

Principles of Partial Denture Design

1. Keep the RPD design as simple as possible

- ▶ “Simple”— those design elements which promote function, esthetics, comfort, ease of fabrication, and ease of maintenance, cleaning, and repair. Example of simplification the design is to eliminate anterior modification spaces.

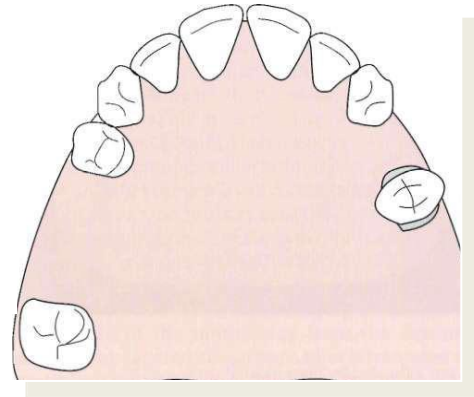
2. Eliminate anterior edentulous spaces by fixed partial denture.

- ▶ Simplify the RPD design
- ▶ Eliminate the technical difficulties of placing anterior prosthetic teeth on an RPD.

3. Eliminate all but one posterior edentulous space per quadrant.

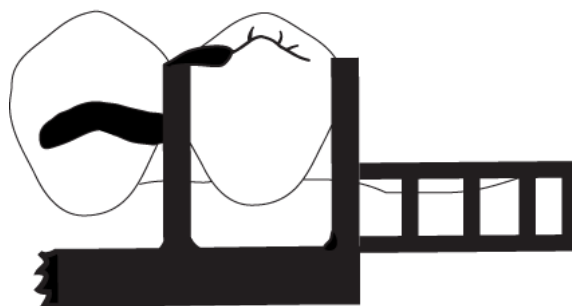
- ▶ Using fixed partial denture to simplify the RPD design.
- ▶ Eliminate the technical difficulties of restoring multiple edentulous spaces in one quadrant
- ▶ Eliminate the potential destructive forces on lone standing distal abutment teeth.

Recommended to splint the lone standing abutment to anterior tooth by bridge



- 4. 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.
- 5. 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.

6. **Plan for the future.** 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). 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-releasing 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.
7. **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)



8. **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.

9. **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.

10. **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 these 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 subsequently the denture framework needs remaking.

11. 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.

12. Occlusion – AVOID:

- ▶ centric contacts on rests (also ensure no increase in OVD).
- ▶ heavy buccal contacts on denture teeth– causes more movement of removable partial denture.

13. Use the simplest clasp possible for the survey line (height of contour) and undercut of the abutment tooth.

Clasps should be selected on the basis of:

- ▶ the survey line on the tooth “can be modified”.
- ▶ the location and depth of the undercut.
- ▶ the presence of muscle or frenum attachments or soft/ hard tissue undercuts which will interfere with infrabulge bar clasp approach arms.

14. All clasps are better to have the same amount of retention.

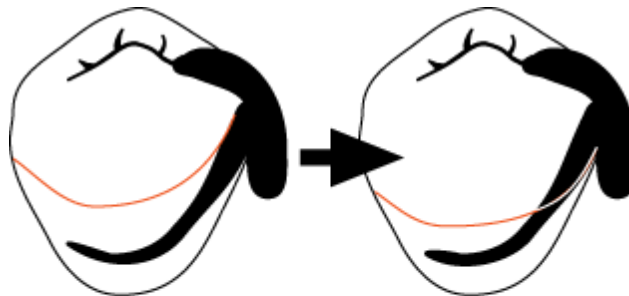
15. **If no retentive undercut can be found, it is possible to prepare a small retentive area on the tooth.** In order to recontour the tooth properly, the designated surface must be approximately parallel to path of insertion or too much tooth structure will have to be removed. The prepared area should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



16. **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 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 of figure 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 are being made subsequently (right of figure).

17. **Bracing arms should be placed in the middle 1/3 of the tooth occlusogingivally (ideally at the junction of the middle and gingival third).** 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.

18. Provide retention on both sides of the arch.

Retention on both sides of the mouth will limit the rotation of the RPD around the anteroposterior fulcrum lines along the edentulous ridges.

19. Provide cross-arch reciprocation when possible.

Design the RPD so that a retentive clasp on one side of the arch is counteracted by a retentive clasp on the opposite side of the arch. ,i.e., retention on the facial or lingual of an abutment tooth on one side of the arch should be reciprocated by facial or lingual retention on a tooth in the same anteroposterior location or as close as possible.

20. Provide cross-tooth reciprocation.

Place a reciprocal guide plane or reciprocal clasp arm on the tooth surfaces from the direction of force applied by the retentive clasp tip.

21. The metal framework should contact at least three natural teeth.

- ▶ Ideally in positive rest seat preparations, the relationship of the RPD framework to the teeth and soft/hard tissues can carefully be evaluated.

- ▶ The contact of the palatal major connector or dental base to the hard palate or residual ridge tissues is not accurate enough to count for the solid contact of the metal framework on a natural tooth.

22. Differentiation between tooth-supported and tooth-tissue

Supported partial denture:

- ▶ The manner in which each is supported
- ▶ The method of impression registration and jaw record required for each
- ▶ The need for some kind of indirect retention
- ▶ The denture base material
- ▶ Differences in Clasp Design

23. In an entirely tooth-supported partial denture, support for the tooth-supported removable partial denture or the tooth-supported modification space comes entirely from the abutment teeth by means of rests.

To evaluate the potential support an abutment tooth can provide, consideration should be given to:

- (1) periodontal health
- (2) crown and root morphologies
- (3) crown-to-root ratio
- (4) bone index area (how the tooth has responded to previous stress)

- (5) location of the tooth in the arch
- (6) relationship of the tooth to other support units (length of edentulous span);
- (7) the opposing dentition.

24. Support for the distal extension denture base comes primarily from the overlying soft tissue and the residual alveolar bone of the distal extension base area. In the latter, rest support is effective only at the abutment end of the denture base.

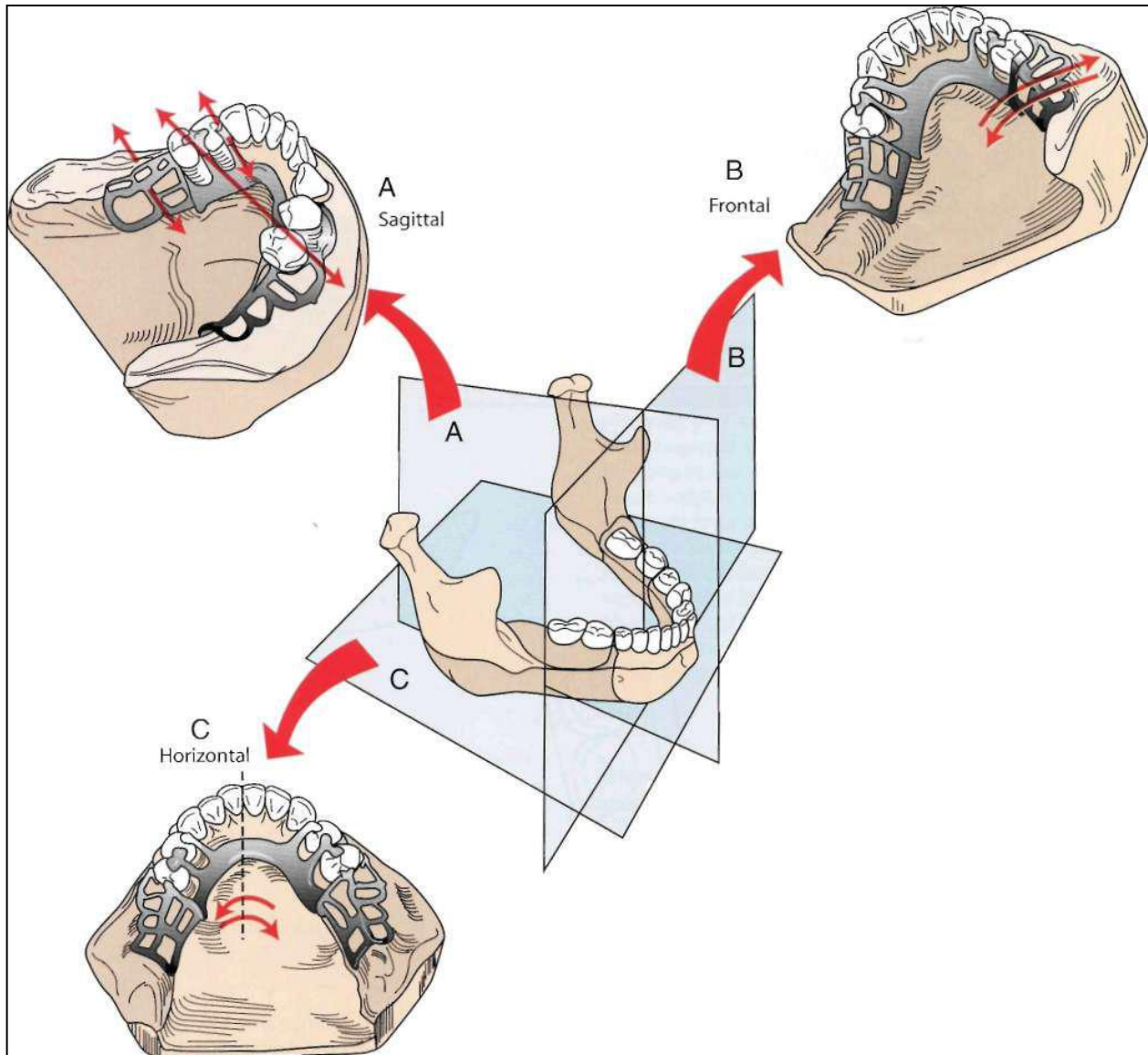
The effectiveness of tissue support depends on six factors

- (1) the quality of the residual ridge
- (2) the extent to which the residual ridge will be covered by the denture base
- (3) the type and accuracy of the impression:
 - Use altered cast impression technique for mandibular distal extension RPD's. Never plan an RPD using a single cast alone as 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.
- (4) the accuracy of the denture base
- (5) the design characteristics of the component parts of the partial denture framework

(6) The anticipated occlusal load: the total occlusal load applied to the residual ridge may be influenced by reducing the area of occlusal contact. This is done by the use of fewer, narrower, and more effectively shaped artificial teeth

25. Distal Extension Case Considerations

- ▶ There are three axes of rotation for these partial dentures (Look at the figure below). If abutment teeth are locked into the frameworks, they can be torqued in many directions. Therefore, stress-releasing clasps allow for some release of the teeth to minimize torquing potential.
- ▶ 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.



Distal extension removable partial dentures will rotate when force is directed on the denture base. Differences in displaceability of the periodontal ligament of the supporting abutment teeth and soft tissue covering the residual ridge permit this rotation. It would seem that rotation of the prosthesis is in a combination of directions rather than unidirectional. The three possible movements of distal extension partial dentures are: **A**, rotation around a fulcrum line passing through the most posterior abutments when the denture base moves vertically toward or away from the supporting residual ridges; **B**, rotation around a longitudinal axis formed by the crest of the residual ridge; and **C**, rotation around a vertical axis located near the center of the arch.

26. **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:

- a. Rests
- b. Major connector
- c. Minor connectors
- d. Direct retainers
- e. Indirect retainers

27. **Rest Seats/ Rests**

Tooth-Borne (Kennedy Class III & IV):

Place rests adjacent to edentulous space (both ends).

Exceptions:

- ▶ Teeth incapable of providing adequate support, poor crown/root ratio, or uncorrectable periodontal disease.
- ▶ If abutment tooth has improper anatomy for the indicated rest.

Tissue-Tooth Borne (Kennedy Class I & II):

- Mesial rest preferred *
- 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

*Distal rests tend to move the clinical crown distally and the root mesially at the apex, resulting in horizontal forces in bone. In contrary, mesial rest will tend to tip the tooth mesially and thus be reinforced by other adjacent teeth. Also, mesial rest provides an axis of rotation that directs applied forces in a more vertical direction (provides more perpendicular support to ridge).

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 prominent cingulum is not found (less dentinal sensitivity)
- ▶ Size - minimum 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 : 1-1.5 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)

28. Major Connectors

Mandibular Major Connectors

- a) Lingual Bar whenever possible (less tissue coverage - hygiene)
- b) Lingual Plate if:
 - ▶ High floor of mouth (< 8 mm)
 - ▶ Lingual tori
 - ▶ Prominent lingual frenum

Tissue relief: mandibular major connectors need 32 gauge relief to avoid tissue impingement.

Maxillary Major Connectors

a) Single Palatal Strap

Tooth-borne (Class III), especially for bilateral edentulous spaces of short span in a tooth-supported restoration, particularly when the edentulous areas are located posteriorly.

b) Anterior-Posterior Palatal Strap

- ▶ Tooth & tissue borne (Class I & II) whenever possible (preferred because of better sensation, and no coverage of minor salivary glands & taste buds).
- ▶ Class I and II arches in which excellent abutment and residual ridge support exists
- ▶ Long edentulous spans in Class II, modification 1 arches
- ▶ Class IV arches

c) Palatal Plate-Type Connector

- ▶ Periodontal involvement of abutments
- ▶ Less than 6 teeth left
- ▶ In most situations in which only some or all anterior teeth remain.
- ▶ Class II arch with a large posterior modification space and some missing anterior teeth.
- ▶ Class I arch with one to four premolars and some or all anterior teeth remaining, and abutment support is poor and cannot otherwise be enhanced; residual ridges have undergone extreme vertical resorption.
- ▶ Displaceable mucosa (you need increased coverage)

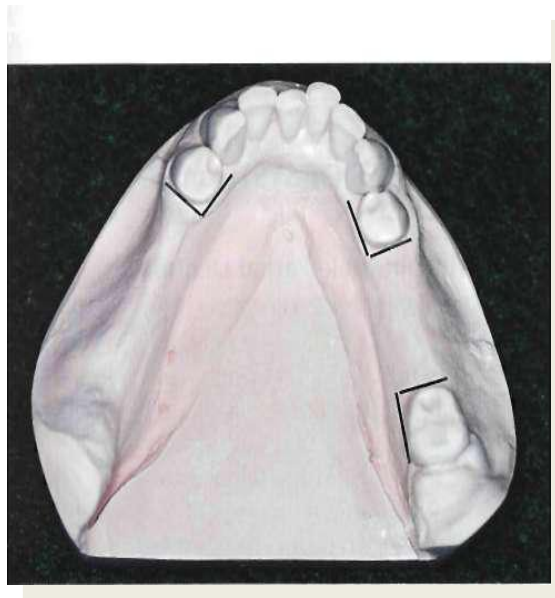
d) U-shaped Palatal Connector or Anterior Strap (Horseshoe)

- ▶ Only if inoperable torus extends to the posterior limit of the hard palate
- ▶ NEVER for Class I or II

29. Place a guiding plane on proximal tooth surfaces adjacent to an edentulous space.

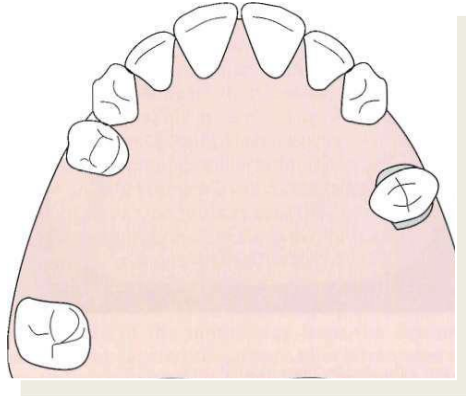
- ▶ Guiding planes may be contacted by various components of the RPD:
 - the body of an extracoronal direct retainer,
 - the stabilizing arm of a direct retainer,
 - the minor connector portion of an indirect retainer

- the minor connector specifically designed to contact the guiding plane surface.
- ▶ Establish guiding planes on several abutment teeth (preferably more than two teeth), which are located at widely separated positions in the dental arch.
 - ▶ Effectiveness of guiding plane surfaces is enhanced if these surfaces are prepared on more than one common axial surface of the abutment teeth.



- ▶ Dimensions: one-half the width of the distance between the tips of adjacent buccal and lingual cusps or one-third of the buccal lingual width of the tooth. At least one-half to one-third of the axial height of tooth (generally a minimum of 2 mm in height).
- ▶ Guiding planes for distal-extension cases should be slightly shorter to avoid torquing of 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-lingivally.

- ▶ A guiding plane should be located on the abutment surface adjacent to an edentulous area. However, excess torquing is inevitable if the guiding planes are used squarely facing each other on a lone standing abutment.



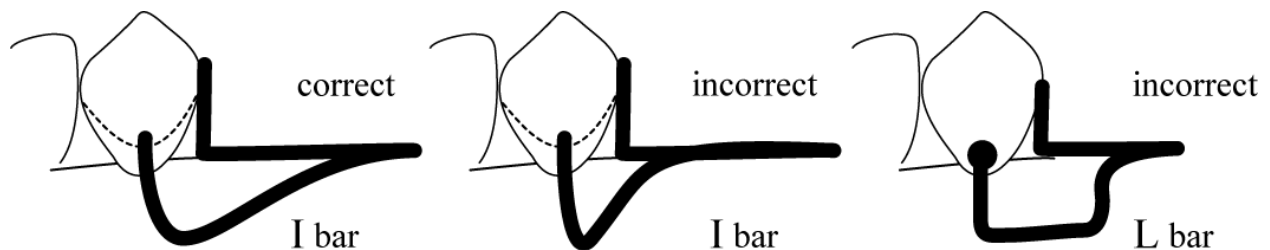
30. Direct Retainers

- ▶ Location of the undercut is the most important single factor in selecting a clasp. Recontouring or restoring the abutment tooth to accommodate a clasp design better suited to satisfy the criteria for clasp selection, however, can modify undercut location.
- ▶ 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.
- ▶ Consider caries susceptibility. Cast clasps cover more tooth surface than wrought round clasps. The latter clasp would be preferred if caries incidence is higher than usual.

- ▶ Consider the tooth position in the arch. Some clinicians feel that the canine teeth should be clasped with cast infrabulge retainers (bar clasps) 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.



- ▶ 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.
- ▶ 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).



31. Direct Retainer Choices

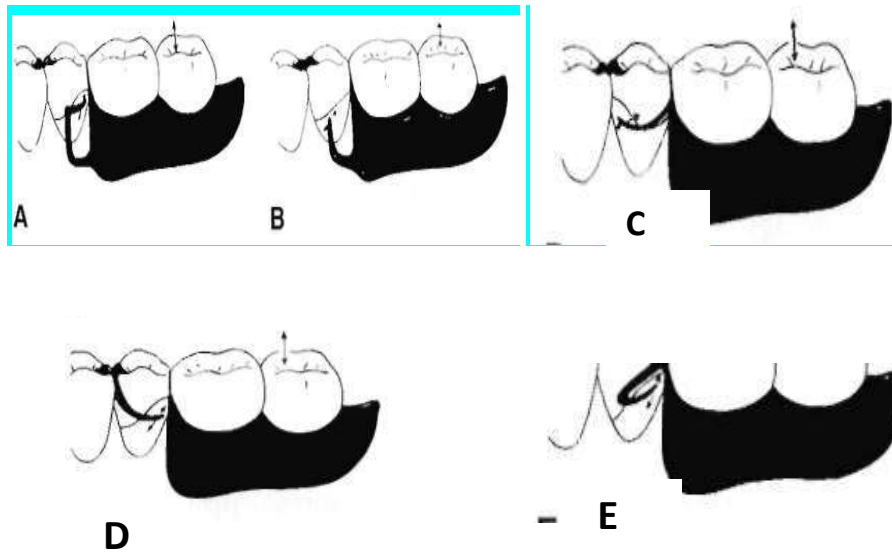
Kennedy Cl III & IV (Tooth-Borne)

- ▶ Retainers for tooth-supported partial dentures have only two functions: to retain the prosthesis against reasonable dislodging forces without damage to the abutment teeth and to aid in resisting any tendency of the denture to be displaced in a horizontal plane. The prosthesis cannot move tissueward because the rest supports the retentive components of the clasp assembly. There should be no movement away from the tissue and therefore no rotation about a fulcrum because a direct retainer secures the retentive component.
- ▶ Any type of direct retainer is acceptable as long as the abutment tooth is not jeopardized by its presence. Therefore, cast clasps of either the circumferential, the bar type, or the combination clasp may be used depending on how one can modify the surfaces of the abutment teeth (guiding planes, rests, and contours for proper location of clasp arms).
- ▶ Clasp of choice: cast circumferential (Akers)
- ▶ If abutment is severely tilted, use (depending on location of undercut):
 - i. Cast circumferential clasp with lingual retention
 - ii. Ring clasp with support strut
- ▶ Use stress-releasing clasps for tooth-borne cases when:
 - Esthetics
 - use infrabulge or wrought wire
 - Poor prognosis for posterior abutment
 - allows conversion to distal extension

Kennedy CI I & II (Tooth & Tissue Borne)

- ▶ Requirements of direct retainers are to retain the prosthesis, and to be able to flex or disengage when the denture base moves tissueward under function. Thus the retainer may act as a stress-breaker.
- ▶ 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.
- ▶ For posterior abutments in distal extension cases, or any tooth needing stress release:
 - Clasp of choice: RPI (mesial rest, distal proximal plate, and buccal I-bar in midfacial undercut except canines mesio-buccal)
 - If can't use an I-bar in vestibule, because of frenum, shallow vestibule, or deep soft tissue undercut, then use an RPA retainer (mesial rest, distal proximal plate and circumferential wrought wire clasp engaging mesiobuccal undercut).
 - If can't use a mesial rest because of tooth rotation, heavy centric contact on mesial, or large amalgam restoration on mesial, then use Combination Clasp (distal rest, buccal wrought wire retention engaging mesiobuccal undercut, lingual bracing)
- ▶ Contraindications for **RPI** concept described by Krol:
 - Deep cervical undercut
 - Excessive buccal or lingual tilt of abutment tooth
 - Shallow buccal vestibule
 - High frenal attachments or floor of the mouth requiring lingual plate

- Large soft tissue undercut
 - food impaction
- Only a disto-buccal undercut exists that does not require a restoration
 - $\leq 180^\circ$ encirclement



Types of extracoronal direct retainer assemblies that may be used on abutments adjacent to distal extension base to avoid or minimize the effects of cantilever design. A, **Distobuccal undercut** engaged by one-half T-type bar clasp. B, I-bar placed in **undercut at midbuccal** surface (RPI). C, Round, uniformly tapered 18-gauge wrought-wire circumferential retainer arm engaging **mesiobuccal undercut** (RPA). A wrought-wire arm, instead of a cast arm, should be used in this situation because of ability of wrought wire to flex omnidirectionally. Cast half-round retainer arm would not flex edgewise, which could result in excessive stress on tooth when rotation of denture base occurs. If mesial rest cannot be used, use a Combination Clasp with distal rest.

D and E, if **distobuccal undercut** exists and bar-type retainer cannot be used because of **tissue undercuts inferior to buccal surface of abutment**, interproximal ring clasp engaging distobuccal undercut (D) or hairpin clasp (E) may be used with mesial rests. However, interproximal ring and hairpin clasps are the least desirable for clasping terminal abutment of distal extension denture.

32. Number of Direct Retainers

Four: Four direct retainers offer an excellent amount of retention and are most frequently 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.

Two: Absolute minimum, usually only used in Class I partial dentures.

33. 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°), and placed on the opposite side of the fulcrum line from the denture base. They are normally not required for tooth-borne RPD's.
- ▶ They must be placed on a rest seat prepared on an abutment tooth that is capable of withstanding the forces placed on it. An indirect retainer cannot function effectively on an inclined tooth surface, nor can a single weak incisor tooth be used for this purpose. Either a canine or premolar tooth should be used for the support of an indirect retainer.
- ▶ An indirect retainer is usually not needed with Kennedy class II modification space anterior to 1st premolar.

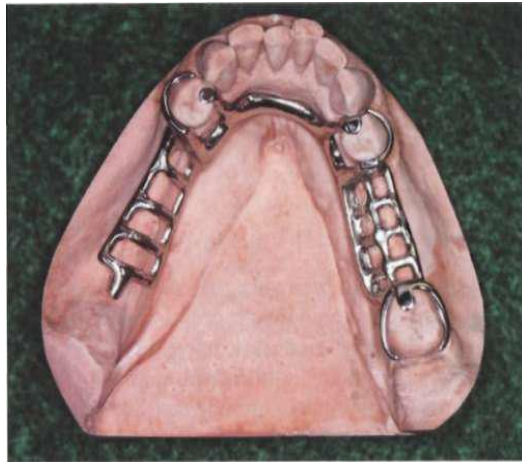
34. Denture Bases

- 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.
- Unless a need for later relining is anticipated in tooth-supported RPD's—as in the situation of recently extracted teeth—the denture base may be made of metal, which has several advantages.

35. Class II Modification 1

- ▶ The use of a cast circumferential clasp engaging a mesiobuccal undercut on the anterior abutment of the tooth-supported modification space may result in a Class I lever like action if the abutment teeth have not been properly prepared and/or if the tissue support from the extension base area is not adequate.
- ▶ It seems rational under these circumstances to use a bar-type retainer engaging a distobuccal undercut.
- ▶ Should the bar-type retainer be contraindicated because of a severe tissue undercut or the existence of only a mesiobuccal undercut on the anterior abutment, then RPA or a combination direct retainer

with the retentive arm made of tapered wrought wire should be used.



Mandibular Class II, mod I, partially edentulous arch. Note that bar-type retentive arms are used on both premolar abutments, engaging distobuccal undercuts at their terminal ends. Lever-like forces may not be as readily imparted to right premolar, as opposed to cast circumferential direct retainer engaging mesiobuccal undercut.

36. Drawing the Design. When drawing a design on diagnostic cast, sharpened, coloured pencils should be used. The following colours will be used to designate various components:

RED – wrought wire, undercut position, circled tripod marks;

BLUE – everything else

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.

37. After RPD Designed, the sequence of teeth preparation is as follows:

- a. Guideplanes
- b. Lower heights of contour to eliminate interferences and improve esthetics
- c. Create undercuts if absolutely necessary (raising heights of contour)
- d. Rest seat preparation

Patient name: _____

Patient number: _____

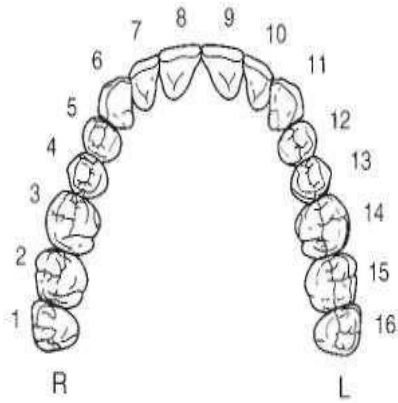
Student name: _____

Student number: _____

Treatment plan

Laboratory instructions

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Design specifications:

1. Rests

2. Retention

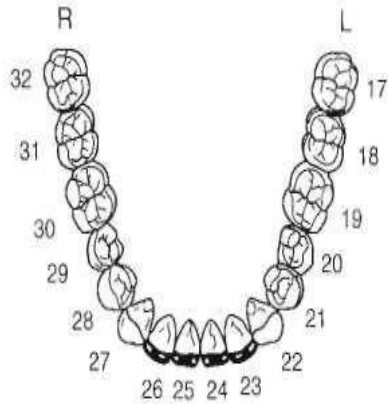
3. Reciprocation

4. Major connector

5. Indirect retention

6. Guide planes

7. Base retention



Color code:

Removable Partial Prosthodontics

Patient name: John Doe

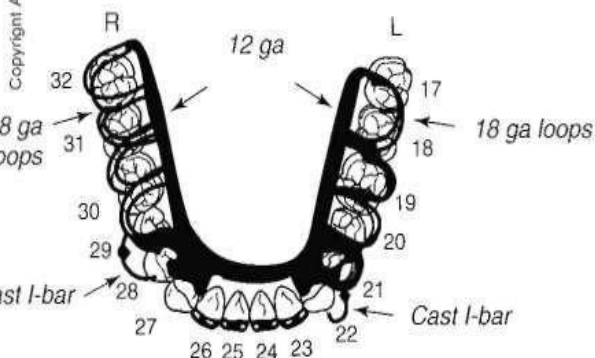
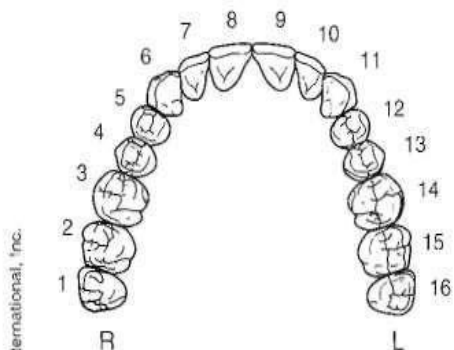
Patient number: 158390

Student name: Joe Smith

Student number: 1234

Treatment plan

Laboratory instructions



Design specifications:

1. Rests
Cingulum rests, #22, #27
MO occlusal rest #20
MO occlusal rest #28
2. Retention
I-bar clasp #28
I-bar clasp #22
3. Reciprocation
Lingual plate #22, #27, #28
4. Major connector
Lingual bar
5. Indirect retention
Cingulum rest #22, #27
6. Guide planes
Distal #20, #22, #27
Mesial #20
7. Base retention
18 ga. loops, 12 ga. inferior border
8. Areas to be modified or contoured
Metal tooth to replace #21

Color code:

Blue: Cast metal
Red: Resin base and wrought wire
Green: Areas to be contoured

Instructor: _____

Approval to send to laboratory: _____ Date: 2/15/99

