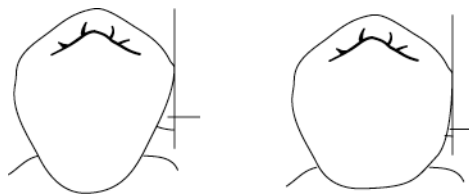


6. **Passivity** - at rest, a direct retainer should not exert force against a tooth

Wherever possible direct retainers should be selected to fit the existing teeth. This is preferable to preparing teeth to fit a particular clasp design. It may be possible to select a different clasp design to meet the retentive requirements for a partial denture. Nonetheless, judicious tooth preparation should not be avoided at all costs, since it can immeasurably improve prosthesis biomechanics.

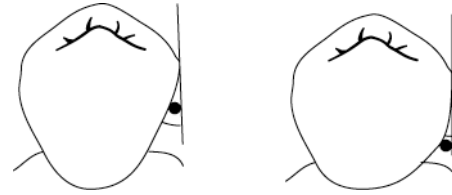
## Factors affecting the magnitude of retention

1. **Size of the angle of convergence.**



## 2. How far into the angle of convergence the clasp terminal is placed.

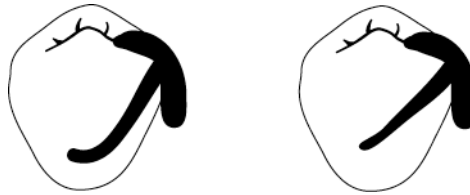
When the angle of convergence between two abutments differs uniformity of retention can be obtained by placing the clasp arms into the same degree of undercut (i.e. both .01"). A guiding principle of partial denture design is that retention should be uniform in magnitude and bilaterally opposed amongst abutments.



## 3. Flexibility of the clasp arm. This is influenced by the following factors:

### i. Length

- c. increased length increases flexibility (increasing clasp curvature increases length)
- d. length is measured from the point where the taper begins
- e. length may be increased by using curving rather than straight retentive arms



### ii. Diameter

- ☐ diameter is inversely proportional to flexibility
- ☐ in a uniform taper the average diameter lies midway
- ☐ if the taper is not uniform a point of flexure will exist at the narrowed area, weakening the clasp arm (possible fracture area)
- ☐ the point of flexure determines flexibility regardless of average diameter



A narrowing of the clasp arm creates a point of flexure which weakens, and affects the flexibility of the clasp, since flexure begins at this point

### iii. Cross-sectional form

- a. round forms are usually more flexible (wrought or cast)
- b. 1/2 round shape is limited to flexure in only two directions (cast)



### iv. Clasp material

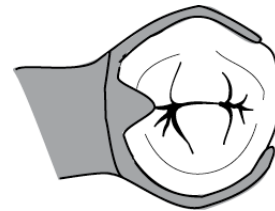
- a) with cast alloys flexibility is inversely proportional to bulk
- b) gold clasps are not as flexible or adjustable as wrought wire
- c) wrought wire clasps have greater tensile strength than cast clasps and hence can be used in smaller diameters to provide greater flexibility without fatigue or fracture

## Direct Retainers For Tooth-Borne RPD's

Clasps for tooth-borne partial dentures (Class III, 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 tissueward 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, II).

### 1. Circumferential (Circle or Akers) clasp

- a. the most simple and versatile clasp (clasp of choice in tooth-borne cases)
- b. clasp assembly has one retentive arm opposed by a reciprocal arm originating from the rest
- c. the retentive arm begins above the height of contour, and curves and tapers to its terminal tip, in the gingival 1/3 of the tooth, well away from the gingiva
- d. the bracing arm is in the middle 1/3 of the tooth, and is broader occluso-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.



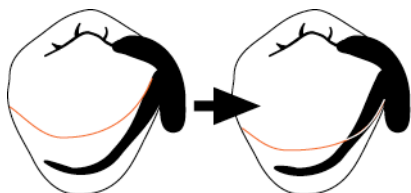
#### Advantages:

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

#### Disadvantages:

- a. More tooth coverage than bar clasps
- b. More metal is displayed than with bar or combination clasps
- c. Adjustments are difficult or impossible due to the half round nature of the clasp

A direct retainer should be designed with its elements in the proper positions and in the correct proportions. If the height of contour is incorrect for placement of the arms of the direct retainer, the heights of contour and NOT the direct retainer should be altered (i.e. perform abutment modifications – don't distort the design of the direct retainer)



Properly design retentive arm necessitates reduction of the height of contour during the preparation phase of treatment



This retentive arm design avoids the height of contour, but compromises esthetics and opposing occlusion (too high), as well as the flexibility of the arm ('S'-shaped)

## 2. Ring clasp

- Encircles nearly the entire abutment tooth
- Usually used with mesially and lingually tilted mandibular molars (with a m-l undercut) or mesially and buccally tilted maxillary molars (with a m-b undercut)
- The undercut is on the same side as the rest seat (i.e. adjacent to edentulous span)
- Should always be used with a supporting strut on the non-retentive side with an auxiliary occlusal rest on the opposite side. Omission of the supporting strut will allow the clasp arm to open and close with minimum or no reciprocation.
- Use a cast circumferential clasp with lingual retention and buccal bracing, in preference to a ring clasp whenever possible, unless a severe tilt of the tooth will not permit



### Advantages:

- Excellent bracing (with supporting strut)
- Allows use of an available undercut adjacent to edentulous area

### Disadvantages:

- Covers a large area of 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 1 mm from the free gingival margin and relieved to prevent impingement of the gingival tissues.

**Contraindications:** excessive tissue undercuts prevent the use of a supporting strut.

## 3. Embrasure (Double Akers) Clasp

- Used in a quadrant where no edentulous area exists, or where a distal approach clasp cannot be used on the most posterior tooth (i.e. No usable retentive undercut).
- Two rests, two retentive arms, and two bracing arms
- Double rests with definite shoulders to prevent weakening of clasp arms, separation of teeth and food impaction
- Buccal and lingual proximal areas must be opened (i.e. Blend with axial contours, reduce height of contours, round occluso-axial line angles)
- Use minimum retention – prone to distortion
- Use with discretion – use another clasp if possible



Buccal



Lingual

### Advantages:

- Allows placement of direct retainer where none could otherwise be placed (especially contralateral to the edentulous span on a Class II case)

### Disadvantages:

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

#### 4. "C" clasp (Hair-pin or Reverse action)

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



##### **Advantages:**

- a. Allows use of undercut adjacent to edentulous space

##### **Disadvantages:**

- a. Almost impossible to adjust
- b. Non-esthetic
- c. Difficult to fabricate so the upper portion of the retentive arm clears the opposing occlusion
- d. Covers extensive tooth surface and acts as a food trap
- e. Insufficient flexibility on short crowns due to insufficient clasp arm length

Cast suprabulge clasps should be used in most tooth borne cases. Exceptions to this rule include:

1. **Esthetic concerns.** Since wrought-wire clasps can be placed into greater undercuts (0.02") than cast clasps (0.01") they can be placed lower on teeth, allowing better esthetics in some cases. Infrabulge clasps are also less visible.
2. Where a **posterior abutment is mobile or of questionable prognosis**, the treatment plan could call for the use of the stress-breaking qualities of a wrought clasp on the anterior abutment. This would allow the prosthesis to be converted into a distal extension type if the weak posterior abutment should be lost.
3. Where **abutments are mobile**, the tooth borne segment is extensive, the use of the stress-breaking clasps should be considered.

##### **Disadvantages of cast suprabulge clasps:**

1. Create a "pump-handle" action on the abutment teeth in distal extension cases if the guiding plane on the distal surface is too long, with insufficient relief.
2. Some clasps can be ineffective on teeth tilted buccally or lingually
3. Some varieties cover more tooth surface than is desirable
4. Poor esthetics in the anterior region

There have been many modifications to cast suprabulge clasps. Some are too complex and impractical for common use.

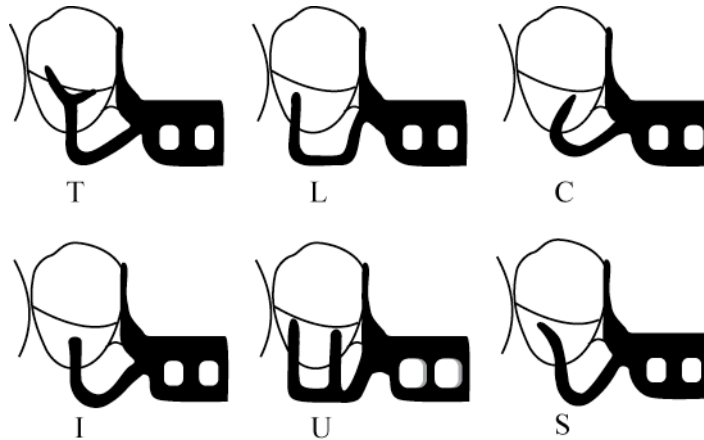
## Direct Retainers For Tooth and Tissue Borne RPD's

Tooth and tissue borne situations (Class I & II) require special attention in direct retainer selection, due to stresses created by rotational movements of the prostheses. When the denture bases are placed under function, rotation occurs about the rest seats of the most posterior abutments. Excessive occlusal forces on the distal-extension portion of the denture could cause a torquing action on the abutment teeth unless direct retainers are designed with stress-breaking capabilities. Stress releasing clasp assemblies include:

1. the bar clasp with mesial rest (e.g. RPI)
2. the RPA clasp
3. the combination clasp

### 1. Bar Clasps

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



- c. The shape is unimportant as long as the direct retainer is mechanically and functionally stable, covers minimal tooth structure with minimum display (the I bar most often meets these requirements)
- d. T-and Y-shaped terminal ends are the most misused clasps. The full area coverage of the T and Y terminal ends is rarely necessary for adequate retention.
- e. L-shaped clasp is same as an I clasp with a longer horizontal component. The U-shaped clasp is same as an L-shaped clasp with a terminal like a double I-clasp.
- f. The S-shaped terminal end is used to avoid a mesial soft tissue undercut.
- g. Soft tissue relief is provided under the approach arm with 28 or 30 gauge wax, to prevent tissue impingement

### Contraindications:

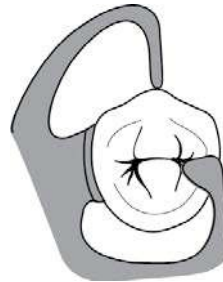
- a) deep cervical undercuts - food trap or impingements result
- b) severe soft tissue or bony undercuts - food trap or impingements result

- c) insufficient vestibular depth for approach arm (requires 4 mm - 3 mm from free gingival margin, 1 mm for thickness of the approach arm)
- d) pronounced frenal attachments in area - impingement

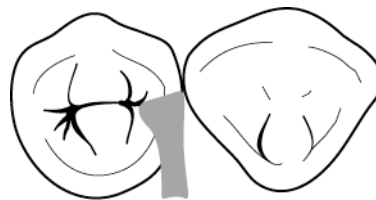
### The R-P-I Clasp

1. The components of this clasp assembly are:

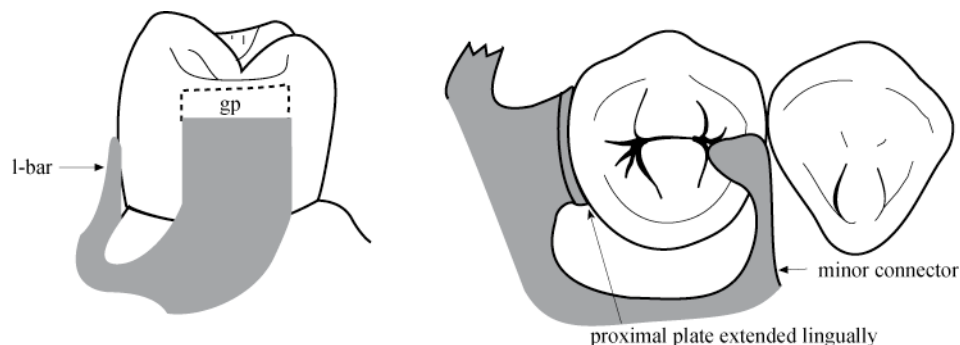
"R" - rest (always **mesial**)  
"P" - proximal plate  
"I" - I-bar (retentive arm)



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

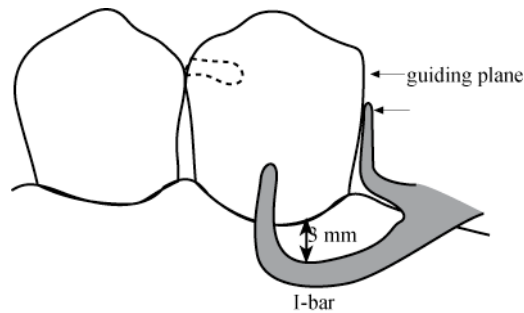


3. The proximal plate (essentially a wide minor connector) is located on a guide plane on the distal surface of the tooth. The superior edge of the proximal plate is located at the bottom of the guide plane (at approximately the junction of the occlusal and middle third of the guide plane). The proximal plate extends lingually so that the distance between the minor connector and the proximal plate is less than the mesio-distal width of the tooth. The plate is approximately 1 mm. thick and joins the framework at a right angle.

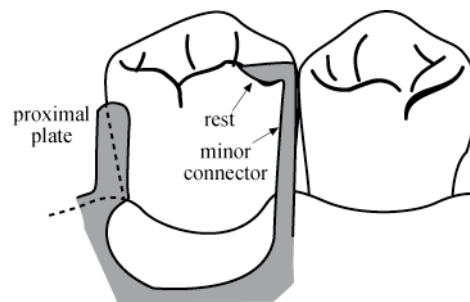


4. The I-bar clasp is located on the buccal surface of the premolar and on the mesio-buccal surface of the canine. The I-bar originates at the gridwork and approaches the tooth from the gingival direction. The bend in the I-bar should be located at least 3 mm. from the gingival margin. This distance will prevent food entrapment and provide the length for the

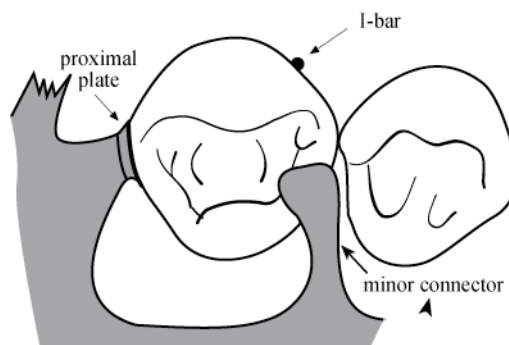
necessary flexibility in the clasp arm. The clasp is usually cast and is placed just below the height of contour line.



5. On **premolars**, the proximal plate should extend lingually **so that the distance between the proximal plate and the mesio-occlusal rest is less than the mesio-distal width of the tooth**. The proximal plate in conjunction with the mesial rest (and minor connector) acts as the reciprocating element of the clasp and prevents the lingual migration of the tooth when the clasp arm moves over the height of contour.



6. On **cuspids**, the minor connector cannot be used for reciprocation since it does not contact the tooth until after the retentive element has passed across the height of contour and the partial denture is seated. This is because the mesio-lingual rest is located fairly low on the cingulum of the tooth. Therefore, the **I-bar is located in the mesio-buccal undercut and is reciprocated directly by the proximal plate**.



7. The guiding plane is a parallel surface prepared on the occlusal one third of the distal surface of the tooth. The guiding plane extends lingually enough so that, along with the mesial rest, it can prevent lingual migration of the tooth. It is approximately 2 to 3 mm in height.

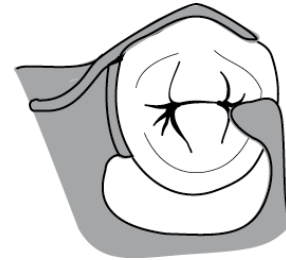


### Contraindications to the R.P.I. Clasp

1. Insufficient depth of the vestibule. (The inferior border of the I-bar must be located at least 4 mm. from the gingival margin.)
2. No labial or buccal undercut on the abutment
3. Severe soft tissue undercut
4. Disto-buccal undercut (less than 180° encirclement)

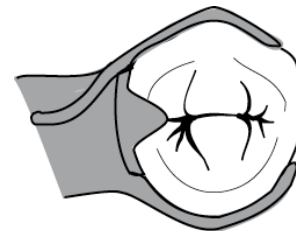
### 2. RPA Clasp

This clasp assembly is similar to the RPI design 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 mesio-buccal undercut. It is used when there is insufficient vestibule depth or when a severe tissue undercut exists.



### 3. Combination Clasp

The combination clasp is similar to the cast circumferential clasp with the exception that the retentive arm is fabricated from a round wrought wire (platinum-gold-palladium alloy or chrome-cobalt alloy).

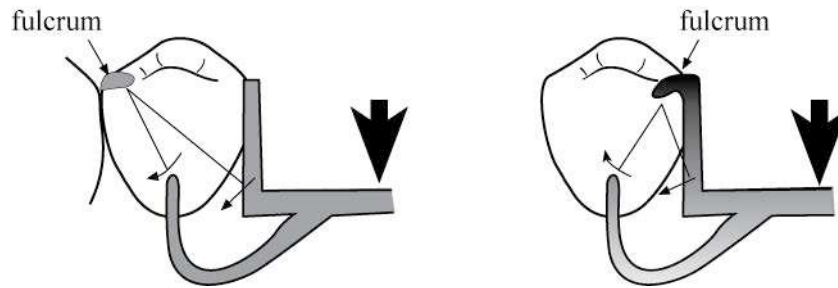


- a. a cast reciprocal arm.
- b. the wrought wire is flexible (round form)
- c. more adjustable than cast or 1/2 round forms
- d. better esthetics (due to its round form and smaller diameter - 18 gauge)
- e. can used with a mesial or buccal undercut
- f. can be placed in 0.02" undercut due to its flexibility (allows lower placement for better esthetics)
- g. can be used in tooth borne cases as described earlier
- h. for best results, the wire should be soldered remotely to the framework so it is not overheated, which would cause recrystallization of the metal and loss of flexibility. If wrought wire clasps are cast into the framework, a low heat chromium alloy should be used to avoid recrystallization as well

### The Distal Rest Concept

The proponents of the mesial rest concept (i.e. RPI, RPA designs) believe that the use of the clasp assembly with a disto-occlusal rest (in a distal extension case) could lead to distal tilting and possible loss of the abutment tooth. However, if correctly designed and executed, the distal rest concept is as viable a treatment alternative as the mesial rest concept.

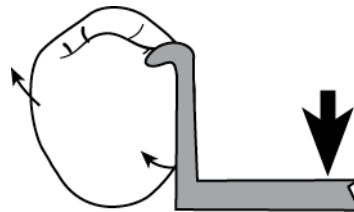
The premise of the mesial rest concept is that during vertical loading the distal extension base causes the I-bar to move mesio-gingivally away from the tooth and the proximal plate to move further into the undercut of the tooth.



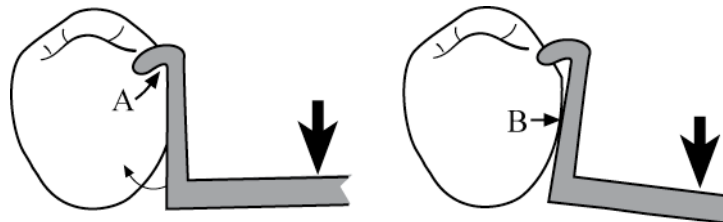
The I-bar and the proximal plate disengage the abutment tooth and thereby reduce torquing of the tooth. This is an accurate deduction. Therefore the RPI design be used wherever possible.

However, an I-bar cannot be used routinely due to the fact that a tissue undercut frequently exists in the region of the abutment.

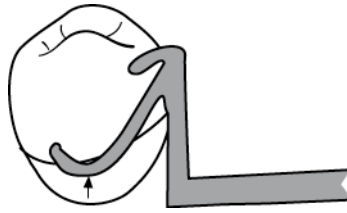
A distal rest concept has drawbacks if designed incorrectly. If the guiding plane on the distal surface of the abutment covers the entire length of the tooth, loading of the denture base will cause the minor connector contacting the guiding plane to act as a "wrench" and torque the tooth.



However, if a short guiding plane is prepared with a relief area between the converging surface of the tooth and the minor connector, the distal tilting of the abutment can be prevented or minimized. During distal loading, the minor connector could move into the relief area and the rest would be permitted to escape from the rest seat. This would change the fulcrum point from point A to point B, driving the abutment tooth mesially against adjacent tooth.



However, if the retentive arm is placed into a mesiobuccal undercut, torquing might still occur, since the retentive tip would tend to rotate in an occlusal direction, thereby engaging the tooth. To minimize the activating effect of the retentive arm, a wrought wire arm should be used (greater flexibility, less ability to torque). In addition and where possible, the retentive undercut should be placed in the mid-buccal of the tooth, with the mesial clasp tip placed above the height of contour. Thus occlusal movement of the clasp tip will disengage rather than engage the tooth. Similarly, lingual bracing arms should not be carried too far into embrasures in distal extension cases, since tissueward movement could also result in torquing forces being placed on the abutments.



If the distal rest retainers are correctly designed, they can be just as effective and safe as the mesial rest retainer.

## Direct Retainer Selection

Selection is based on:

1. Position of tooth undercuts, restorations, occlusion, classification of edentulous arch, tooth type
2. Nature of the bony and soft tissue support. Is there an unfavourable:
  - a) bony undercut
  - b) frenal attachment
  - c) vestibular depth
3. Esthetics

## Direct Retainer Choices

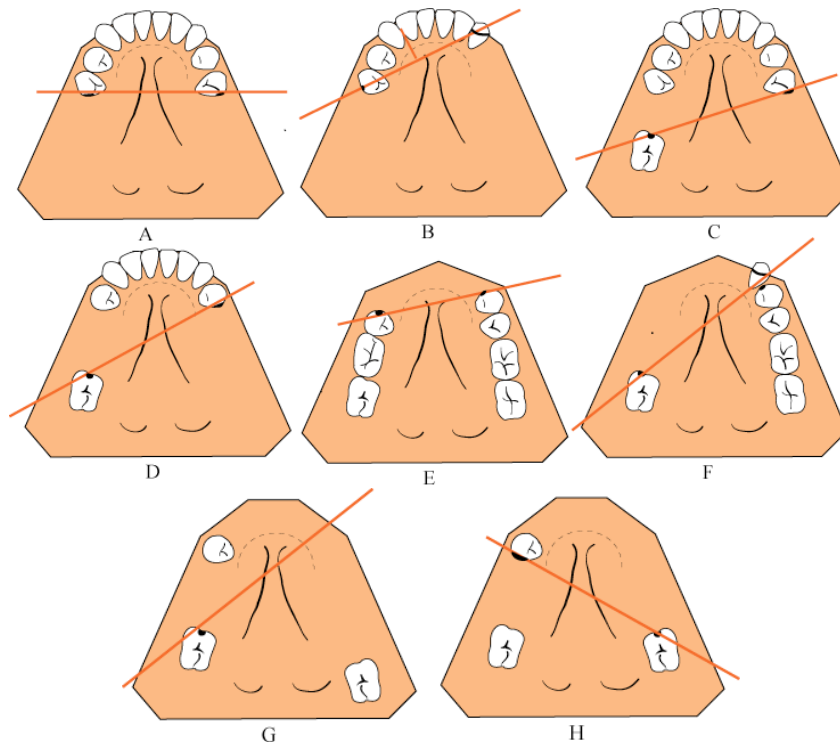
- **Kennedy Cl III & IV (Tooth Borne)**
  - 
  - Clasp of choice: **cast circumferential**
    - if can't use cast circumferential next to edentulous space, use **double embrasure clasp**
    - if abutment is severely tilted use (depending on location of undercut):
      - **Cast circumferential clasp with lingual retention**
      - **Ring clasp** with support strut
      - **Rotational path removable partial denture**
- **Kennedy Cl I & II (Tooth & Tissue Borne)**
- For posterior abutments, or any tooth needing stress release:
  - **Clasp of choice: RPI (mesial rest, distal proximal plate and I-bar)**
  - If can't use an I-bar in vestibule, because of
    - frenum
    - shallow vestibule
    - deep soft tissue undercutthen use an **RPA** retainer (mesial rest, distal proximal plate and wrought wire clasp)
  - If can't use a mesial rest because of:
    - rotation
    - heavy centric contact on mesial
  - large amalgam restoration on mesial
  - then use **Combination Clasp** (distal rest, buccal ww retention, lingual bracing)
- for abutments adjacent modification spaces (use tooth borne retainers)
- # of direct retainers –, minimum of 2 posterior abutments for Cl. I & II, all abutments for Cl III, IV to maximum of 4 normally
- if eliminate a direct retainer for esthetics, plan more retention with other features (soft tissue coverage, longer guiding planes, etc)

### III. Indirect Retainers

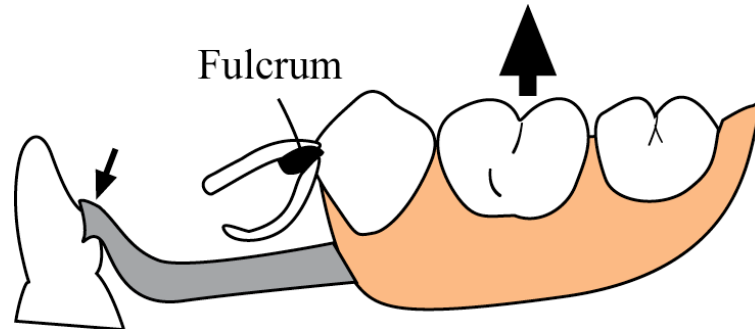
**Definition:** A part of a removable partial denture that prevents rotational displacement of the denture about the rests of the principal abutment teeth. Indirect retainers usually take the form of rests, on the opposite side of a fulcrum line.

Vertical movements of distal extension bases can occur in two directions. Movement of a distal extension base toward the ridge tissues will be proportionate to the displaceability of those tissues, the fit of the denture base and the load applied. Movement of a distal extension base away from the ridge tissues will occur via either displacement of the entire denture (resisted by the direct retainers), or a rotational movement about an axis. This axis passes through rests of the most posterior abutment teeth and is called the **fulcrum line**. Most tooth borne partial dentures do not exhibit rotational movements, due to their extensive tooth support. However, any Class III or Class IV partial denture that has mobile abutments may exhibit rotational movements.

The fulcrum line on a Class I partial denture as passes through the rest areas of the most posterior abutment on either side of the arch (A and B). On a Class II partial denture, the fulcrum line is always diagonal, passing through the occlusal rest area of the abutment on the distal extension side and occlusal rest area of the most distal abutment on the other side (C). If a modification area is present on that side, the additional abutment lying between the two principle abutments may be used for support of the indirect retainer if it is far enough removed from the fulcrum line (D). In a Class IV partial denture, the fulcrum line passes through the two abutments adjacent to the single edentulous space (E and F). In a tooth and tissue supported Class III partial denture, the fulcrum line is determined by considering the weaker abutment as nonexistent and that end of the base as being a distal extension (G and H).



Rotation of a partial denture about the fulcrum line is prevented by indirect retainers placed against definite rest seats on the opposite side of the fulcrum line from the distal extension base. Indirect retainers should be placed as far as possible from the distal extension base so as to gain the best possible leverage advantage against lifting of the distal extension base.



Although, the most effective location of an indirect retainer is frequently in the vicinity of an incisor tooth, these teeth may not be strong enough to support an indirect retainer. In addition, incisors often have steep lingual inclines that cannot be favourably altered to support a rest. In such cases, the nearest canine tooth or the mesial occlusal surface of the first premolar may be the best location, despite the fact that it is not as far removed from the fulcrum line.

The factors influencing the effectiveness of an indirect retainer include:

1. Proper seating of the denture. Unless the principle occlusal rests are held in their seats by the action of the direct retainers, rotation about the fulcrum line will not occur and, therefore, an indirect retainer cannot act to prevent lifting of the distal extension base away from the tissues.
2. Distance from the fulcrum line.
3. The rigidity of the connectors supporting the indirect retainer. All connectors must be rigid if the indirect retainer is to function as intended.
4. The effectiveness of the supporting tooth surface. The indirect retainer must be placed on a definite rest seat, on which slippage or tooth movement will not occur. Tooth inclines and weak teeth should never be used for the support of indirect retainers.

In addition to preventing movement of a distal extension base away from the tissues, an indirect retainer may serve the following auxiliary functions:

1. It tends to reduce torquing leverages on the principle abutments. This is important when an isolated tooth is being used as an abutment (a situation that should be avoided whenever possible). Ordinarily, proximal contact with the adjacent tooth prevents such tilting of an abutment as the base lifts away from the tissues.
2. Contact of the indirect retainer's minor connector with vertical tooth surface aids in stabilization against horizontal movement of the denture. Such tooth surfaces, when made parallel to the path of placement, may also act as auxiliary guiding planes.

3. Anterior teeth with indirect retainers are supported against lingual movement.
4. Indirect retainers act as an auxiliary rests to support a portion of the major connector. For example, a lingual bar may be supported against settling into the tissues by an indirect retainer acting as an auxiliary rest.

The indirect retainer may take any one of several forms. All are effective proportional to their support and the distance from the fulcrum line that they are placed.

1. **Auxiliary cingulum rests.** The cuspid is the most easily utilized anterior tooth for preparation of a rest seat since the cingulum is usually more prominent than the lateral or central incisors.
2. **Auxiliary occlusal rest.** Usually placed on the mesial occlusal of a first bicuspid tooth when there is inadequate cingulum tooth structure on the canines or there is poor access to the lingual surfaces of the anterior teeth.
3. **Continuous bar retainers and lingual plates.** Technically, continuous bar retainers and lingual plates are not indirect retainers since they rest on unprepared lingual inclines of anterior teeth. The indirect retainers are actually the terminal rests at either end in the form of auxiliary occlusal rests or canine rests.

## **Denture Bases and Replacement Denture Teeth**

### **Functions**

1. Support and retention of the denture teeth
2. Transmission of stresses to oral tissues - maximal coverage within anatomic limitations, accurate reproduction of supporting tissues
3. Improve esthetics

### **Materials**

#### ***1. Acrylic Resin Bases***

Acrylic resin bases are the most common types used in removable partial dentures. They should be routinely used in distal extension cases to allow for relining of the base to maintain mucosal support. Acrylic resin should make a butt joint (or slightly undercut joint) with the major and minor connectors. If the resin is brought to a feather edge, it will distort, break or separate from the framework, causing injury to the underlying soft tissues.

#### **Advantages:**

- a. ability to reline the base as the supporting tissues change
- b. esthetically superior to metal bases
- c. ease of repair

#### **Disadvantages:**

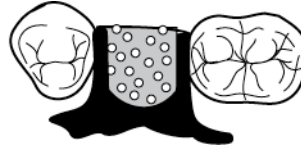
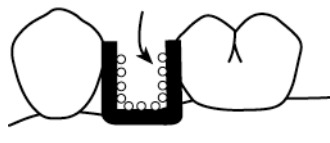
- a. dimensional stability less than metal bases - warpage
- b. lower strength than metal - long spans
- c. porous - hygiene
- d. low thermal conductivity

#### ***2. Metal Bases***

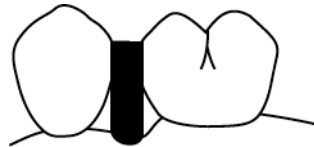
Metal bases can be used wherever acrylic resin bases are used. However, the esthetic result can be compromised unless the metal can be veneered with sufficient thickness of acrylic. If an insufficient veneer is used, a greyish hue of the underlying metal becomes visible. Where single tooth replacements are placed, there is often insufficient room to fabricate a retentive gridwork. A full metal base is often used in these instances. When this type of base is used, denture teeth are attached to the framework with acrylic resin via beading or retentive posts on the metal surface. In some rare instances, a tooth-bounded edentulous span may exist that is too small for placement of a denture tooth. When this type of edentulous space is encountered, it can be completely filled with the framework metal, if it will not compromise esthetics.

Metal bases cannot be relined, so they are generally not used for tooth-tissue borne removable partial dentures, or in areas where teeth have been removed within 12 months (resorption will still be occurring at an increased rate and relining will be usually be required).





Beaded metal base for single tooth replacement



Metal filled edentulous space

Retentive posts  
can be particularly useful  
in anterior regions

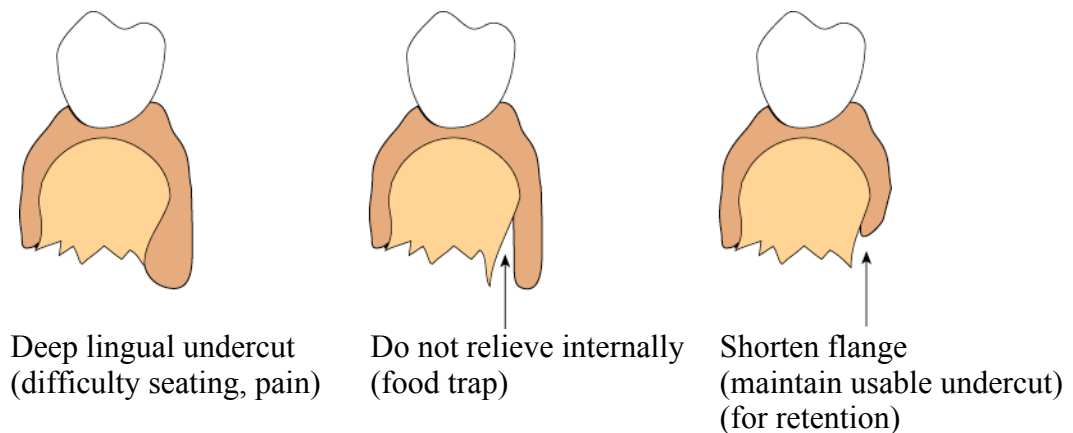
### Advantages:

1. **Thermal Conductivity** - Thermal conductivity is thought to maintain tissue health by ensuring patients do not swallow substances that are too hot. Some patients feel that improved thermal perception lessens the feeling of the denture as a foreign object.
2. **Accuracy and Permanence of Form** - Metal alloys cast accurately and maintain their accuracy. The accuracy in casting can eliminate the need for a posterior palatal seal. In contrast, acrylic resins distort due to release of internal strains after processing. This causes them to distort away from palate in the posterior region, thereby affecting retention. In addition, acrylic resins can imbibe or lose moisture depending on their storage conditions, leading to distortion and/or warpage if they are improperly stored. Abrasion from tooth brushing can adversely affect retention of acrylic resin bases in extreme cases.
3. **Hygiene** - Metal surfaces are less porous than resin surfaces. This lessens food, plaque and calculus accumulation, thereby maintaining healthy tissues.
4. **Weight and Bulk** - The metal bases can be cast thinner than resin bases while maintaining adequate strength. Thus, metal bases have minimal weight and bulk.

### Flange Extension

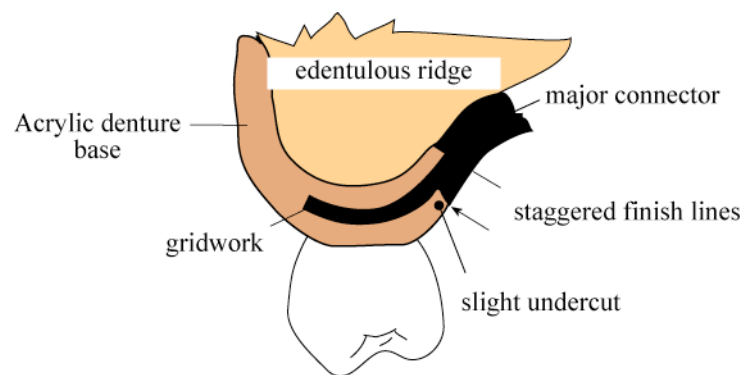
1. Denture bases for tooth-tissue supported partial dentures (Class I and II) should be extended to provide the greatest available surface area for support and retention, without overextension or impingement on movable border tissues.
2. Tooth supported partial dentures (Class III and IV) need not necessarily be extended maximally, since most of the support for these dentures comes from the teeth.
3. Maxillary distal extension denture bases should terminate in the hamular notches.

4. Mandibular distal extension denture bases should terminate on the pear-shaped retromolar pads.
5. Occasionally, the path of insertion can cause the denture flanges to impinge on the mucosa above undercut portions of the residual ridge, when the partial denture is being seated. In these instances, it is usually preferable to shorten the flange, rather than relieving the internal surface. If the internal surface is relieved significantly, a space will exist between the denture base and the tissues when the denture is fully seated. Food may become trapped in the space and work its way under the partial denture.



### Acrylic Resin Finish Lines

1. Denture bases should have internal and external finish lines which do not coincide (offsetting improves the strength at the metal/denture base junction). Internal finish lines should be placed furthest from the abutment teeth.
2. Finish lines should be slightly undercut to provide a margin with maximum bulk of resin strength and maximum retention of the resin.
3. The external metal finish line should be located approximately 2 mm lingual to the lingual surface of the replacement denture teeth.



### Partial Denture Replacement Teeth

#### Material

Acrylic denture teeth should be used in most instances since they will not wear the opposing dentition to the same degree as porcelain teeth. Porcelain denture teeth cause accelerated wear

of the natural dentition, particularly once the surface glaze has been broken. Acrylic teeth are easier to arrange, modify and adjust.

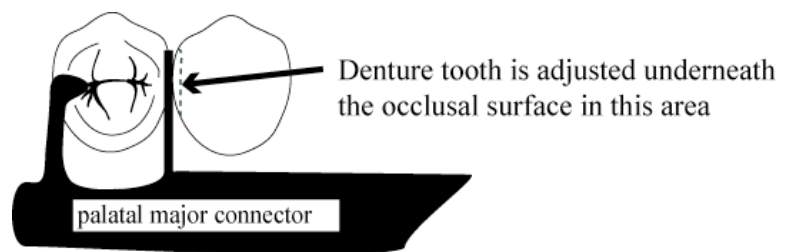
### ***Tooth Form***

The selected tooth form should be selected to harmonize with the opposing teeth. Where the replacement teeth oppose natural dentition with minimal wear, a 30° or 33° tooth form may be indicated. Where the opposing dentition exhibits advanced occlusal wear, a form with more shallow or no cuspal inclinations might be indicated. In almost all instances where the teeth will oppose a natural dentition, adjustment of the occlusal surfaces will be necessary to provide acceptable occlusal contacts.

Denture teeth should be selected to harmonize with the shade, shape, length and width of the remaining dentition. Appearance will be most compromised if there is a vast difference in tooth length between the replacement tooth and adjacent natural teeth.

In order to improve esthetics, teeth adjacent to the abutment teeth may have to be modified to ensure the proximal plates and other framework components do not interfere with proper positioning of the denture teeth. Replacement teeth may be modified so they can veneer over proximal plates and other framework elements to provide the best possible appearance.

The denture tooth is adjusted to provide room for the proximal plate, while allowing placement of the tooth close to the natural tooth for best appearance. Note on the facial surface that the denture tooth slightly overlaps the proximal plate to hide this portion of the framework.



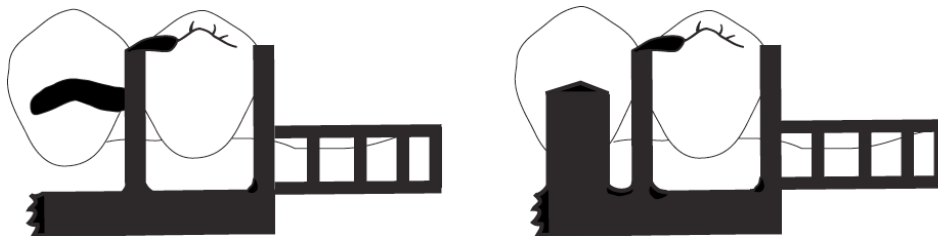
### ***Occlusal Scheme***

The occlusal scheme selected for a partial denture may vary from a fully balanced occlusal scheme when opposing a complete denture, to an anterior disclusion arrangement when a tooth borne partial opposes a natural dentition with all remaining natural anterior teeth. If the partial denture can be made with a scheme that does not require balance to ensure its stability, then a nonbalanced scheme should be chosen. As more of the occlusal table is involved in the prosthetic replacement teeth, the more a balanced occlusal scheme may be of benefit.

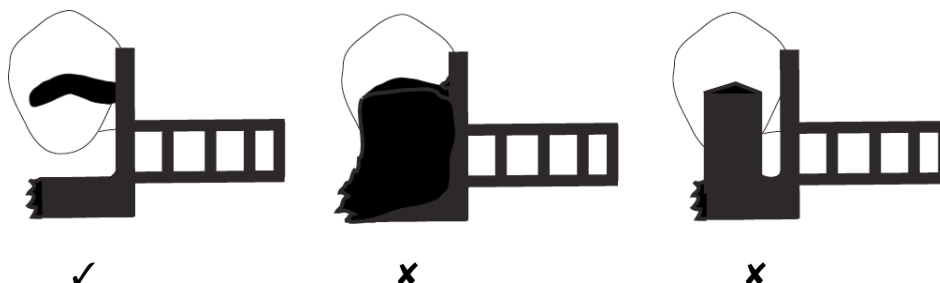
## Principles of Partial Denture Design

### General:

1. **Utilize what's present.** Whenever possible, select a design that fits the teeth and soft tissues, rather than choosing one that requires tissue alteration. When minimal tooth recontouring is required, surface roughness is minimized and teeth will be less susceptible to plaque adhesion and subsequent caries. Minimal preparation may also provide an economic advantage to the patient (e.g. if crowns are not required). The goal is to avoid gross, unnecessary preparation but not to avoid essential preparation. For instance, when recontouring of axial surfaces is required to lower heights of contour to place retentive arms lower for esthetics, it should be done. On the other hand, if a posterior tooth already has an occlusal rest seat prepared on it, placing a new rest seat in a different position due to design philosophies will adversely affect the integrity of the tooth.
2. **Plan for the future.** When abutments of questionable prognosis are present, a design should be chosen that would enable the partial denture to be adapted if such a tooth were lost. An example would be a tooth borne partial denture in which a posterior abutment was periodontally involved. In this instance, a stress-relieving clasp should be used on the anterior abutment so that torquing stresses would not compromise its periodontal support upon conversion to a distal extension partial denture. Planning for the future might also involve designing castings with rest seats and guiding planes so they may subsequently be used as partial denture abutments, if required.
3. **Minimize framework elements** whenever possible. The fewest number of minor connectors should be used. This decreases potential for plaque adhesion. In some distal extension cases, one minor connector may be used for adjacent direct and indirect retainers (e.g. mesial occlusal rest on a first premolar and a cingulum rest on the adjacent canine)



Cingulum rests can be designed to join proximal plates, rather than having separate minor connectors, whenever possible.

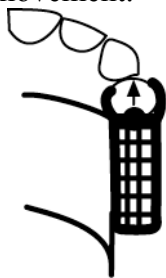


## Denture Bases

1. **Use broad tissue base support.** Maximizing the denture base coverage provides greater stress distribution and resistance to displacement by lateral forces. However, the denture base should not be overextended so that it is displaced during functional movements. If this occurs the overextension will cause greater rotational forces to be placed on the denture and the abutment teeth.
2. Distal extension bases should be **extended to the retromolar pads** and the **maxillary tuberosities** as these structures provide comfort and a peripheral seal for retention.

## Direct Retainers

1. **Minimize requirements for direct retention** by maximizing other retentive factors (e.g. broad and intimate denture base adaptation, use of guiding planes, indirect retainers, use of minor soft tissue undercuts).
2. **Design retentive clasps tips to be ideally placed in the gingival 1/3** and modify any heights of contour to eliminate interferences with rigid portions of the direct retainer. This minimizes the torque on teeth and optimizes esthetics.
3. **Consider caries susceptibility.** Cast clasps cover more tooth surface than wrought or cast round clasps. The latter two clasps would be preferred if caries incidence is higher than usual.
4. The **height of tooth** may affect the choice of retentive clasps, since it affects possible clasp length and hence flexibility. Less flexible clasp materials or designs can be used on large teeth since the increase in clasp length compensates by increasing clasp flexibility.
5. Consider the **tooth position in the arch.** Some clinicians feel that the canine teeth should be clasped with cast infrabulge retainers since these teeth are relatively unsupported against mesially directed forces. It is reasoned that wrought clasps are too flexible and will not resist such movement.



Mesial movement of the premolar is prevented by the canine anteriorly. The canine, when clasped, has no tooth immediately anterior to buttress against such movement.



6. If **no retentive undercut** can be found it is possible to **prepare a small retentive area** on the tooth. In order to recontour the tooth properly, the designated surface must be approximately parallel to path of insertion or too much tooth structure will have to be removed. The prepared area should follow the shape of the retentive arm tip and should be well away from free gingival margin (at least 1-1.5mm from the free gingival margin).

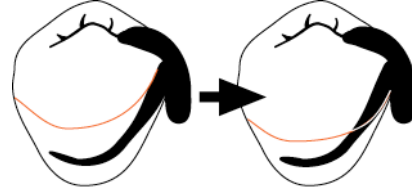


If the proposed retentive surface diverges greatly from the path of insertion and no other usable retentive area exists even crowning the tooth may not provide adequate retention. A diagnostic wax-up should be undertaken to see if adequate retention can be placed in the crown.

7. Circumferential retentive arms should be drawn in ideal position on diagnostic casts – the retentive tip no closer than 1-1.5 mm from the free gingival margin and the beginning rigid portion of the clasp low enough to prevent occlusal contact with the opposing tooth and low enough for acceptable esthetics.



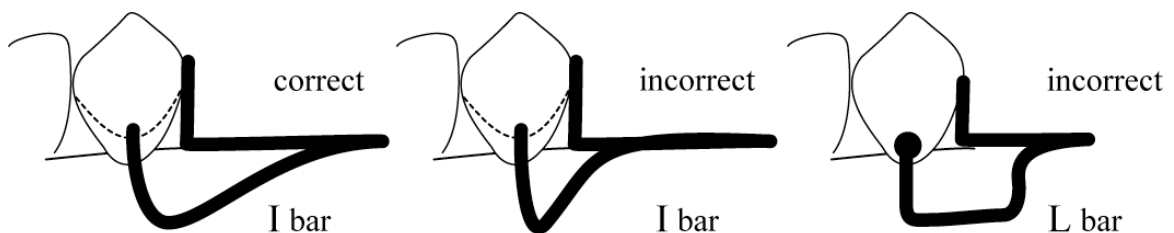
This retentive arm design avoids the height of contour, but compromises esthetics and opposing occlusion (too high), as well as the flexibility of the arm ('S'-shaped)



Properly design retentive arm necessitates reduction of the height of contour during the preparation phase of treatment

The retentive arm on the left has been designed to avoid height of contour at the beginning of the arm rather than being designed ideally, and appropriate height of contour changes being made subsequently

8. Bracing arms should be placed in the middle 1/3 of the tooth occlusogingivally. If the height of contour is above the inferior border of the arm, the height of contour should be lowered by preparing a guiding plane on the corresponding axial surface.
9. When there is marked **mobility** of one or more of the abutments, the use of **stress-releasing direct retainers** becomes more important. Stress relieving clasp assemblies allow release of the tooth and therefore, result in more of load being transferred to the denture base tissues.
10. I-bars should gently curve from the gridwork and originate from the gridwork approximately one tooth posterior to the replacement tooth adjacent to the abutment. Do not use L-bars (less flexible). Do not flatten retentive end of the I-bar, to increase surface contact since the hygienic properties of the clasp will be compromise. A properly designed I-bar should not require an increased contact area with the tooth.



11. Whenever possible, it is advisable to **avoid placing rest seats or guiding planes on direct restorations** such as amalgams. The relatively high creep values and low yield strengths of these materials results in frequent failure under partial denture frameworks. It is better to redesign the partial denture to avoid these restorations or to replace the restorations with onlays or crowns. While partial dentures can and are made upon direct restorative materials,

the financial savings to the patient in not replacing such restorations is often lost when the restoration fails and a casting or remake of the denture framework is subsequently required.

12. **Avoid placing rest in areas of heavy occlusal contact.** Therefore, it is imperative that the clinician check the occlusion intraorally. In addition, extrusion of opposing teeth must be noted to ensure that there is room for replacement denture teeth.

### **Number of Direct Retainers**

**Four:** Four direct retainers offer an excellent amount of retention and are most frequently used in often used in tooth borne cases (i.e. Cl. III, mod 1). More than four direct retainers are rarely necessary, except in maxillofacial prostheses. Normally a single clasp can be omitted, if other supplemental retention is substituted (long guiding planes, many modification spaces, short edentulous spaces)

**Three :** Less retentive than four direct retainers, most commonly used in Class II cases. Minimal number of clasps usually used in a Class III partial denture.

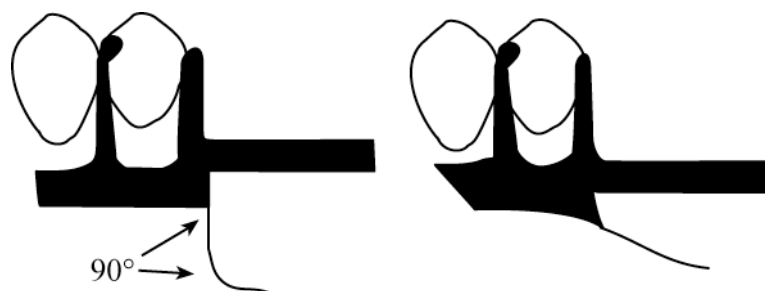
**Two:** Absolute minimum, usually only used in Class I partial dentures, unless a rotational path design is selected.

### **Indirect Retainers**

Class I and Class II partial dentures often require indirect retainers. These should be as far from the primary fulcrum line as possible ( $90^\circ$ ), and placed on the opposite side of the fulcrum line from the denture base. They are normally not required for tooth-borne RPD's.

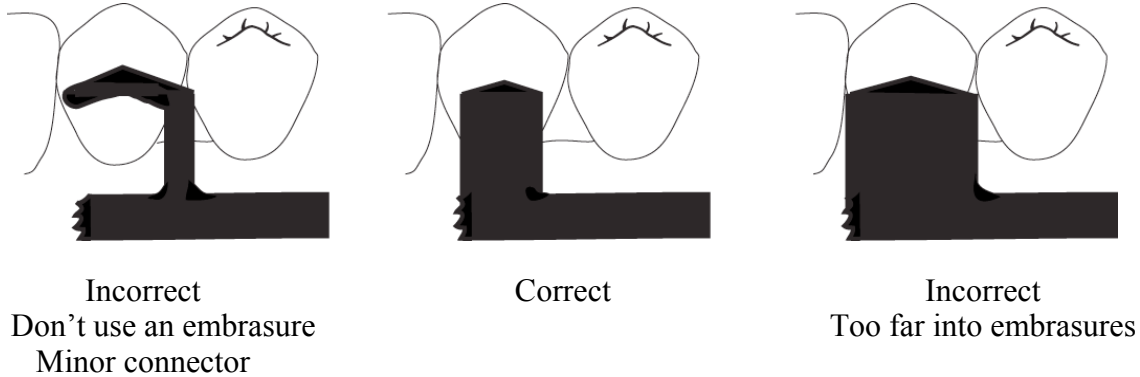
### **Major Connectors**

1. Assess tori, height of floor of mouth, frenal attachments. These will affect the type of major connector and direct retainers selected.
2. The posterior extensions of a maxillary distal extension framework should point to hamular notches.
3. Major connectors should have smooth continuous contours that flow into other elements of the partial denture. Abrupt changes of contour or bulky contours should be avoided, particularly at junctions with the acrylic denture bases.



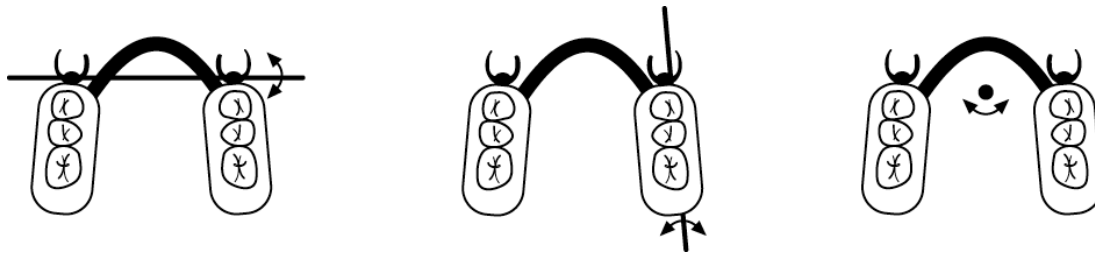
## Minor Connectors

Where a cingulum rest is not adjacent an embrasure minor connector to an occlusal rest, cross the free gingival margin directly – do not use an embrasure minor connector. Cover the entire rest seat preparation, but do not wrap these minor connectors into embrasures.



## Distal Extension Case Considerations:

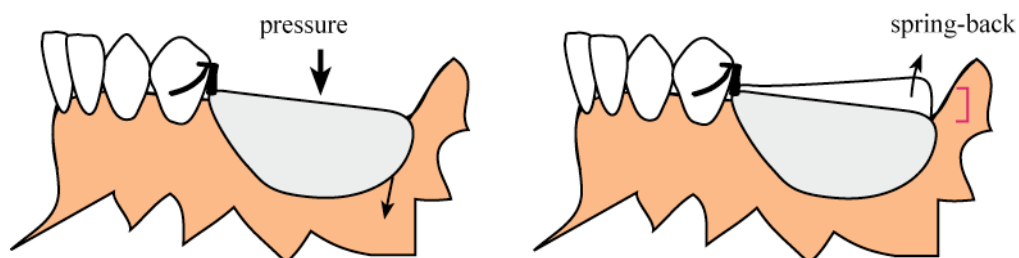
1. Use **stress releasing direct retainers in distal extension cases**. There are three axes of rotation for these partial dentures. If abutment teeth are locked into the frameworks they can be torqued in many directions. Stress-relieving clasps allow for some release of the teeth to minimize torquing potential.



Three Axes of Rotation of a Partial Denture

Rotational movements increase with length of span of the distal extension. Also as arm flexibility increases, resistance to lateral displaceability decreases. Therefore, it is important to use maximum coverage of the edentulous ridge to reduce the degree of lateral movement. This is particularly effective when there are large, broad ridges which tend to provide greater resistance to horizontal movements.

2. The character of the mucoperiosteum can affect rotational movements. Flabby tissue is more displaceable leading to increased rotation and therefore increased potential for stress transference to the abutment teeth.





## **General Considerations**

### ***Consider Soft Tissue Variables***

Soft tissue anatomy such as frenal attachments and vestibular depth can affect the choice of major connectors, and direct retainers. Characteristics of the soft tissues, such as undercuts and tissue compressibility of attached mucosa, may also affect design decisions. These aspects of the tissue need to be identified intraorally, since they can frequently not be determined solely on the basis of a diagnostic cast.

### ***Consider Hard Tissue Variables***

The opposing occlusion, significant abutment mobilities, the access to embrasures, presence of rotations, the positions of tooth undercuts and the presence of restorations can all influence the selection of direct retainers. The presence of tori can affect major connector selection.

### ***Design Sequence***

In general, after the path of insertion and the abutment teeth have been selected, the positions of the rests for the partial denture are chosen, since their placement will affect other parts of the design. The order of other design elements usually follows the sequence:

1. Rests
2. Major connector
3. Minor connectors
4. Direct retainers
5. Indirect retainers

## **Drawing the Design**

When drawing a design on a cast, sharpened, coloured pencils should be used. The following colours will be used to designate various components at Dalhousie University:

**Red:** Retentive undercut, Wrought wire arms

**Blue:** All other elements

Clinicians should use absolute accuracy in drawing their desired framework elements, in order to avoid guesswork on the part of the laboratory technician. In order for technicians to place elements in proper position, with proper proportions, the design should be drawn with single distinct lines.

## **Summary of Design Principles for Removable Partial Dentures**

### **General Principles**

- Minimize framework elements (minimize minor connectors, plating, etc.) – more hygienic
- Obtain good base adaptation - better stress distribution; use altered cast for mand. distal extensions
- Use what is present (e.g. existing rest seats)
- Plan for the future (e.g. designing for continued use of RPD framework if a critical abutment is lost; placing rest seats, guide planes and undercuts on crowns to allow fabrication of an RPD later)
- Never plan an RPD using a single cast alone. You can't assess abutment mobility, compressibility of mucosa, the level of the floor of the mouth, prominent frena, or occlusion. Use mounted models and assess these features intraorally as you plan and check your design.
- Occlusion – AVOID:
  - o centric contacts on rests (also ensure no increase in OVD)
  - o heavy buccal contacts on denture teeth– causes more movement of removable partial denture
- When other dental treatment is planned, and an RPD will be made at the end of treatment – ALWAYS PLAN THE RPD FIRST. You will see which abutment modifications will be needed, and will ensure the planned RPD is feasible, prior to beginning treatment

### **Rest Seats/ Rests**

Ensure sufficient depth, especially at junction of the rest & minor connector (1.5mm minimum)

**Tooth Borne (Kennedy Class I & II)** – place rests adjacent to edentulous space (both ends)

**Tissue/Tooth Borne (Kennedy Class I & II)**

- mesial rest preferred (less torquing of abutment)
- distal rest preferred when:
  - abutment is rotated (limited access for minor connector to mesial)
  - plunger cusp/heavy centric contact on mesial
  - large restoration on mesial
- no long guiding planes with distal rests - potential torquing
- if tooth is severely weakened periodontally – sometimes move rest to the next tooth anterior

### **Incisal rests/rest seats**

- don't use
  - poor esthetics
  - more tilting/torquing forces (long lever arm from center of rotation)

### **Cingulum rests/rest seats**

- use composite build up, if no prominent cingulum (less dentinal sensitivity)
- size - min 1 mm (if deeper, chance of dentin exposure)
- ensure sufficient clearance from opposing occlusion for maxillary cingulum rests

### **Occlusal rests/rest seats**

- size - 1/3 of B-L width of the tooth
- depth : 1.5 mm of clearance from opposing occlusion (critical at junction of rest & minor connector)
- line angle of the marginal ridge should be rounded
- deepest part should be located centrally (positive)

### **Indirect Retainers**

- 90° from fulcrum line & as far away from primary abutment as possible
- none required on tooth borne (CI III & IV) cases
- canine is usually the most anterior tooth used for indirect retention
- usually don't use a lateral (root length) or central incisor (speech)
- also helpful for seating and support, but not always possible or necessary

## Direct Retainers

- **Kennedy CI III & IV** (Tooth Borne)
- – Clasp of choice: **cast circumferential**
  - if can't use cast circumferential next to edentulous space, use **double embrasure clasp**
  - if abutment is severely tilted use (depending on location of undercut):
    - **Cast circumferential clasp with lingual retention**
    - **Ring clasp** with support strut
    - **Rotational path removable partial denture**
- **Kennedy CI I & II** (Tooth & Tissue Borne)
- For posterior abutments, or any tooth needing stress release:
  - Clasp of choice: **RPI** (mesial rest, distal proximal plate and I-bar)
  - If can't use an I-bar in vestibule, because of
    - frenum
    - shallow vestibule
    - deep soft tissue undercutthen use an **RPA** retainer (mesial rest, distal proximal plate and wrought wire clasp [Akers])
  - If can't use a mesial rest because of:
    - rotation
    - heavy centric contact on mesial
  - large amalgam restoration on mesial
  - then use **Combination Clasp** (distal rest, buccal ww retention, lingual bracing)
- for abutments adjacent modification spaces (use tooth borne retainers)
- # of direct retainers –, minimum of 2 posterior abutments for CI I & II, all abutments for CI III, IV to maximum of 4 normally
- if eliminate a direct retainer for esthetics, plan more retention with other features (soft tissue coverage, longer guiding planes, etc)

## Mandibular Major Connectors

**Lingual Bar** whenever possible (less tissue coverage - hygiene)

**Lingual Plate** if:

- high floor of mouth
- tori
- frenum
- terminate at FGM

Tissue relief – mandibular major connector (29-30 gauge relief) to avoid tissue impingement

## Maxillary Major Connectors

No tissue relief

Tooth borne (Class III & IV): **Palatal Strap**

Tooth & Tissue borne (Class I & II):

**A-P Strap** whenever possible

- better sensation, preferred (minor salivary glands & taste buds)

**Full Palatal Strap**

- periodontal involvement of abutments
- less than 6 teeth left
- displaceable mucosa (increased coverage)

**Anterior Strap** (Horseshoe) – only if inoperable torus is present

- NEVER for Class I or II

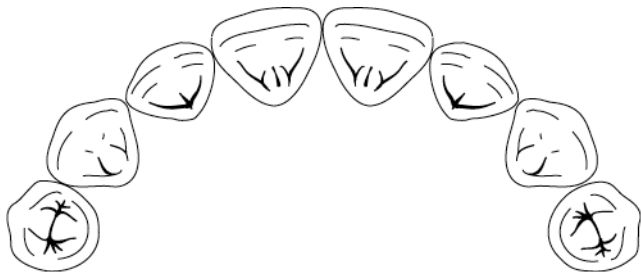
## Other Principles of Design:

Design drawings – absolute accuracy

- RED – wrought wire, undercut position, circled tripod marks; BLUE – everything else

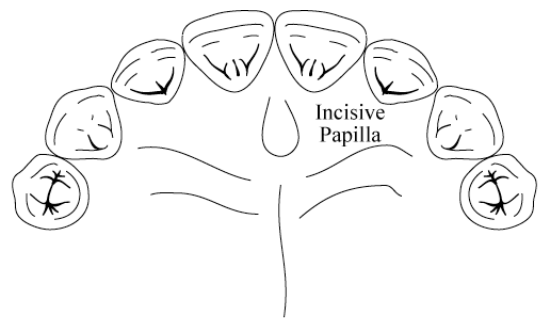
Design Session

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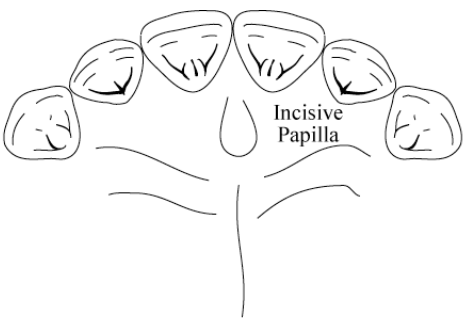


Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
Design Alternatives	

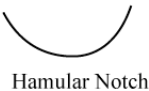
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Variation 'B'



Component of Choice

Rationale

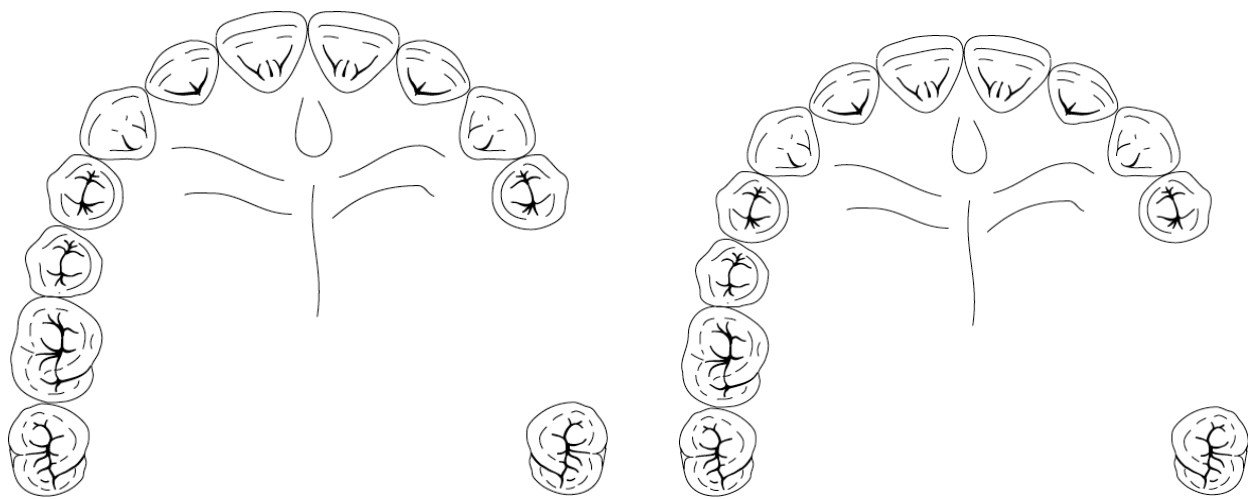
Major Connector:

Direct Retainers:

Variation 'B'

Design Alternatives

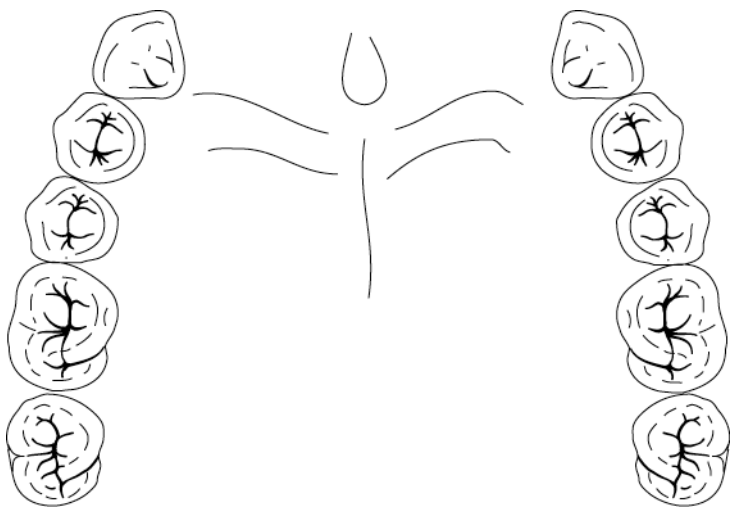
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Variation 'B'

Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
<i>Variation 'B'</i>	
Design Alternatives	

Classification\_\_\_\_\_



**Component of Choice**

**Rationale**

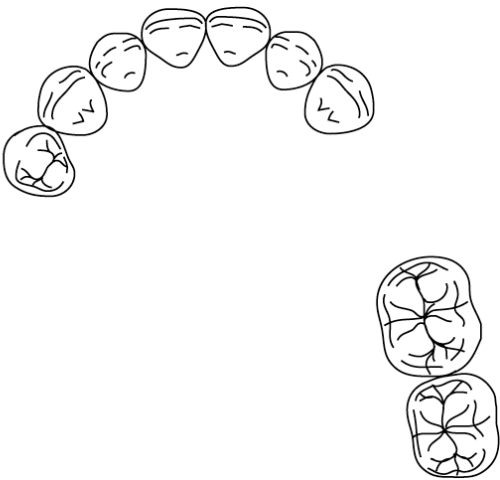
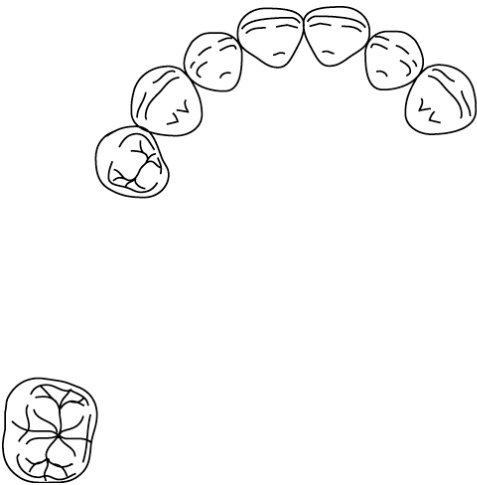
Major Connector:

Direct Retainers:

Design Alternatives

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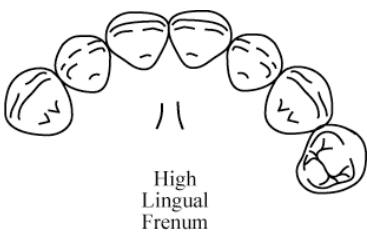
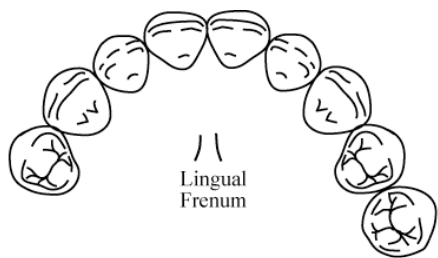
Variation 'B'

Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
Variation 'B'	
Design Alternatives	



Classification \_\_\_\_\_

Classification \_\_\_\_\_



Retromolar Pad

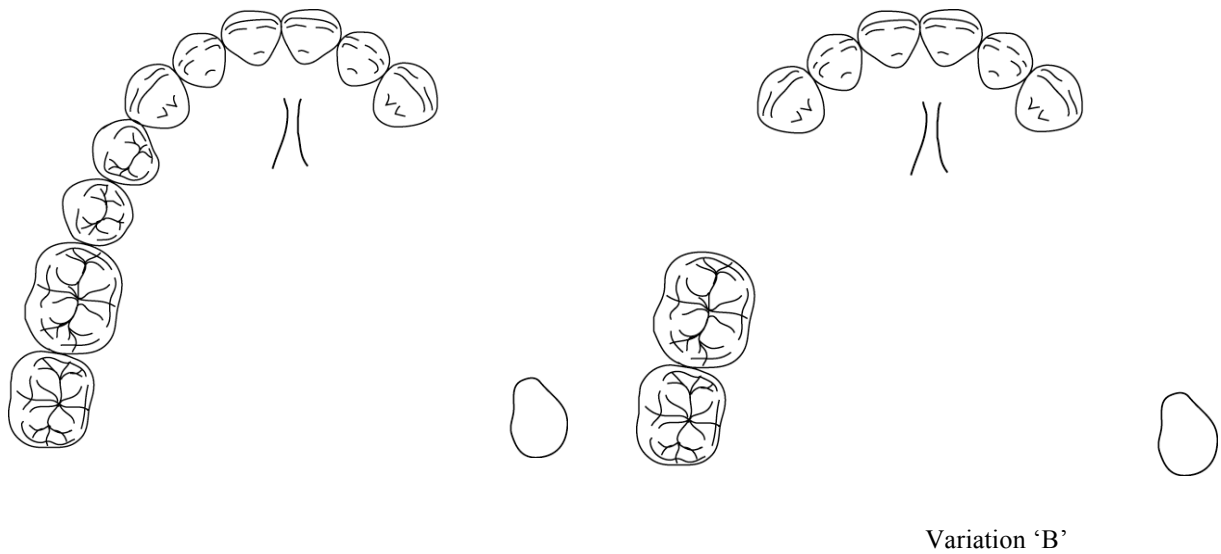


Retromolar Pad

Variation 'B'

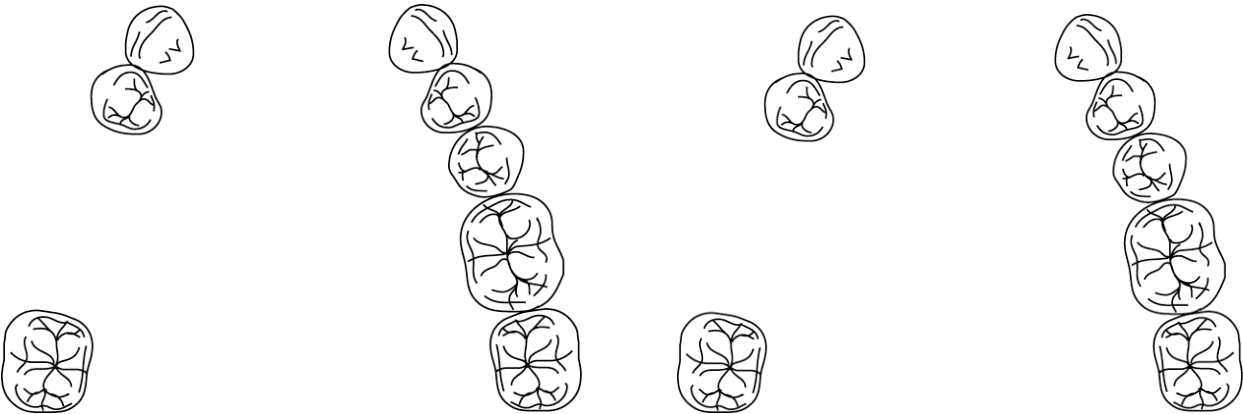
Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
Variation 'B'	
Design Alternatives	

Classification\_\_\_\_\_



Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
<i>Variation 'B'</i>	
Design Alternatives	

Classification\_\_\_\_\_



Variation ‘B’

Component of Choice	Rationale
Major Connector:	
Direct Retainers:	
<i>Variation ‘B’</i>	
Design Alternatives	

## **Clinical Protocol for Removable Partial Dentures**

### **Summary**

If an RPD is part of planned Treatment:

#### **PLAN THE RPD BEFORE BEGINNING ANY OTHER TREATMENT**

- Survey, tripod, heights of contour
- Draw design on surveyed cast
- **Design approved** before any treatment started:
  - Affects direct restorations
  - Can influence need for/preparations for crowns
  - Insures RPD can be completed successfully
  - NO EXCEPTIONS

#### **CLINICAL STEPS**

1. Diagnosis, Treatment Plan, Hygiene
2. Diagnostic Casts
3. Draw design & list abutment modifications on the Prosthesis Design page (see attached)
4. Instructor Approval
5. Complete Phase 1 treatment
6. Abutment modifications
7. Preliminary impression to check abutment modifications
8. Fabricate & cement crowns or fixed partial dentures
9. Final Framework Impression
10. Make two casts
11. Draw design on 2nd cast
12. Instructor approval/corrections of drawing/design on cast
13. Complete RPD Framework Prescription (instructor signature required)
14. Second poured cast with design sent to Lab with 1st pour
15. Inspect wax-up
16. Framework Adjustment
17. Altered Cast impression, if needed
18. Jaw relation records
19. Select & set denture teeth
20. Try-in with teeth in wax
21. Process, adjustment, deliver to patient

## **Diagnosis & Treatment Planning**

Gather all diagnostic information required for treatment planning complete or partial denture therapy (e.g. including tooth mobility, tissue displaceability, etc.). Preliminary impressions should be made and evaluated by an instructor. Diagnostic models should be poured and evaluated. When required (e.g. difficult occlusal pattern, deep overbite, extruded teeth, insufficient interarch space, etc.), diagnostic models should be mounted on a semiadjustable articulator.

**Independent of instructor input, formulate an appropriate treatment plan and enter your design in the patient's chart on the "Prosthesis Design" page** (see Appendix). Factors that may modify the prognosis or treatment of the case should be noted. **Treatment plans should be specific**, detailing the direct retainers and the degree of undercuts selected, the major connectors to be used, the position of rests, guiding planes, bracing and retentive arms and abutment modifications. Draw a tentative design on the diagnostic casts. Enter the provisional design and tooth modifications required in on the "Prosthesis Design page". Have the design approved by a faculty member. Upon approval of the provisional design, enter the final design on the "Prosthesis Design page" and draw the final design as planned on the diagnostic cast. **No removable partial denture preparations will be allowed to commence unless the final design has been entered and signed for approval in the chart and drawn on the diagnostic cast.**

Before discussing specific partial denture treatment plans with an instructor, discuss the proposed treatment with an instructor. Students will be expected to defend their treatment plan, based on theoretical considerations discussed pre-clinically. The student is not expected to be able to correctly treatment plan all cases upon initial exposure to the clinic. However, as the student progresses through the clinical experience they will be expected to improve in their diagnostic and treatment planning skills. The instructor may modify treatment plans after the case has been presented and discussed.

THEREFORE, IN ORDER TO PREVENT PATIENT CONFUSION, STUDENTS SHOULD  
NOT DISCUSS THE PROPOSED TREATMENT PLAN WITH THE PATIENT UNTIL IT  
HAS BEEN APPROVED BY AN INSTRUCTOR.

## **Final Impressions for Partial Dentures**

### **Framework Impressions**

All framework impressions should be made in a border molded custom tray. A custom tray is a tray made specifically for a cast made from a preliminary impression. It allows closer adaptation of the tray to the tissues so there is less soft tissue displacement. It reduces cost of the final impression by decreasing the amount of impression material needed and it results in greater accuracy of the impression because a more uniform thickness of material.

Border molding is the shaping of the border of a custom tray by manipulating the tissues adjacent to the borders to duplicate the contour and size of the vestibule. Custom trays for removable partial dentures are usually border molded in the edentulous areas and areas where framework elements will be close to vestibular tissues.

Custom trays should have two thicknesses of baseplate wax spacer over the remaining teeth and one thickness over edentulous ridges. Two thicknesses of baseplate wax over the edentulous portion of the tray provide additional space for increased flexibility to help prevent breakage of the teeth during separation of the impression from the model. The tray should be short of the vestibular depth in dentate areas remote from abutments or framework. Custom trays should be neat, rigid and properly extended.

When border molding is completed, the custom tray should be stable at rest and during slight manipulation of tissues and the flanges should extend to height of vestibule. No border molding is necessary on the buccal of uninvolved dentate areas.

Particular attention should be focused on the peripheral extension of the anterior lingual portion of mandibular trays. Overextension in this area will result in a cast with an inaccurate registration of the level of the floor of the mouth, which can affect the selection of the major connector. Similarly, attention should be focused on the extension of the tray in areas of frenal attachments or areas of minimal vestibular depth. Overextension in these areas can result in a master cast that appears to allow for the selection of infrabulge direct retainers even though soft tissue contours dictate otherwise.

The posterior extension for maxillary bilateral extension cases should be marked at or anterior to the vibrating line prior to the impression so that the line can be transferred to the impression and thus the master cast. Do not err in marking the posterior limit past the vibrating line, since the metal will have to be shortened. This is difficult due to hardness of the metal. If the metal is shortened the beading on the posterior border of the denture will be lost, possibly allowing for food to get under the denture.

All framework impressions will be made with polyvinyl siloxane material in custom trays. These materials have the following properties, which make them the impression material of choice for removable prosthodontics:

- a) low viscosities available (less tissue distortion)
- b) excellent dimensional stability
- c) good tear strength
- d) no taste

Polyvinyl siloxanes are sensitive to latex glove powder contamination, so try to minimize or avoid contact of the tray in areas where the impression material will contact. Contaminated impression material will tend not to set. Some glove/material combinations are worse than others. Early silicone impression materials were severely hydrophobic causing bubble formation during pouring, but most materials have improved significantly in this regard.

Prior to making a final impression of the mouth preparations, make an alginate impression and pour it in quick setting plaster, and survey the resulting cast to ensure optimum preparations have been achieved. A small amount of alginate should be wiped into the rest seats and over guiding plane surfaces prior to seating the filled impression tray. The student may repeat this process several times if required, but should discuss additional preparations with their instructor before proceeding further. **Final impressions cannot be made if there is any plaque or calculus on the teeth, since this will affect the fit of the framework.** Therefore it is essential to ensure proper oral hygiene and prophylaxis prior to the tooth preparation appointment. **Failure to do so**

**will result in an unacceptable master cast.** Additionally, soft tissues should be healthy with no evidence of inflammation or ulceration. All initial therapy should be completed.

Teeth and soft tissues should be dried for final impressions. Light-bodied impression material should be syringed around the abutment teeth ensuring proper coverage of guiding planes, rest seats and retentive areas. Trays should be loaded with light- or regular-bodied polysulfide material. Increased filler content of medium body material will cause less shrinkage of the material during

polymerization, and the use of these viscosities will cause less displacement of soft tissues than high viscosity materials.

The tray should not be over-filled since gross excess will distend the soft tissues, resulting in an inaccurate impression. Large embrasures or bridge pontics may be blocked out with orthodontic wax using care to avoid placement on occluding surfaces or near abutments. This will make removal of the impression easier, and minimize possible distortions of the impression. Practice inserting and removing the tray prior to making the impression.

### **Evaluating the Impression**

Final impression should meet the following criteria:

- ☐ No voids on any area where direct or indirect retainer will contact an abutment (rest seats)
- ☐ No large voids under major connectors, minor connectors, infrabulge arms
- ☐ No significant tears, material not separated from the tray
- ☐ Peripheries well defined
- ☐ Accurately records available supporting tissues
- ☐ Allows for all elements of design
- ☐ No significant areas of “burn through” – areas where the border molding is not covered and the tissues have been displaced

In the mandible, ensure the floor of the mouth and lingual frenum has been accurately recorded to allow for major connector placement. An easy means to ensure non-encroachment on these structures is to measure from the free gingival margin of 3-4 teeth to floor of mouth when the tongue has been activated. Record and transfer these measurements to the master cast – the inferior framework border should not be placed above this level

All critical anatomy should be recorded:

- Vestibular depths recorded accurately
- Hamular notches (marked)
- Vibrating line (marked)
- Retromolar pads
- Frenal attachments
- Floor of mouth (measured)

It is helpful to mark the vibrating line prior to making an impression because partially edentulous impressions cannot be resealed over the teeth to determine this critical landmark, after removal from the mouth, since the impression will not fully or properly seat over tooth undercuts.

To improve strength of the master cast, impression material in embrasures may be removed with scissors to provide extra bulk of stone, in areas not involved in the partial denture framework. This is particularly useful when teeth are widely spaced.

The final steps in making a master cast for the fabrication of a removable partial denture framework include:

1. Boxing and pouring the final impression to make a master cast (replica of a dental arch used to fabricate a restoration or prosthesis). Pour the cast with improved dental stone, Type IV (e.g. Silky Rock) that has been vacuum-mixed. Allow to set at least 1 hour – to achieve sufficient strength to resist fracture.
2. Separation of the master cast and pouring of a secondary cast.
3. Examination of the master cast to make sure it meets the following criteria:
  - ☐ No significant bubbles or flaws in stone
  - ☐ Teeth not fractured from cast
  - ☐ Includes all anatomical surfaces of final impressions
  - ☐ Includes 3-4 mm. land area
  - ☐ Base parallel ridge
  - ☐ 1/2 inches thick (minimum)
  - ☐ Evidence of a dense stone surface
  - ☐ Clean & well trimmed (keep wet while trimming)
4. Surveying and tripoding, drawing the design on the secondary cast
5. Instructor approval or correction of the drawing of the framework on the cast, and transfer of this approved version to the master cast (first pour)
6. Completion of the Work Authorization for framework fabrication and signing of the authorization by an instructor. Make sure half payment has been received from the patient prior to sending the prescription and the cast to the laboratory.



## **Removable Partial Denture Framework Fabrication**

After fabrication of the master cast, the laboratory will perform the following steps in the fabrication of the removable partial denture framework:

1. Place wax blockout in undercuts on the master cast:
  - below heights of contour
  - minor connector & lingual plate embrasures
  - soft tissue undercuts (if necessary)
2. Place relief on the master cast:
  - under gridwork
  - over free gingival margin
  - under mandibular major connector
3. Duplicate master cast in refractory material, which will withstand casting temperatures
4. Wax-up framework according to design on secondary cast using prefabricated patterns
5. Invest refractory cast, solder wrought wire clasps
6. Burnout wax, cast in a chrome cobalt or other alloy
7. Finish & polish, return to dentist

## **Partial Denture Framework Adjustment**

Even the best partial denture frameworks do not fit perfectly in the mouth. Stewart Rudd and Kuebker have stated that up to 75% of all frameworks may not fit the mouth on the day of insertion. Since clasp tips are designed to fit passively into a specified undercut, any discrepancy in seating of the partial denture framework will cause the direct retainers to become active, thereby causing orthodontic movement of the teeth. For this reason, frameworks must be adjusted intraorally. This is accomplished most easily when the denture base is not attached to the framework. Metal framework try-in should be accomplished as soon after the framework is returned from the laboratory to minimize changes that occur due to tooth migration.

### **Pre-clinical Inspection and Adjustment**

Ensure that the partial denture has been fabricated as designed. The dental laboratory should never change the framework design without consulting the dentist. Conversely, errors in framework design caused by inaccurate drawing on casts or omissions in laboratory prescriptions are the fault of the dentist. The framework should fit the master cast. If it does not, it will probably not fit intraorally. Replace the framework on master cast as little as possible to prevent abrasion (in case a remake is necessary). The framework should be assessed using the following criteria:

1. Rest seats should be fully seated (adequate support)

2. Reciprocal arms and proximal plates should be contacting the cast
3. Linguoplates and maxillary palatal major connectors should be in intimate contact with the cast (food impaction)
4. Major and minor connectors should be an adequate distance from abutment teeth (hygiene). Adjust, if possible, or have lab adjust or remake framework
5. Major and minor connectors should be of proper proportions (rigidity, hygiene). Note especially that cingulum rests should not be carried into embrasures and that embrasure minor connectors for distal extensions should not be in contact with the more anterior tooth (unless it has a rest seat preparation). Adjust, if possible, or have lab adjust or remake framework.
6. Butt joints should be adequate for acrylic resin (slightly undercut). Adjust, if possible, or have lab adjust or remake framework
7. Clasps should be of uniform taper
8. Proper gridwork should have adequate relief
9. Finish and polish of the framework should be adequate - no evidence of pits, nodules and scratches in the metal. Eliminate sharp edges that might impinge on the oral mucosa.

Check framework with an instructor prior to making adjustments. These adjustments should proceed the patient's clinical appointment for framework adjustment. Heatless stones, diamond burs, Brasseler E-Cutter burs, carborundum disks and coarse stones may be used to make adjustments to the major and minor connectors. Remove and replace the framework on the master casts as few times as possible. In this way, it will not be severely abraded should a remake of the framework be necessary.

### **Clinical Adjustment (Fit)**

Binding against one or more of the abutment teeth can cause inadequate seating of a framework. The area(s) of binding cannot be located without the use of an indicating medium. Several media can be used for this purpose:

1. **Spray type Powders (Occlude):** A small amount is sprayed in an even continuous layer over ALL tooth-contacting portions of the framework. The advantage of this medium is that it is thin and accurate and is not easily displaced from the framework. The material can get quite thick if over-sprayed. Teeth, tissues and the framework must be dry to prevent the pigment bleeding and making reading of the indicator difficult. A disadvantage of this technique is that it provides only two-dimensional assessment of fit.
2. **Disclosing wax (Kerr):** A small amount of wax is removed from the jar and placed on a mixing pad. A warmed instrument (#7 wax spatula, PKT waxing instrument, etc.) is used to pick up and melt a portion of the wax. The melted wax is applied in an even coat over ALL tooth-contacting portions of the framework. The wax is allowed to gel prior to placement in the mouth. The advantage of this medium is that it provides three-dimensional assessment of fit. Areas of burn-through indicate possible areas of binding, and the thickness of the remaining wax indicates how far the rest of the framework is from contact with the teeth. A disadvantage of wax is that it can stick to teeth or be wiped away easily if the framework is seated improperly.

3. **Silicone impression materials or indicating medium** (e.g. Fit Checker™):  
These materials can also be used as three-dimensional indicators. A disadvantage of elastic materials is that they can tear or pull off the framework. In addition, time is required for set of the materials. In this regard the silicone fit-checking media are more useful since they have shorter working times.

### Use of Indicating Media

1. Attempt to place framework intraorally. If gross resistance to placement is felt, remove and coat with indicating medium. If the framework seats, ask the patient if they feel the framework pulling on any teeth. The latter sensation will be caused by active engagement of abutment teeth. Inquire as to the overall comfort of the framework.
2. Remove the framework and coat it with indicating medium. Align the framework over the abutment teeth and use finger pressure **over rest seats** along the path of insertion. **DO NOT PLACE PRESSURE OVER GRIDWORK OF DISTAL EXTENSIONS** as this will fulcrum the framework. If gross resistance to seating is encountered, remove and inspect for areas of burn-through. Have an instructor inspect the framework. Relieve areas of binding as indicated. Repeat until seating is achieved. The master cast can be inspected for areas of abrasion that may indicate areas of gross binding as well.
3. Once the denture can be seated, coat with media and seat along the path of insertion again. Use firm even pressure over the rest seats and or indirect retainers. A mirror handle can be used for seating purposes. Use care in removing the framework, as removal along the wrong path of insertion will change the markings with displaceable media (wax & spray media).
4. Use caution in adjusting the framework. The clinician must differentiate between normal and abnormal contacts. Guiding planes normally will exhibit long vertical areas of contact, but broad areas of complete burn-through may indicate a binding contact on the guiding plane. Similarly, the retentive tip of direct retainers will normally exhibit burn-through, but active clasp retention must be eliminated after the framework is fully seated. **Therefore, the first step in adjustment is to ensure complete seating.** The most common areas that interfere with seating are:
  1. under rests
  2. rigid portions of direct retainers (e.g. above the survey line)
  3. interproximal portions of linguoplate major connectors
  4. interproximal minor connectors
  5. shoulder areas of embrasure clasps

Experience is required to differentiate between normal and excessive marking of the indicator medium. Therefore it is wise to consult with an instructor regarding proposed changes prior to adjustment. Adjustments can be made with small round diamond burs, white stones or rubber abrasive points, depending on the position and extent of binding. Do not use excessive force or the framework may

be bent. Heat generation is one of the reasons major adjustments are made prior to acrylic placement (i.e. the heat would melt the acrylic).

5. Completely remove any media contaminated with metal grindings and place fresh media. Repeat this procedure until full seating is achieved. At this point a thin, even film of media should be observed under rests and indirect retainers. The wax or silicon media will have a greyish hue from the underlying metal. The feel of the denture upon seating will change from a grating or snapping sensation to one of a gliding sensation. Normal adjustment of a framework should take no longer than 20 minutes.
6. Check for soft tissue impingements using pressure-indicating paste. Remove a small portion from the jar, and place it on a mixing pad. Use a stiff-bristled brush to spread a thin layer over the tissue surfaces of the major connector, and infrabulge clasps. Leave streaks in the paste. Place intraorally with moderate pressure and remove. Relieve any areas of marked burn-through. If streaks are left in the paste, this indicates no contact with the tissues. Adjust or leave accordingly. Maxillary palatal connectors should exhibit broad even contact with the palate.
7. If the framework cannot be adequately adjusted, it should be remade. In some cases this decision may be made at the pre-clinical inspection stage. Make this determination early, so that time will allow for a new impression to be made. Determine if the casting fits similarly on the cast and in the mouth. If it does not, the final impression was most likely inaccurate and should be remade. If the casting does fit similarly, the discrepancy may be due to laboratory errors. In many cases abrasion of the master cast will require re-making of the final impression as well. If the pre-clinical inspection leads the dentist to believe a remake is a possibility, a new custom tray should be made prior to the patient appointment in anticipation of the need for a new impression.

### **Occlusal Adjustments to the Framework**

Since most frameworks are fabricated on unmounted casts there are usually occlusal interferences present on rests and indirect retainers. These should be adjusted at this time. Vertical dimension should remain unchanged by a removable partial denture in almost all instances. The framework should not interfere with normal centric and eccentric contacts of the maxillary and mandibular teeth. Contacts should be identical with and without the framework in the mouth.

Mark occlusal contacts with thin articulating paper and remove the framework for adjustment. The highly polished metal surfaces do not mark well with articulating paper so that the opposing occlusion should be checked for heavy contacts. Diamond burs, heatless stones, Shofu coral stones or cross cut Brasseler lab burs will most readily remove interferences. **DO NOT FORGET TO LOCATE AND ADJUST EXCURSIVE INTERFERENCES.**

When maxillary and mandibular frameworks are being adjusted, they should be adjusted individually, then placed in the mouth together to eliminate interferences between the frameworks. Occlusal rests or indirect retainers that have inadequate thickness ( $< 1.5$  mm)

after adjustment will be subject to fatigue and possible fracture. The latter situation may occur due to inadequate preparation (i.e. not considering opposing occlusion) or subsequent extrusion of teeth. If the teeth have extruded, the entire framework will most likely not fit. If occlusal interferences exist that will excessively thin the rests, the rest seat preparation may have to be deepened and a new impression taken, or an opposing cusp or framework element may have to be reduced. Reduction of opposing cusps should be performed as a last resort to save an otherwise acceptable framework.

Occlusal interferences should not normally occur on retentive clasp arms if proper treatment planning has been followed. However, if the opposing occlusion is not considered at the time of mouth preparations, it is possible that occlusal contact may occur on a retentive arm. If this contact is minor, the opposing cusp may be reduced. Again, reduction of opposing cusps should be performed as a last resort to save an otherwise acceptable framework. If the interference is gross, the tooth surface should be recontoured (i.e. lower height of contour) and a new impression taken. **IN NO INSTANCE SHOULD A RETENTIVE ARM BE RELIEVED**, since this will affect its flexibility and resistance to fracture.

### **Special Adjustments for Distal Extension Cases:**

In most cases distal extension cases will be designed with relatively short occluso-gingival guiding planes to allow for release of the abutments during tissueward movement of the denture base. However, there are some cases where teeth are tipped and a long guiding plane is the only type of guiding plane that can be placed. In these instances, "physiologic relief" of the framework should be used to provide release. With this technique the distal guiding planes, minor connectors and linguoplates are coated with alcohol and rouge (not wax or silicone). The framework is placed intraorally and placed under hyperfunction by pressing over the distal extension gridwork. The framework is removed and the guideplanes and other rigid metal contacts, which could torque the tooth, are relieved in areas of burn-through. **Relief should be provided so that marks remain in only the occlusal one third of the guiding planes.**

### **Finishing and Polishing of Adjusted Surfaces**

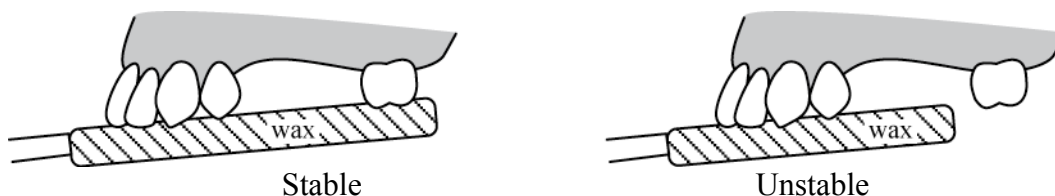
All adjusted surfaces should be smoothed and brought to a high polish. This is imperative, since even well finished frameworks have been shown to enhance intraoral plaque adhesion. Dedco green knife-edge wheels for chrome cobalt alloys will remove scratches and bring the adjusted surface to a high shine quickly. Additionally, Dedco blue clasp polishers or any other carborundum-impregnated points can be used to finish the chrome cobalt alloy. A final polish can be placed using a tripoli on a bristle brush and rouge on a small diameter cloth wheel. Use care not to snag the cloth wheel on sharp edges of the framework (to prevent injury to yourself). Remove traces of the polishing compounds with soap and water and a toothbrush.

## Maxillo-Mandibular Relations, Altered Cast Impressions and Wax Try-in Procedures

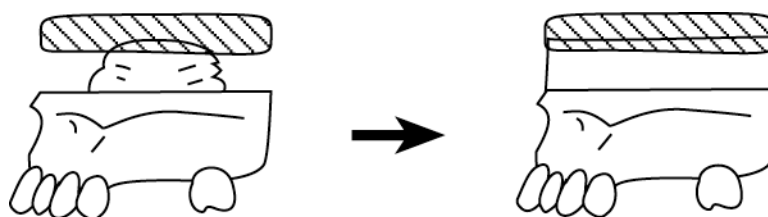
Once a removable partial denture framework has been properly adjusted, teeth must be placed on a framework to check the esthetics, phonetics and function. To set denture replacement teeth, the casts must be mounted on an articulator.

For tooth-borne partial dentures with small edentulous areas, a wax denture base can be placed directly on the denture framework. One thickness of baseplate wax is adapted over the edentulous area, the framework is heated sufficiently to melt the wax, and the framework is fully seated onto the cast, so that the wax melts and attaches to it. For more extensive tooth borne partial dentures, and tooth-tissue partial dentures, an acrylic base (without wax spacer) is attached, for greater stability. Wax occlusion rims are added to the wax or acrylic base and maxillo-mandibular relation records are obtained for the purposes of mounting the casts on an articulator. The steps in this procedure are as follows:

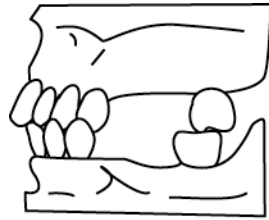
1. Make a face-bow (earbow) transfer and have it checked by an instructor prior to removal from the patient. Wax is softened, placed on the face-bow bitefork and while the wax is still softened, placed intraorally with minimal pressure (to minimize possible tooth movement). The posterior-most teeth **MUST BE CAPTURED IN THE WAX RECORD** so that the maxillary cast is stable once placed in the record.



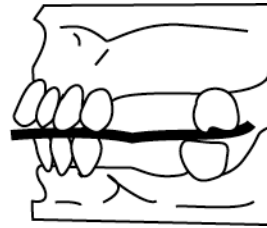
If the cast tends to unseat from the registration (e.g. due to weight of cast, angulation of face-bow etc.) it should be stabilized with sticky wax or elastic bands. Prior to mounting of the cast, three 'V' or 'U'-shaped notches, with no undercuts should be placed in the base of the cast (similar to those placed for complete dentures). The maxillary cast is mounted in a two-step method. Initially the base of the cast is dampened and a small mound of fast set plaster is placed so that it locks onto the mounting ring and covers a small area of the upper cast surface. The plaster should not extend past the cast periphery in any area. The plaster is allowed to set (<5 min.) and the cast and mounting ring are removed from the articulator and plaster is used to fill the remainder of the space between the ring and cast. This results in a neater finish and obviates the necessity to clean excess plaster from the articulator.



2. The mandibular cast is mounted in **centric occlusion without an interposing medium if there are solid, stable contacts**. If contacts are unstable (casts rock when placed in maximum intercuspation), a elastomeric interocclusal record can be used to mount the cast in **centric occlusion**.

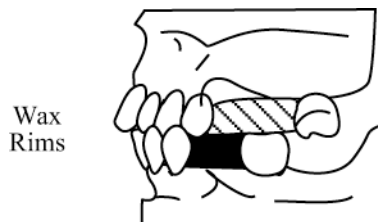


Stable

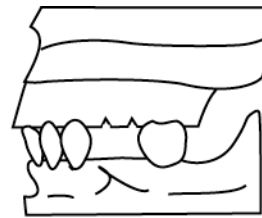


Unstable

If there are no centric contacts of the posterior teeth (i.e. some instances of opposing maxillary and mandibular partial dentures; partial denture opposing a complete denture) the casts will be mounted in a **centric position** using wax occlusion rims placed over the denture base areas of the framework. In these instances vertical dimension must be verified (with an instructor) prior to making the centric position record. The centric position record will be made similarly as for complete dentures. The posterior portion of the occlusal rims should have 'v'-shaped notches placed on the occlusal surface. Bilateral centric stops (tooth or baseplate opposing a flattened baseplate surface) must be maintained to ensure the record is made at the correct vertical dimension. Elastomeric bite registration material will be used to make the centric jaw relationship record. Because of the many combinations of missing maxillary and mandibular teeth, the mounting of casts with interocclusal records can be more complicated than with other less extensive restorative procedures. If you anticipate difficulty with occlusal relations, read your textbook and then discuss your case with an instructor well before the patient appointment, to enable you to be properly prepared.



Wax Rims



CUD record base

3. Notch the base of the mandibular cast. Sticky wax the occlusion rims together, or use tongue blades and sticky wax to stabilize the relation of the maxillary cast to the mandibular cast. Mount the mandibular cast in the same manner as the maxillary cast.
4. A protrusive registration should be taken. Methodology for this jaw relation should follow that of centric position procedures, except that the record is made at 4-6 mm of protrusion. Subsequently the condylar elements are adjusted accordingly.
5. The bite registration record is removed.
6. Denture teeth are set in the wax occlusal rims over the edentulous ridges. Anatomical, acrylic posterior teeth should normally be chosen to oppose natural teeth, to permit proper articulation. In almost all instances, the denture teeth will require extensive adjustment to ensure a proper cusp/fossae or cusp/marginal ridge relationship that is not a pin-point contact with opposing natural dentition. The latter would wear away quickly eliminating all partial denture occlusion.

7. The denture is placed intraorally to assess occlusion, vertical dimension, esthetics, phonetics, and comfort.
8. A laboratory prescription form (for acrylic processing) and the articulator with mounted models are sent to the laboratory for processing.

### **Altered Cast Impressions**

Since frameworks made from master casts must be adjusted to fit intraorally, the relationship of the teeth and denture base can change from that observed on the master cast. In tooth-borne partial dentures this small change is negligible since the teeth provide almost the entire support for the denture. In distal extension cases, however, the change can produce deleterious effects on the supporting residual ridge and/or teeth, since the load must be distributed between the two tissues. For this reason, a new impression (***altered cast impression***) is made with the partial denture framework (after intraoral adjustment) so as to capture an accurate relation between the teeth, framework and residual ridge.

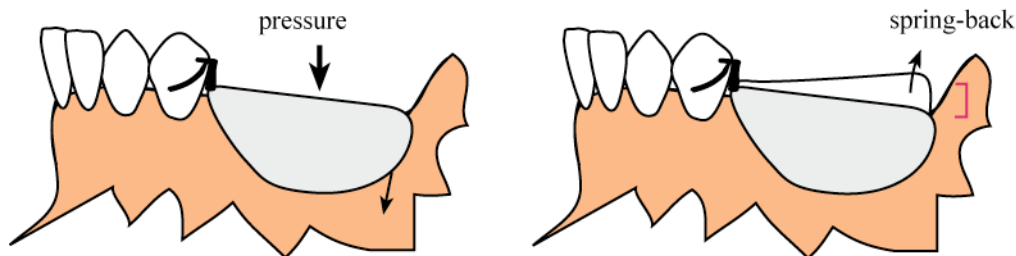
### **Tooth and Tissue-Borne Removable Partial Dentures**

Since the relationship of the framework to the soft tissues may change in a tissue-borne partial denture, it is necessary to re-relate the framework to the supporting mucosa. This is accomplished by attaching a small custom tray over the meshwork of the edentulous ridge, by border molding the tray for proper extension and then making a new impression of the residual ridge. The steps in this procedure are as follows:

1. The tentative outline of the denture base is drawn on the master cast with the framework in place. This will permit greater accuracy in tray extension.
2. Remove the framework and place one thickness of baseplate wax spacer over the edentulous ridge.
3. Grasp the framework with a hemostat or similar instrument and heat the meshwork over a flame. While the framework is still hot, replace it over the master cast. Press to place with a mirror handle, paper towels etc. to ensure you do not burn yourself. It is extremely important that the framework fully seat at this stage. If it does not, the wax will prevent full seating of the framework at the border molding, and possibly, the impression stage. This would produce exactly the opposite effect that we wish to obtain (i.e. it would impair the framework/tissue relation rather than improve it). To ensure the framework is fully seated inspect it for the following:
  - a. tissue stop(s) should be entirely through the spacer(s)
  - b. the metal in region 1.5 -2 mm adjacent to the edentulous span should be entirely through the spacer(s)
  - c. there should be no resistance felt as mesh melts through wax
  - d. rests should be fully seated in their rest seats
4. With a #7 wax spatula, remove wax from 6-7 of the holes in the meshwork. Leave meshwork slightly undercut so acrylic tray can lock onto it.



5. Block-out soft tissue undercuts with wax. If these undercuts are extensive, they may limit the extension of the denture border, depending on the selected path of insertion. Coat the master cast with 2 coats of Alcote. Mix tray acrylic resin, role it flat on thick side of acrylic rolling board. Place the acrylic over the meshwork, and adapt it to the model, ensuring that resin is pressed into undercuts in the meshwork. Trim the acrylic to the base outline on the cast, allow it to harden, and trim and round the flanges with acrylic burs.
6. Border mold intraorally with compound. If the master cast was severely under-extended this will be difficult due to the thickness of compound that must be added.
7. Remove the border-molded tray from the mouth, scrape the compound and remove the wax spacer.
8. Fill the tray with impression material. If the partial denture is a bilateral distal-extension case, impressions should be taken of both sides at the same time. Care must be taken to fill the edentulous areas but not cover the major connectors. This is especially important with a maxillary full palatal major connector where impression material under the palatal portion will tend to unseat the entire denture. Similarly, if impression material is allowed to run all over the framework, impression material may prevent complete seating. To permit neat placement of impression material, use a small instrument such as a #7 spatula or a small cement spatula to load the tray. **Use light-bodied polyvinyl siloxane impression material.**
9. Place the tray intraorally and seat to place. **DO NOT PLACE PRESSURE ON THE DISTAL EXTENSION PORTION OF THE TRAY.** If pressure is applied here, the framework will fulcrum, and/or the tissue will compress so that when the impression is removed, the base will not touch the tissue at rest. Pressure should be applied evenly over the rest seats to ensure complete seating of the framework (e.g. mirror handle)



- a) Remove the impression, check for voids or over-extensions that might indicate improper seating. Have the impression inspected by an instructor. Send impression to the lab immediately for fabrication of a pink acrylic denture base. Include a prescription for processing of acrylic. The technician requires at least several days to process the base. The technician will section off the edentulous ridge portion of the cast corresponding to the altered cast impression, and replace this area by pouring stone into the altered cast impression. Your textbook outlines details of this procedure.
- b) Mount casts and set denture teeth as previously described.

## Interim Removable Partial Dentures

An interim removable partial denture (RPD) is sometimes made prior to making a definitive removable partial denture. The patient may wear the interim RPD for a very short period or for a more extended period of years, depending on the situation.

### Indications:

1. Large pulps may preclude the use of fixed partial dentures until a later time.
2. The clinical crowns may be short without any usable undercuts (in children or adolescents, the teeth may not be fully erupted).
3. Children - arches still growing, and a permanent prosthesis would not fit for long.
4. Temporary space maintenance for missing teeth in esthetic areas (congenital, caries, trauma)
5. Prevent extrusion, migration of adjacent/opposing dentition
6. Temporary time or financial constraints
7. Temporary improvement of esthetics after sudden loss of teeth, before sufficient healing has occurred to fabricate a permanent prosthesis (accidents, after extractions)
8. **Transitional Denture:** a removable partial denture used as a transition to a complete denture when:
  - a. all or some teeth need to be extracted but can't be immediately (medically compromised patient)
  - b. patient is not psychologically prepared to loose all the teeth at one time
9. **Treatment Denture:** a removable partial denture used to improve a condition before a definitive denture can be made. The types of treatment may include:
  - a. Tissue Conditioning
    - papillary hyperplasia (massage, brushing, with or without surgery)
    - acute inflammation (increase tissue adaptation and redistribute the stress)
    - may use the existing denture or a new treatment denture may be made
  - b. Implant healing
    - a treatment RPD may be necessary for esthetics and/or function
    - an existing RPD or a new denture may be made
    - a soft liner is placed so that the fixtures can heal unloaded
  - c. Alteration of Vertical Dimension / Occlusal Scheme
    - important use to determine how the patient will react to the changes (TMD)
    - may be required in order to use an occlusal splint
  - d. Surgical Splint
    - after the removal of palatal tori, etc.

### **Fabrication:**

1. Make preliminary impressions
2. Pour diagnostic casts, survey, design a definitive partial denture
3. **Optional Step (preferred)**
  - Prepare guide planes, rest seats that will be used in the definitive RPD
  - Make new alginate impression, pour, survey, select path of insertion, tripodize
4. Maxillo-mandibular relations (facebow, occlusal vertical dimension, centric record if there are unstable contacts, protrusive record)
5. Articulate the casts
6. Draw design for interim partial denture

### **Interim Partial Denture Design:**

#### **Clasps** (Wrought wire 0.02")

- Circumferential
- Adams clasps
- Ball clasps

#### **Bracing**

- the lingual/palatal acrylic of the RPD provides bracing through contact with the teeth at the heights of contour of the teeth

#### **Rests**

- wrought wire can be bent on itself and/or flattened and placed into the rest seats
- acrylic may be used over cingulum rest seats
- if longer term use is expected, cast rests and bracing arms can be embedded in the acrylic

#### **Major Connectors**

- Full palatal coverage increases strength and stability
- Generally extend the denture to at least the first molar for stability
- Retentive clasps are embedded into the acrylic major connector

### **Prescription writing:**

1. Mark any teeth to be extracted on the cast and write the teeth number on the prescription, draw a line where the cast to where the cast should be surgerized
2. Survey the cast and mark height of contour and retention areas (0.02")
3. Indicate type of retentive clasp, rest and bracing.
4. Indicate where rests, retention arms and bracing are to be placed, state tooth # and surface
5. Draw the outline of the denture on the cast
6. Identify the shade and mould of teeth selected
7. State the type of occlusion required

**Laboratory Steps:** To improve results, interim partial dentures should be sent to the lab for three distinct procedures:

1. Blockout & duplication of casts, fabrication of record bases & occlusion rims. The lab will return these for you to make jaw relations records and mount casts
2. Setting of teeth. The lab will return the partial dentures for a full wax try-in
3. At the final lab phase, the technicians will place retainers, scribe post dam, process

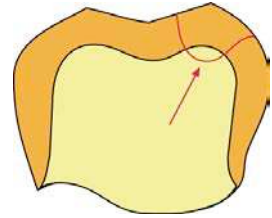
## Coordinating Fixed and Removable Prosthodontics

When removable partial denture abutments require full coverage restorations it is important to treatment plan removable partial denture first. Pick a path of insertion, select abutments, draw design on the diagnostic cast. It is critical to plan the placement of rest seats, retentive undercuts, since these may affect the degree of crown preparation on the various surfaces.

In general, is advantageous to prepare guide planes and rest seats on natural abutments (i.e. abutments not being crowned) prior to crown preparations. Having these aspects present on the crown and bridge master cast will allow the technician to make crown contours parallel path of insertion, and produce the proper degree of retention.

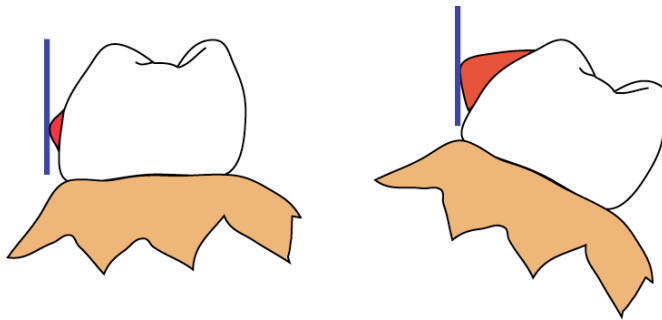
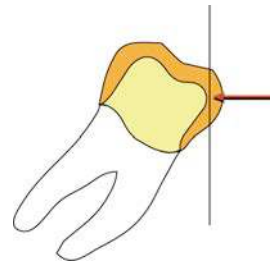
During crown preparations, extra reduction will normally be needed in the following areas:

1. rest seats
2. guide planes
3. axial reduction on tilted teeth



There should be a minimum 0.5 mm of metal under the rests or guide planes.

Tilted teeth require extra reduction on the side to which the tooth tips to gain sufficient metal thickness where guiding planes will be placed, and less reduction on the opposite side.



Poor contours cannot always be corrected by crowning. Severely tipped teeth will need gross alterations of axial contours in order to gain a retentive undercut. It is wise to use a diagnostic wax-up to check whether the desired contours can be obtained.

After completing preparations for cast restorations for RPD Abutments:

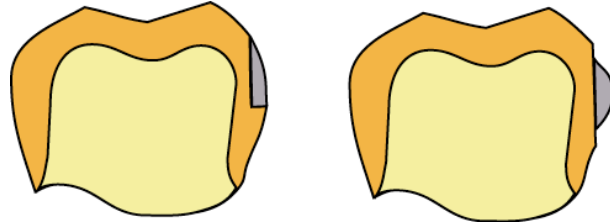
1. Make final impression for crowns
2. Pour models
3. Select an acceptable path of insertion
4. Tripodize, and then mount casts on semiadjustable articulator

Master casts for crowns with guiding planes must include accurate reproduction of all abutments on one cast to allow proper alignment of guide planes.

In the laboratory the technician will wax the crown, place rest seats, guide planes, place retentive undercuts. Crowns should be evaluated at the wax-up stage, before they are cast. Check to make sure the guiding planes are parallel the desired path of insertion, and that rest seats are placed in the proper position, with proper form and adequate thickness of wax. Make sure there is an appropriate amount of undercut in the appropriate position. Axial surfaces should not be over contoured.

One variation that can be incorporated into crowns is a lingual ledge for the bracing arm. This allows the placement of the bracing arm within confines of crown, making it:

1. less obtrusive
2. a less complex surface, improving hygiene
3. act as an auxiliary support



Prior to cementation recheck the following:

1. Axial contours on the surveyor
2. Size, position, depth, morphology of rests
3. Sufficient retention, position

Make any necessary changes extraorally— alterations will be more intraorally

Prior to cementation check the fit of any crowns, check interproximal contacts, margins and occlusion. Following cementation, allow the cement to set at least 10 minutes prior to the framework impression, then proceed as with a conventional RPD.

### **Coordinating Complete and Removable Partial Dentures**

When a complete denture is to be fabricated against a removable partial denture, it is best to make both prostheses at the same time. This allows the occlusion to be optimized to improve the stability of the complete denture. If the prostheses are made separately, it is possible that destabilizing occlusal interferences may be introduced that are difficult or impossible to eliminate without resetting denture teeth or severe adjusting the existing occlusion. Treatment planning should be undertaken as previously outlined. Diagnostic workups should be used to manage difficult situations such as extruded teeth, severe curves of Spee, etc.

A typical treatment sequence follows:

1. Preliminary impressions, diagnostic casts (mounted, if complicated occlusion), design of the removable partial denture (diagnostic wax-up in complex cases)
2. Tooth preparations, border molding the RPD tray, final RPD impression (if extracoronary restorations are need, follow the sequence outlined above)
3. Border molding the CD tray, final CD impression (this can be done while the framework is being made, in order to expedite treatment)
4. Adjust the RPD framework
5. Altered cast impression
6. Maxillomandibular relations
7. Setting of CD and RPD teeth, wax try-in,
8. Delivery, adjustment, continuing care

## Removable Partial Denture Checklist

### 1. Diagnosis and Treatment Plan

- ☐ Significant clinical findings and history recorded in data base
- ☐ Pertinent radiographs taken
- ☐ Required diagnostic procedures identified (consults, diagnostic casts, splint etc.)
- ☐ Student understands significance of data collected
- ☐ Treatment plan appropriate for prosthodontic and health problems identified
- ☐ Treatment plan recorded in correct sequence
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

### 2. Preliminary Alginate Impressions

- ☐ Trays properly selected and centered over the ridges
- ☐ Minimal areas where trays have contacted tissues
- ☐ Accurately records the available supporting tissues
- ☐ Peripheries well defined (minimum of voids; showing muscle and frenal attachments)
- ☐ Accurate recording of the retromolar pads, retromylohyoid area, post palatal seal area and proper height of floor of mouth
- ☐ Material properly mixed as indicated by impressions
- ☐ Minimum of voids
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

### 3. Diagnostic Casts

- ☐ Includes all anatomical surfaces
- ☐ Base trimmed parallel to the residual ridge - 1/2 inch thick
- ☐ Casts neatly trimmed
- ☐ All existing teeth represented / intact
- ☐ No bubbles flaws in stone
- ☐ Smooth, neat, and properly mounted
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

### 4. Occlusal Analysis

- ☐ Rotated, tilted, malposed teeth noted
- ☐ Occlusal plane discrepancies noted
- ☐ Notation of areas requiring occlusal adjustment to optimize occlusion
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

### 5. Survey of Diagnostic Casts

- ☐ Height-of-contour lines indicated on all possible abutments
- ☐ Acceptable path of insertion selected
- ☐ Cast tripodized
- ☐ Retention areas indicated
- ☐ Guiding planes indicated
- ☐ Change of tooth contour indicated
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

### 6. RPD Design/Approval

- ☐ Design approved prior to Phase I & Phase II treatment
- ☐ Design drawn on diagnostic cast
- ☐ Acceptable major connector selected
- ☐ Acceptable direct retainers selected
- ☐ Framework elements minimized
- ☐ Modifying factors (occlusion, restorations, ridge form etc.) considered
- ☐ Elements drawn to proper proportions
- ☐ Clarity of design
- ☐ RPD Design Approval Form signed & place in chart
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**7. Abutment Modifications**

a. Guiding Planes

- ☐ Parallel to path of insertion
- ☐ Proper length
- ☐ Proper width, rounding facial and lingual line angles
- ☐ Smooth single plane surface

b. Rest Seats

- ☐ Acceptable depth
- ☐ Proper position on tooth
- ☐ Acceptable morphology
- ☐ Marginal ridge lowered and rounded
- ☐ Acceptable cavosurface angle (<90°)

c. Retentive Areas

- ☐ Sufficient retention for designed retainers
- ☐ Correction of height of contour lines
- ☐ Infection Control/Judgment/Other

**8. Acrylic Impression Tray(s)**

- ☐ Tray not significantly underextended
- ☐ Stable, does not rock on cast
- ☐ Extended to correct position (2-3mm short of vestibular depth)
- ☐ Uniform thickness (= 3mm; wax relief not showing through tray)
- ☐ Acceptable wax relief
- ☐ Labial and buccal notches properly placed
- ☐ Borders rounded, not sharp
- ☐ Small handle, properly positioned
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**9. Border Molding for R.P.D. Framework**

- ☐ Tray stays in place at rest and during slight manipulation of tissues; stable
- ☐ Labial and buccal flanges extend into height of vestibule
- ☐ No border molding on buccal of dentate areas
- ☐ Flange thickness generally no greater than 4 mm
- ☐ Frenular areas properly contoured
- ☐ Flanges smooth, continuous; rolled and not sharp
- ☐ Flanges relatively symmetrical on contralateral sides (where applicable)
- ☐ Infection Control/Judgment/Other \_\_\_\_\_
  
- ☐ Mx:Posterior palatal seal is properly covered
  
- ☐ Md:Includes retro-molar pads
- ☐ Includes buccal shelf
- ☐ Lingual flanges at or slightly below mylohyoid ridges (when not severely undercut )
- ☐ Posterior extensions of lingual flanges extends into retromylohyoid space (when possible)
- ☐ Palpation over masseter reveals no over-extensions

**10. Final Impression for R.P.D. Framework**

- ☐ Peripheries well defined
- ☐ No significant voids (rest seats, guiding planes, areas of major connector, edent, ridge etc.)
- ☐ Tray compound properly relieved
- ☐ No significant areas of "burn through"
- ☐ Impression material well distributed in tray
- ☐ Maxillary tuberosities adequately recorded
- ☐ Retromylohyoid space and retromolar pads recorded
- ☐ Accurately records available critical anatomy (allows for all elements of tentative design)
- ☐ Appropriate impression material selected
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**11. Master Casts**

- ☐ No significant bubbles or flaws in stone
- ☐ Teeth not fractured from cast
- ☐ Includes all anatomical surfaces of final impressions
- ☐ Includes 3-4 mm. land area
- ☐ Base approximately parallel to ridge and approximately 1/2 inches thick (minimum)
- ☐ Evidence of a dense stone surface
- ☐ Clean and well trimmed
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**12. Survey of Master Cast**

- ☐ Height-of-contour lines indicated on all possible abutments
- ☐ Acceptable path of insertion, with parallel guide planes
- ☐ Cast tripodized
- ☐ Retention areas indicated
- ☐ Guiding planes indicated
- ☐ Height of contour indicated
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**13. Framework Design and Prescription**

(Draw on duplicate cast, have marked, then submit with master cast and completed prescription)

- ☐ Major connector designed correctly
- ☐ Direct retainers designed correctly
- ☐ Neatly and accurately drawn
- ☐ Lab prescription legibly, accurately completed
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**14. Framework Adjustment**

- ☐ Framework elements seat completely (tissue contact verified)
- ☐ Framework does not interfere with occlusion
- ☐ Proper use of indicating medium
- ☐ Framework elements of proper proportions
- ☐ Framework elements correct distance from abutments, embrasures
- ☐ Framework stable, does not rock
- ☐ Passive when seated
- ☐ No soft tissue impingement (check with PIP.)
- ☐ Adequate finish and polish
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**15. Altered Cast Impression (Distal extensions, extensive tooth-borne cases)**

- ☐ Acrylic tray securely attached to framework, properly extended
- ☐ Framework passive when fully seated intraorally, stable with impression in place
- ☐ No impression material under direct retainers, major or minor connectors
- ☐ Correctly border molded
- ☐ Accurately records available supporting structures
- ☐ No significant areas of "burn through"
- ☐ Peripheries covered by a thin layer of impression material
- ☐ No significant voids
- ☐ Infection Control/Judgment/Other \_\_\_\_\_



**16. Baseplate and Occlusal Rims**

- ☐ Framework stable on cast, properly related and passive when seated.
- ☐ Wax rim at a level compatible with existing vertical dimension
- ☐ Undercuts blocked out so baseplate does not scrape master cast upon removal
- ☐ Wax rim centered over ridge (mandibular); slightly facial to ridge (maxillary)
- ☐ Labial inclination on anterior portion of wax rim
- ☐ Width approximately 7 mm anteriorly and 10 mm posteriorly
- ☐ Flat occlusal surface
- ☐ Wax smooth, neat and sealed to base
- ☐ Baseplate well adapted to cast tissues
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**17. Vertical Dimension**

- ☐ Patient sitting or standing upright for procedure
- ☐ Lips/cheeks not strained
- ☐ Proper lip support
- ☐ Patient demonstrates a 2-4 mm closure from lips touching to rims/teeth touching (patient constraints)
- ☐ Framework does not alter existing vertical dimension
- ☐ Patient's posterior teeth don't touch during sibilant sounds
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**18. Facebow Record (Checked prior to removal from patient and prior to mounting)**

- ☐ Casts notched and grooves lubricated
- ☐ Bitefork correctly attached to occlusal rim with indices for remaining teeth and tightened
- ☐ Facebow condylar arms properly oriented
- ☐ Maxillary cast mounted in same relationship to articulator as maxilla to arbitrary hinge axis      Proper  
anterior reference point used
- ☐ Incisal pin correctly oriented
- ☐ Cast well united to mounting ring with a smooth neat finish
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**19. Centric Record**

- ☐ Repeatable recording
- ☐ Occlusal rim properly reduced for recording media
- ☐ Mandibular cast notched and grooves lubricated
- ☐ Proper quantity and utilization of medium
- ☐ Indices interdigitate accurately
- ☐ Horizontal component is correct
- ☐ Vertical component is correct
- ☐ Cast well united to mounting ring with smooth neat finish
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**20. Protrusive Record**

- ☐ Mandibular cast and articulator guides indicate the proper amount of protrusion (usually 4-6mm)
- ☐ Proper quantity and utilization of medium
- ☐ Indices interdigitate accurately
- ☐ Condylar inclination properly adjusted and locked
- ☐ Lateral condylar guidance (Bennett Angle) set at 15°
- ☐ Protrusion relatively centered
- ☐ Registration at a jaw opening greater than the vertical dimension of occlusion
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**21. Wax Try-In**

- ☐ Centric record verified with recording medium on widely separated teeth
- ☐ Vertical dimension verified
- ☐ Tooth form, arrangement and shade verified
- ☐ Phonetics verified ("50's-60's" and "M" sounds)
- ☐ Dentition relatively symmetrical
- ☐ Protrusive relationship verified
- ☐ Teeth set in proper plane of occlusion
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**22. Insertion/Delivery - Denture base**

- ☐ Retentive, does not displace with moderate vertical pressure
- ☐ Proper flange extension (not dislodged by moderate tissue manipulation; palpation reveals no overextensions)
- ☐ Indicating medium reveals no areas of soft tissue impingement
- ☐ Not underextended
- ☐ No spicules and well polished
- ☐ Proper flange thickness (generally not > 4mm, rolled not sharp)
- ☐ Proper relief of frenula
- ☐ Bases terminate at proper anatomical landmarks (post-palatal seal area, hamular notches retromolar pads, mylohyoid ridge, retromylohyoid spaces)
- ☐ Patient comfortable
- ☐ Framework passive; seats completely
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**23. Insertion/Delivery-Occlusion and Vertical Dimension**

- ☐ Teeth contact simultaneously and bilaterally in centric position without interferences
- ☐ Acceptable occlusal scheme in excursions
- ☐ Acceptable interocclusal space
- ☐ Acceptable esthetics
- ☐ Acceptable phonetics
- ☐ Instructions re: use and home care
- ☐ No occlusal interference by framework
- ☐ Contact on both natural and partial replacement teeth in centric position
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**24. Clinical Remount**

- ☐ Student identifies need for remount
- ☐ New casts fabricated (when necessary)
- ☐ Accurate centric record using medium on widely separated teeth
- ☐ Mounted accurately and neatly on an articulator
- ☐ Acceptable contacts in centric position
- ☐ Acceptable contacts in eccentric positions
- ☐ Occlusal interferences eliminated
- ☐ Infection Control/Judgment/Other \_\_\_\_\_

**25. Adjustments (Patient seen until comfortable and no evidence of tissue irritation)**

- ☐ Demonstrates knowledge of problem prior to adjustment
- ☐ Adjustment not overextended
- ☐ Apt 1 - patient comfortable, no evidence of tissue irritation    date \_\_\_\_\_
- ☐ Apt 2 - patient comfortable, no evidence of tissue irritation    date \_\_\_\_\_
- ☐ Apt 3 - patient comfortable, no evidence of tissue irritation    date \_\_\_\_\_

## Summary of Design Principles for Removable Partial Dentures

### General Principles

- Minimize framework elements (minimize minor connectors, plating, etc.) – more hygienic
- Obtain good base adaptation - better stress distribution; use altered cast for mand. distal extensions
- Use what is present (e.g. existing rest seats)
- Plan for the future (e.g. designing for continued use of RPD framework if a critical abutment is lost; placing rest seats, guide planes and undercuts on crowns to allow fabrication of an RPD later)
- Never plan an RPD using a single cast alone. You can't assess abutment mobility, compressibility of mucosa, the level of the floor of the mouth, prominent frena, or occlusion. Use mounted models and assess these features intraorally as you plan and check your design.
- Occlusion – AVOID:
  - o centric contacts on rests (also ensure no increase in OVD)
  - o heavy buccal contacts on denture teeth – causes more movement of removable partial denture
- When other dental treatment is planned, and an RPD will be made at the end of treatment – ALWAYS PLAN THE RPD FIRST. You will see which abutment modifications will be needed, and will ensure the planned RPD is feasible, prior to beginning treatment

### Rest Seats/ Rests

Ensure sufficient depth/clearance, especially at junction of the rest & minor connector (1.5mm minimum)

**Tooth Borne (Kennedy Class III & IV)** – place rests adjacent to edentulous space (both ends)

**Tissue/Tooth Borne (Kennedy Class I & II)**

- mesial rest preferred (less torquing of abutment)
- distal rest preferred when:
  - abutment is rotated (limited access for minor connector to mesial)
  - plunger cusp/heavy centric contact on mesial
  - large restoration on mesial
- no long guiding planes with distal rests - potential torquing
- if tooth is severely weakened periodontally – sometimes move rest to the next tooth anterior

### Incisal rests/rest seats

- don't use
  - poor esthetics
  - more tilting/torquing forces (long lever arm from center of rotation)

### Cingulum rests/rest seats

- use composite build up, if no prominent cingulum (less dentinal sensitivity)
- size - min 1 mm (if deeper, chance of dentin exposure)
- ensure sufficient clearance from opposing occlusion for maxillary cingulum rests

### Occlusal rests/rest seats

- size - 1/3 of B-L width of the tooth
- depth : 1.5 mm of clearance from opposing occlusion (critical at junction of rest & minor connector)
- line angle of the marginal ridge should be rounded
- deepest part should be located centrally (positive)

### Indirect Retainers

- 90° from fulcrum line & as far away from primary abutment as possible
- none required on tooth borne (CI III & IV) cases
- canine is usually the most anterior tooth used for indirect retention
- usually don't use a lateral (root length) or central incisor (speech)
- also helpful for seating and support, but not always possible or necessary

## Summary of Design Principles for Removable Partial Dentures

### Direct Retainers

- **Kennedy Cl III & IV** (Tooth Borne)
- – Clasp of choice: **cast circumferential**
  - if can't use cast circumferential next to edentulous space, use **double embrasure clasp**
  - if abutment is severely tilted use (depending on location of undercut):
    - **Cast circumferential clasp with lingual retention**
    - **Ring clasp** with support strut
    - **Rotational path removable partial denture**
- **Kennedy Cl I & II** (Tooth & Tissue Borne)
- For posterior abutments, or any tooth needing stress release:
  - Clasp of choice: **RPI** (mesial rest, distal proximal plate and I-bar)
  - If can't use an I-bar in vestibule, because of
    - frenum
    - shallow vestibule
    - deep soft tissue undercutthen use an **RPA** retainer (mesial rest, distal proximal plate and wrought wire clasp [Akers])
  - If can't use a mesial rest because of:
    - rotation
    - heavy centric contact on mesial
    - large amalgam restoration on mesialthen use **Combination Clasp** (distal rest, buccal ww retention, lingual bracing)
- for abutments adjacent modification spaces (use tooth borne retainers)
- # of direct retainers –, minimum of 2 posterior abutments for Cl. I & II, all abutments for Cl III, IV to maximum of 4 normally
- if eliminate a direct retainer for esthetics, plan more retention with other features (soft tissue coverage, longer guiding planes, etc)

### Mandibular Major Connectors

**Lingual Bar** whenever possible (less tissue coverage - hygiene)

**Lingual Plate** if:

- high floor of mouth
- tori
- frenum
- terminate at FGM

Tissue relief – mandibular major connector (29-30 gauge relief) to avoid tissue impingement

### Maxillary Major Connectors

No tissue relief

Tooth borne (Class III & IV): **Palatal Strap**

Tooth & Tissue borne (Class I & II):

**A-P Strap** whenever possible

- better sensation, preferred (minor salivary glands & taste buds)

**Full Palatal Strap**

- periodontal involvement of abutments
- less than 6 teeth left
- displaceable mucosa (increased coverage)

**Anterior Strap** (Horseshoe) – only if inoperable torus is present

- NEVER for Class I or II

### Other Principles of Design:

Design drawings – absolute accuracy

- RED – wrought wire, undercut position, circled tripod marks; BLUE – everything else