

Mechanics of Distal Extensions



Yaquina Bay Bridge
Designer: Conde McCullough

- Every beam in this bridge experiences either a pushing or pulling force. The bridge is designed to distribute the force favorably.

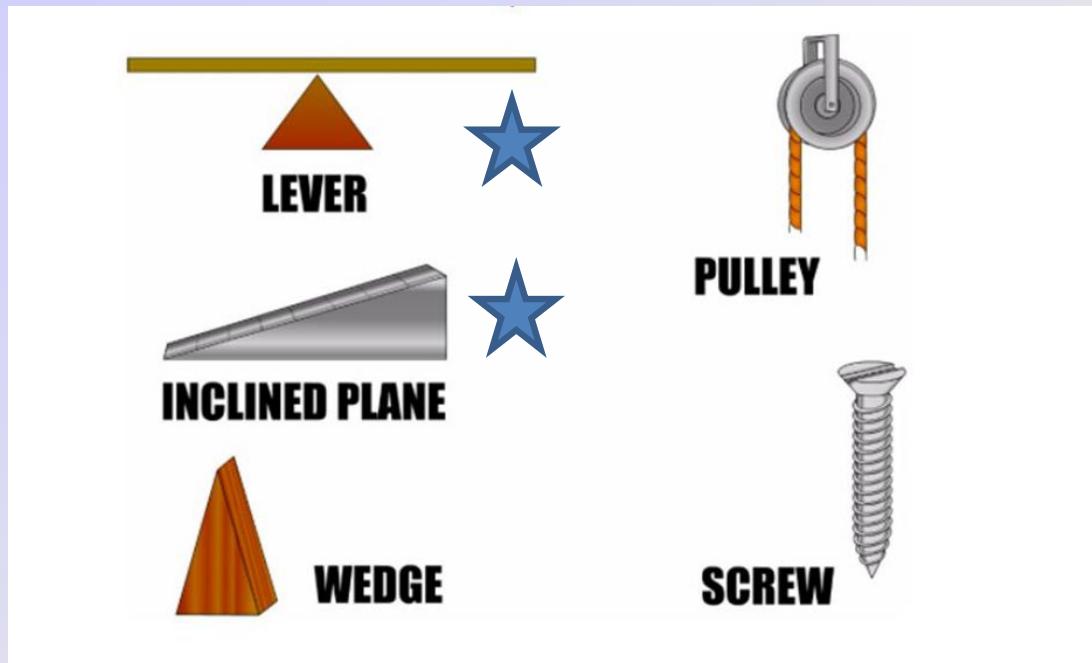
Coos Bay Bridge

PROPERTIES OF FORCE:

Prosthodontic Considerations

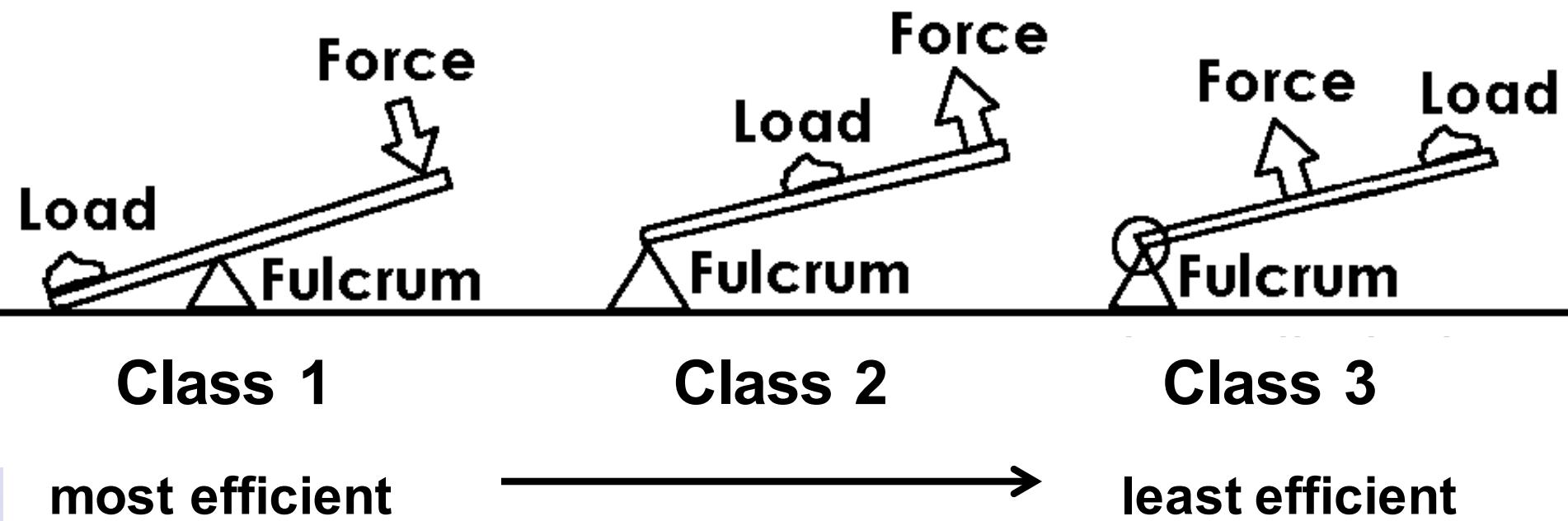
- Has magnitude
 - For instance, variable masticatory force.
- Has direction
 - Favorable, along long axis of tooth or compressive stress to bone.
 - Unfavorable, shear or lateral forces.
- Has area of application
 - Distribution of occlusal forces.
 - Broad distribution reduces stress,
Stress = force/area.

5 Simple Machines



Machines increase mechanical advantage—
more work output with less effort input (force).

LEVERS



Mechanical Advantage

Do we want mechanical advantage?

- For oral surgery
 - Yes



Mechanical Advantage

Do we want mechanical advantage?

- For oral surgery
 - Yes
- For RPD frameworks
 - NO
 - Increased mechanical advantage means it takes less force to increase stress to teeth.

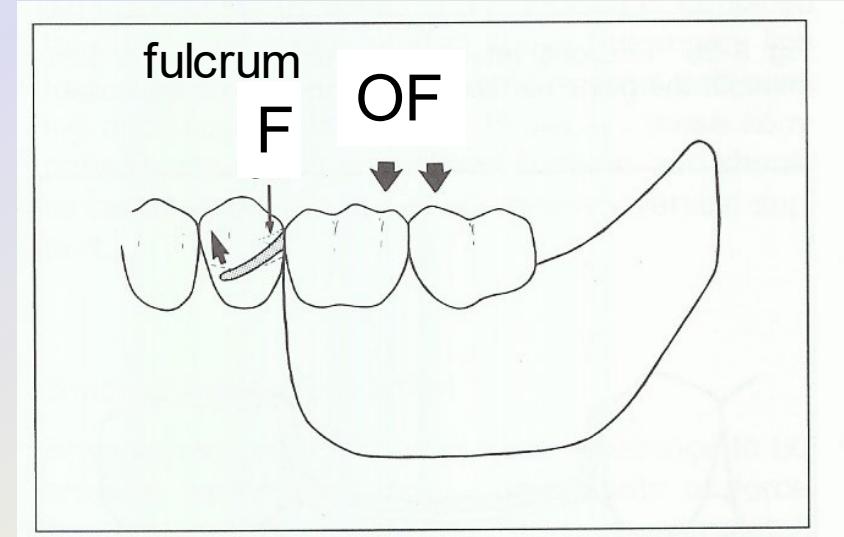
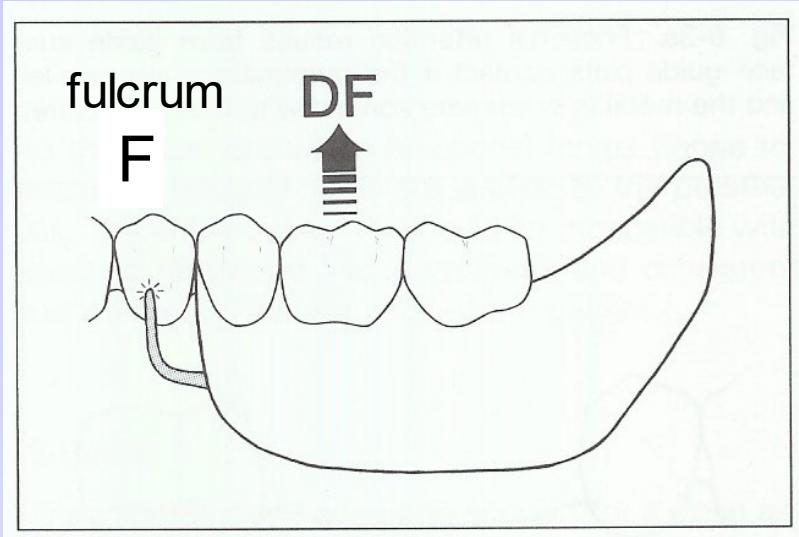


The rationale for any distal extension clasp design is

first

to protect the abutment tooth, not to retain prosthesis.

There are two vertical forces acting on framework.



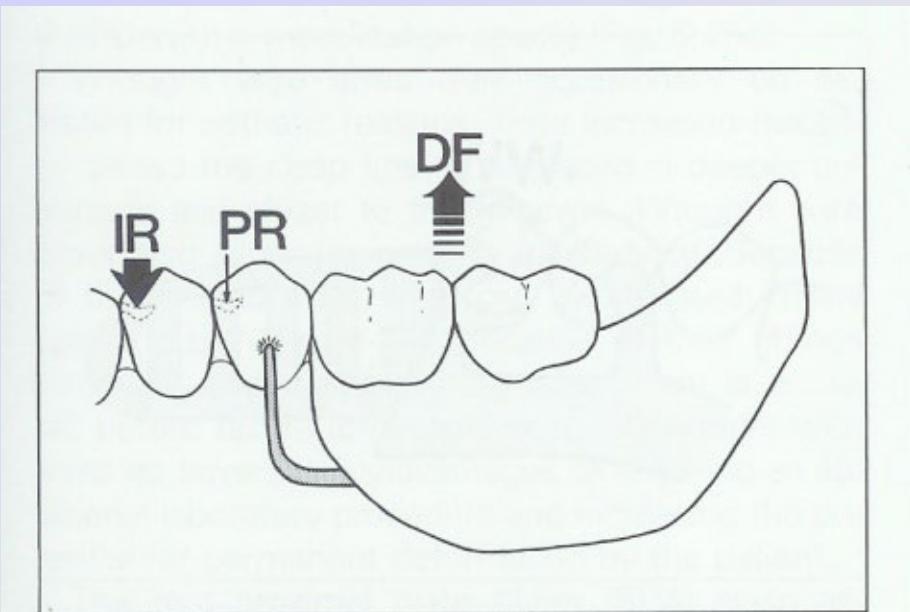
Dislodging force is resisted by retention.

Occlusal force is resisted by support.

Both movements cause the DE framework to behave as lever and rotate.

Dislodging Force:

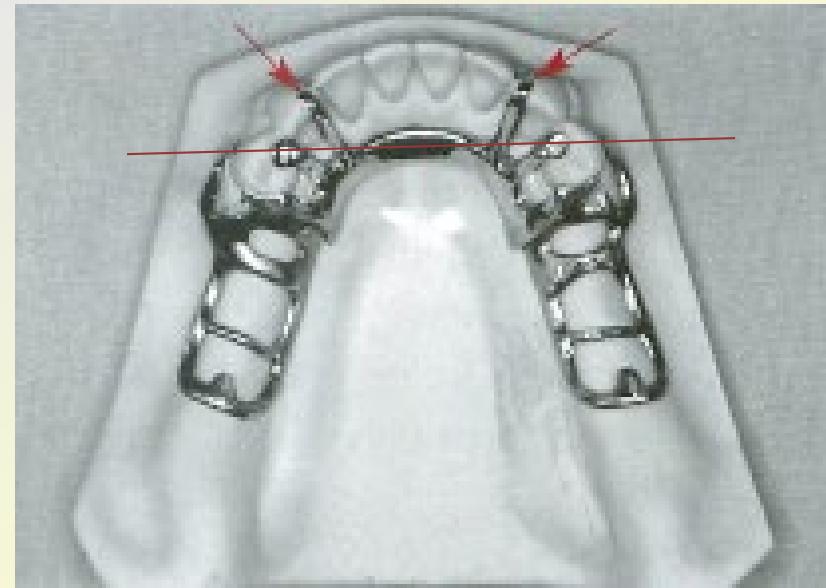
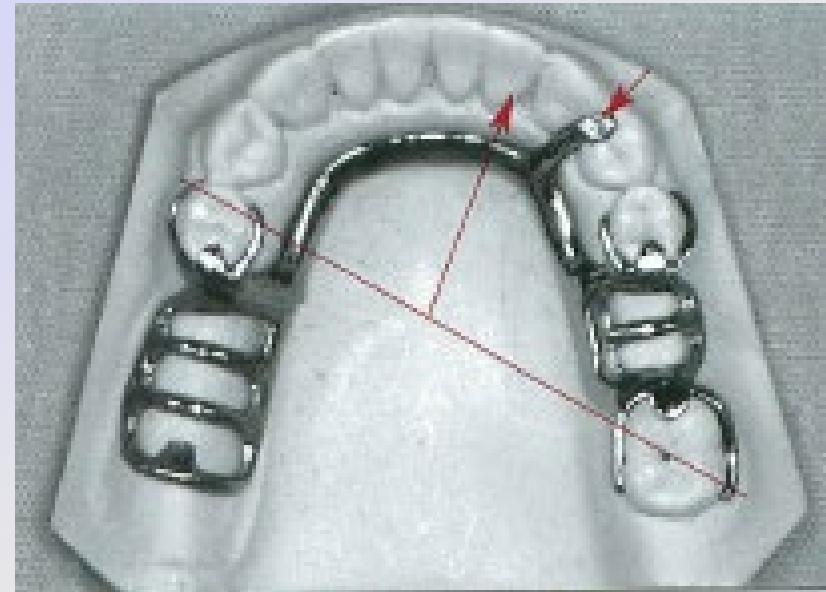
Opposite movement of Occlusal Loading



- Framework components anterior to retentive tip act as CI I lever arm, moving tissueward when DE is dislodged.
- Indirect retention consists of support component – RESTS.
- Placed as far anteriorly, away from the axis of rotation as possible.

Identify the axis of rotation during dislodgement and place IR to counteract movement.

- To locate rest for indirect retention:**
 - 1. Identify axis of rotation-abutment teeth with the most posterior retentive tips.**
 - 2. Place indirect retention rest perpendicularly, as far away from axis as possible.**



**Indirect retention only applies to
resistance of movement during
dislodgement.**

**All indirect retention is in the form
of rests.**

Occlusal Force: A special problem for DE RPDs

- Fact:

Distal extension RPDs move under function because of the different displacement of PDL and soft mucosa. Stewart says mucosa displaces 250x more than PDL.

- Problem:

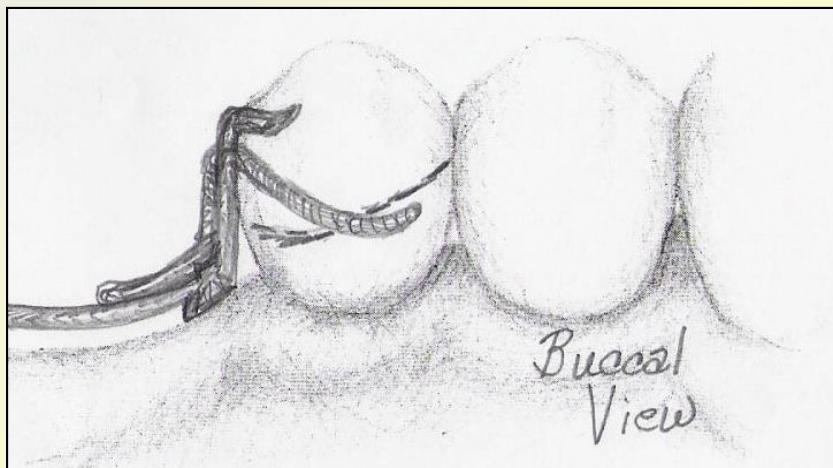
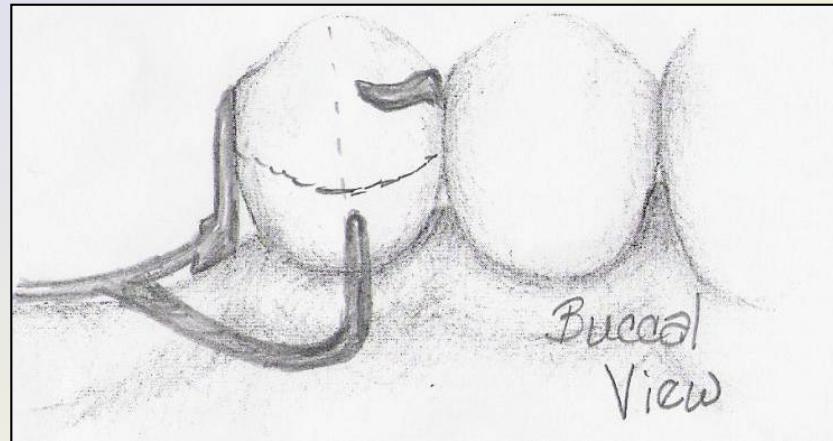
How can we control the movement of extension base RPDs so we achieve a favorable biomechanical outcome and protect abutment teeth?

By specific design guidelines governing distal extensions.

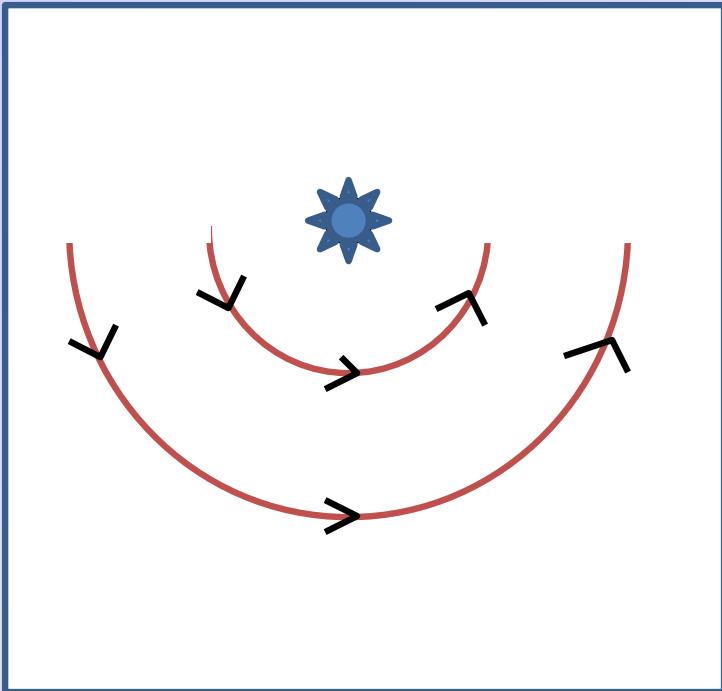
Occlusal Force: Factors that control DE mechanics

HINT: ITS ALL ABOUT LEVERS

- Rest positions (the fulcrum of the lever):
 - Mesial vs distal
- Retentive clasps:
 - Infrabulge vs. suprabulge
 - Material –cast metal vs. wrought wire
- Retention location:
 - Mesial vs. distal

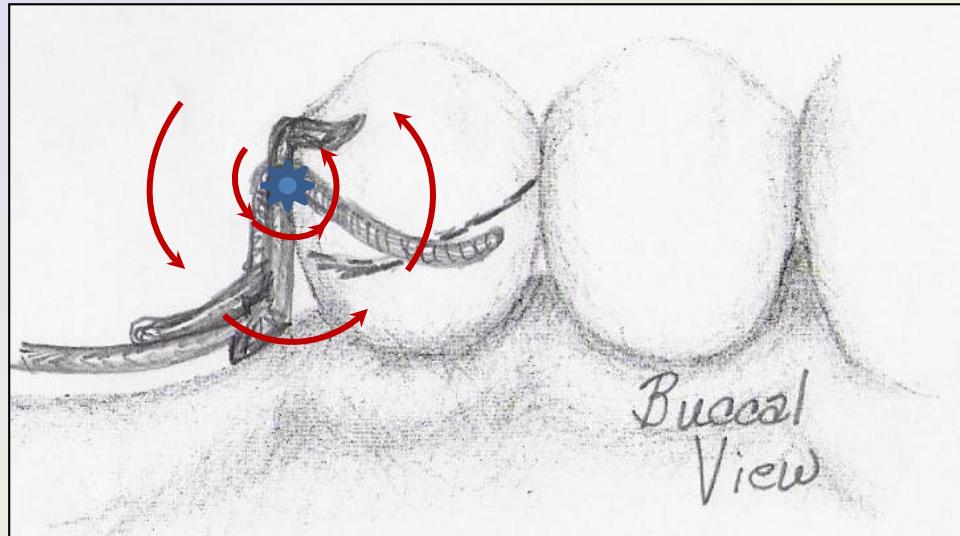
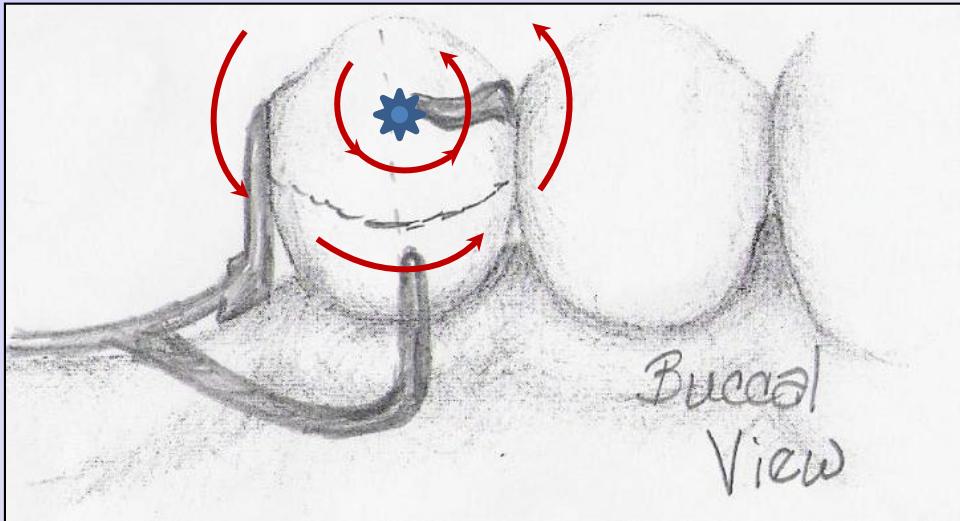


Rotational Center (during occlusal loading)



- Through fulcrum pivot points (rests).

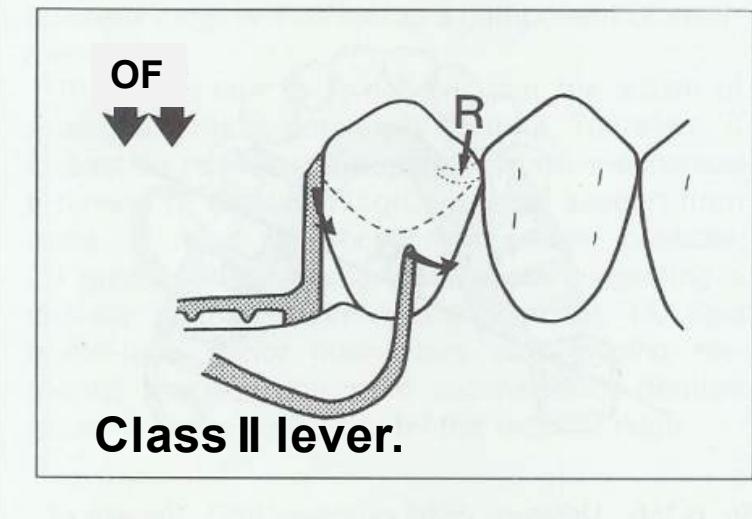
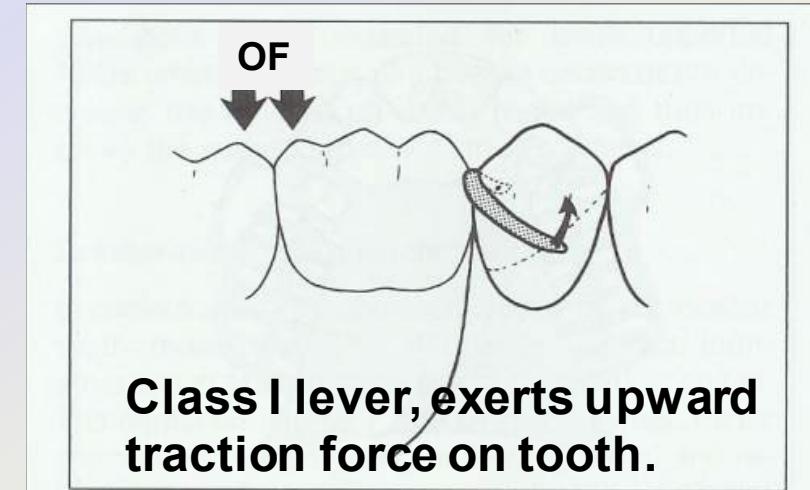
The most distal rest acts as a fulcrum and is the center of rotation.



Location of rotational center changes with location of most terminal rest.

Mesial and Distal Rests: Different location of lever fulcrum

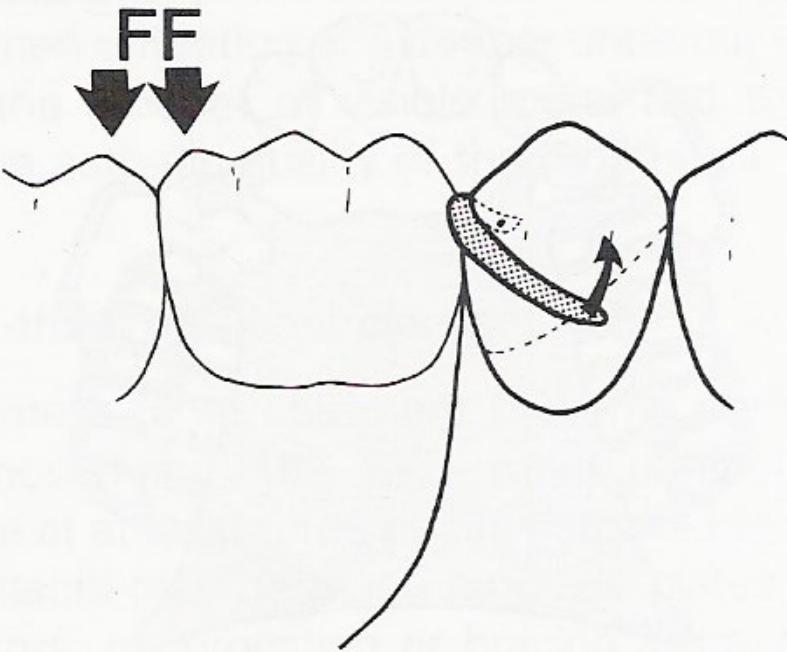
- All framework components on same side of fulcrum as occlusal loading move tissueward with occlusal loading
- All framework components on opposite side of fulcrum as occlusal loading move upward



Protection of abutment tooth

during occlusal loading

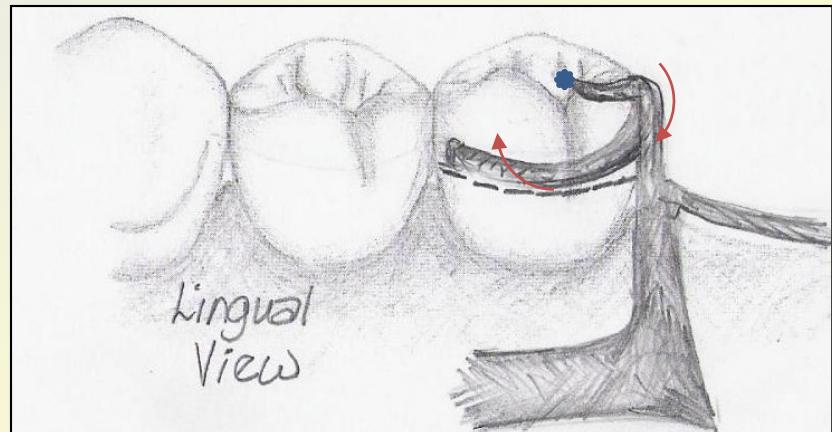
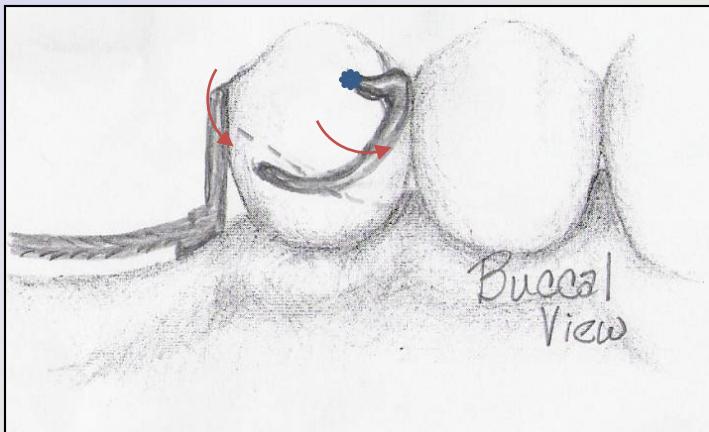
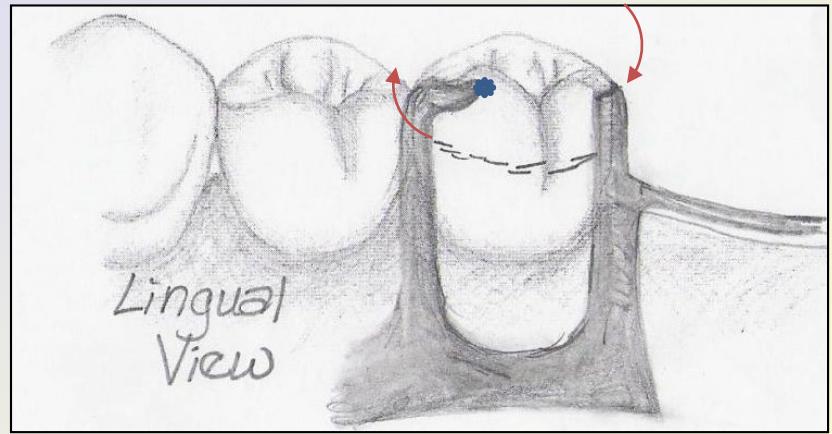
“Lifting” stresses should be eliminated/reduced.

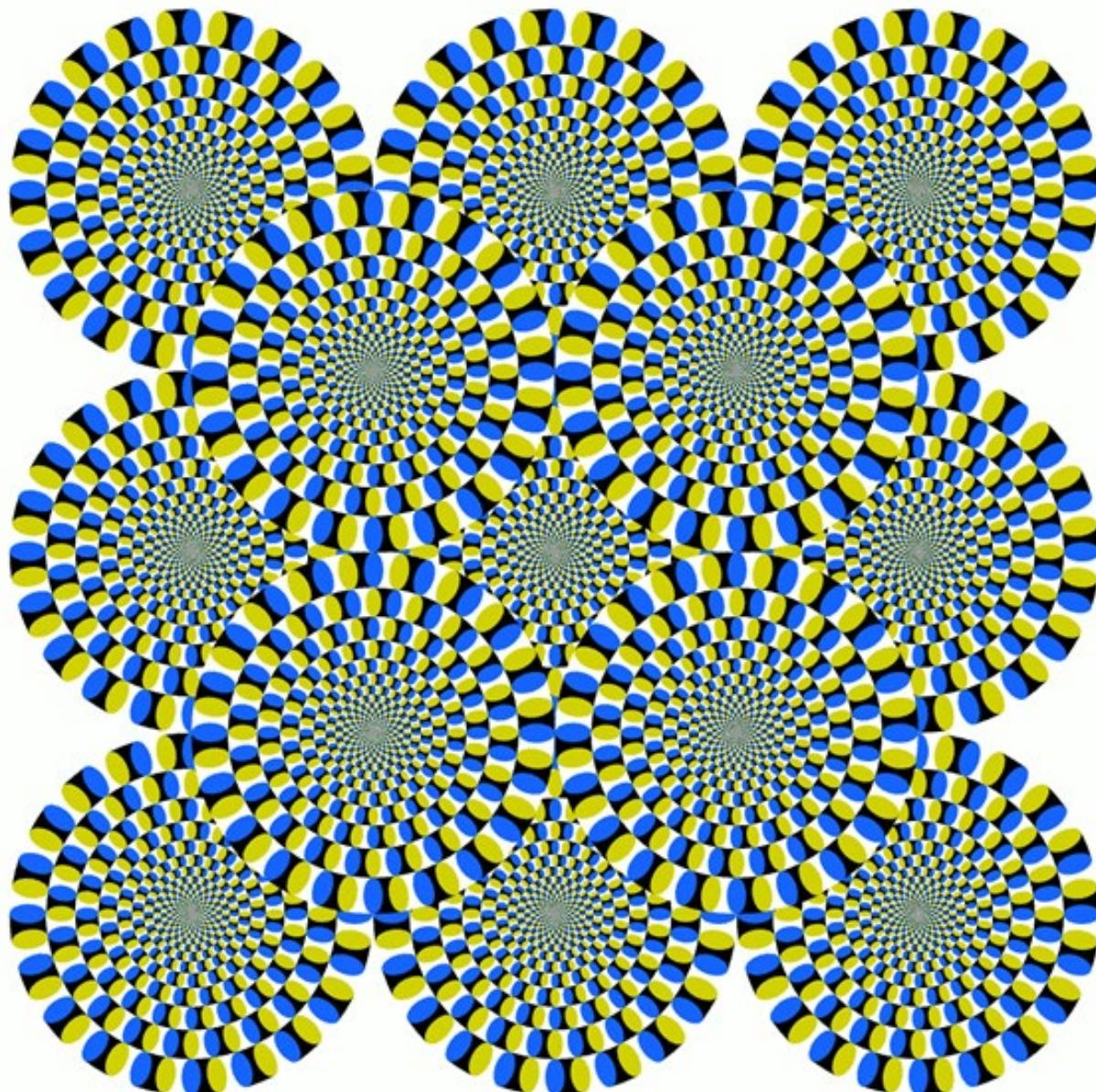


- This is the classic example of destructive clasp assembly design:
 - Distal rest with cast circlet retentive clasp to MB undercut.
- A class I lever lifts against the survey line exerting traction forces on the abutment tooth.

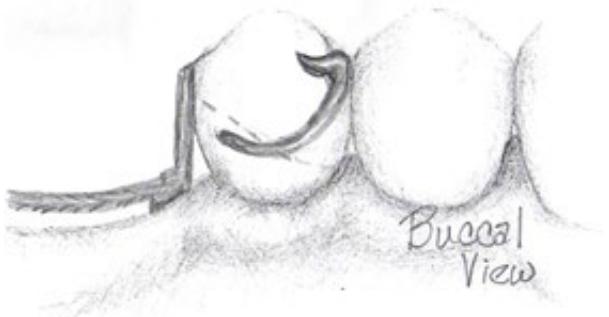
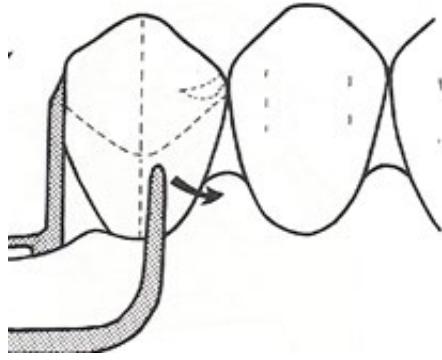
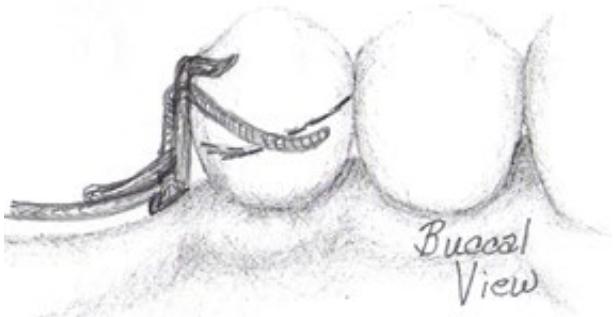
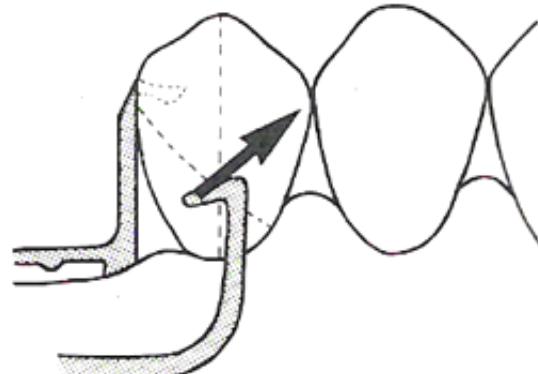
Besides movement of retentive tip, you must also consider movement of all components of clasp assembly during occlusal loading.

- Minor connectors
- Proximal plates
- Reciprocation
- Shoulders of retentive clasps

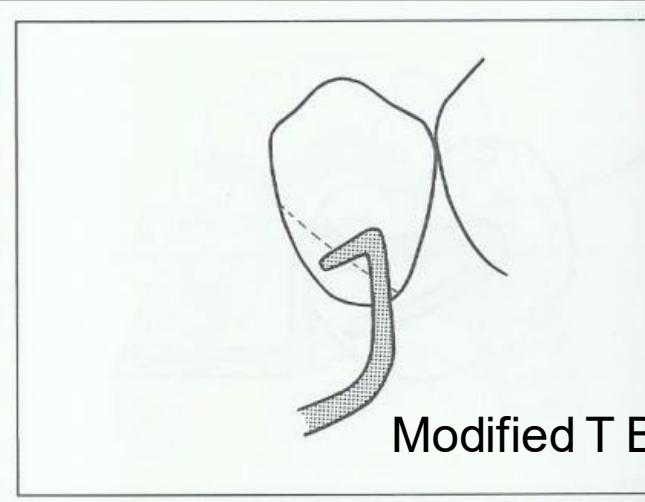
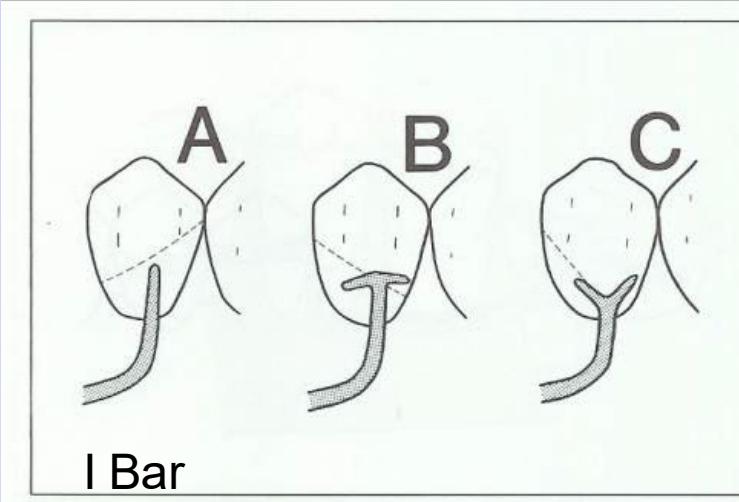




Options for DE clasp assemblies

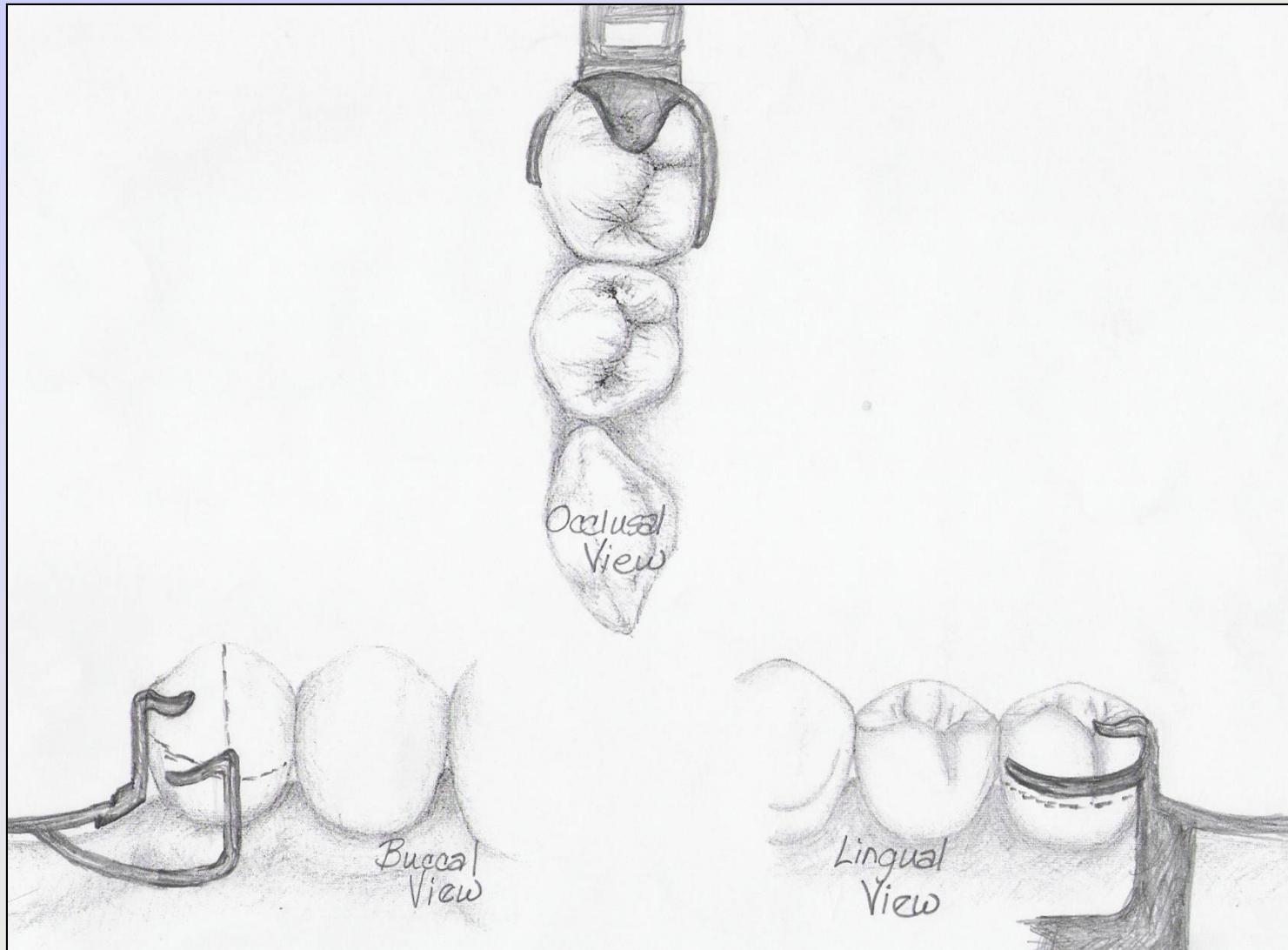
| Rest location \ Clasp type | Suprabulge | Infrabulge |
|----------------------------|---|---|
| Mesial | Reverse circlet  | I Bar  |
| Distal | Wrought wire  | Modified T bar  |

Infrabulge retainers: I Bar and Modified T Bar



- Approach retention from below rather from above survey line.
- Less tooth contact, some feel it is superior clasp to suprabulge.
- Contraindications:
 - Bony undercuts
 - Mucogingival defects
 - Cl V restorations
 - Interference of buccal frena

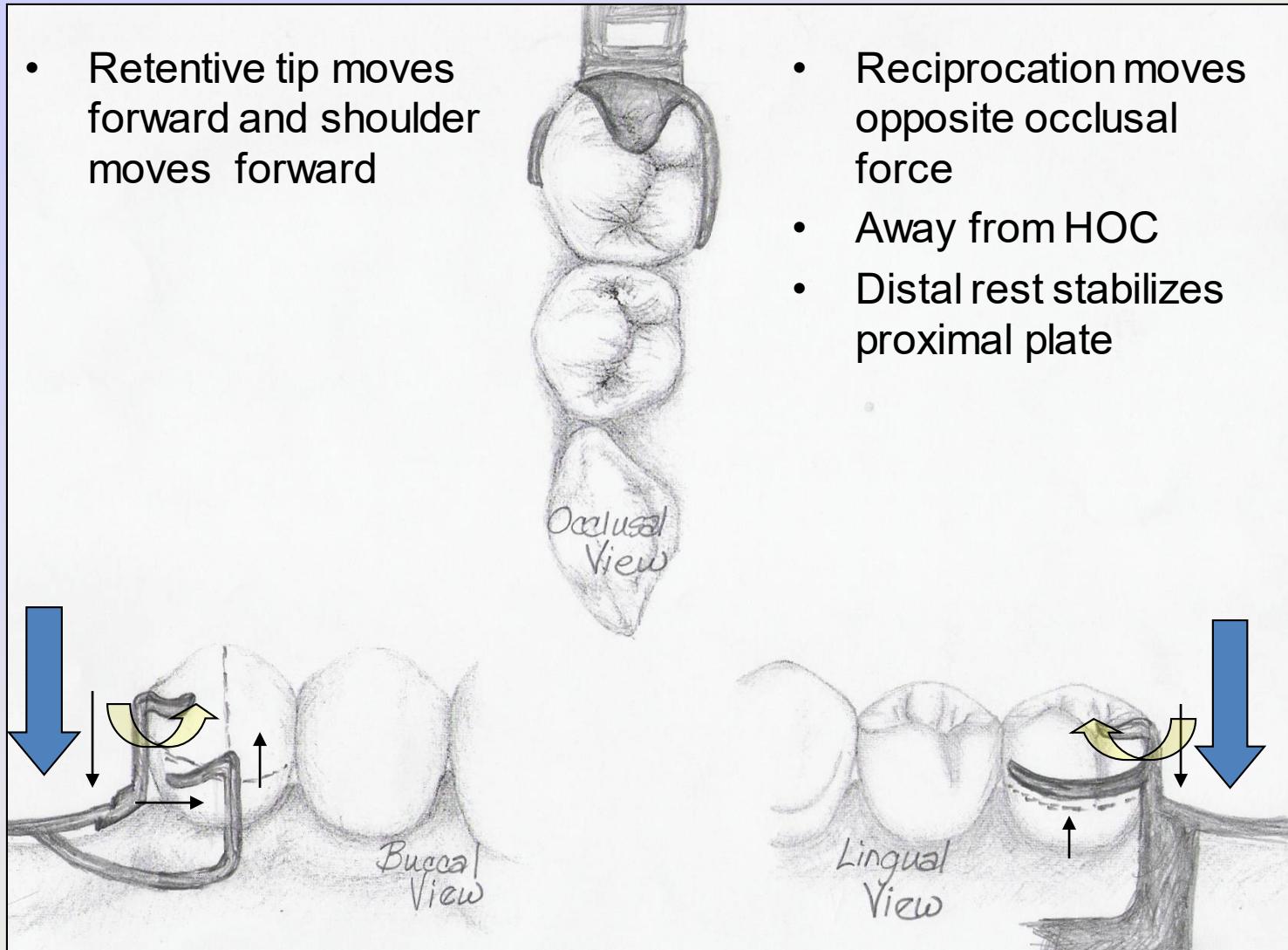
Modified T Bar



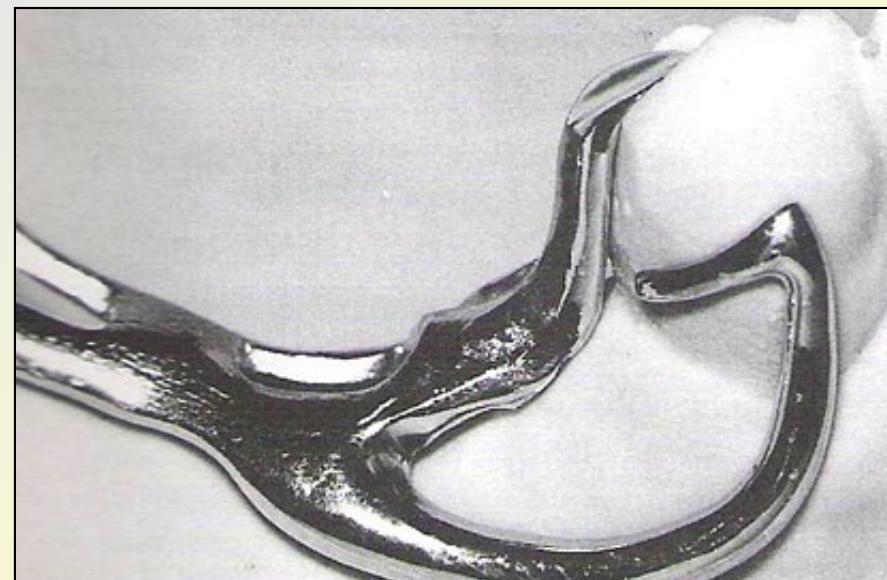
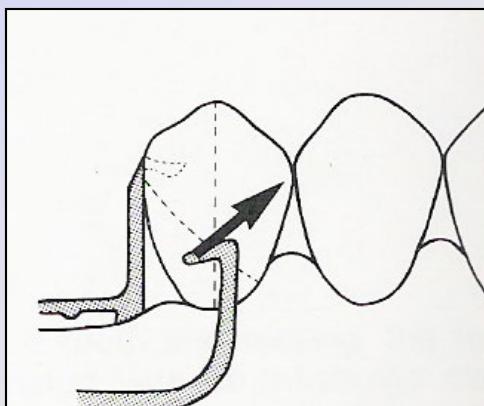
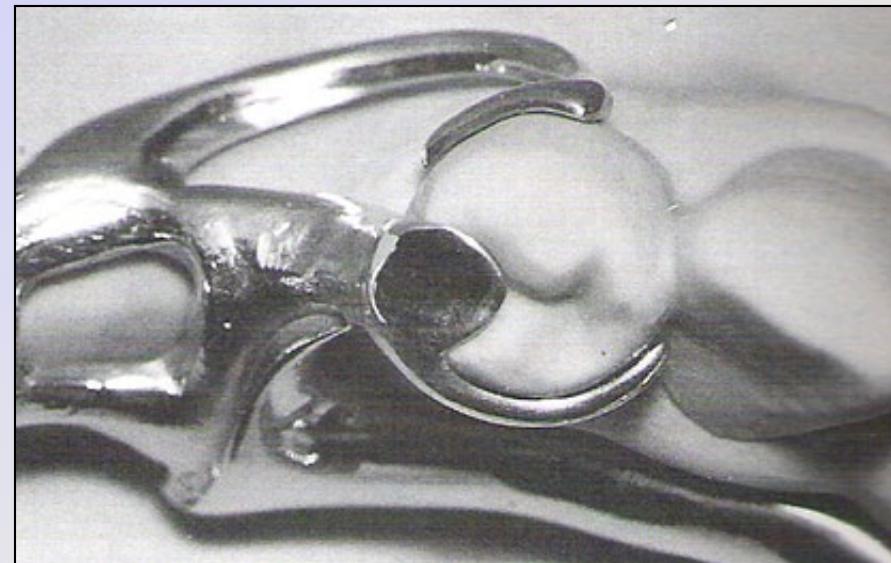
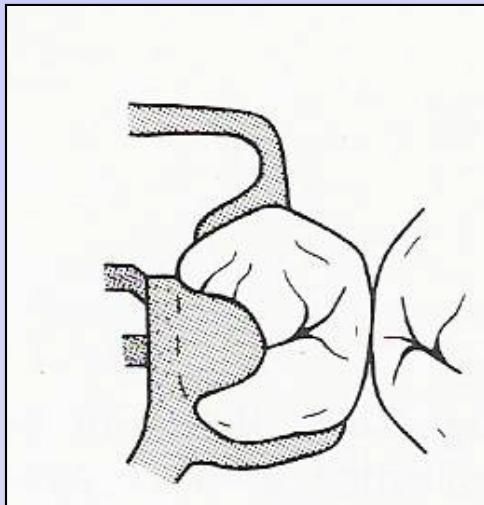
Modified T Bar

- Retentive tip moves forward and shoulder moves forward

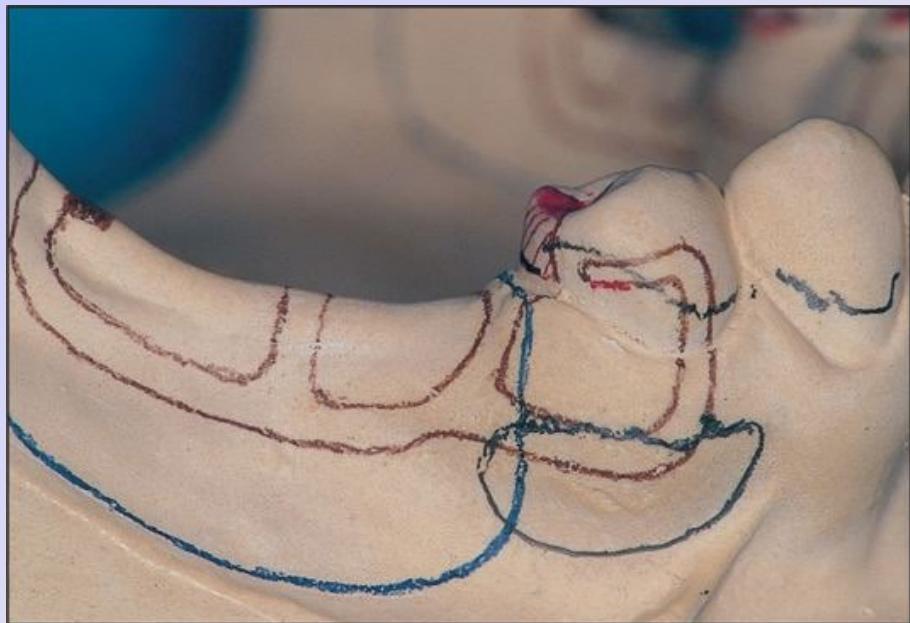
- Reciprocation moves opposite occlusal force
- Away from HOC
- Distal rest stabilizes proximal plate

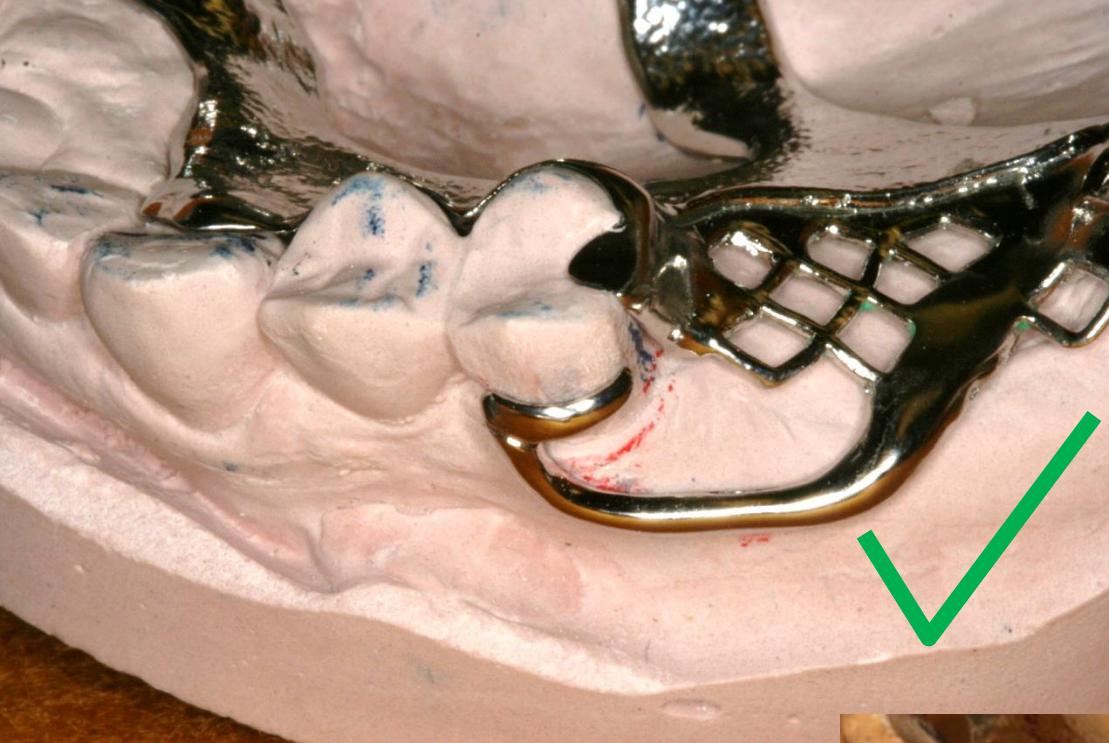


Modified T Bar



Modified T Bar





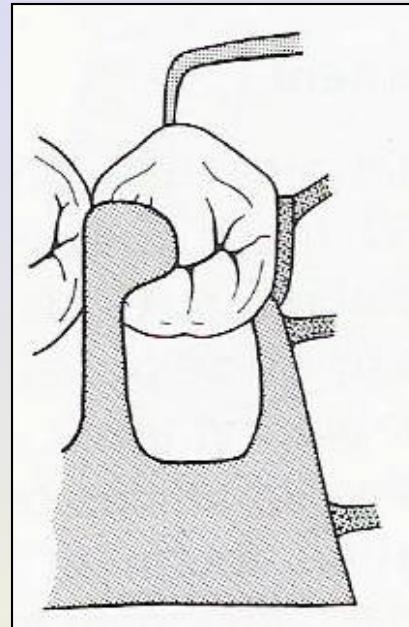
T bar
with
DO vs. MO rest

With MO rest...

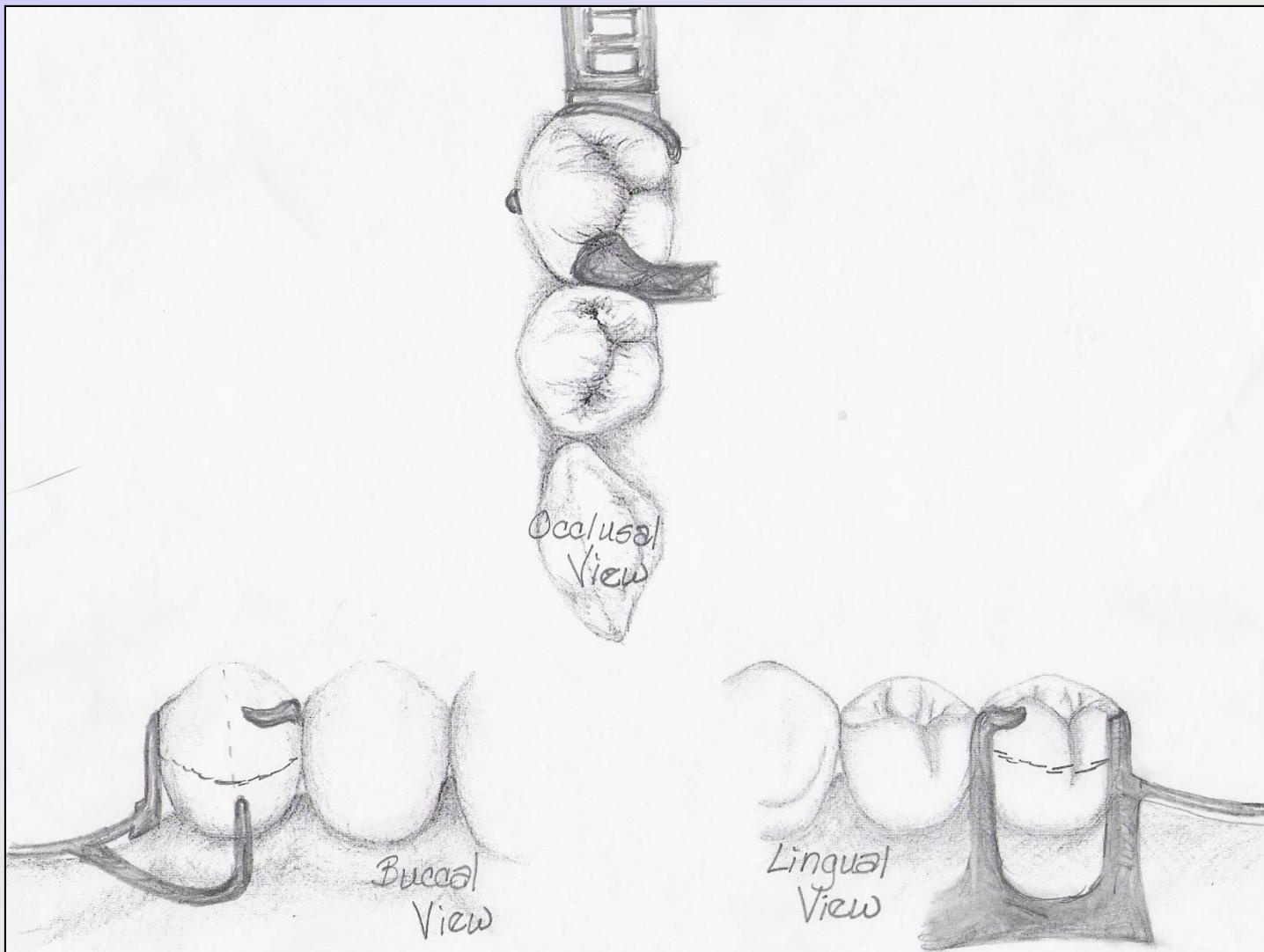
**Reciprocation moves downward toward HOC,
while retentive clasp disengages from tooth.
Could this cause buccal force?**



I Bar

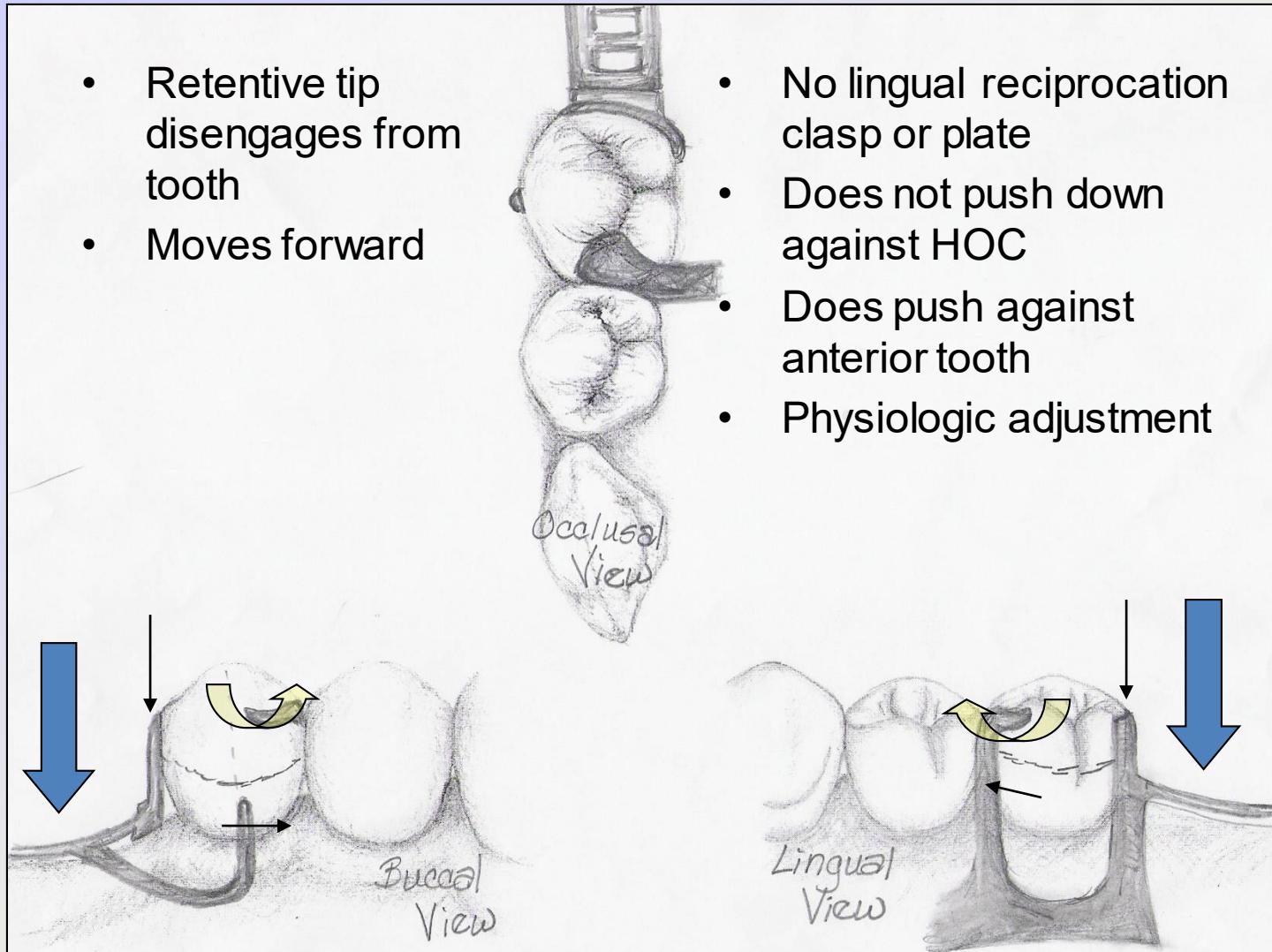


I Bar



I Bar

- Retentive tip disengages from tooth
- Moves forward
- No lingual reciprocation clasp or plate
- Does not push down against HOC
- Does push against anterior tooth
- Physiologic adjustment



Choosing DE clasp assemblies

| Clasp type | Suprabulge | Infrabulge Mucogingival issues Class V restorations High frena Bony undercuts |
|---------------|-----------------|---|
| Rest location | | |
| Mesial | Reverse circlet | I Bar |
| Distal | Wrought wire | Modified T bar |

Suprabulge: This row applies to rest locations above the gingival bulge (infrabulge). It includes the **Reverse circlet** clasp assembly for mesial rests and the **Wrought wire** clasp assembly for distal rests.

Infrabulge: This row applies to rest locations below the gingival bulge (suprabulge). It includes the **I Bar** clasp assembly for mesial rests and the **Modified T bar** clasp assembly for distal rests.

Clasp types:

- Reverse circlet:** A clasp that wraps around the mesial aspect of a tooth, forming a circular loop that extends buccally and lingually to grip the tooth structure.
- Wrought wire:** A clasp that uses a continuous wire loop to grip the mesial surface of a tooth, often with a small auxiliary arm extending into a undercut area.
- I Bar:** A clasp consisting of a vertical metal bar (the I-bar) that is attached to the mesial surface of a tooth and extends into a gingival undercut or a high frenum area.
- Modified T bar:** A clasp similar to the I-bar but with a horizontal extension (the T-bar) that provides additional support or engagement in a different area of the tooth preparation.

Rest locations:

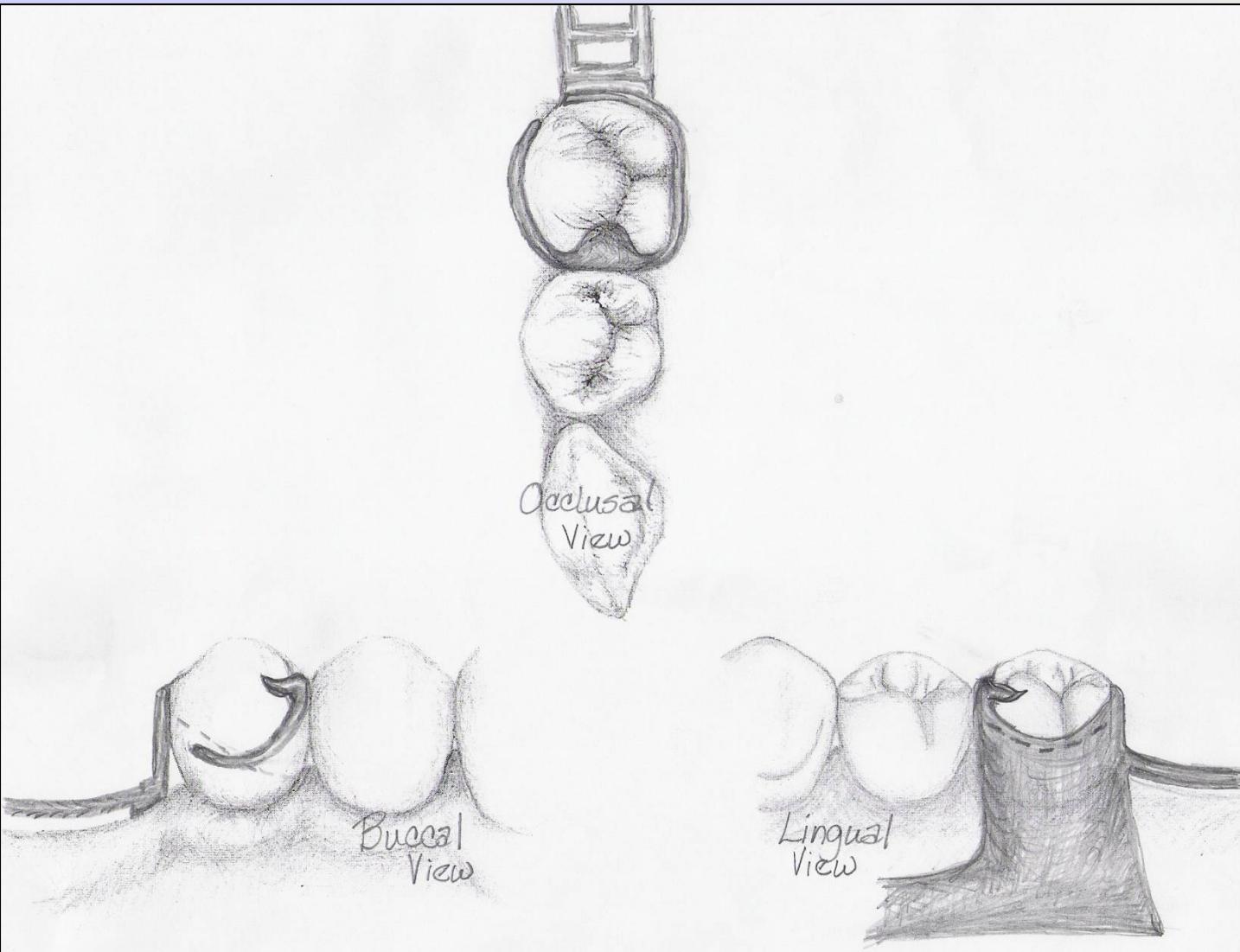
- Mesial:** Refers to a rest located on the mesial (towards the midline) surface of a tooth.
- Distal:** Refers to a rest located on the distal (away from the midline) surface of a tooth.

Indications:

- Suprabulge:** Rests located above the gingival bulge.
- Infrabulge:** Rests located below the gingival bulge.
- Mucogingival issues:** Problems related to the soft tissue (mucogingival junction) and bone support.
- Class V restorations:** Small, shallow restorations placed in the gingival or occlusal areas of a tooth.
- High frena:** A thick, tight band of tissue (frenum) originating from the gingiva and extending towards the midline.
- Bony undercuts:** Anatomical features where the bone is irregularly shaped, creating a depression or a ledge that must be avoided during clasp placement.

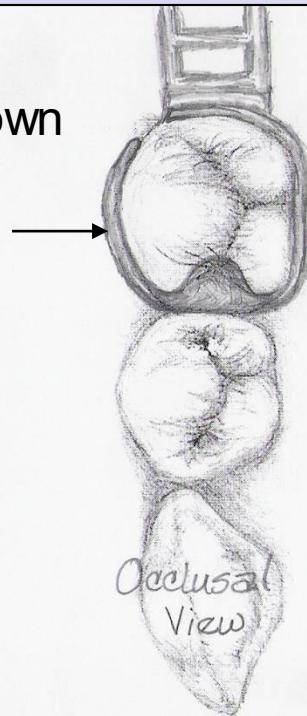
Suprabulge Retainers

Reverse Circlet

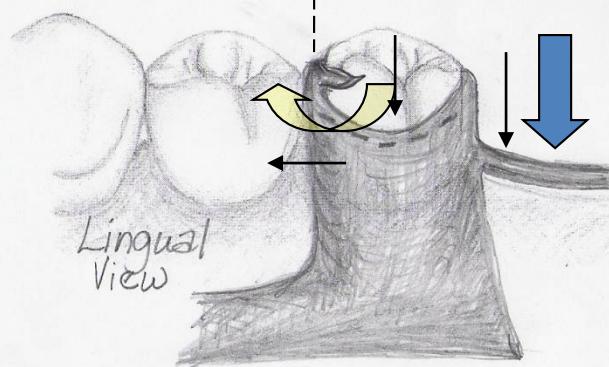
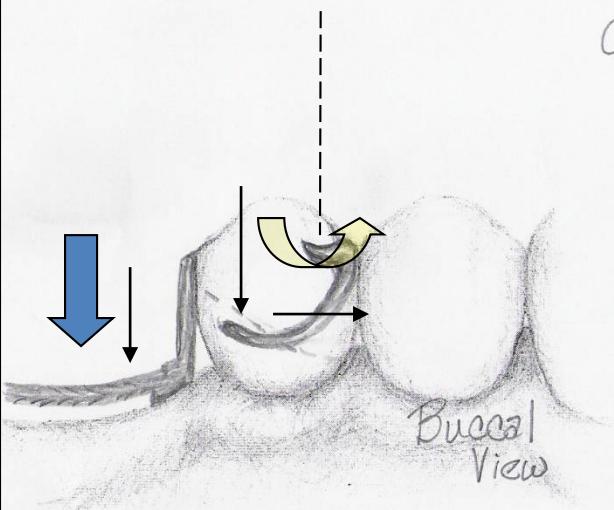


Reverse Circlet

- Retentive tip and shoulder move down and forward
- Must assume proximal plate displaces



- With mesial rest reciprocation moves downward with occlusal force –against HOC
- Retentive shoulder and reciprocation balance each other.
- Mesial edge moves forward against anterior tooth-Requires physiologic adjustment

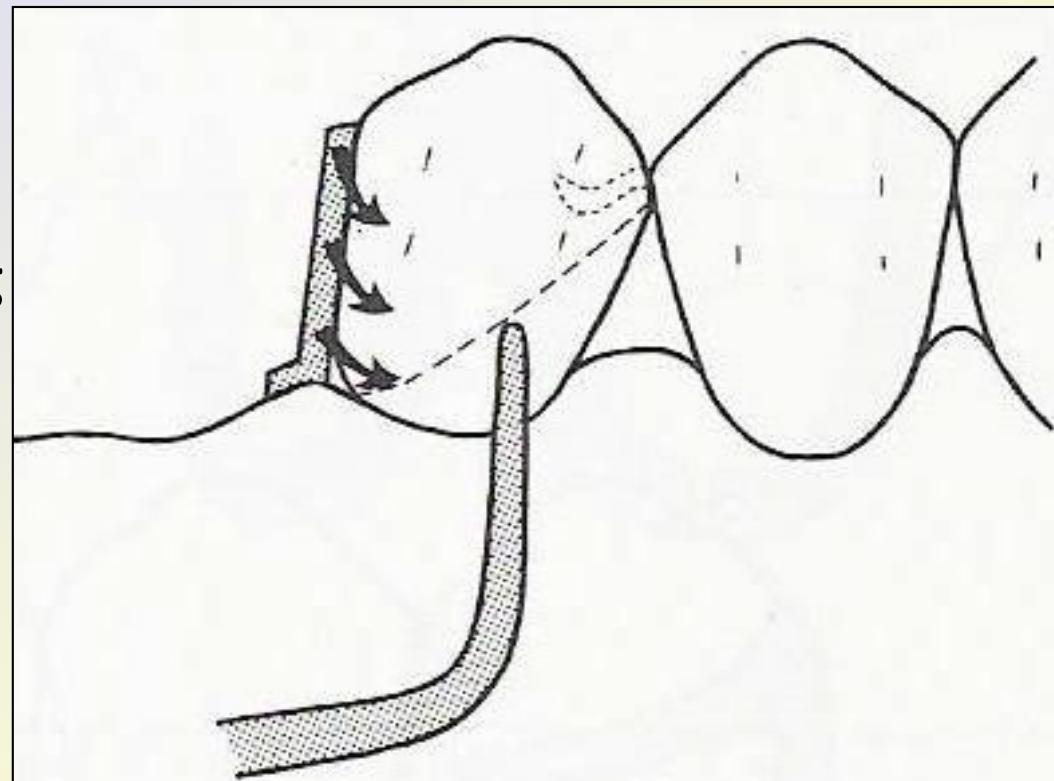
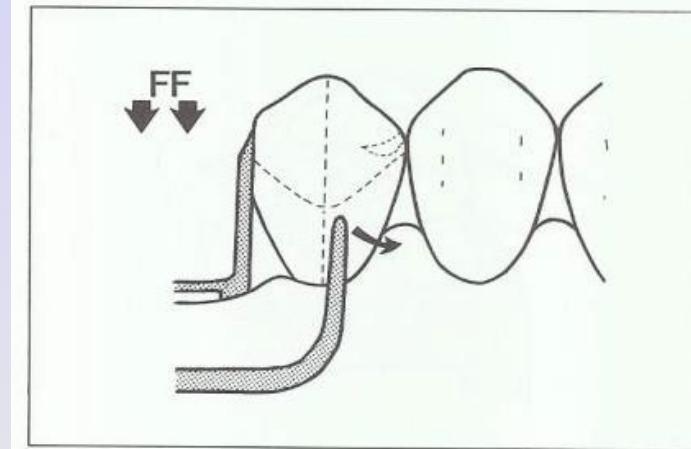


Reverse circlet as part of embrasure clasp assembly

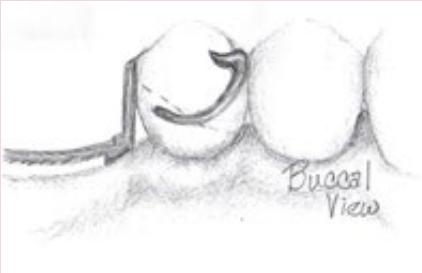
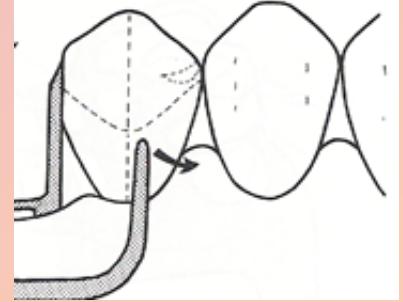
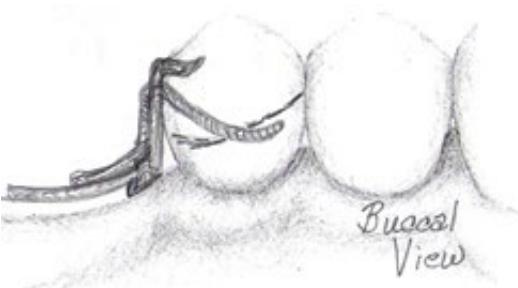
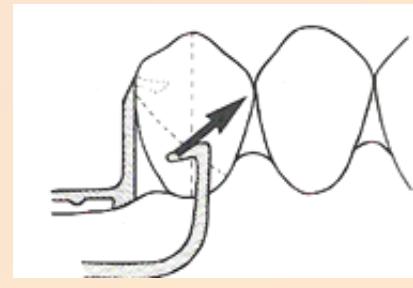


Mesial tilt:

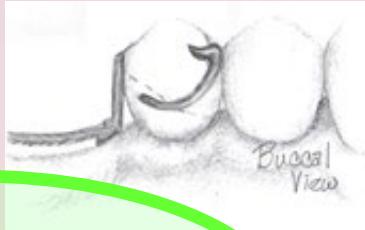
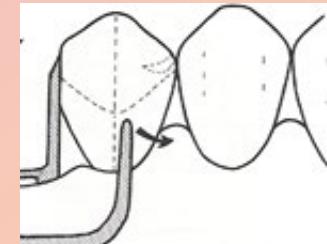
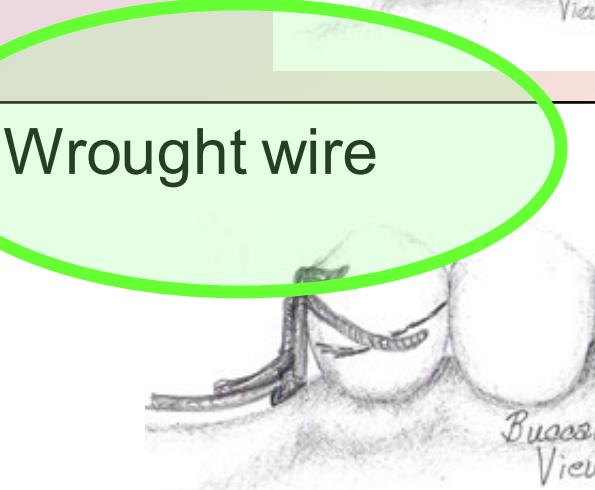
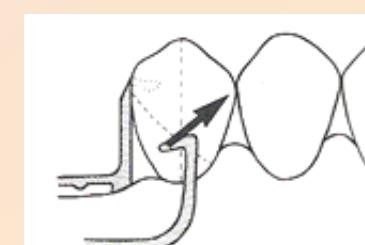
- A mesial rest allows more vertical movement during occlusal loading.
- There must be space for the proximal plate to have play during loading.
- A mesially tipped tooth provides no such space and causes destructive torquing stress to the abutment tooth.
- Therefore, mesial rests should not be used for distal extension RCAs on mesially tipped teeth.



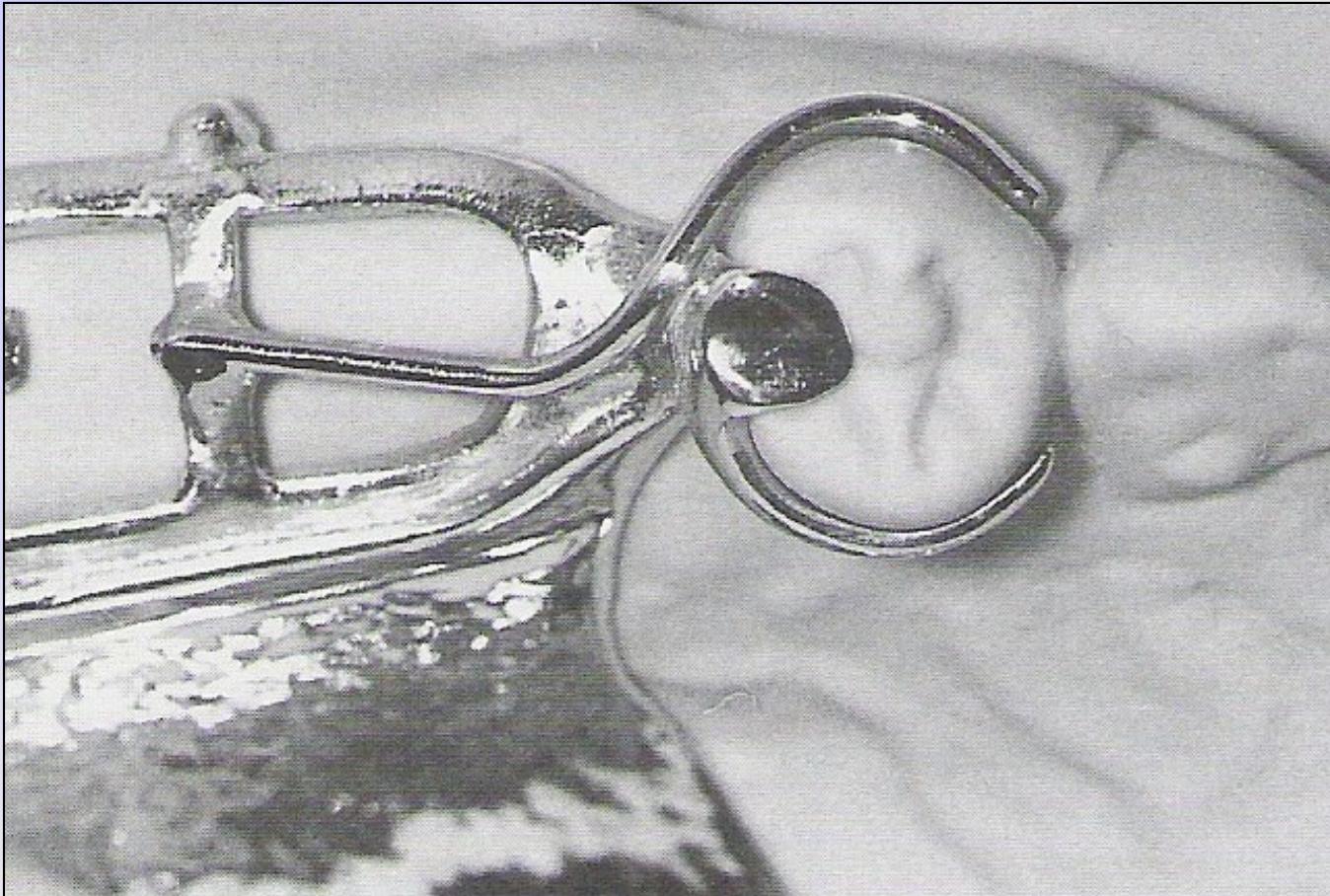
Choosing DE clasp assemblies

| Clasp type | Suprabulge | Infrabulge Mucogingival Class V restorations High frena Bony undercuts |
|-------------------------------------|---|--|
| Rest location Mesial tilt | Reverse circlet Occlusion  | I Bar  |
| Distal | Wrought wire  | Modified T bar  |

Choosing DE clasp assemblies

| | | |
|-------------------------------------|---|--|
| Clasp type | Suprabulge | Infrabulge Mucogingival Class V restorations High frena Bony undercuts |
| Rest location Mesial tilt | Reverse circlet Occlusion  | I Bar  |
| Distal | Wrought wire  | Modified T bar  |

Wrought Wire

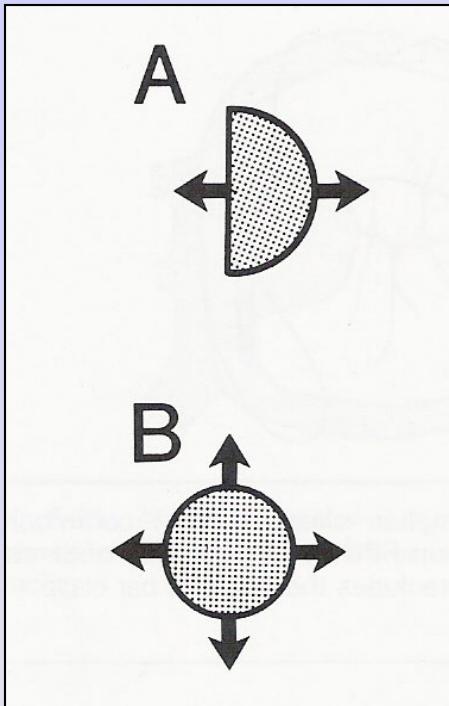


This is a class 1 lever!

However, the unique flexibility of WW clasps means they can be used in Class I lever situations.

- Wrought wire clasps are flexible due to:
 - Cross-sectional geometry
 - ROUND
 - The wire's material property
 - NOT AS STIFF AS CAST CLASP MATERIAL

Difference in flexibility of cast clasps vs. wrought wire clasps



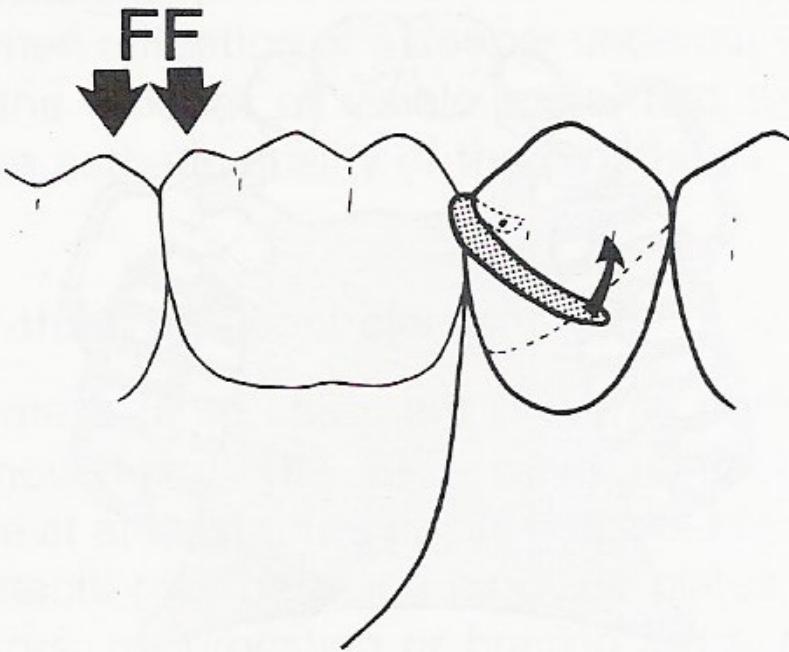
Cast clasps are made of less flexible material and can only allow deflection in lateral direction because of cross sectional geometry.

Wrought wire is more flexible material and deflect laterally and vertically. When it pushes up against HOC, it flexes and does not cause stress.

Protection of abutment tooth

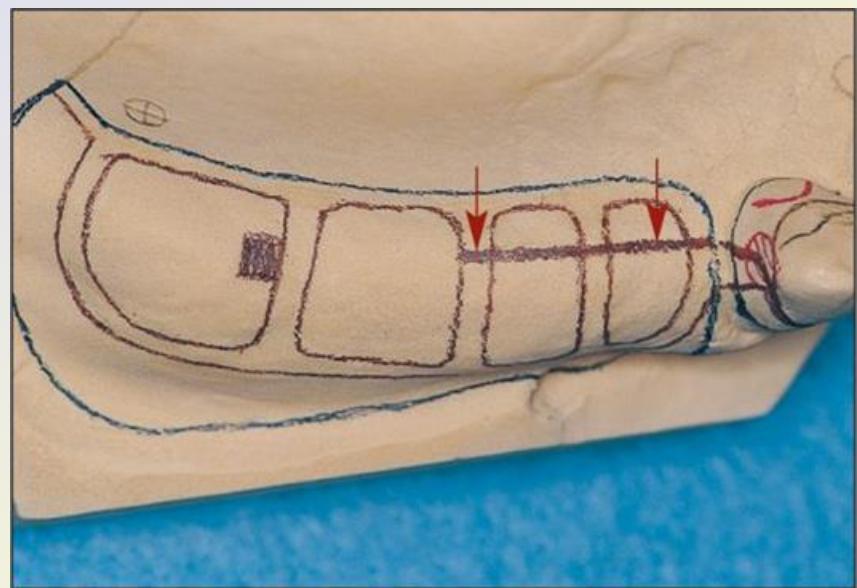
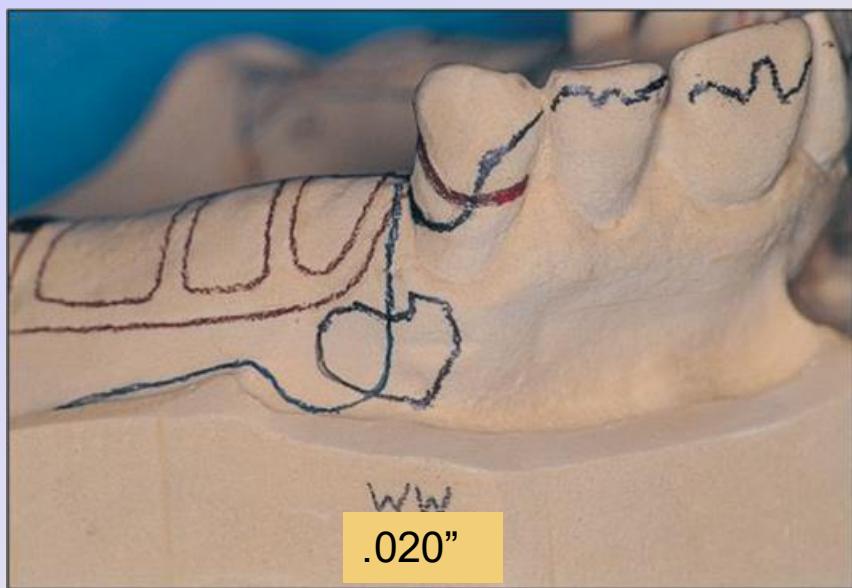
during occlusal loading

“Lifting” stresses should be eliminated/reduced.

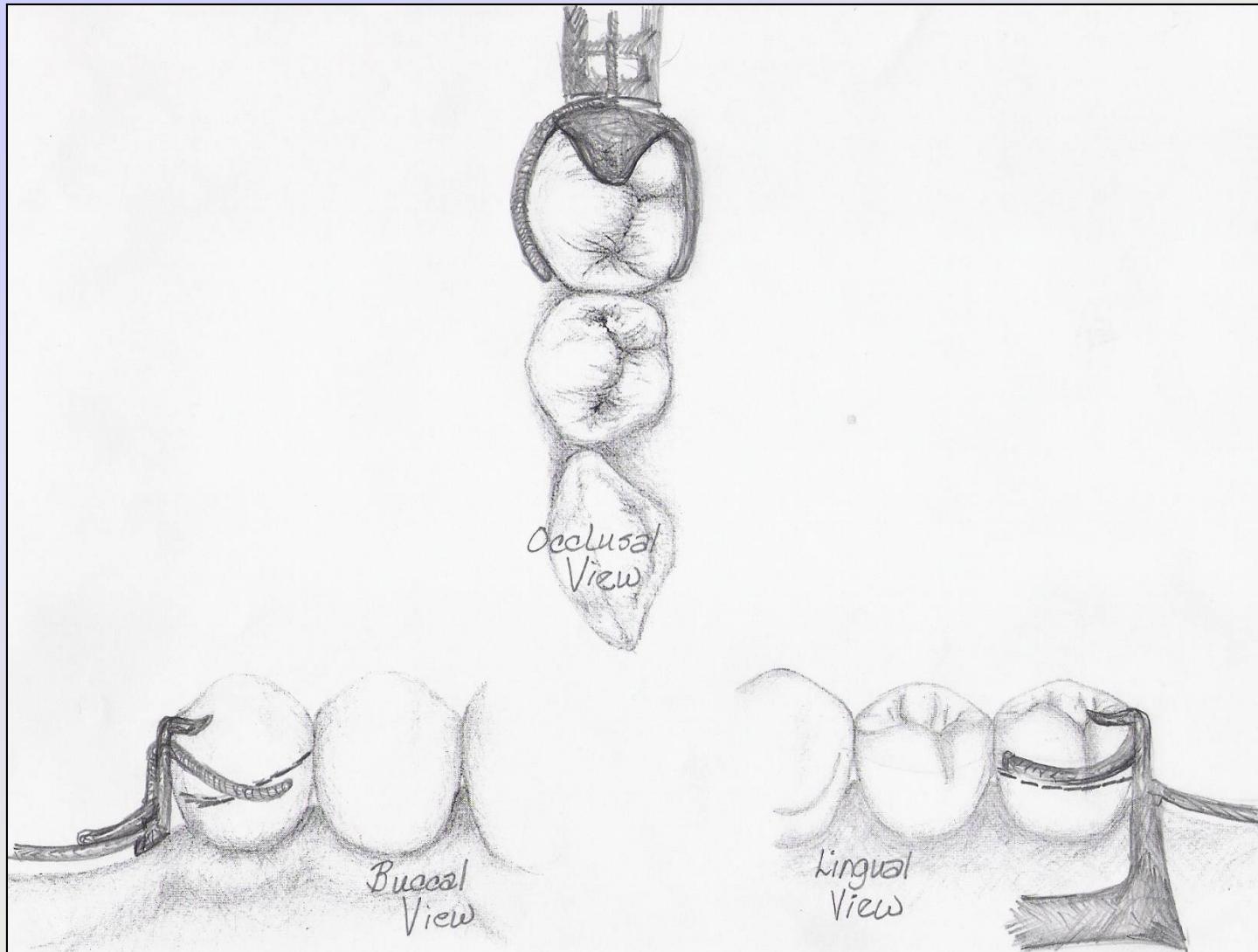


- This is the classic example of destructive clasp assembly design:
 - Distal rest with cast circlet retentive clasp to MB undercut.
- A class I lever lifts against the survey line exerting traction forces on the abutment tooth.

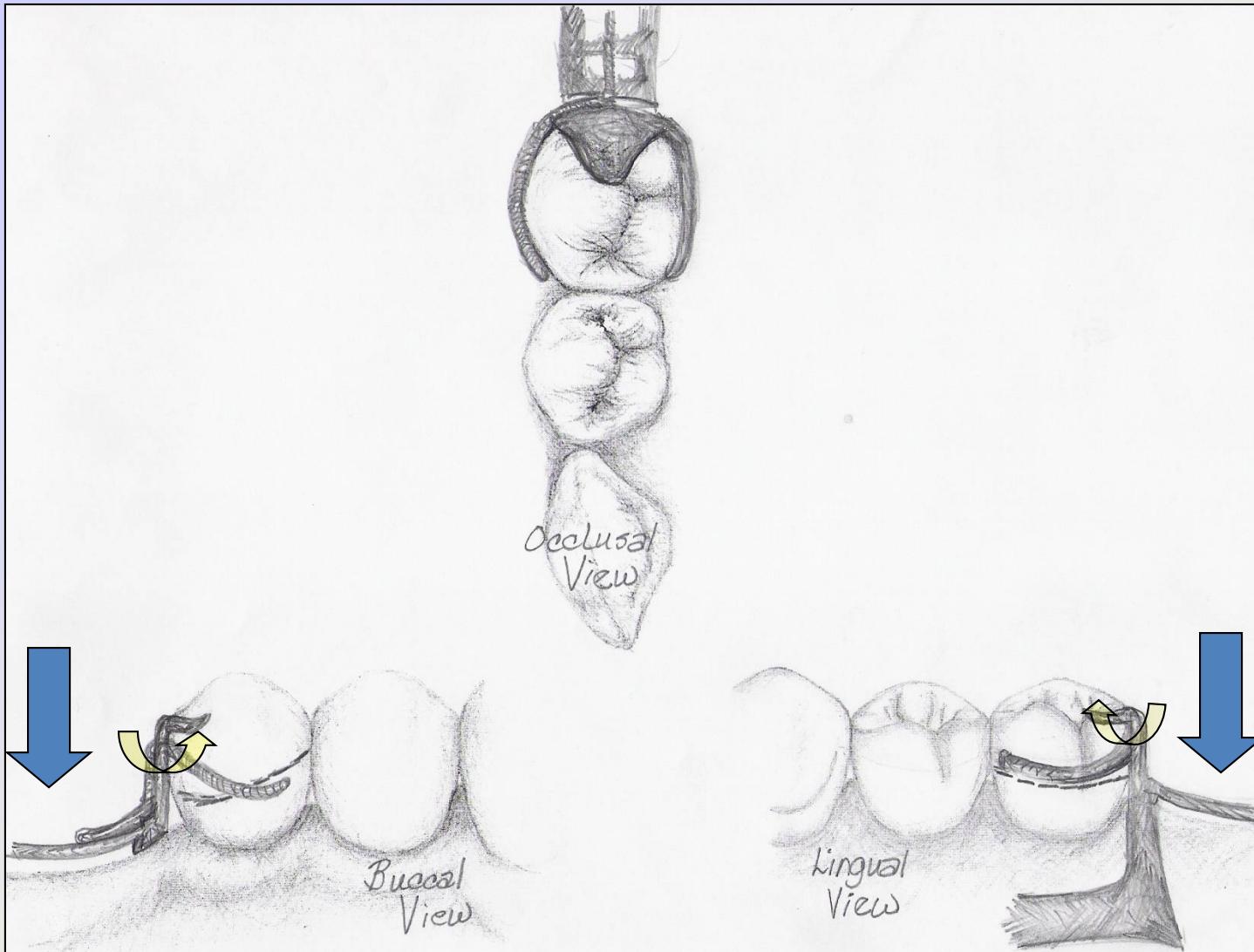
Wrought Wire Clasp



Wrought Wire



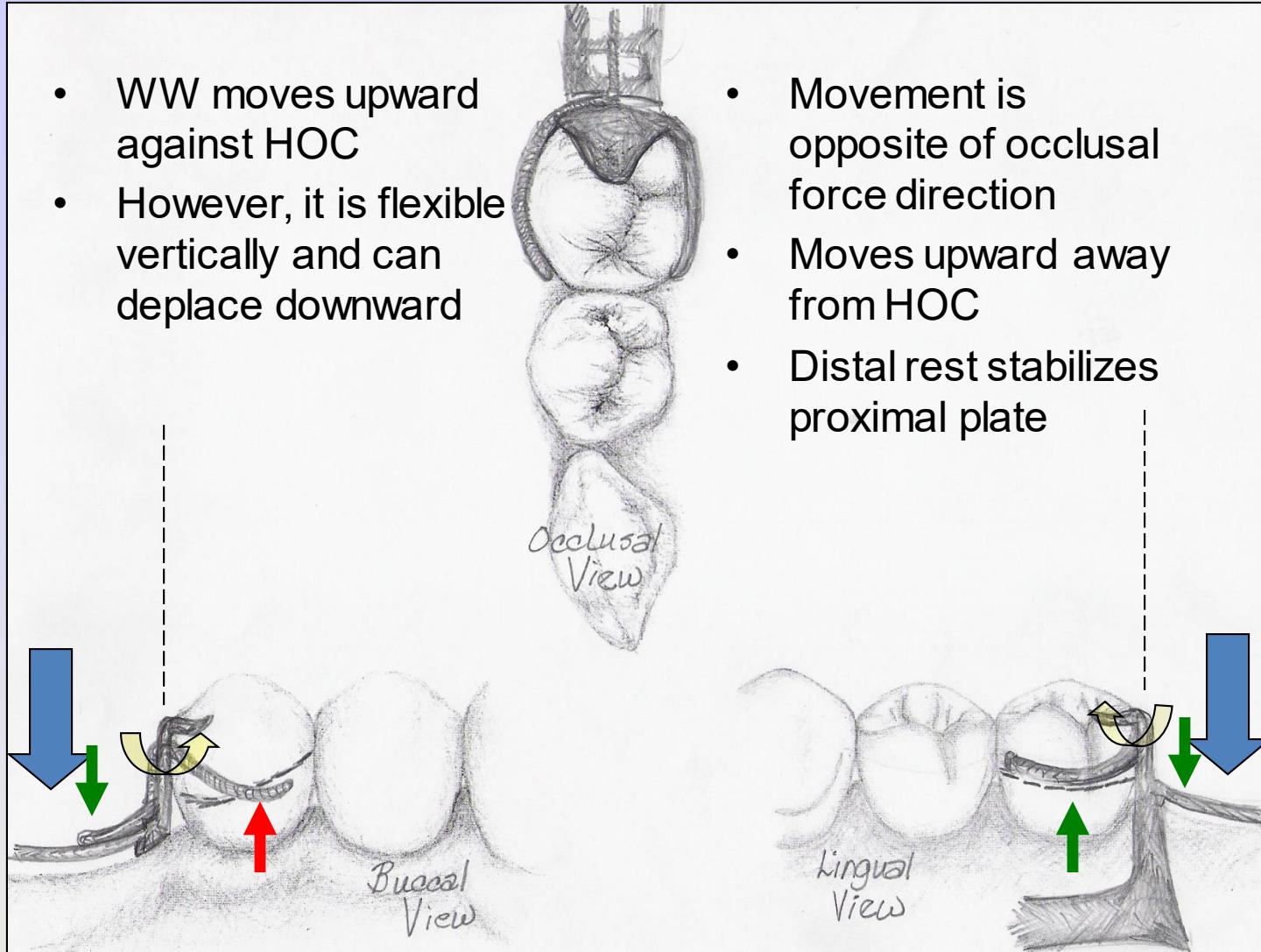
Wrought Wire



Wrought Wire

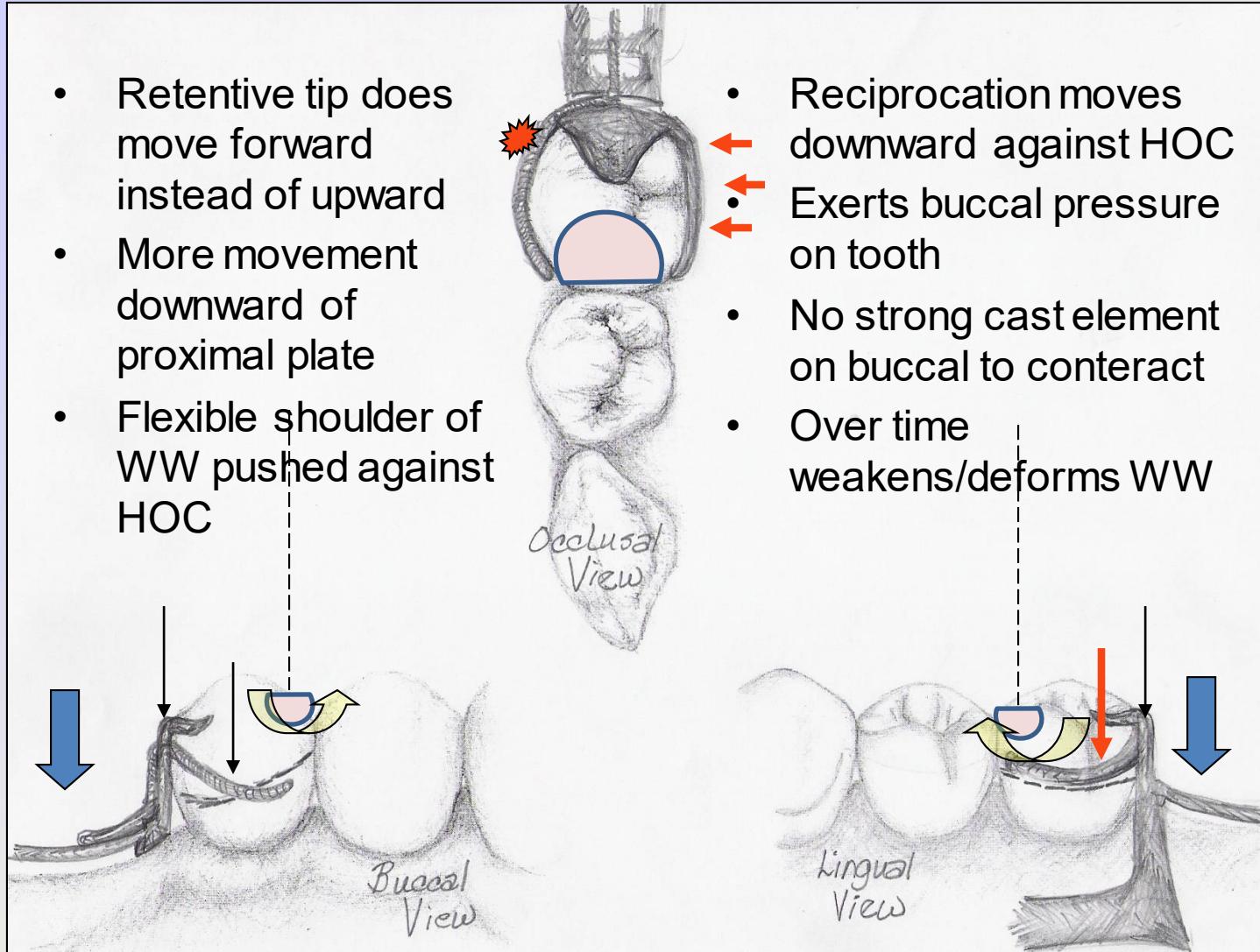
- WW moves upward against HOC
- However, it is flexible vertically and can displace downward

- Movement is opposite of occlusal force direction
- Moves upward away from HOC
- Distal rest stabilizes proximal plate



Wrought Wire with INCORRECT MO rest

- Retentive tip does move forward instead of upward
- More movement downward of proximal plate
- Flexible shoulder of WW pushed against HOC
- Reciprocation moves downward against HOC
- Exerts buccal pressure on tooth
- No strong cast element on buccal to counteract
- Over time weakens/deforms WW





Wrought wire with DO (right) vs MO (wrong) rest

Rigid reciprocation moves downward toward HOC, while shoulder of flexible WW also moves down toward HOC.

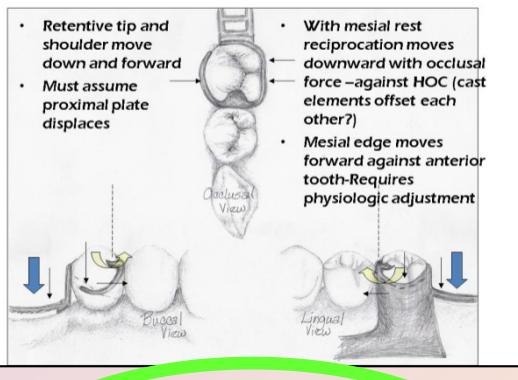
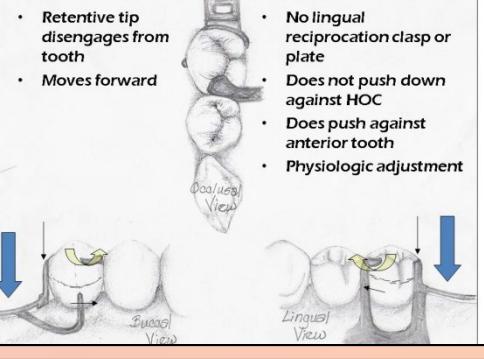
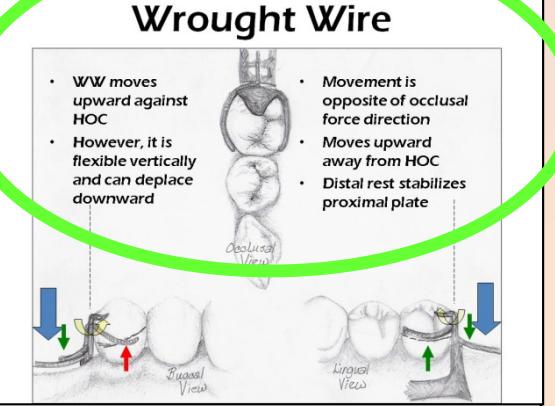
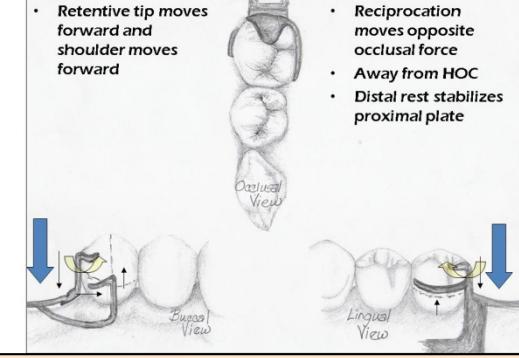
Could this result in buccal movement and deformation of WW?



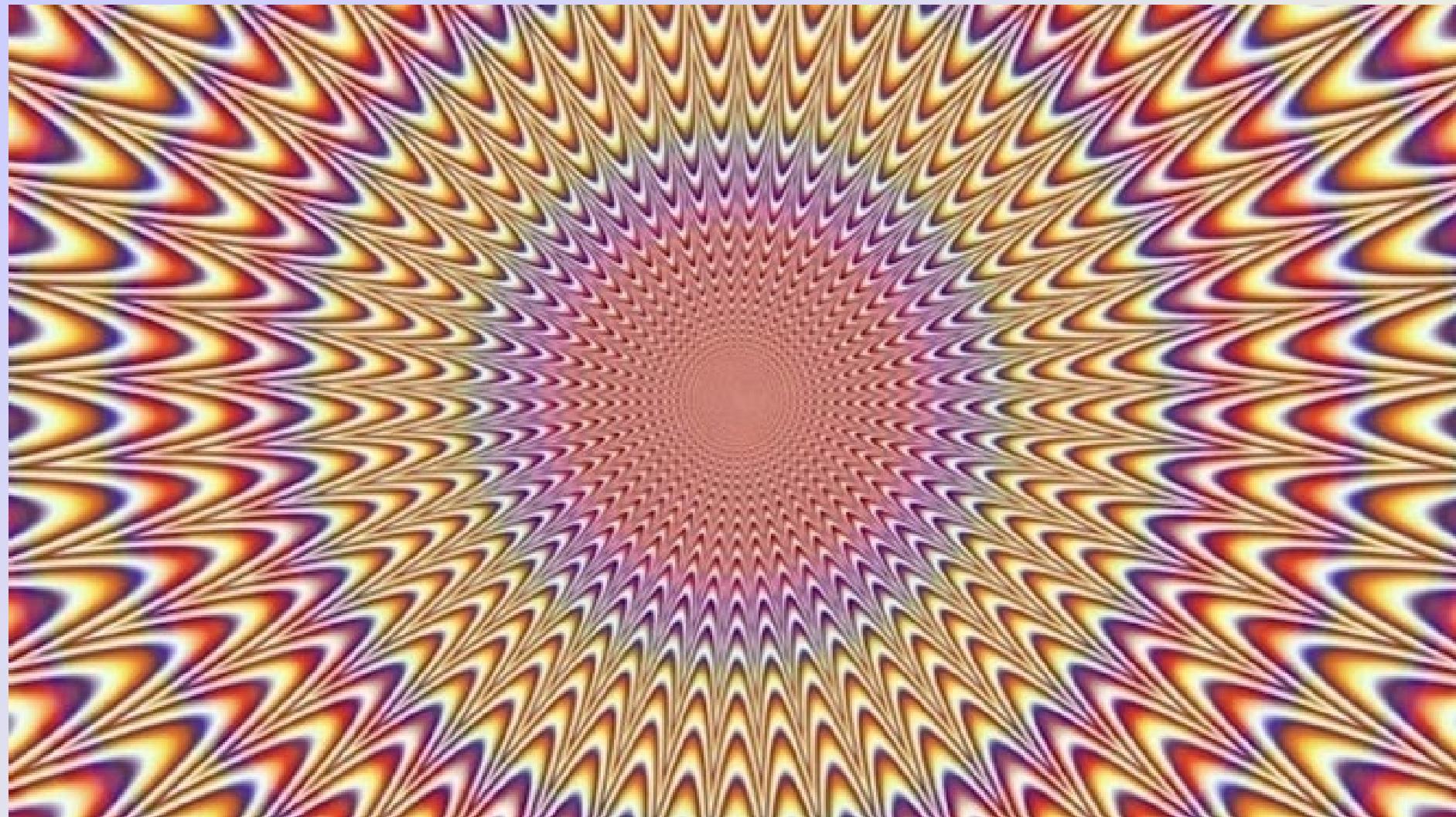
What an MO rest w/ WW allows to happen biomechanically.



Choosing DE clasp assemblies

| Clasp type | Suprabulge | Infrabulge |
|------------------------------|--|--|
| Rest location* | | Mucogingival undercuts Bony Class V restorations High frena |
| Mesial Mesial tilt | Can be unacceptable due to occlusal interference |  <ul style="list-style-type: none"> Retentive tip and shoulder move down and forward Must assume proximal plate displaces With mesial rest reciprocation moves downward with occlusal force –against HOC (cast elements offset each other?) Mesial edge moves forward against anterior tooth-Requires physiologic adjustment |
| Distal | Often becomes only remaining option |  <ul style="list-style-type: none"> No lingual reciprocation clasp or plate Does not push down against HOC Does push against anterior tooth Physiologic adjustment |
| | |  <ul style="list-style-type: none"> WW moves upward against HOC However, it is flexible vertically and can displace downward Movement is opposite of occlusal force direction Moves upward away from HOC Distal rest stabilizes proximal plate |
| | |  <ul style="list-style-type: none"> Retentive tip moves forward and shoulder moves forward Reciprocation moves opposite occlusal force Away from HOC Distal rest stabilizes proximal plate |

*Rotational center location



Cape Creek Bridge

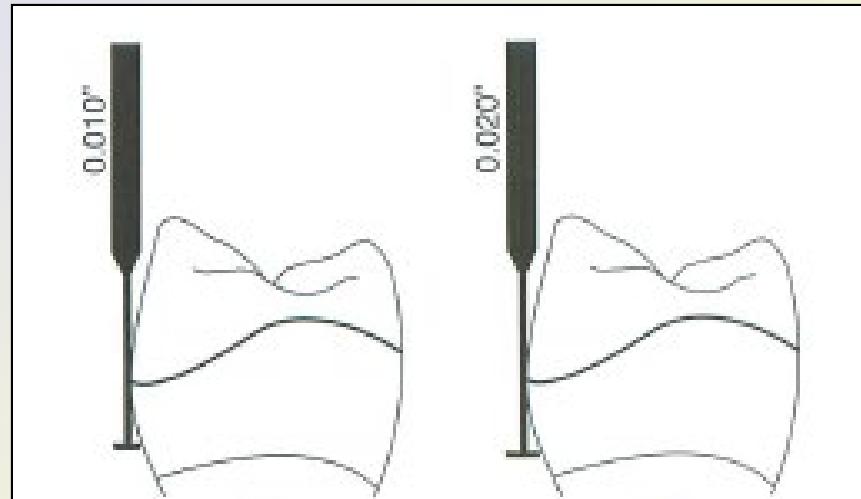


Design Notes

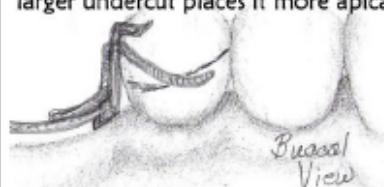
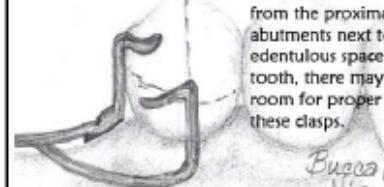
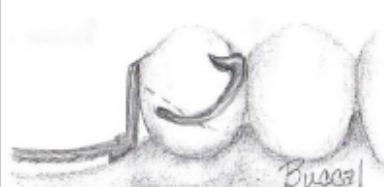
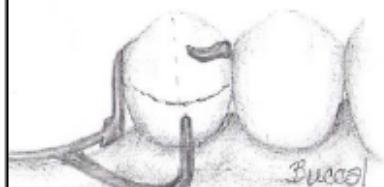
- Symmetry is desirable whenever possible.
- Know bilateral, tripodal, or quadralateral RCA configurations for Kennedy classes(p. 107)

Thousandths of an inch= a “mil”

- Engineering and manufacturing terminology.
- Describes thickness of thin items such as paper, wires, fibers.
- A plastic ID card is 30 mils, or 0.030”.
- $0.010" = \sim \frac{1}{4} \text{ mm.}$

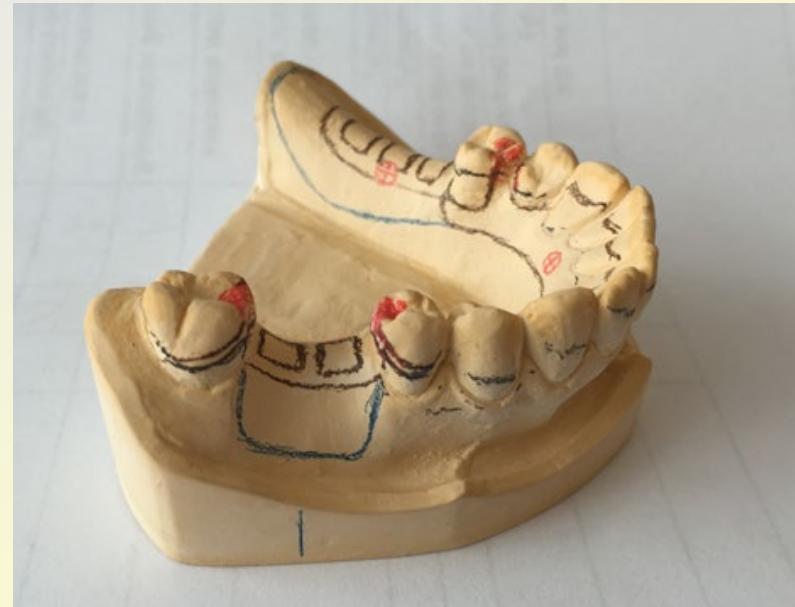


Rules are for posterior abutment what happens with anterior abutments

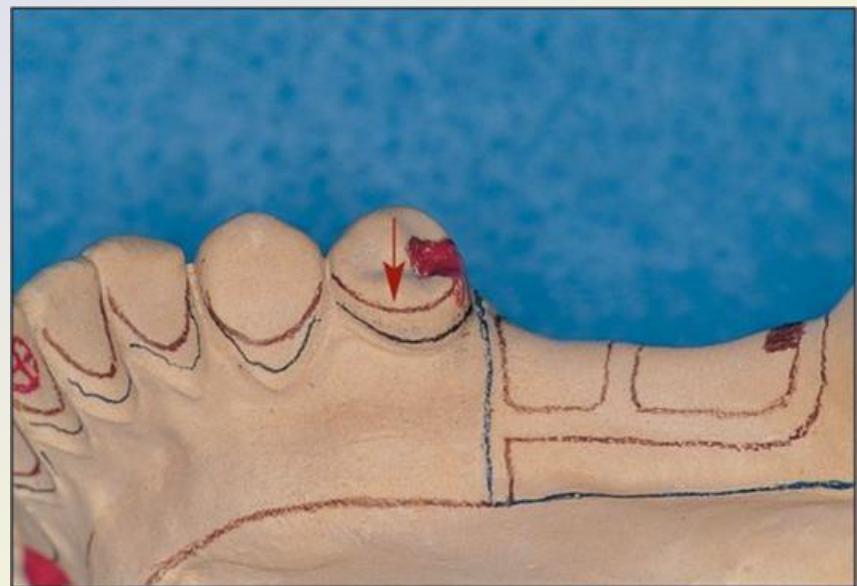
| Clasp assemblies by: | | SUPRABULGE | INFRA BULGE |
|----------------------|--|---|--|
| | Retentive clasp Rest location | May need to adjust survey line for shoulder. Unesthetic | Esthetic... But, cannot be used if: High frena attachment Mucogingival defect Bony buccal undercut CI V restoration |
| DISTAL REST | WW More stress to tissue, less stress to tooth. More esthetic than cast circlet because larger undercut places it more apically. | WW More stress to tissue, less stress to tooth. More esthetic than cast circlet because larger undercut places it more apically.  | MOD T BAR  |
| | Less vertical movement. Clasps move opposite occlusal load. | | |
| MESIAL REST | REVERSE CIRCLET May have difficulty with occlusal clearance. |  | I BAR Special requirements for reciprocation elements and distal guiding plane. Physiologic adjustment.  |
| | More vertical movement. Distal plate and clasps move same direction as occlusal load. Cannot use on mesially tipped tooth. | | |

Lingual surfaces

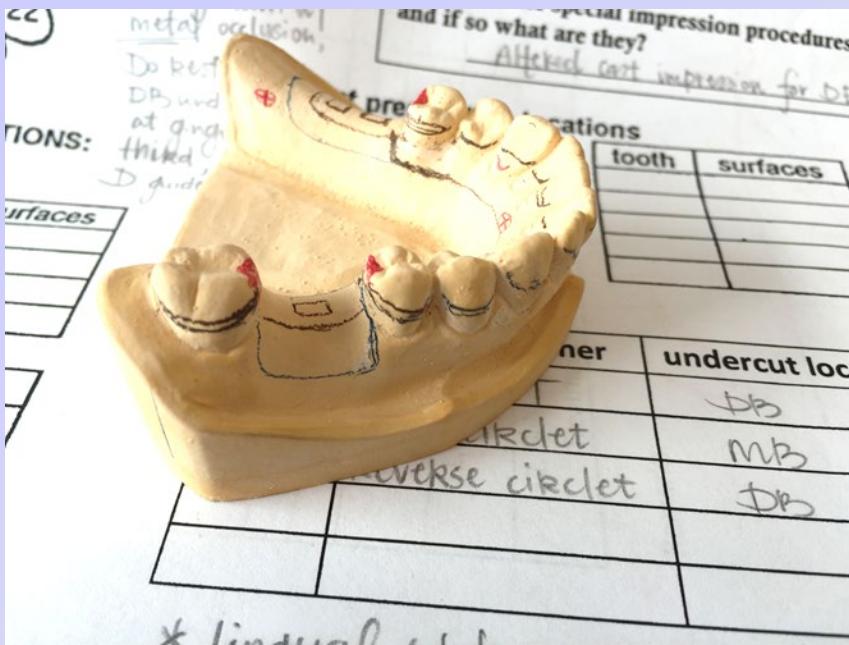
- Either have plate or clasp-not both.



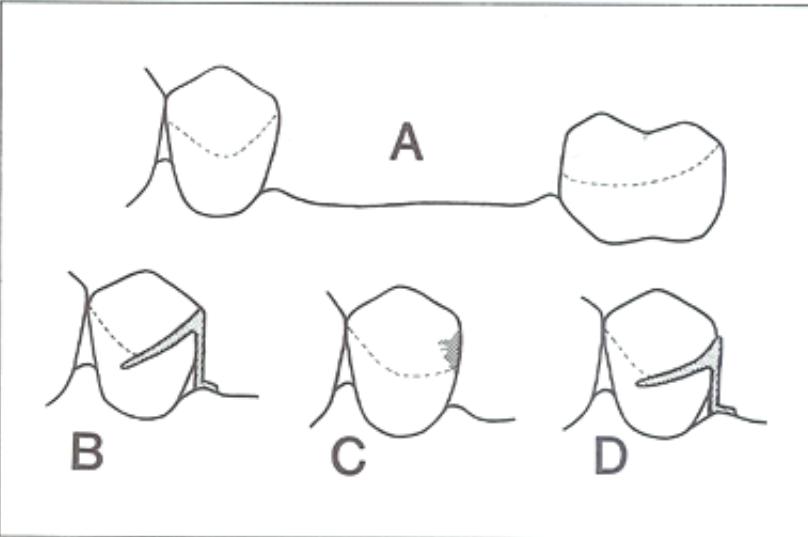
Lingual Clasp and Lingual Plate



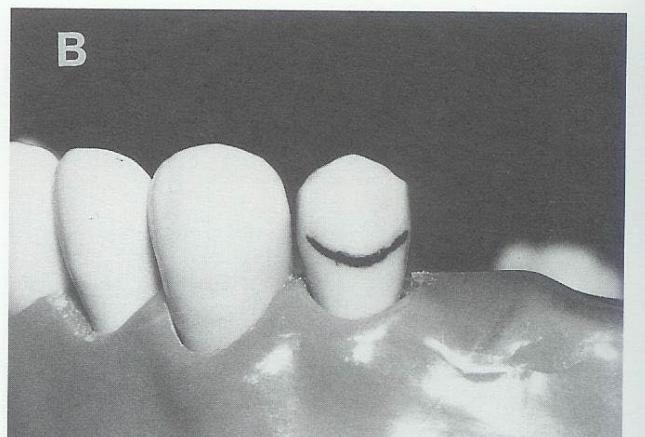
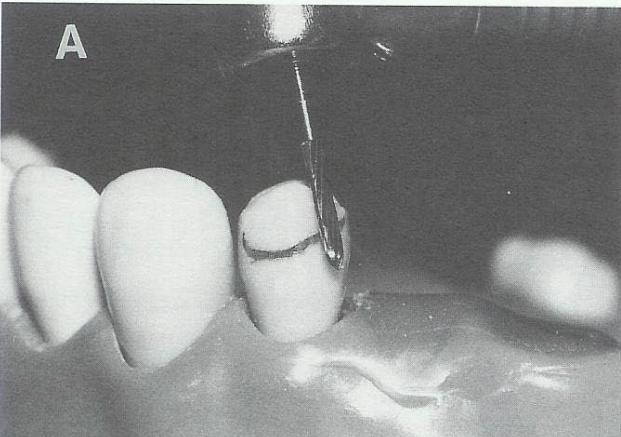
ERRORS



Modify Survey Lines: Direct Retainers



- Shoulder of circlet clasp must stay above survey line.
- This can put the clasp shoulder very high on tooth if survey is also high.
- Recontour to lower survey line so non flexible shoulder can lay lower on tooth.



“Enhancing retentive undercuts”

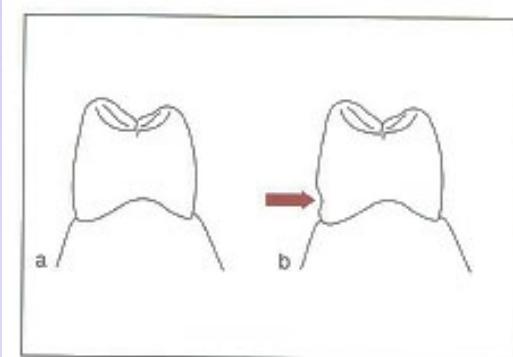


Fig 10-34 (a) The facial and lingual surfaces of the tooth are relatively vertical. (b) As a result, a gentle depression (arrow) may be created. In this instance, the depression has been created on the facial surface.

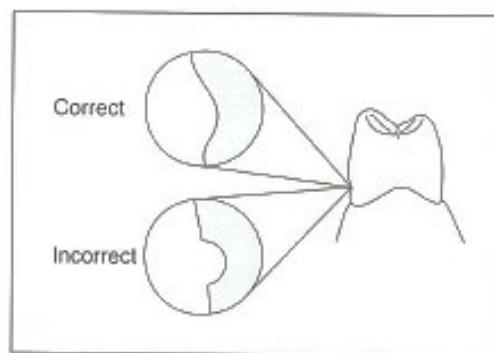


Fig 10-35 A depression should exhibit smooth, flowing contours. Sharply defined dimples and pits should be avoided since retentive clasps cannot flex into and out of these indentations.



Fig 10-36 A gentle depression is prepared using a round diamond bur in a high-speed handpiece. The bur is moved in an anteroposterior direction (arrow).



Fig 10-37 The preparation is smoothed using a carbonundum-impregnated rubber point in a low-speed handpiece. Care must be taken not to obliterate the depression.

North Bend, Oregon

