Biomechanical Principles of Tooth Preparation

Lecture 2

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Third stage

Aims of lecture

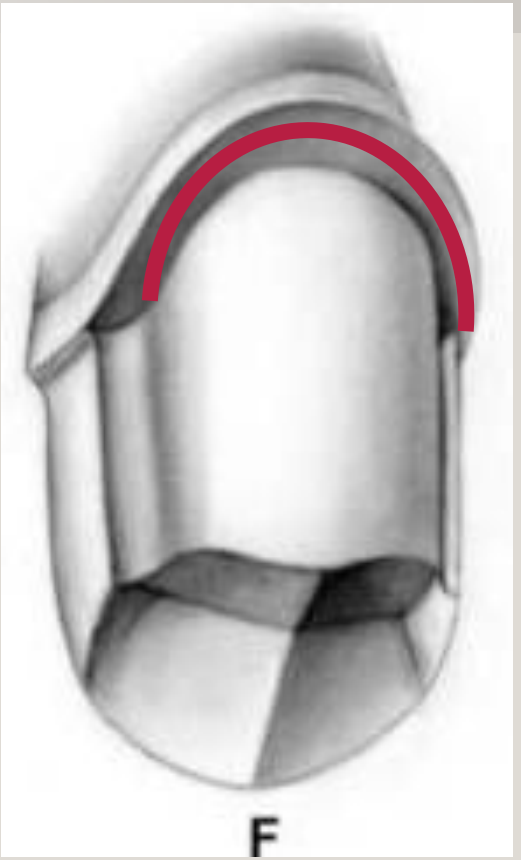
1. How can you prepare tooth to restore it with crown?
2. How can you protect the tooth structure?
3. How can you get the retention and resistance forms of restoration?
4. Is there any correlation between thickness of restoration and dental preparation?

Tooth Preparation

- It is the cutting procedure on the tooth during the crown construction procedure.
- The prepared tooth is the final shape of the tooth after the preparation procedure.
- Rotary instruments are used to reduce the height and contour of the tooth.
- The aim of tooth preparation is that crown restoration can slide into place and be able to withstand the forces of occlusion.

Finish line (FL) of the preparation

- It is a line that separates between the prepared and the unprepared tooth portions.
- It represents the end margin of the preparation.
- It should be smoothly continuous from one surface to the other; otherwise, it will interfere with the seating of the crown if it is poorly done.



The main objectives of tooth preparation

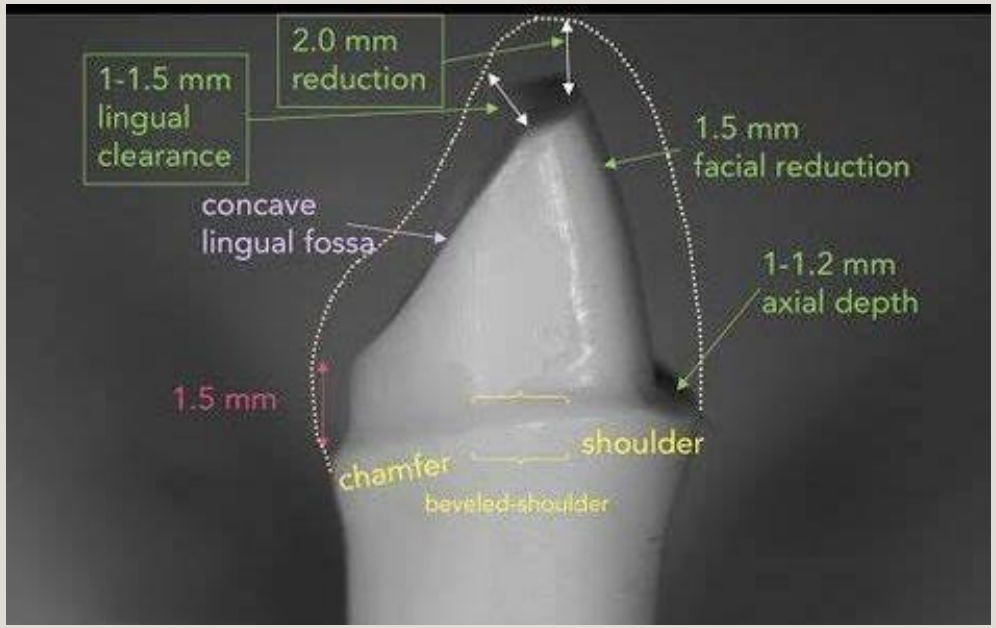
1-To eliminate undercuts from the axial surfaces of the tooth.

Note: The axial surfaces are the facial (labial or buccal), proximal (mesial and distal), and palatal (lingual).

2-To provide enough space for the crown restoration to withstand the force of mastication.

3-Not to enlarge the size of the tooth.

4-To provide good esthetic.



Disadvantages of crowns

1. Heat generation during the cutting procedure of the teeth might affect the health of the pulp; therefore, water coolant must be used during the preparation procedure.

2. Over preparation can cause pulp irritation or even pulp exposure which might lead to death of the pulp. Excessive tooth preparation can also weaken the tooth structure.

3. Periodontal problems: food impaction with subsequent gingivitis and periodontal pocket formation and secondary caries might develop.

- **Five principles limit the design of the tooth preparation for cast metal or porcelain restorations :**

1- Preservation of tooth structure.

2- Retention and resistance form.

3- Structural durability of the restoration.

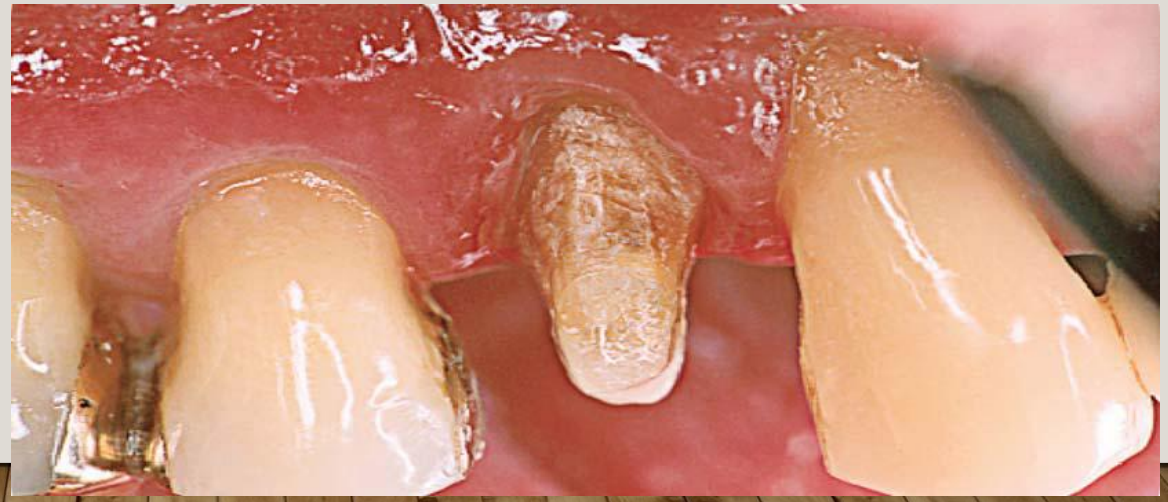
4- Preservation of periodontium.

5- Marginal integrity.

1. Preservation of the tooth structure

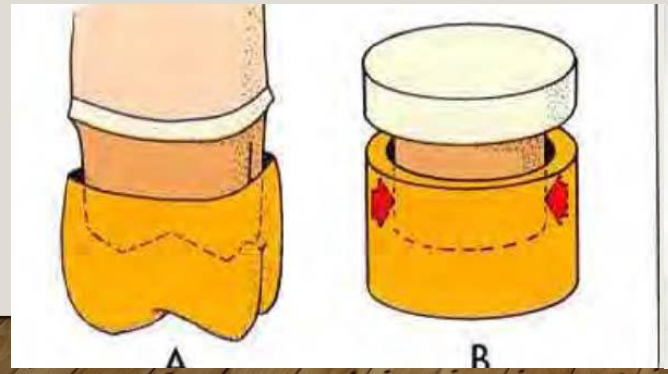
The preparation of the tooth must be conservative, minimal amount of tooth structure must be removed. Because, excessive amount of tooth structure removal has many harmful effects:

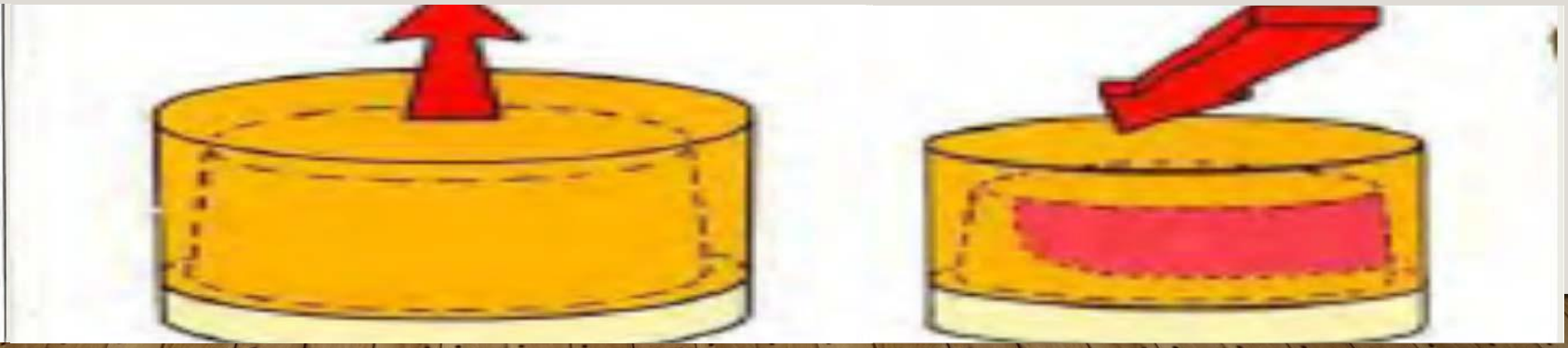
1. Excessive reduction will lead to thermal hypersensitivity, pulpal inflammation and necrosis may result from approaching to the pulp closely.
2. The tooth might be over tapered or shortened and this might affect the retention and resistance of the prepared tooth.



2. Retention and resistance forms:

- **Retention** is the ability of the preparation to resist the dislodgement of the crown restoration by forces directed along its path of insertion.
- **Resistance** is the ability of the preparation to resist the dislodgment of the restoration by forces directed obliquely or horizontally to the restoration.

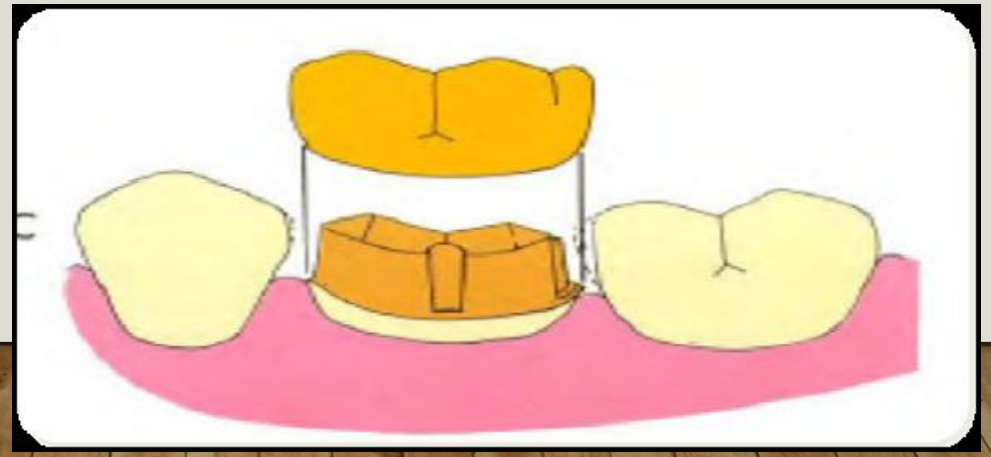




Path of insertion

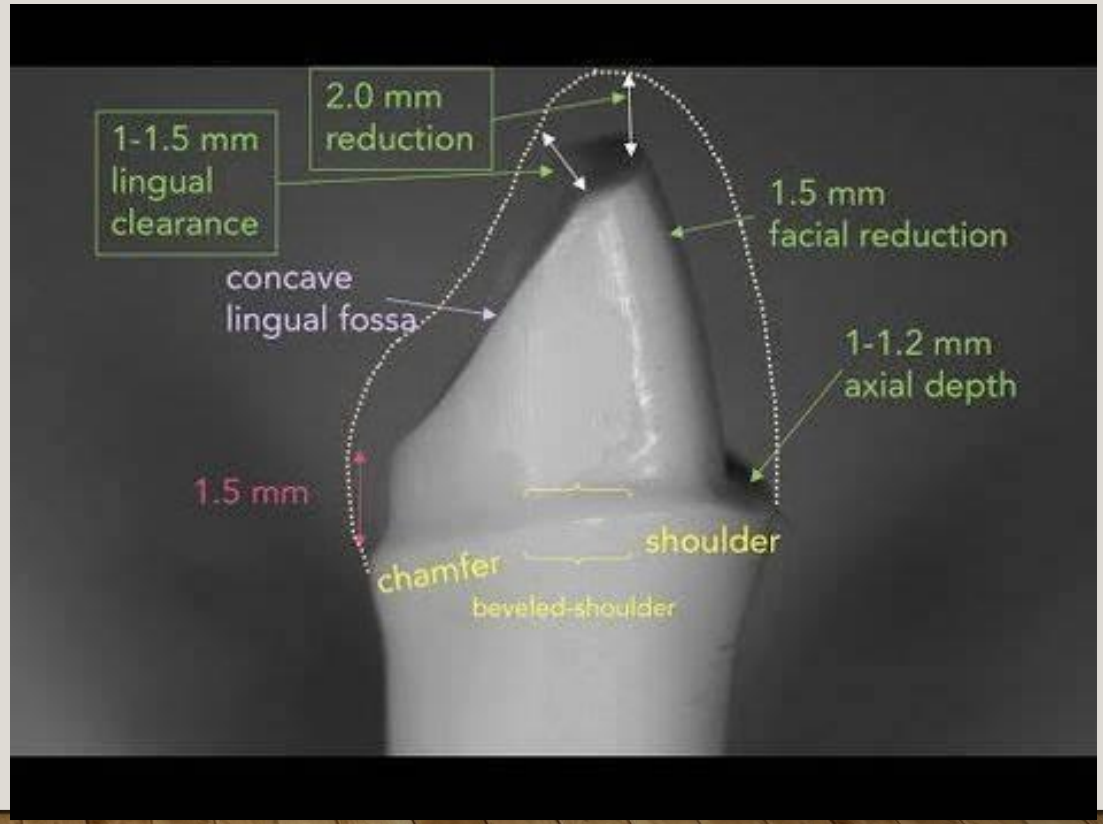
- The crown restoration should have a **single** path for insertion to be retentive.
- The path of insertion of the crown restoration is parallel to the long axis of the tooth, except for the three-quarter crown for the anterior teeth, where the path of insertion should be parallel to the incisal two-thirds of the crown, not to the long axis.
- By limiting the path of withdrawal of the restoration, retention is improved.
- A preparation with unlimited freedom of displacement is much less retentive.





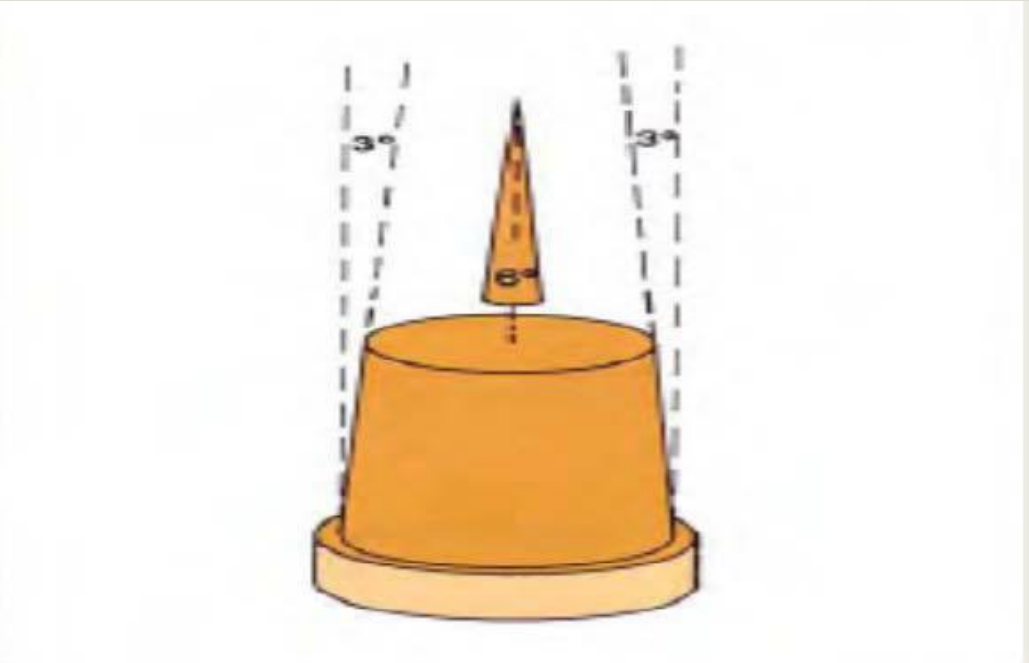
Factors affecting retention and resistance

1. Taper of the preparation.
2. Surface area of the preparation.
3. Length and height of the preparation.
4. Diameter of the tooth (tooth width).
5. Texture of the preparation.
6. Accessory means.

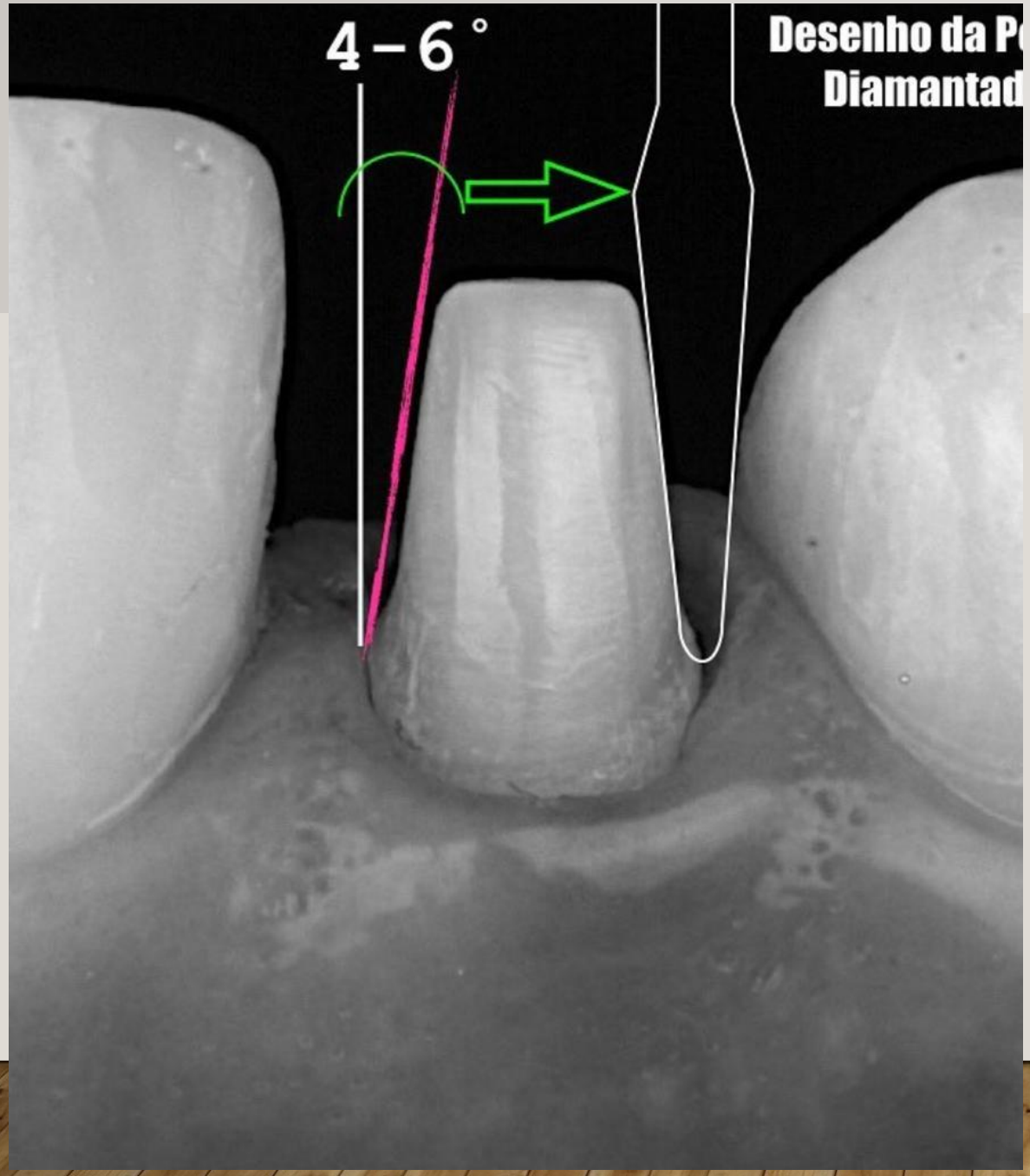


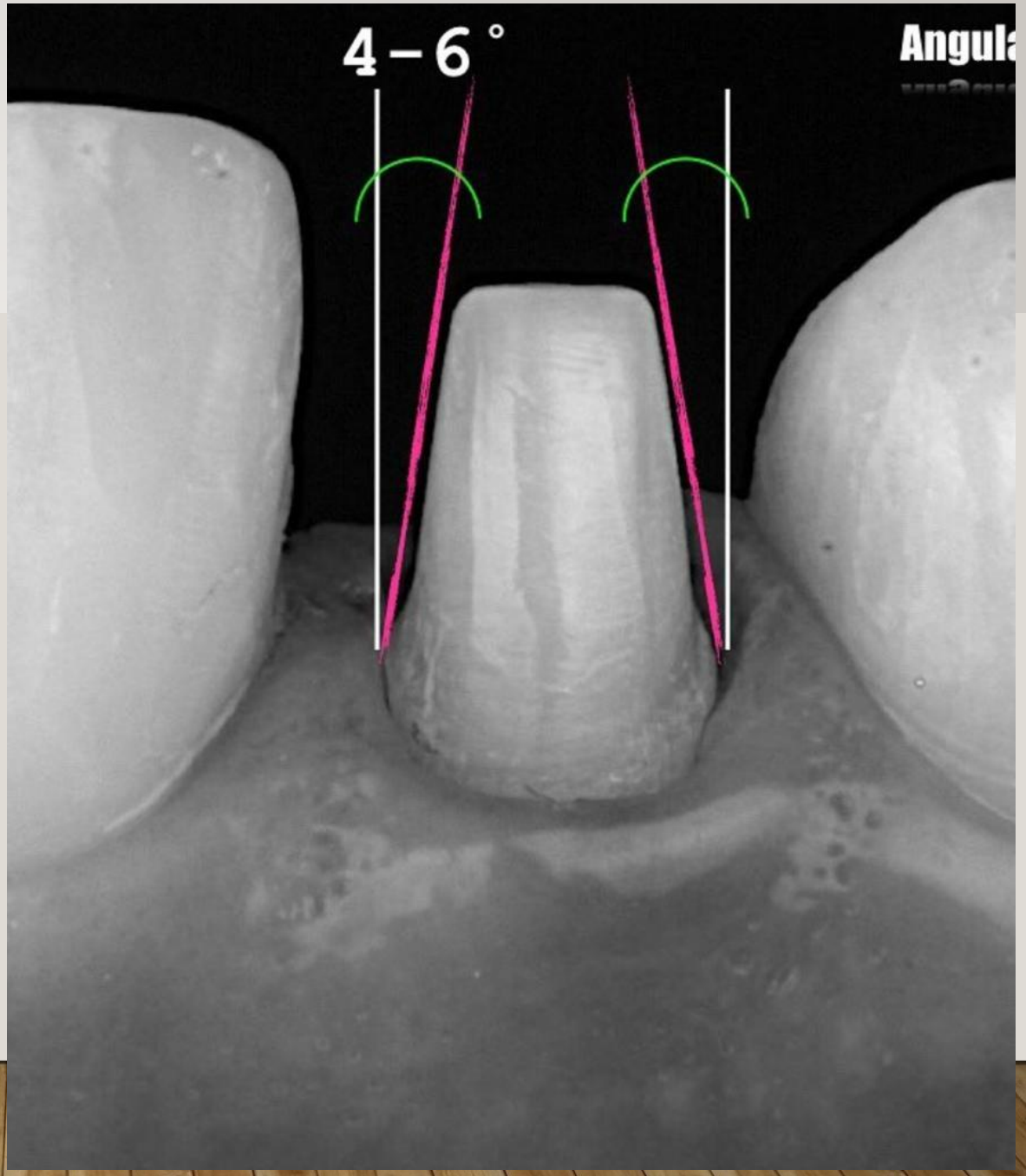
1. Taper of the preparation

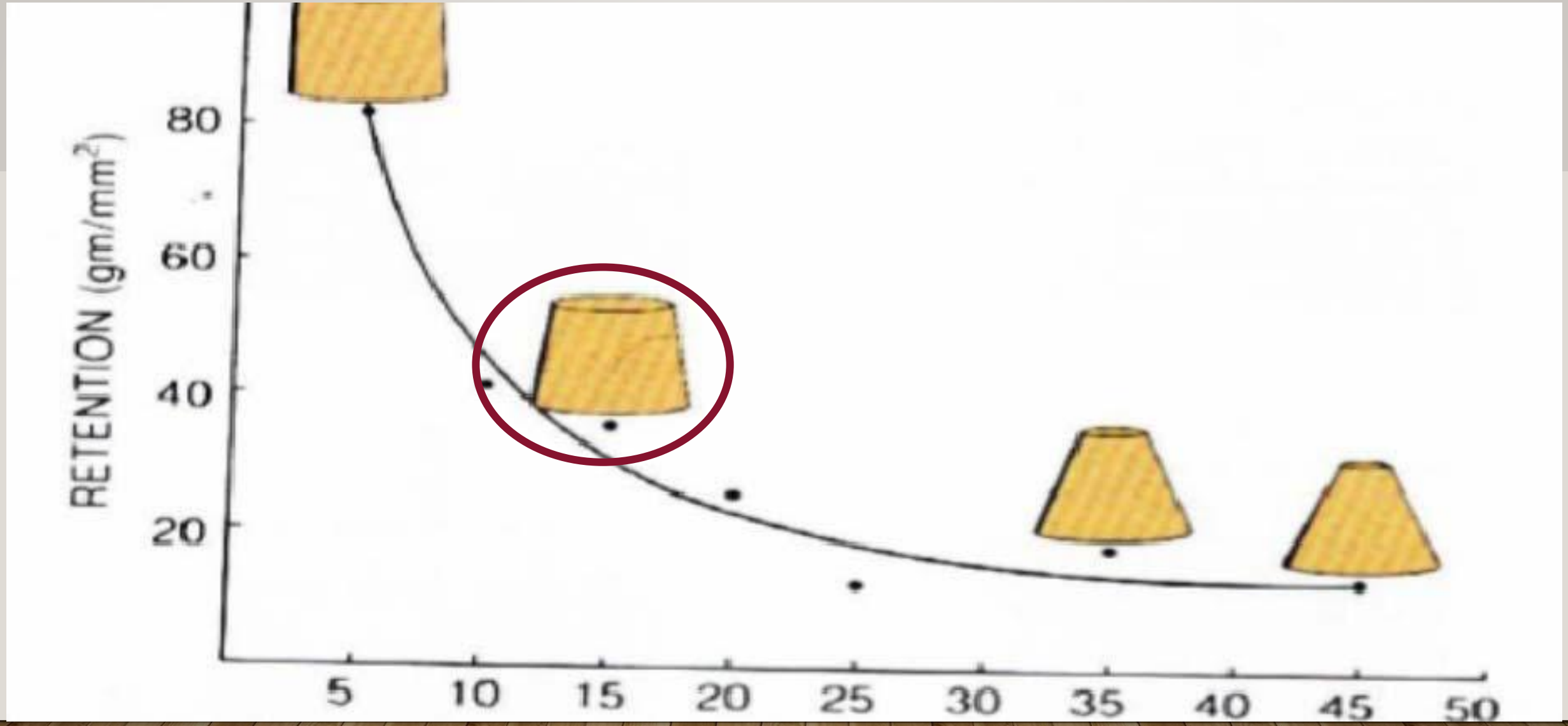
- **Convergence angle** is the angle formed between the two opposing axial walls of prepared tooth to receive a crown restoration.
- It determines the convergence (taper) of the prepared tooth.

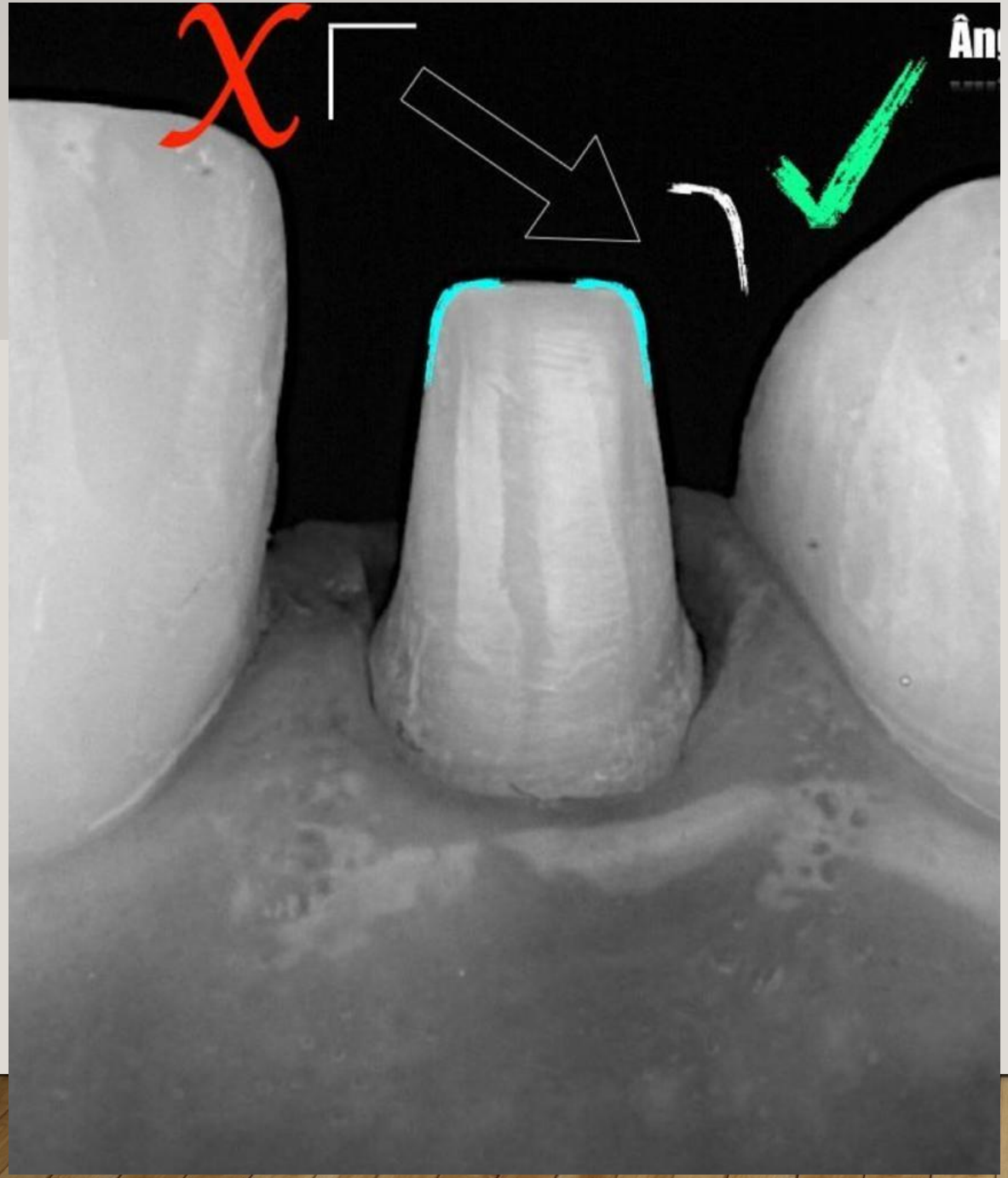


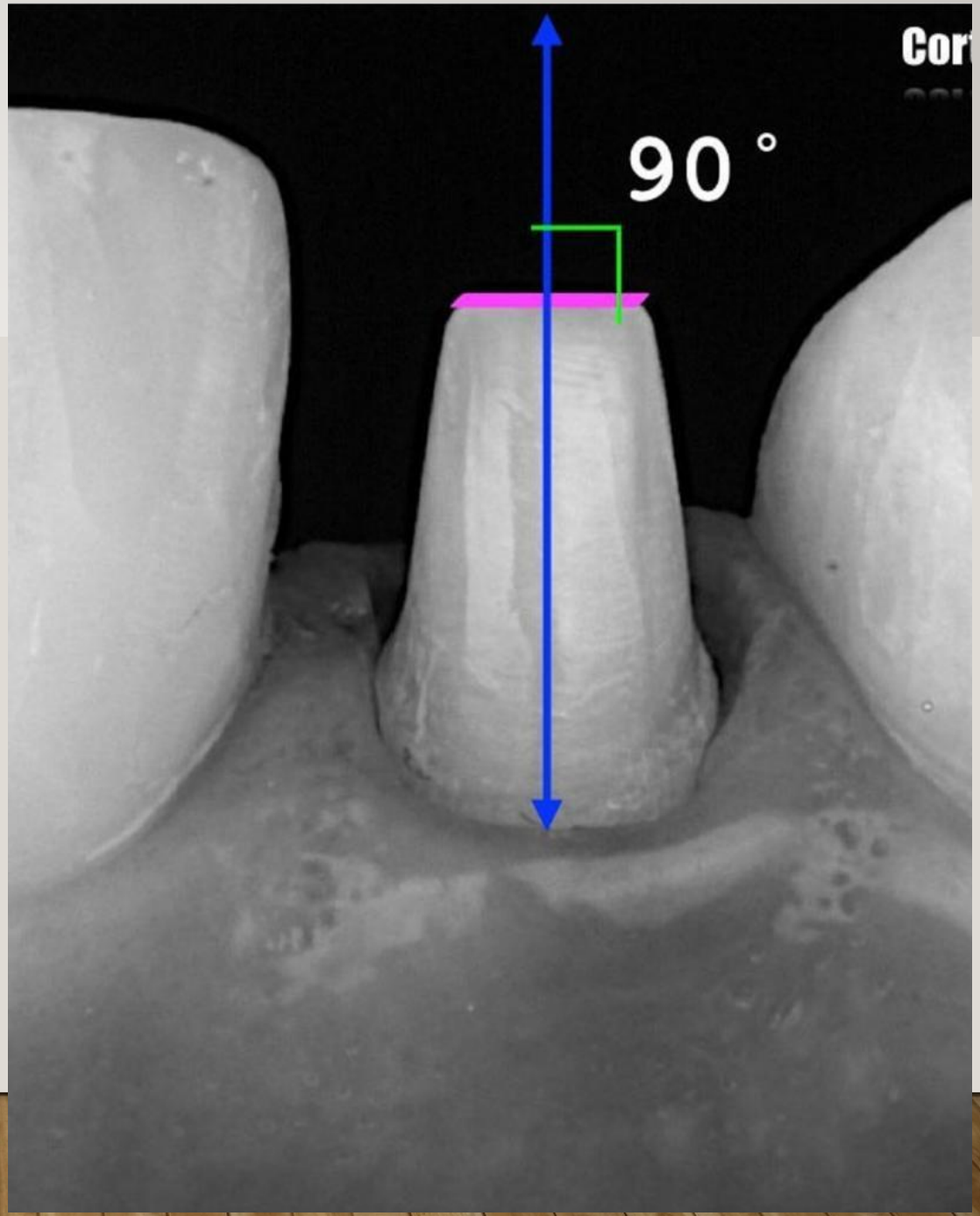
- The retention depends on the degree of this angle, **the greater taper, the less the retention.**
- The degree of the convergence angle is one of the factors that determines the amount of axial and non-axial forces which can be tolerated without leading to loss of the crown restoration. A **5-6 degrees** convergence angle is mostly used to provide the needed retention.
- The more nearly parallel the opposing walls of preparation, the greater retention but parallel walls are difficult to obtain inside the patient's mouth without creating undercuts and might lead to difficulty in seating the crown restoration, thus 5-6 degrees convergence angle is mostly used to provide the needed retention.


4 – 6 °
Desenho da P
Diamantad


4 – 6 °
Angula


RETENTION (gm/mm²)
80
60
40
20
5
10
15
20
25
30
35
40
45
50




90 °

Taper and Resistance:

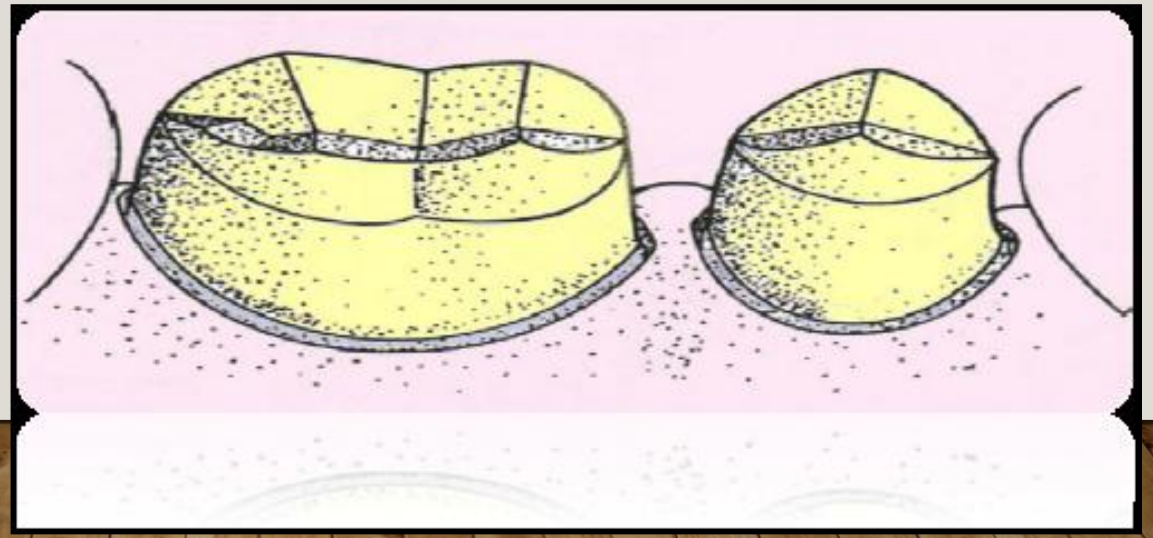
- The more parallel the axial walls of the preparation, the more will be resistance to crown restoration.
- The walls of a short, wide preparation must be kept parallel to achieve adequate resistance form.

2. Surface area of the preparation

- Increasing the surface area will increase the retention.
- The factors that influence the surface area are:

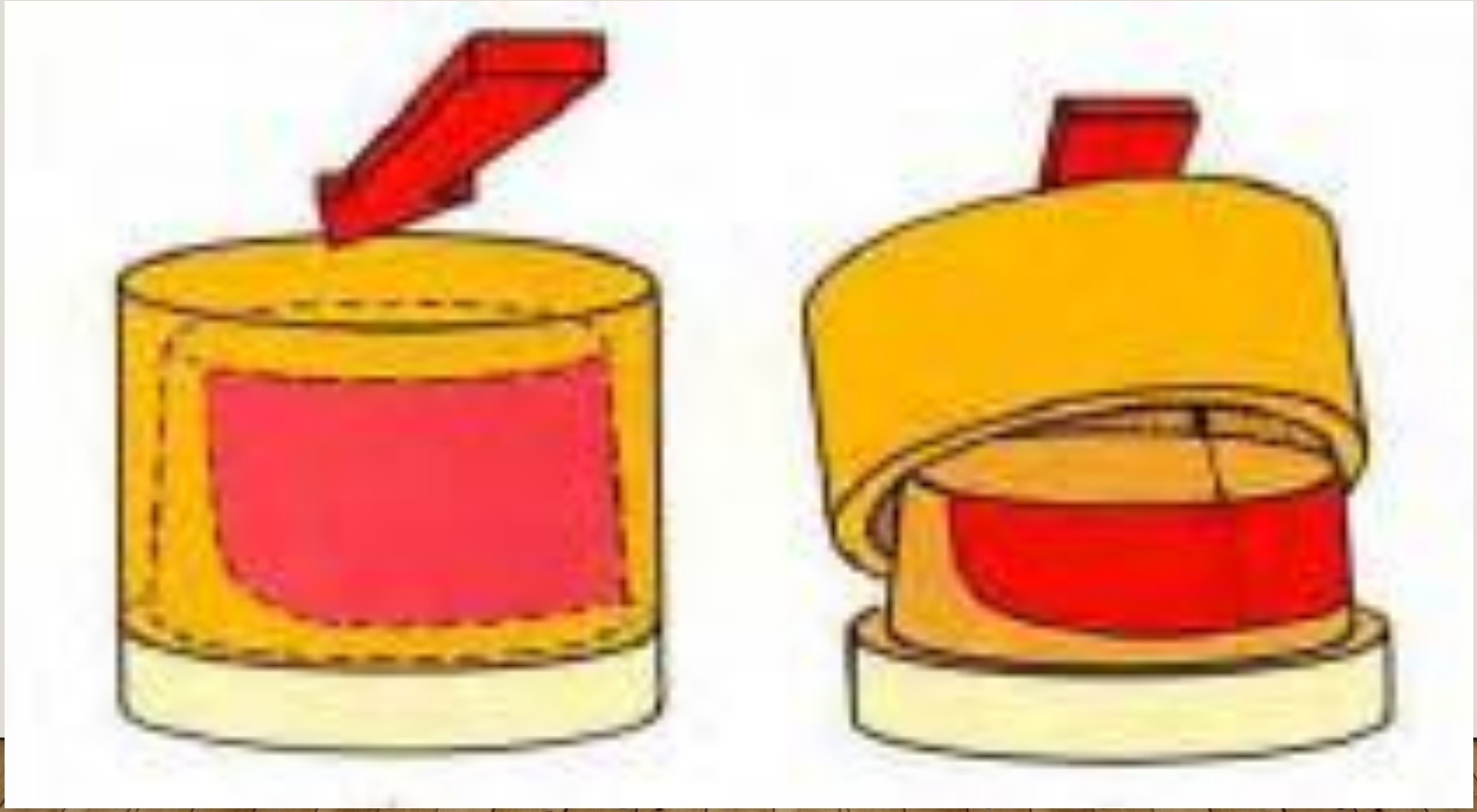
(a) Size of the tooth: The larger the size of the tooth, the greater will be the surface area of the preparation, and thus the more retention.

- In this issue, a full metal crown on a molar tooth will be more retentive than that on a premolar tooth.



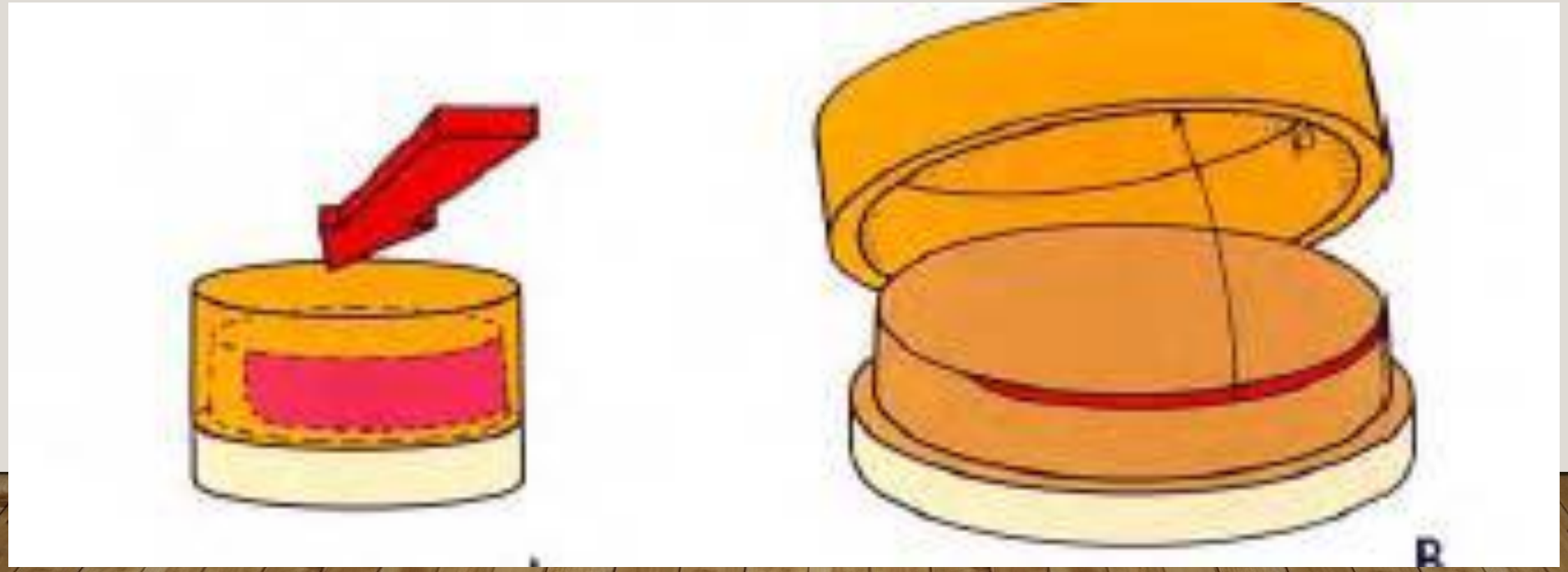
- **(b) Extent of tooth coverage by the restoration:**
- The more area covered by the crown restoration will be more retention.
- Thus full metal crown on a molar tooth is more retentive than a three-quarter crown on the same tooth.
- (c) **Accessory features:** such as boxes, grooves, and pin holes.

- **3. Length (height) of the preparation**
- Increasing the length of the preparation will **increase** the retention and resistance and vice versa.



4-Diameter of the tooth (tooth width)

- A crown on a narrow tooth have **greater resistance** to tipping than the one on a wider tooth.
- This occurs because the crown on the narrower tooth has a shorter radius for rotation resulting in a lower curve line and a larger resisting area.



5.Texture of the preparation

- Depending on the type of luting cement, the texture of the preparation might affect the retention of cast crown. Smooth surfaces are less retentive than rough (mechanical interlocking).

6. Extra retention means

- The retention of the preparation can be greatly enhanced by the addition of **grooves, pinholes or boxes**.

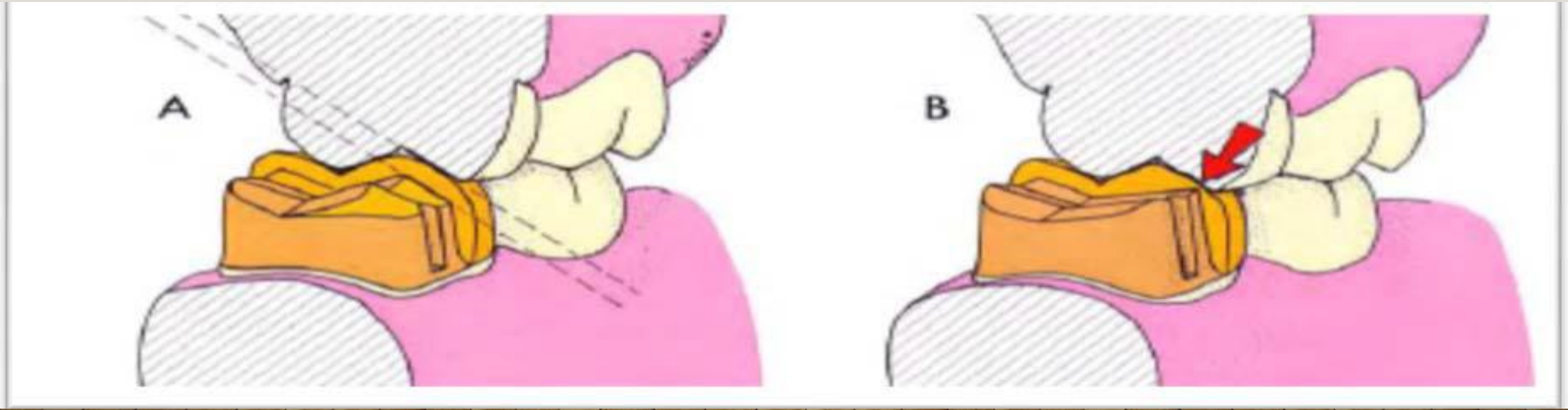
3. Structural Durability

- The preparation must be designed to provide structural durability to the restoration. i.e. the crown restoration must be rigid enough to not flex, perforate (if made of metal) or even fracture (if made of plastic material).
- For the restoration to be rigid; it should be bulk.
- To provide enough bulk to the crown restoration, by removing sufficient tooth structure from the prepared tooth to create enough space.

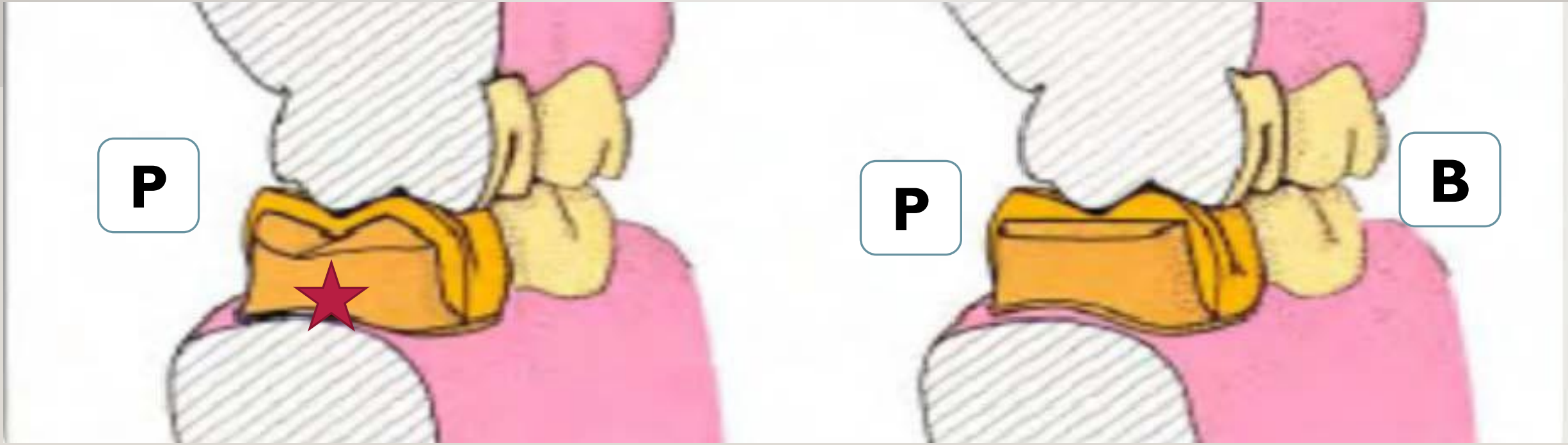
The preparation features related to structural durability are:

(1) Occlusal reduction:

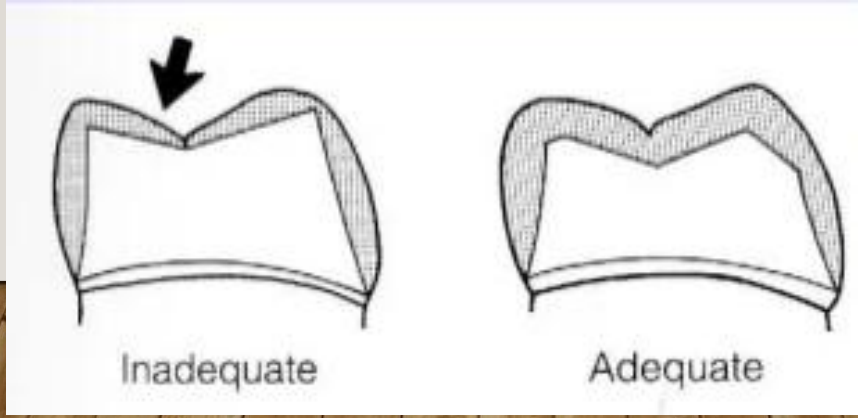
- Enough tooth structure must be removed from the occlusal surface; so that the restoration can be built back to ideal occlusion and thick enough to prevent wearing or distortion (**1-1.5mm**)or (**1.5-2mm**).



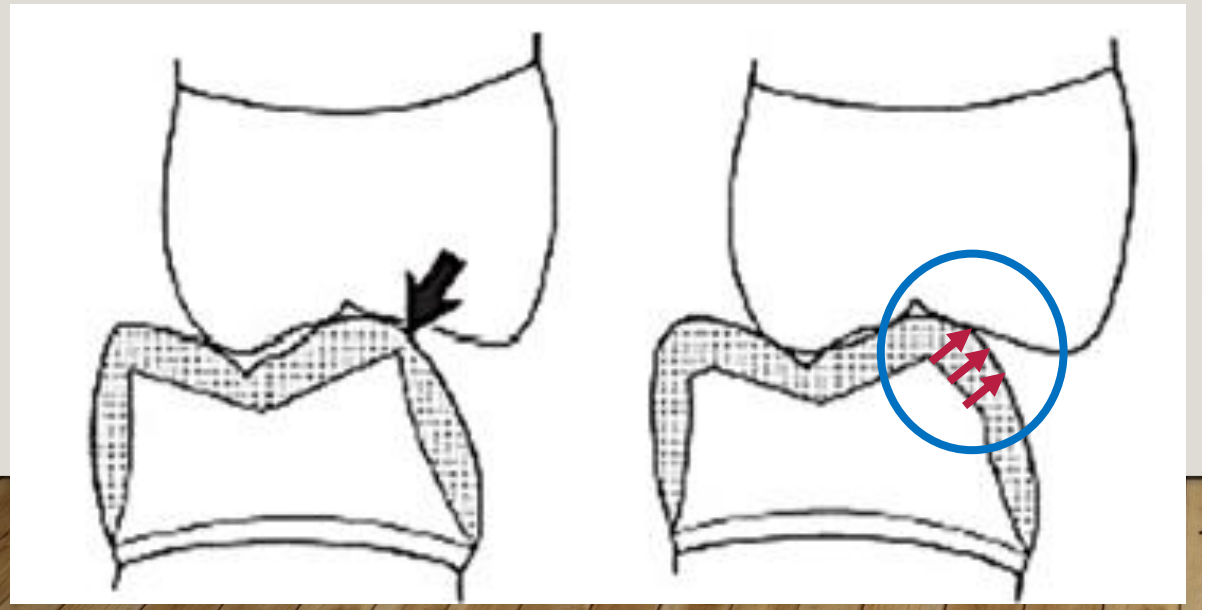
- **Occlusal clearance:** the space created between the occlusal surfaces of the prepared tooth and the opposing tooth.
- It should be evaluated in centric and eccentric relations.
- Enough tooth structure must be removed occlusal; so that when the restoration is built back to ideal occlusion; it will be thick enough to prevent wearing or distortion of restoration (crown).
- **Functional cusps:** the cusps that give centric stops of occlusion (**Palatal** of upper posterior teeth and **buccal** of lower posterior teeth).
- Occlusal reduction must reflect the **geometric inclined planes** of the occlusal surface (so-called "planar occlusal reduction" or "anatomical occlusal reduction").

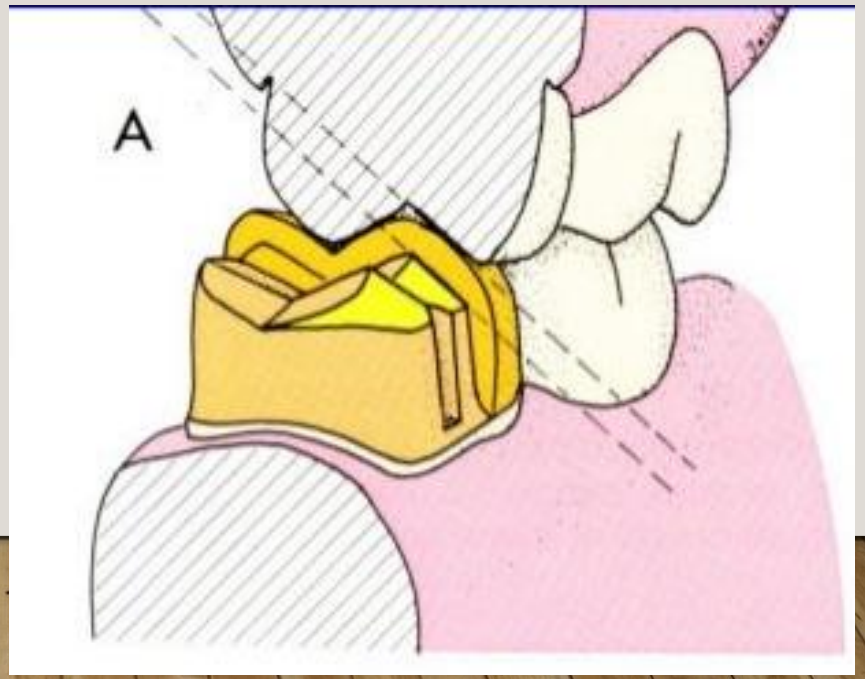

P
P
B

- When doing occlusal reduction, we should avoid creating steep planes with sharp angles because it will lead to stress.
- On the other hand, flat occlusal reduction will lead to too thin metal and this will lead to perforation of the crown restoration in the future.
- Meanwhile, lowering the entire occlusal surface in an attempt to provide sufficient space might lead to **tooth structure destruction** (non-conservative preparation) which interferes with the first principle of tooth preparation (the conservation of tooth structure).
- In addition, lowering the entire occlusal surface will shorten the axial walls of the prepared tooth which affects the retention-resistance features of the preparation.

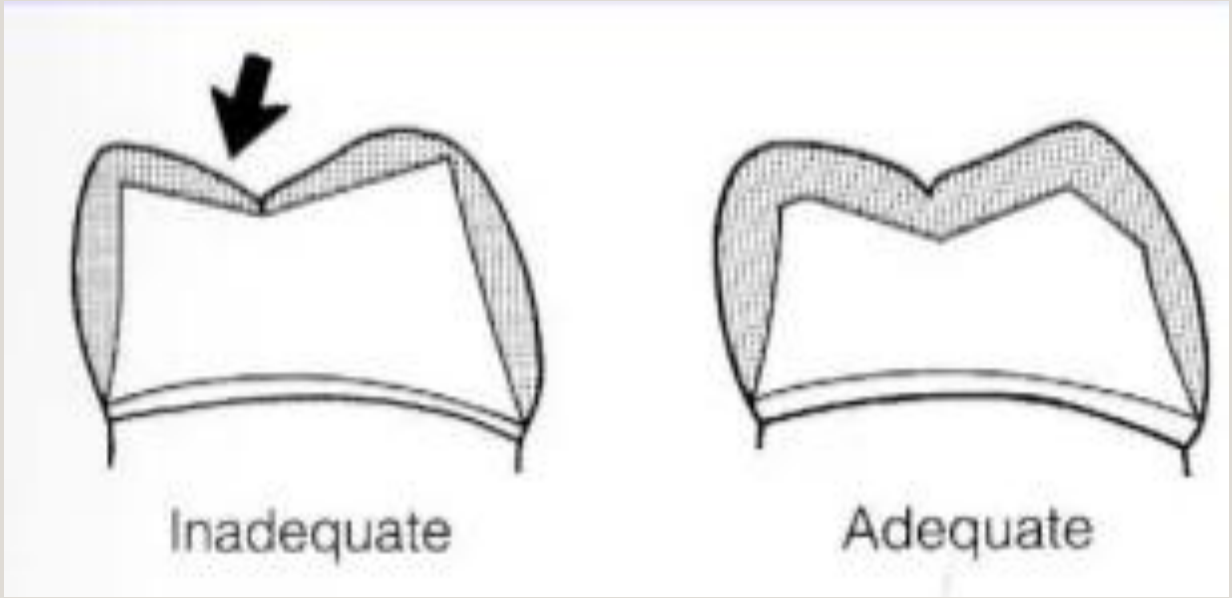


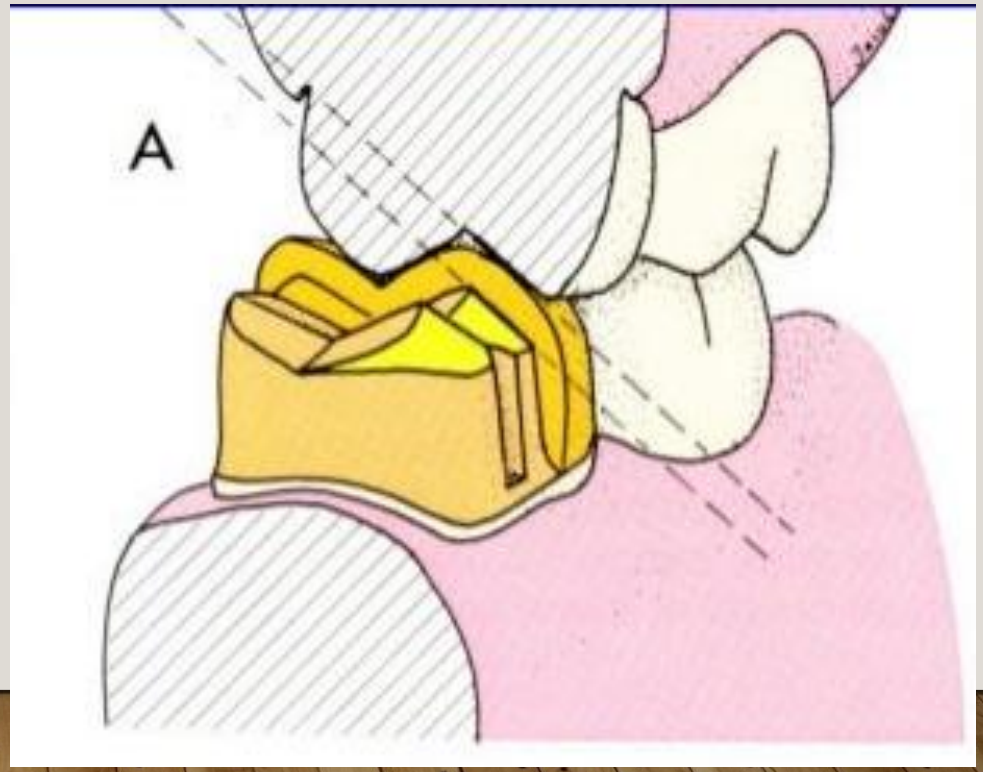
- **Functional cusp bevel (FCB):** a wide bevel placed on the functional cusps of posterior teeth to provide structural durability.
- It allows adequate thickness of restoration at this critical area without scarifying of tooth structure.
- If FCB is omitted, the restoration is likely to be too thin in this stress-bearing area.





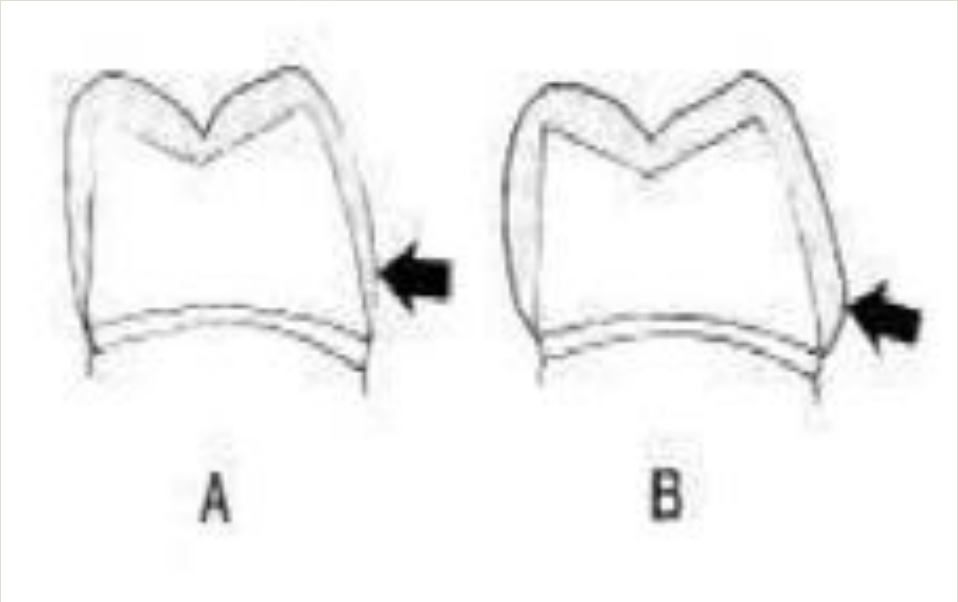
- In the absence of FCB, the laboratory technician **overbuilds the crown restoration** in an attempt to provide structural durability for the restoration; this will **lead to premature contact** with the opposing tooth.





(2) Axial reduction:

- Sufficient axial reduction is important to provide sufficient space so that the restoration can be built with sufficient thickness.
- This will prevent flexing of the crown restoration when the occlusal forces act on.

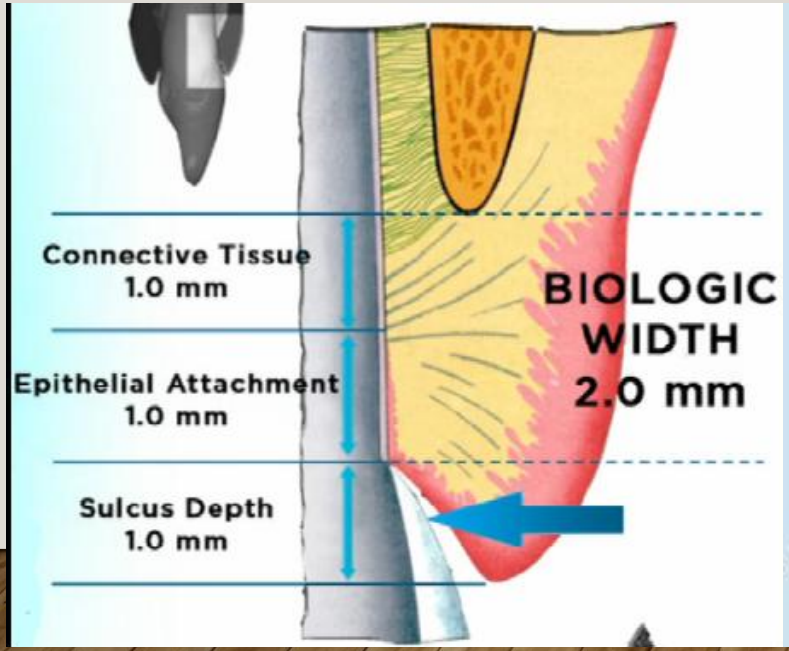


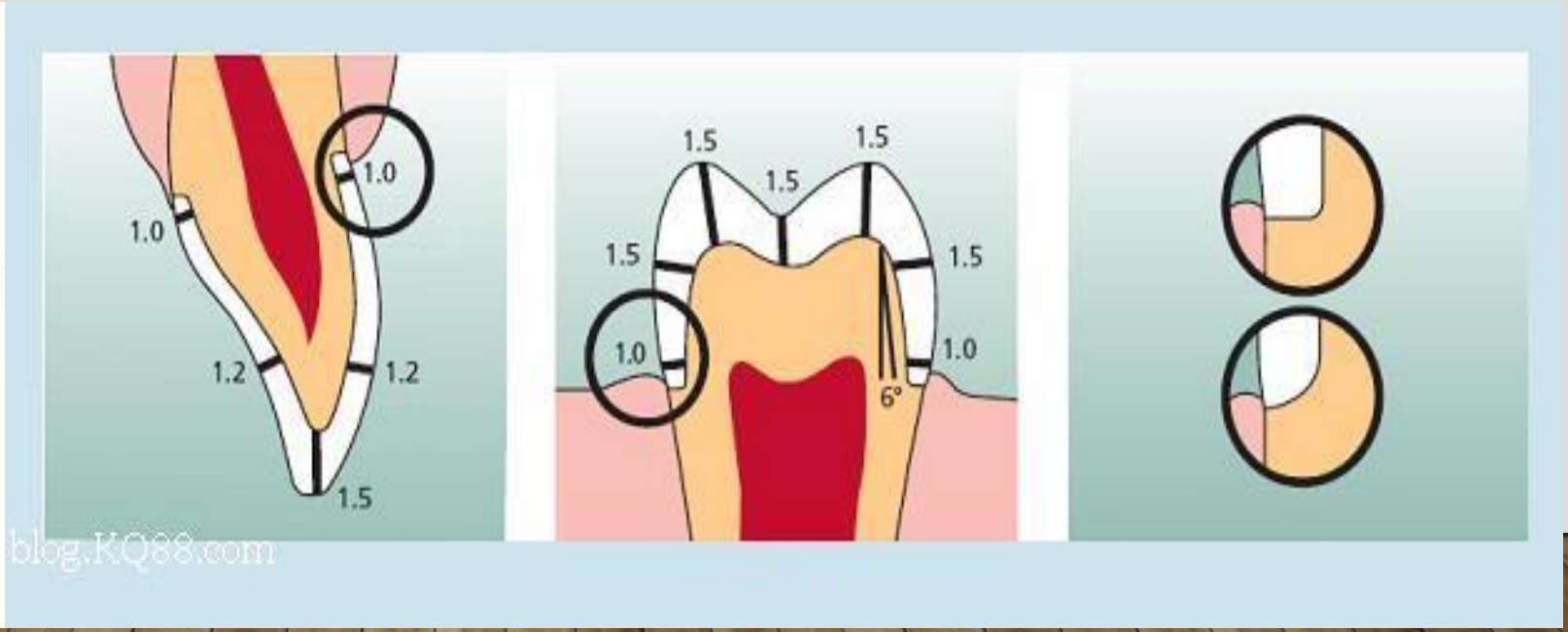
4. Preservation of the periodontium

- For the preservation of the periodontium, the following points should be considered:

(a) The margin of the preparation should be placed **supragingival**.

(b) The crown restoration should have proper proximal contact, embrasure form, occlusion and a healthy occlusal-gingival contour.





Margin placement (finishing line placement):

- The finishing line of the preparation can be placed either supra-gingivally, sub-gingivally, or equi-gingivally (with the level of the gingiva).

- **Advantages of placing the margin of the preparation supra-gingivally:**

A- can be easily prepared and finished by the operator.

B- to provide good vision for the operator during preparation.

C- the impression can be easily made.

D- the patient can keep the area clean more easily.

E- Most of the time, such a position is situated on hard enamel.

F- less destructive

- So, as mentioned above, it is better to place the margin of the preparation supra-gingivally whenever possible.
- However, there are some situations which require sub-gingval placement of the finishing line as listed below:
  1. For esthetic.
  2. When we need extra retention as in teeth with short crowns.
  3. When there is caries or filling at the area of the finish line (the preparation margin should be placed on sound tooth structure).

- **5. Marginal Integrity**
- The restoration can survive in the biological environment of the oral cavity only if the margin is closely adapted to the preparation margin.
- The configuration of the finishing line determines the shape and bulk of the restoration margin that will affect both marginal adaptation and the degree of seating of the restoration.
- **The restoration margin should have the following requirements:**

(a) It must fit as closely as possible against the finishing line of preparation.

(b) It must have sufficient strength.

(c) It should be placed in an area where the dentist can finish easily and the patient can clean properly.

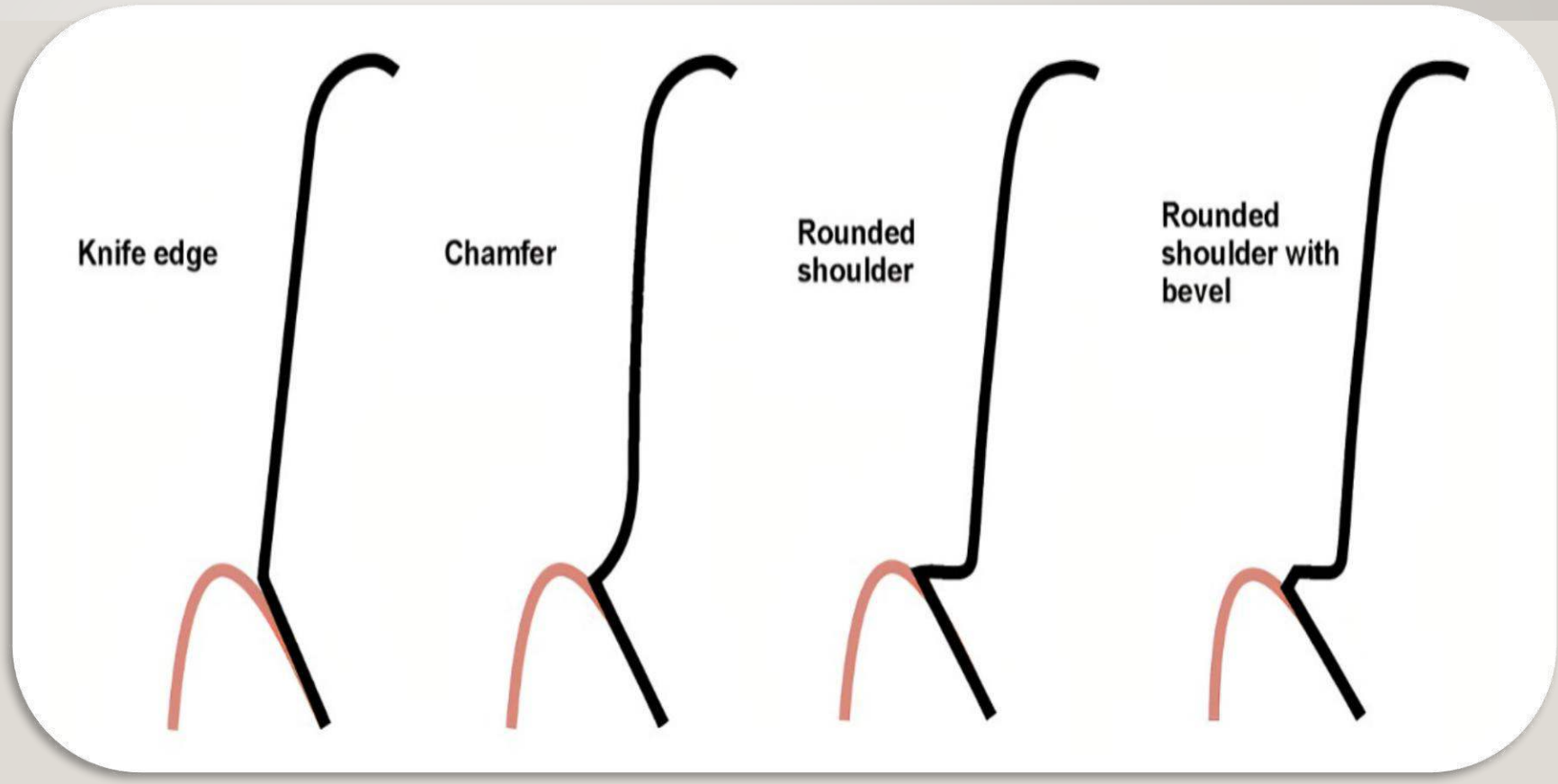
- **The finishing line of the preparation** (or "The preparation margin") is the final margin that separates between the prepared and the unprepared tooth structure.
- This line should be smoothly continuous from one surface to another; otherwise, it will interfere with the seating of the crown.
- The margin between the prepared and unprepared tooth structure is a very critical area as most failures start from this margin.





Types of finishing line according to its design or configuration

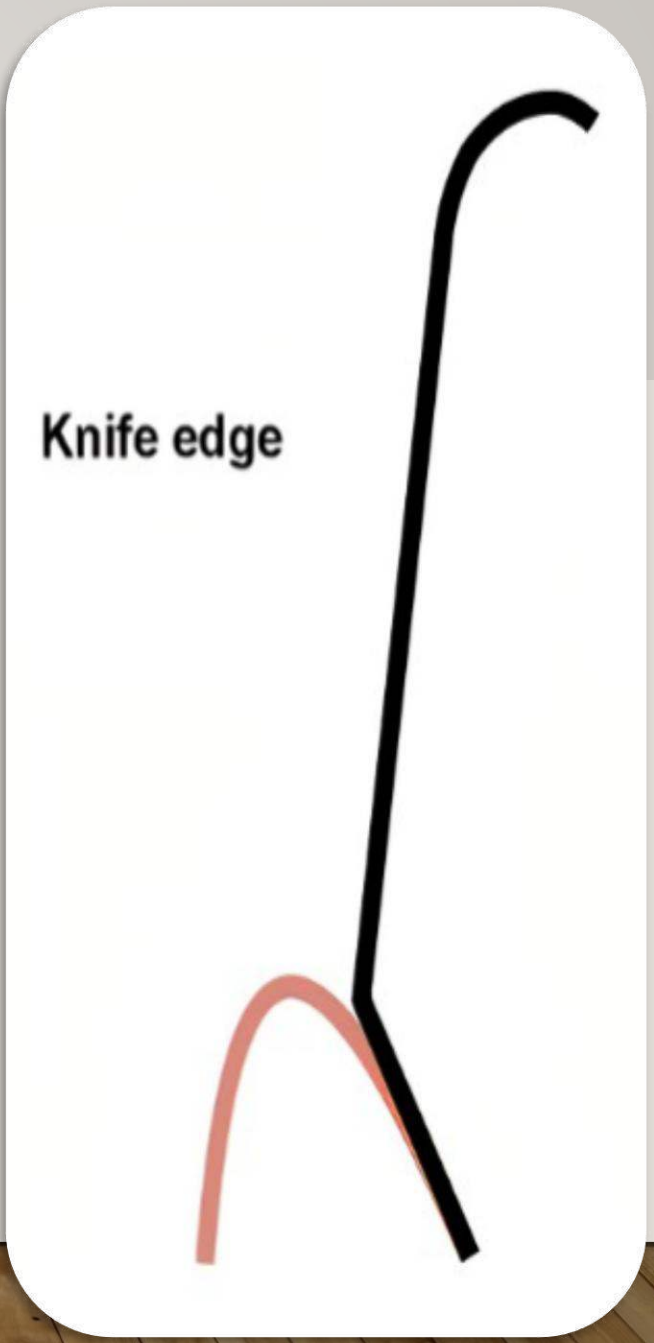
1. *Knife edge*
2. *Chamfer*
3. *Heavy chamfer*
4. *Shoulder*
5. *Radial shoulder*
6. *Shoulder with bevel*



Advantages of knife edge finishing line

1. It is the most conservative type of finishing line.
2. It is easy to prepare.
3. It is a burnishable type of finishing line.

Burnishing is the further adaptation of the **margin** of restoration to the tooth structure.



Indications of knife edge finishing line

- It is mainly used for:

1. Full Metal Crown (All the surfaces).

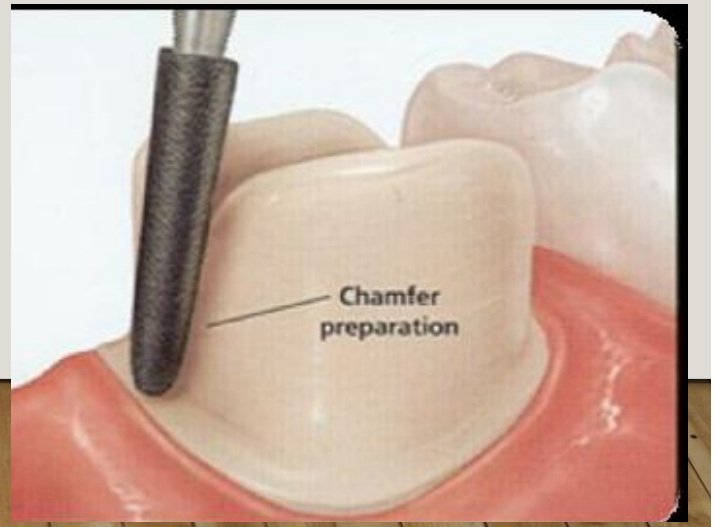
2. The lingual and proximal surfaces of full veneer crown, three-quarter crown and post crown.

2. Chamfer finishing line

- It is similar to a knife edge finishing line **except** that the cut is made deeper.
- It forms a 130-160° cavo-surface line angle.
- A **rounded tapered fissure bur** is used to obtain this preparation margin.
- It provides adequate space at the cervical region; so it can make the contour of the crown restoration within the contour of the natural tooth without contouring the final restoration.
- However, the restoration margin obtained with this type of finishing line is thick, so it is **unburnishable type**.





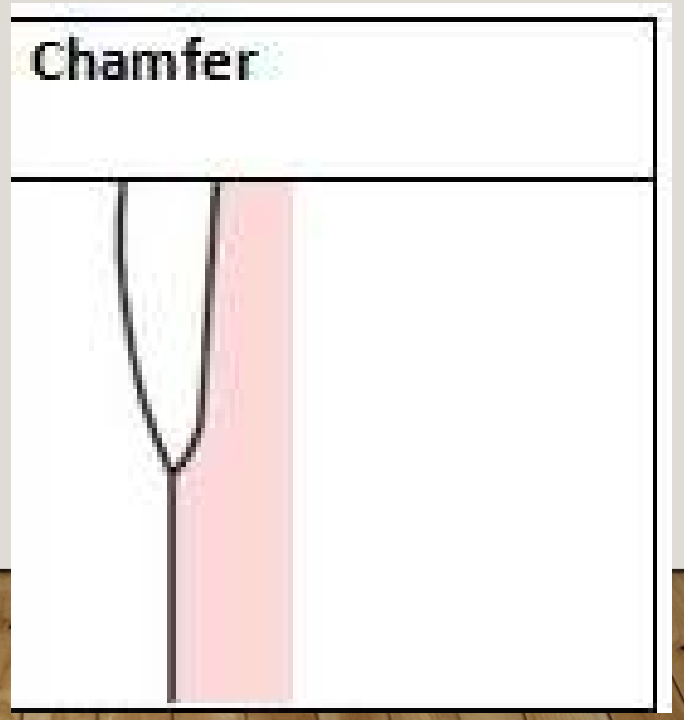




Indications of Chamfer Finishing Line

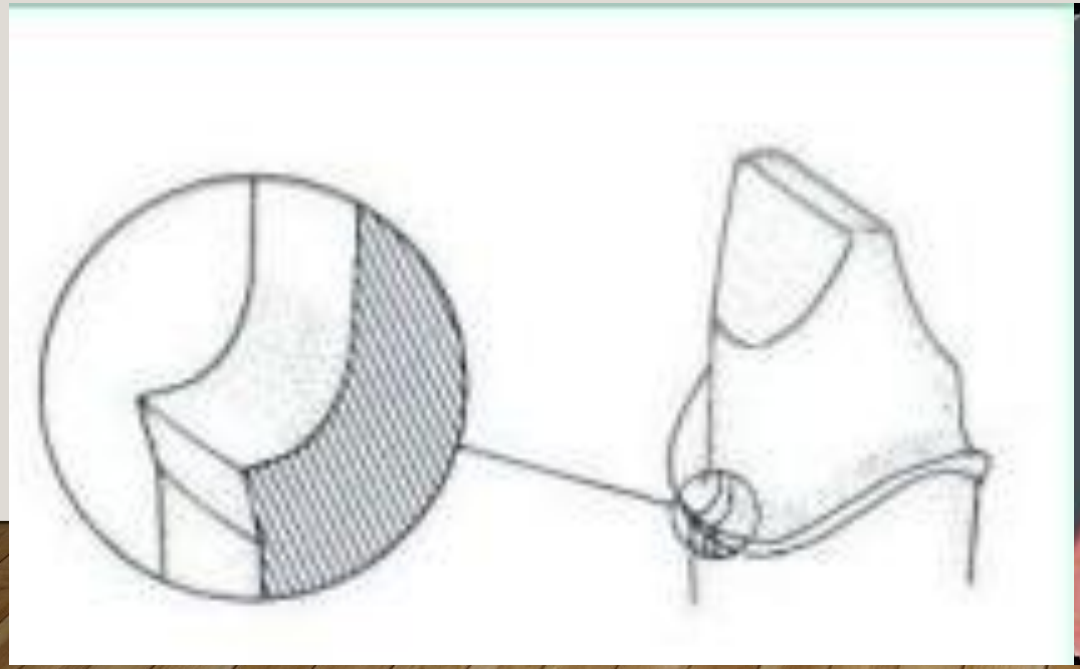
1. Full Metal Crown (All the surfaces).

2. The lingual and proximal surfaces of the full veneer crown, three-quarter crown and post crown(endocrown).

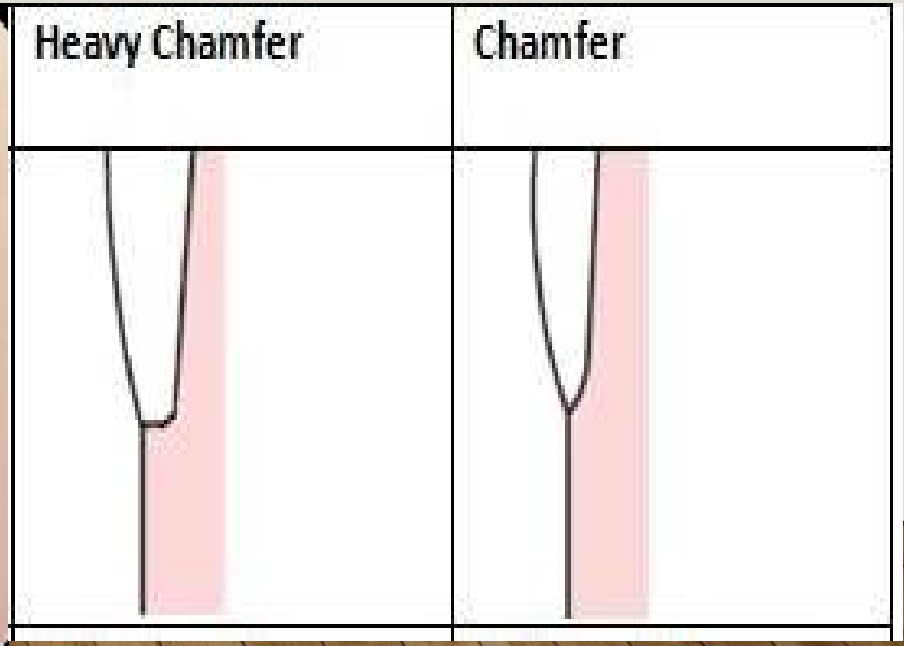


3. Heavy chamfer finishing line

- This type of finishing line provides a **90°** cavo-surface line angle with a large radius internal angle, so it provides better support for the ceramic crown.
- It can be used with porcelain fused to metal (PFM) crown and All Ceramic crowns.



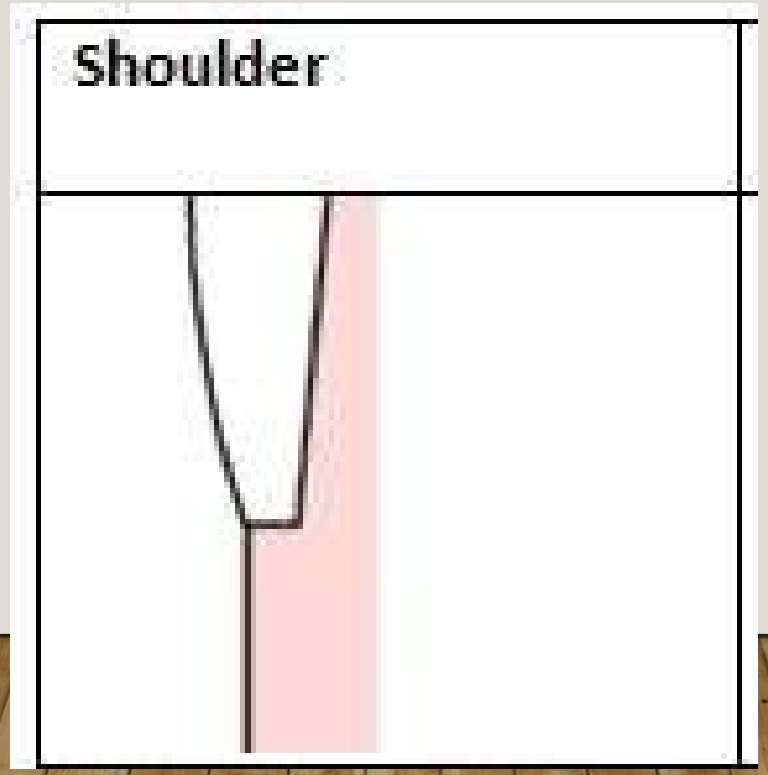




4. Shoulder finishing line (Butt shoulder)

- Shoulder finishing line is the least conservative type of finishing line due to the excessive amount of tooth structure removed to obtain this type of finishing line.
- In the shoulder finishing line, the axial walls meet the finishing line at a right angle.
- A **flat-end tapered fissure bur** is used to obtain this finishing line.





- This type of finishing line is used when the bulk is required for strength or esthetic, that's why it is almost used with **jacket crowns** since jacket crown is made of either porcelain or acrylic resin, which are brittle materials and require enough thickness to withstand the occlusal forces without fracture.
- On the other hand, the increased thickness provides better shade of the material and so better esthetics.

6. Shoulder with bevel finishing line

- Shoulder with bevel is another modification of the shoulder finishing line by adding a bevel to the shoulder.
- The bevel is at 45° angle.
- A **flat-end tapered fissure bur** and **flam-shaped burs** are used to obtain this finishing line.



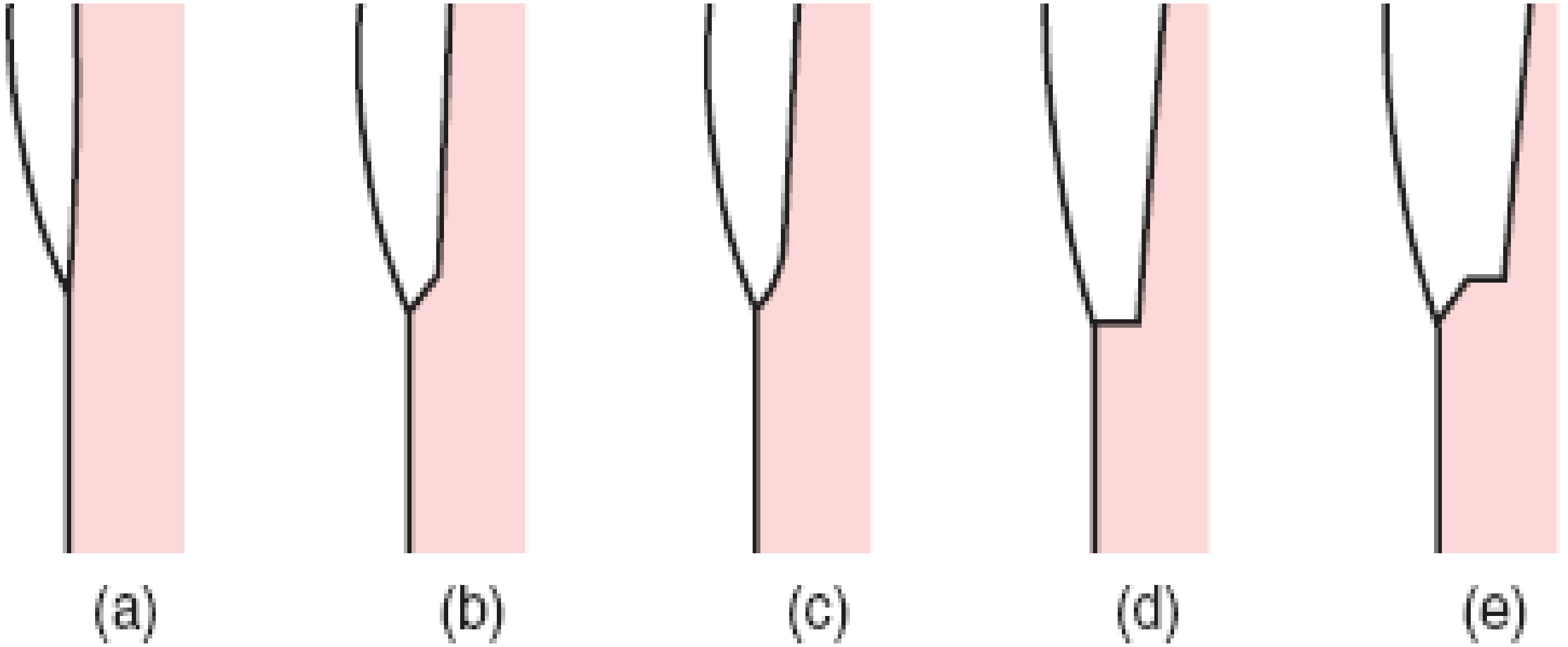
Objectives of adding a bevel to the shoulder finishing line

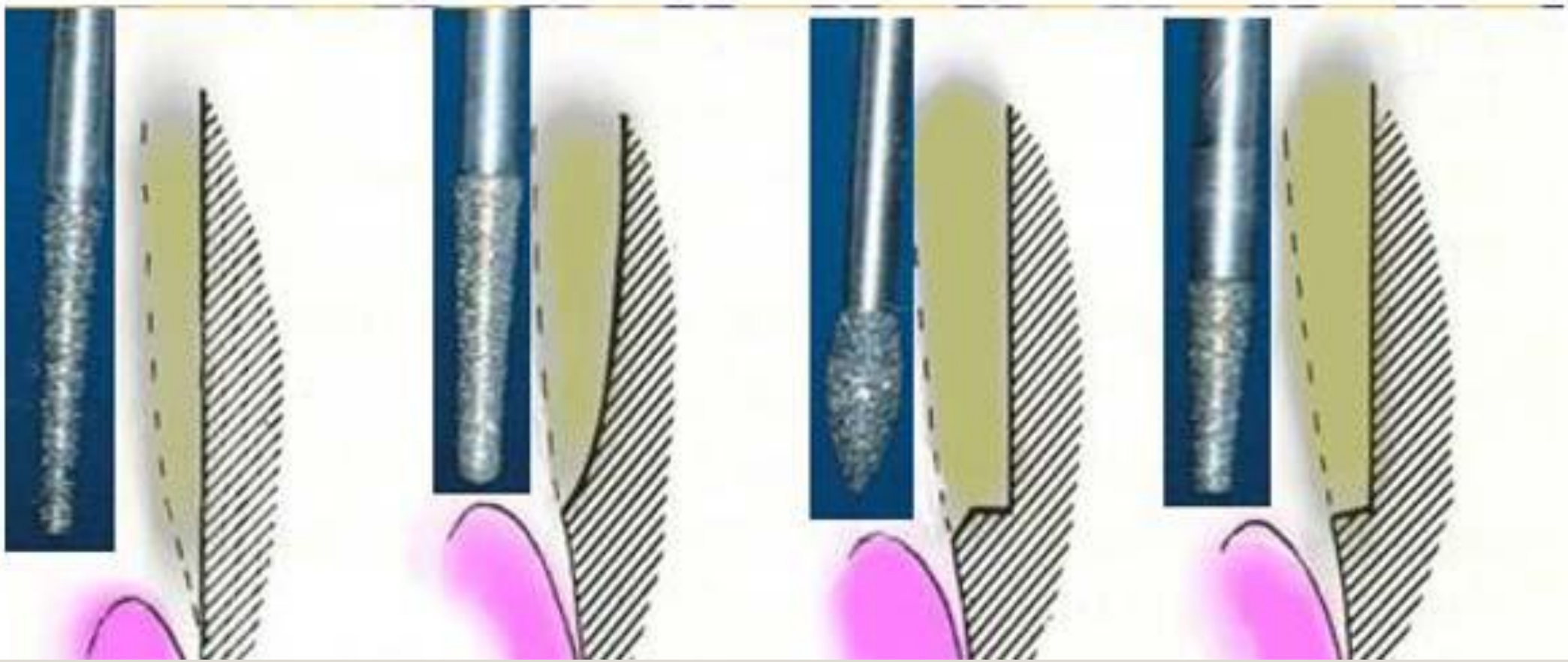
1. To provide a burnishable margin for the metal that may extend subgingivally
2. To provide enough space for shape and contour.
3. To reduce marginal discrepancies.
4. To remove unsupported enamel.

Indications of the shoulder with bevel finishing line

1. It is indicated when we use a combination of the metal with facing porcelain (PFM) as in a full veneer crown for the labial surface.

2. Shoulder with a bevel is recommended for **extremely short walls**.


(a)
(b)
(c)
(d)
(e)



Biomechanical Principles of Tooth Preparation

Lecture 4

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Third stage

- Full metal crown is a full crown covering all axial surfaces of the tooth as well as the occlusal surface and is made of metal.
- It is one of the most commonly indicated crown restorations for posterior teeth.
- It can be used as a single unit or as a retainer for an F.P.D., especially when we have a small abutment tooth with a long-span edentulous area to overcome the occlusal forces and prevent bridge displacement.
- Since it is a full crown, it has better retention and resistance than other crown restorations such as 3/4 Crown and 7/8 crown because all the axial walls and the occlusal surface are included.





Types of metal alloys used for full metal crown

1. High noble alloys (gold alloys).
2. Low noble alloys (silver-palladium and gold-palladium alloys).
3. Non-noble alloys (Nickel-chromium alloy).





Indications of a full metal crown

1. A tooth with extensive destruction due to caries or trauma to protect the remaining tooth structure from fracture.
2. A tooth with large amalgam restoration to protect the remaining tooth structure and amalgam from fracture.
3. Endodontically treated teeth.
4. When maximum retention and resistance are needed as in a tooth with a short crown.
5. Recontouring of the tooth as in a tooth receiving a clasp for a removable partial denture.
6. As a bridge retainer.
7. A patient with a high caries index.
8. Correction of the occlusal plane.



Contra-indications of full metal crown

1. If high esthetic need is demanded.
2. When less than maximum retention and resistance necessary.
3. When a more conservative crown could be used such as 3/4 crown as in a tooth with intact buccal surface and very short span bridge.
4. When caries index is low.

Advantages of full metal crown

1. Greater retention and strength.
2. High resistance to deformation.
3. Modification of axial tooth contour is possible
4. More conservative than other types of full crown such as porcelain fused to metal and all ceramic crowns.

Disadvantages of a full metal crown

1. Extensive tooth structure removal as compared with a partial crown, such as a 3/4crown.

2. Difficulty in the vitality test of the tooth, especially with the electrical pulp tester.

3. May interfere with taste.

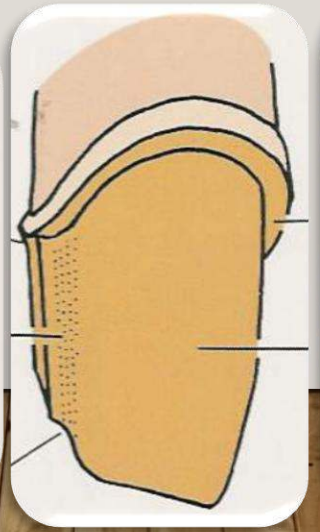
4. Display of metal.

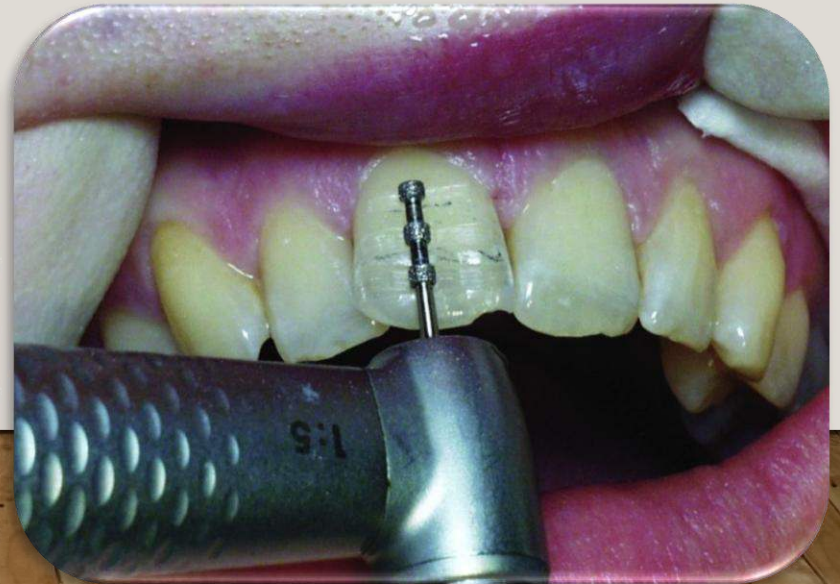
- **Preparation steps:**

1. Occlusal surface preparation.
2. Buccal surface preparation.
3. Lingual surface preparation.
4. Proximal surfaces preparation.

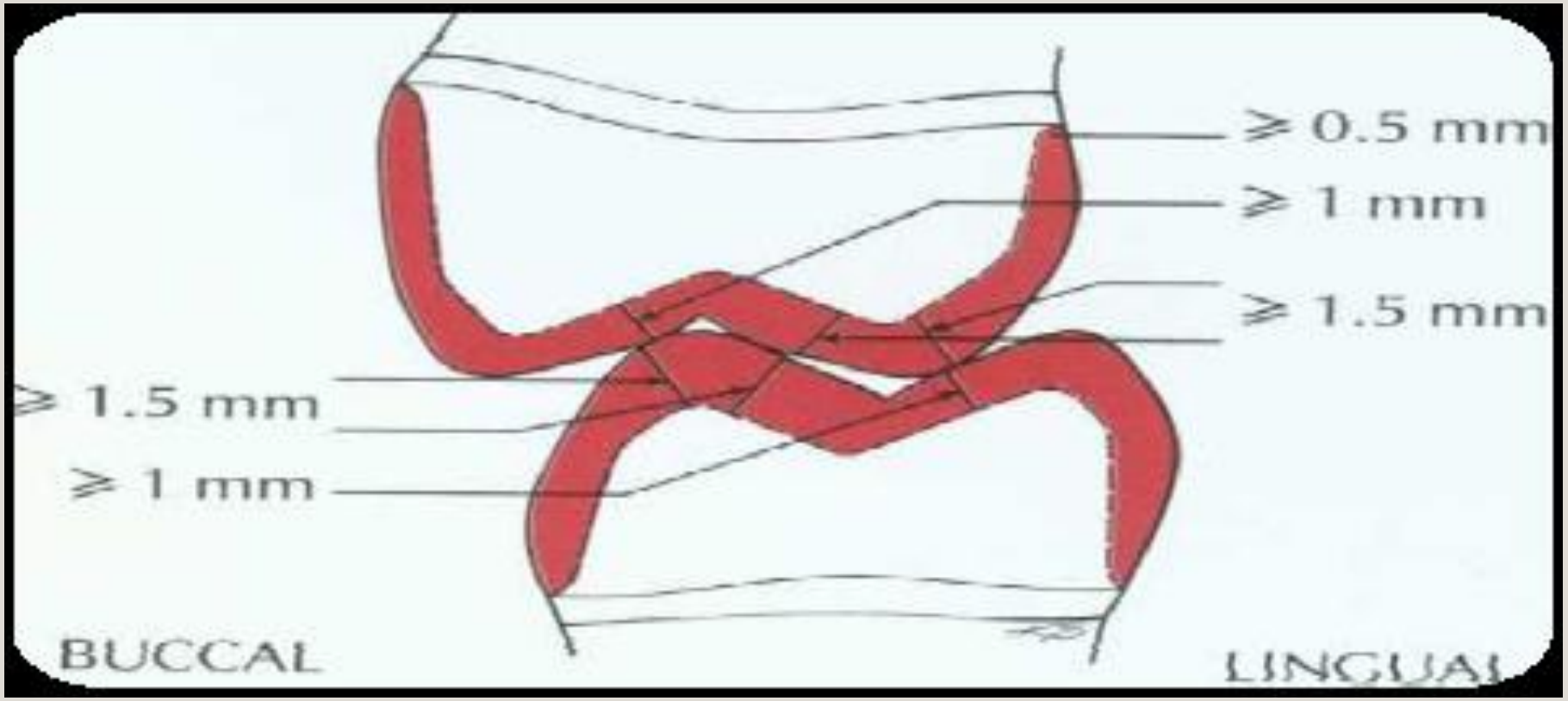
- **Depth Orientation grooves (D.O.G)** are grooves prepared on the surface of the tooth to act as a guide to determine the amount of tooth structure removed by preparation.
- If the preparation is done without these grooves, under or over-preparation is possible.
- It is chamfer finishing line prepared by a **round-end tapered fissure** .
- Knife edge finishing line may also be used.







- The recommended tooth reduction for full metal crown is shown in the figure below:



Occlusal surface preparation

- The aim of the occlusal surface preparation is to create 1.5mm occlusal clearance over the **functional cusps** and 1 mm over the **non-functional cusps.**
- Planar occlusal reduction (anatomical reduction) following the geometric inclined planes of the occlusal surface should be done for the following objectives:

  -To provide a restoration with uniform thickness.

  -To preserve the tooth structure (axial wall length).

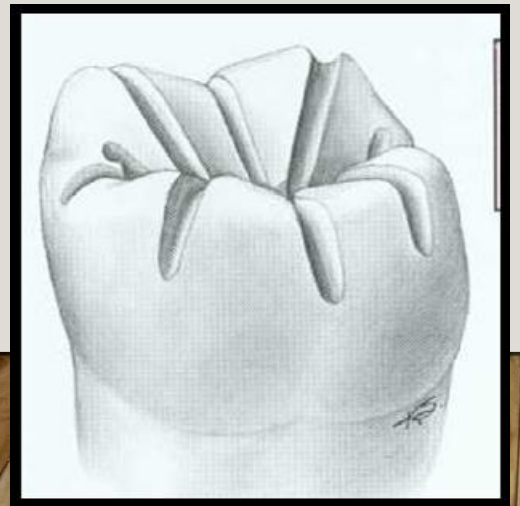
  -To improve the retention- resistance features of the preparation.

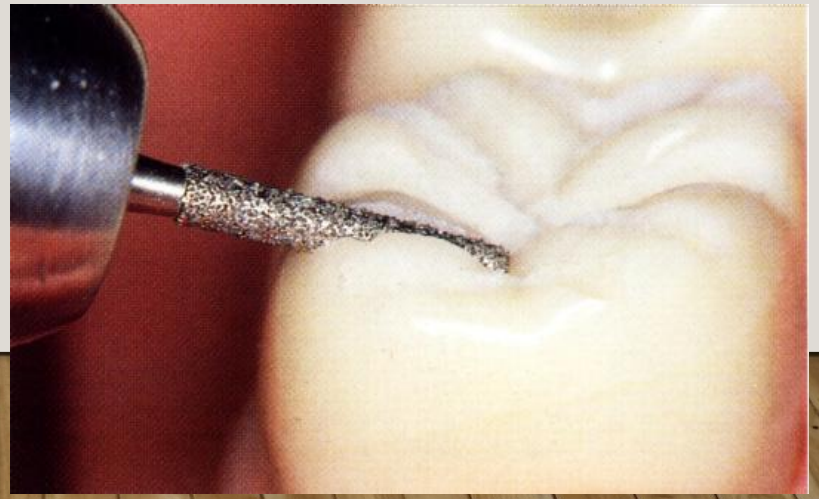


The sequence of the occlusal surface preparation is as follows:

1. Depth orientation grooves (D.O.G) are prepared in the occlusal surface by a fissure bur to follow the inclines of the cusps.

- A D.O.G is prepared in each cusp extending from the cusp tip to the central groove, which represents the deepest part of the occlusal surface.
- The depth of each groove corresponds to the diameter of the fissure bur used. i.e. a fissure bur with 1.5 mm diameter is used to prepare D.O.G on the functional cusps, while a fissure bur with 1 mm diameter is used to prepare D.O.G on the non-functional cusps.

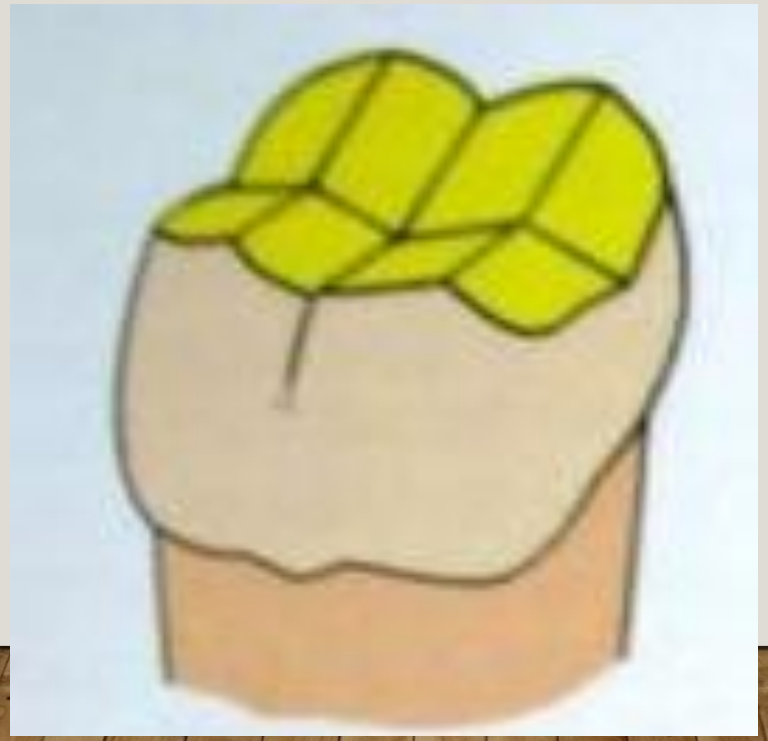




2. Any tooth structure between D.O.G should be removed following the normal contour of the cusps.

3. A wide bevel is placed on the functional cusps.

4. The occlusal clearance is then checked in centric & eccentric occlusal relations.



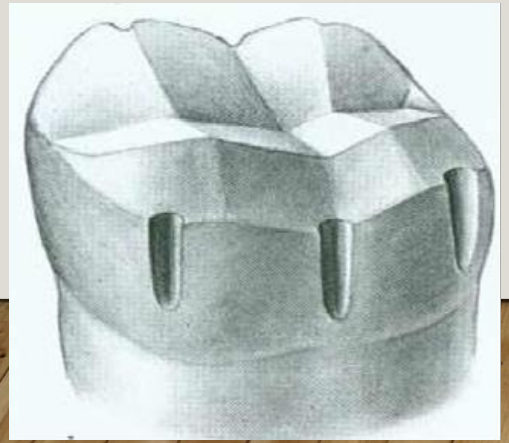
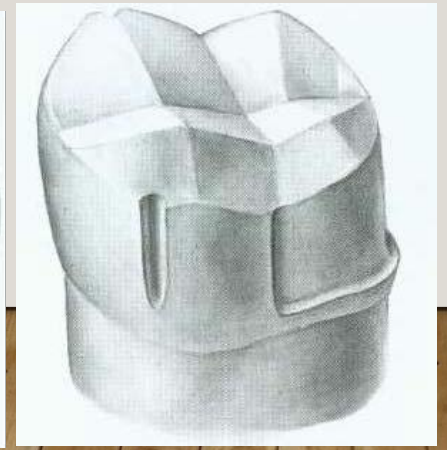
Buccal surface preparation

1. Three D.O.G with 1 mm depth are prepared in the buccal surface of the tooth, one placed in the centre of the wall and one in each medial and distal transitional line angles.

- These grooves are prepared parallel to the long axis of the tooth.

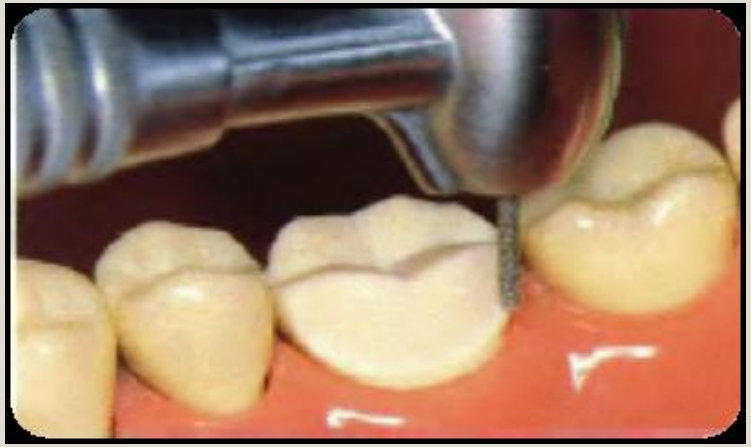
2. Move the bur mesially and distally following the inclination of this surface to remove any islands of tooth structure between D.O.G.

- The gingival extent of the preparation will determine the position of the margin (whether to be placed supragingivally, which is preferable, or extend the finishing line sub-gingivally).
- **A round-end tapered fissure bur** is used during axial reduction to obtain a chamfer F.L.


Lingual surface preparation

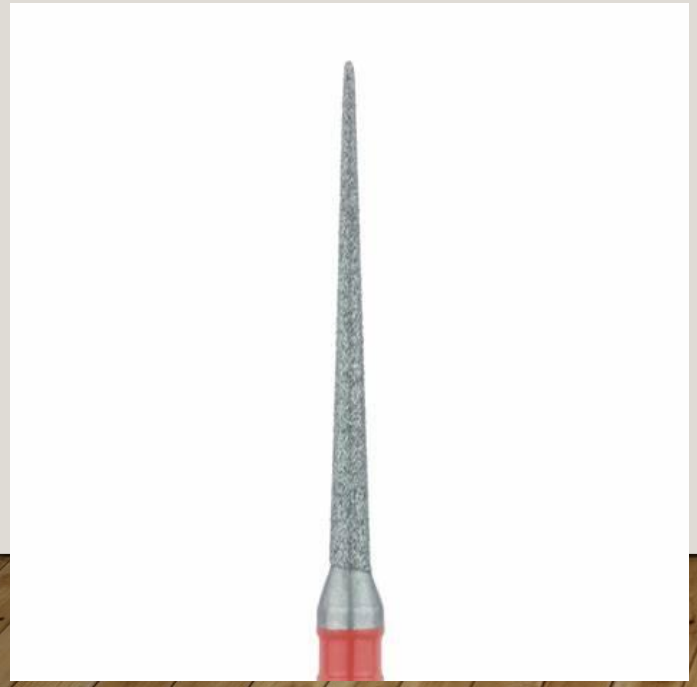
- The preparation of the lingual surface is the same as that of the buccal surface.





Proximal surfaces preparation

- Using a very thin long **pointed tapered diamond bur**, the contact is removed carefully with the bur rested on the prepared tooth (to prevent any damage to the adjacent tooth), moving the bur up & down, the contact will be opened bucco-lingually.
- Once the contact is opened, a **round-end tapered fissure bur** is used to plane the wall while forming a chamfer finishing line.







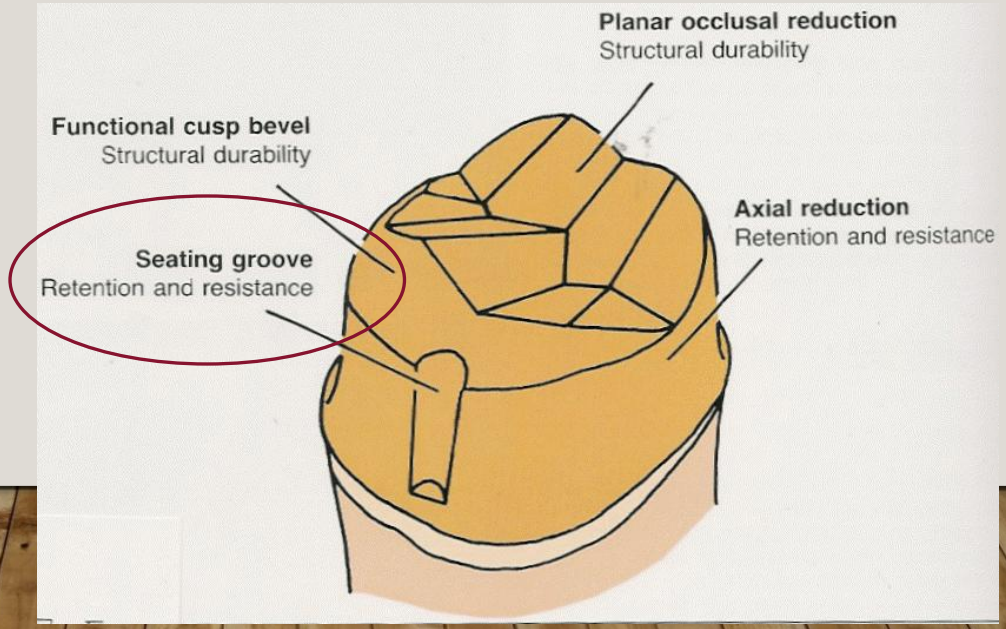
- Safe-sided disc can also be used during the proximal reduction in order to prevent any damage to the adjacent tooth.
- Placing a matrix band on the adjacent tooth can also help.
- After completing the preparation of the occlusal and axial surfaces, smoothening of all surfaces is done to remove sharp line and point angles because they act as stress concentration areas.





- A **seating groove** is finally placed in the buccal surface of the lower molar and the palatal surface of the upper molar.
- **The advantages of placing a seating groove are:**

1. It acts as a guide during the placement of the crown.
2. It prevents the rotation of the crown (by increasing the resistance).
3. It improves the retention.




thank
you
FOR
LISTENING