PORCELAIN FUSED TO METAL CROWNS

Principles of Tooth Preparation

Tooth Preparation - Steps

Dr V Matsubara

Learning Outcomes:

- Understand and discuss the **objectives of tooth preparation** for indirect restorations.
- Identify the **indications** for tooth preparation in indirect restorative procedures.
- Explain the **principles of tooth preparation**, including **biological**, **mechanical**, and **aesthetic** considerations.
- Describe the **general features** of a **Porcelain-Fused-to-Metal (PFM) crown**.
- Discuss the **indications and contraindications**, as well as the **advantages and disadvantages** of PFM crowns.
- Discuss the **types of metal alloys** used in PFM fabrication and the **basic material science** involved.
- Understand the **clinical steps involved in preparing a tooth for a PFM crown**, including the **required amount of tooth reduction**.

PART I

Tooth Preparation for indirect restorations

Clinical process of mechanically altering a tooth to receive a custom-made restoration fabricated outside the mouth

- Crown prep.
- Bridge prep.
- Inlay/onlay prep.
- Veneer prep.
- Post space prep.

Objective of Tooth Preparation

To optimize the shape and form of a tooth that will receive an indirect restoration:

- Create room for the selected restorative material
- Remove diseased and/or weakened tooth structure
- Provide retention and resistance to the restoration
- Allow a proper fit, function, aesthetics and longevity
- Facilitate subsequent procedures (provisional restoration, impression, cast pouring, final restoration fabrication)
- Preserve healthy tooth structure

Indications for Tooth Preparation

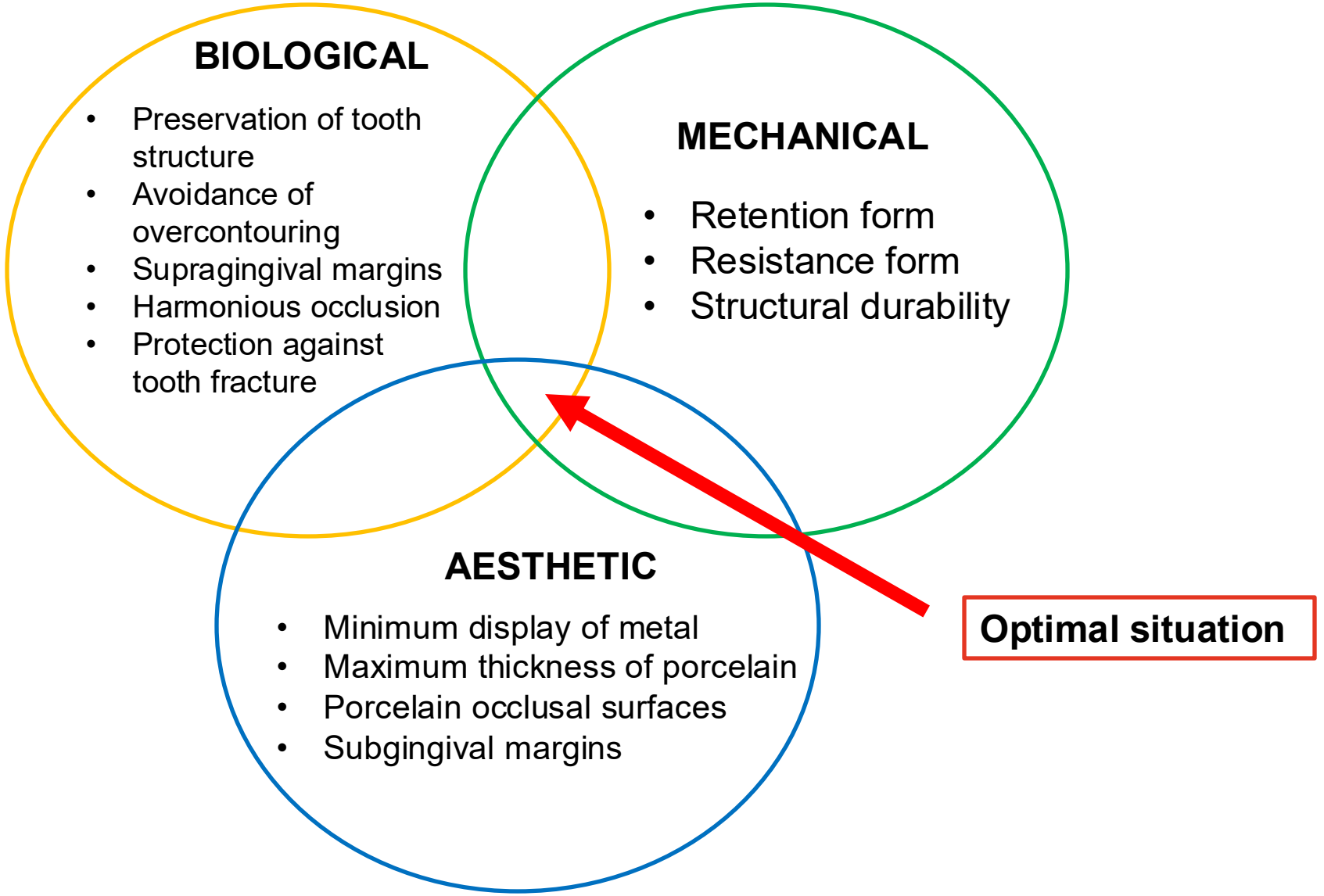
1) Therapeutic preparations:

Restoration of teeth that have lost tooth structure by caries and non-caries lesions: attrition, abrasion, erosion, abfraction; or fractures.

2) Preparations of healthy teeth:

Preparation of abutments, supports of RPR, occlusal correction, aesthetics.

Principles of Tooth Preparation



Principles of Tooth Preparation

Biological factors

- Affect the health of oral tissues

Mechanical factors

- Determine the integrity and durability of the restoration

Aesthetic factors

- Determine the appearance of the final restoration

Case by case decision: choose the ideal combination

Biological Factors

- Prevention of tooth damage during preparation
- Preservation of tooth structure
- Avoidance of overcontouring the restoration
- Supragingival margins
- Marginal integrity
- Harmonious occlusion
- Protection of remaining tooth structures

Biological Factors

Prevention of Tooth Damage During Preparation

1) Proximal teeth
   - Can lead to caries and gingivitis
2) Soft tissues
   - Gingival tissues, tongue & cheeks
3) Pulp
   - Thermal irritation: use copious irrigation
   - Chemical irritation: bases, resins, etch, solvents & luting agent (4-8% of pulps die in the 10 years following crown preparations)
   - Bacterial irritation: either left behind or gained access due to microleakage

Valderhaug et al; 1997

Biological Factors

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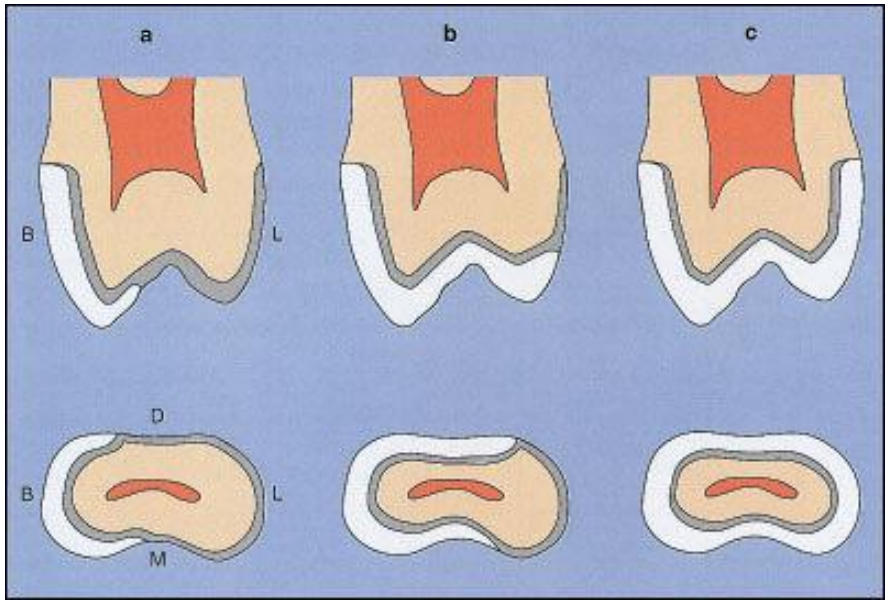
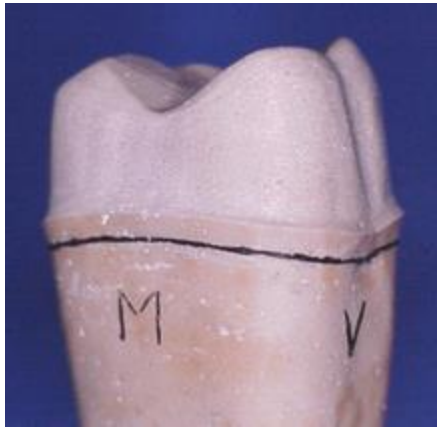
Preservation of Tooth Structures

- Tooth structures loss due to material selection
- Metal coverage alone requires less reduction



Gold crown



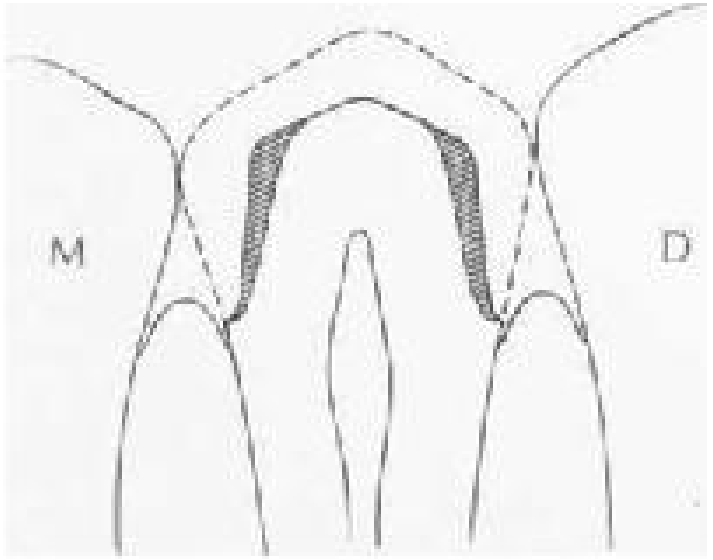
PFM

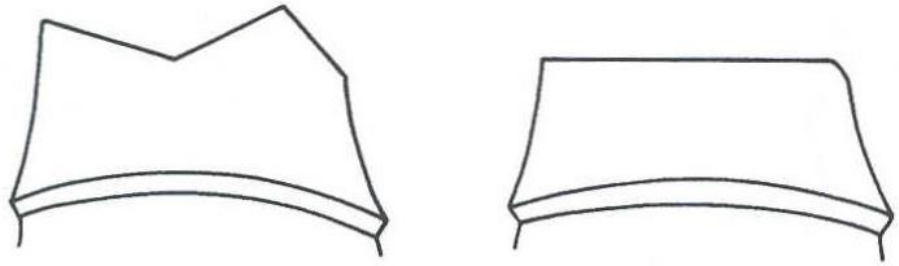
Biological Factors

Preservation of Tooth Structures

Preparation with minimal taper

Occlusal reduction following the anatomical contour





Biological Factors

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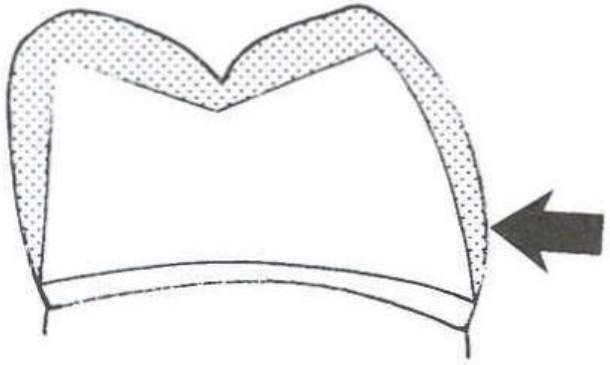
Preservation of Tooth Structures

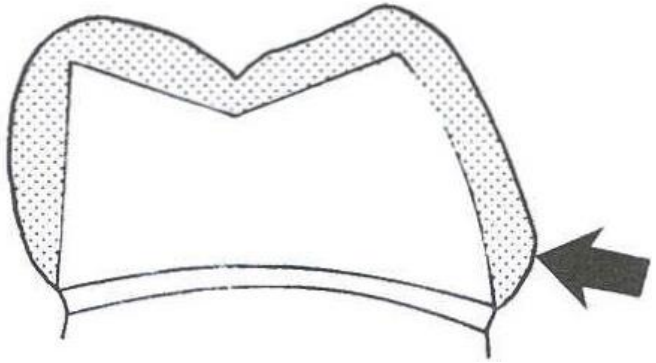
Uniform axial reduction
Conservative margins
Avoid unnecessary apical extension of the preparation

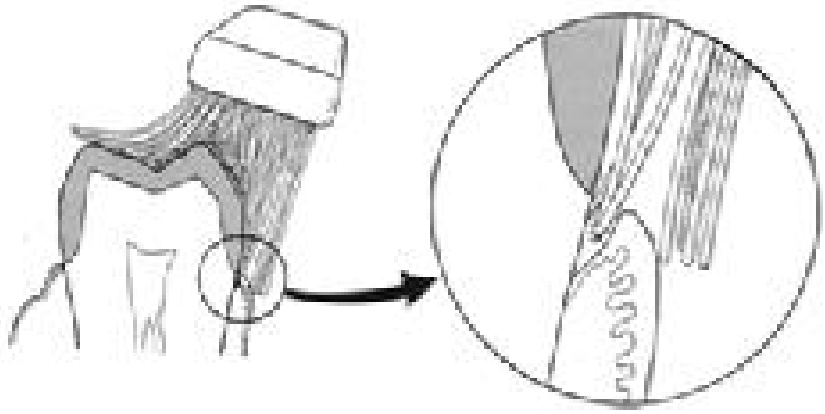
Biological Factors

Avoidance of Over contouring the Restoration

- Favors plaque build ups – gingivitis, periodontitis
- Ideal contours of the restoration should follow the natural contour of the tooth and surrounding tissue (emergence profile)







Biological Factors

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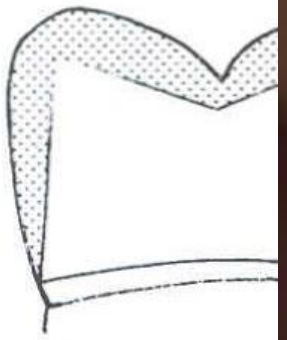
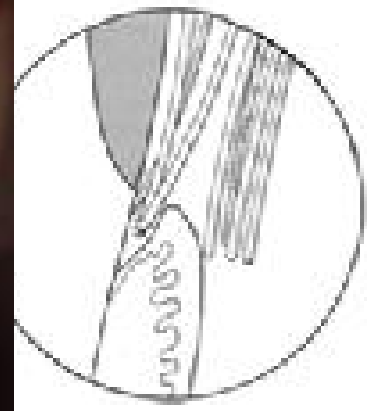
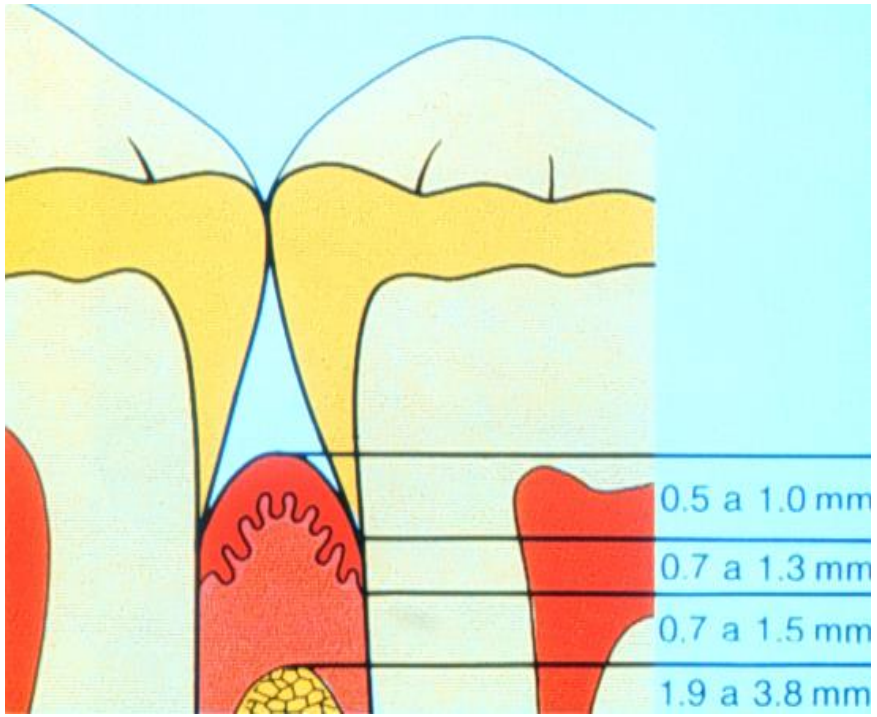




Biological Factors

Supragingival Margins

- Easily prepared
- Easier to take impressions
- Easily maintained by patient
- Easily evaluated at recalls
- Preserve periodontium



Sulcular epithelium

Junctional epithelium

Connective tissue attachment

Alveolar crest

Subgingival Margins

Indications

- Subgingival dental caries, erosion, fracture line or restoration
- Apical proximal contact area
- Additional retention is needed
- Aesthetic margins
- Coverage of root surface
- Modification of axial contour

Biological Factors

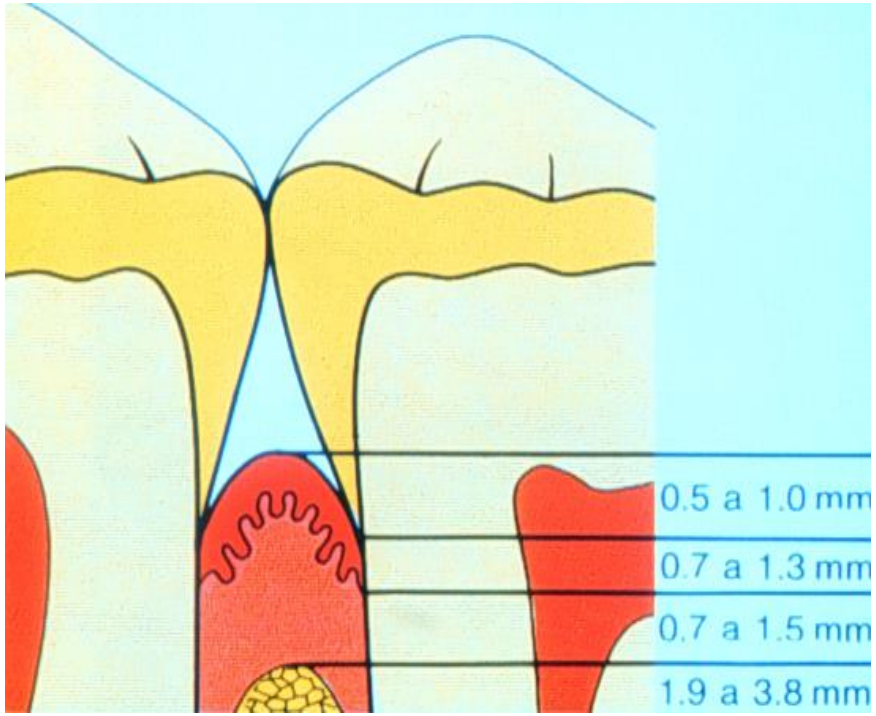
Marginal Integrity

- Potential site for caries:
  - Dissolution of cement
  - Inherent roughness leading to plaque accumulation

- Should be even and smooth:
  - Facilitates subsequent steps till the delivery of the restoration

Biological Factors

Marginal Integrity



Healthy periodontium:

- Mean sulcular depth 0.69 mm
- Mean junctional epithelial length 0.97 mm
- Mean connective tissue attachment length 1.07mm
- JE + CT attachment is known as “biological width”

If you place a margin within the biological width, increase the chance of gingival inflammation
Followed by bone loss as the biological width tries to re-establish itself

Biological Factors

Marginal Integrity

Follow the gingival and papillary contour to avoid violation of biological width

Biological Factors

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Margin/finishing lines

Design requirements

- Simplicity of preparation
- On intact tooth surface
- No unsupported enamel
- Ease of identification
- Allows sufficient bulk of restoration
  - Durability
  - Aesthetics
- Conservative

Possible Designs

1) Feather edge
2) Bevel
3) Chamfer
4) Shoulder
5) Shoulder with bevel

Biological Factors

Margin/finish lines

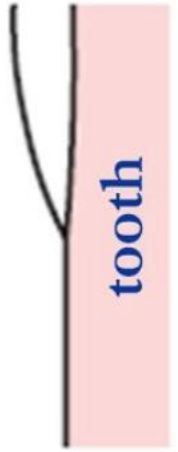
1) Feather edge

- Advantages:

Conservation of tooth structure

- Disadvantages:

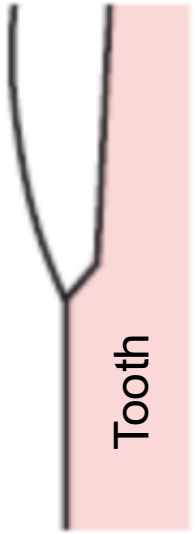
Fail to provide adequate bulk at margins



Biological Factors

Margin/finish lines

2) Bevel



- Advantages:

- Allow the margin of crown to be burnishing against tooth structure
- Protect the unprepared tooth structure from chipping by remove unsupported enamel

- Disadvantages:

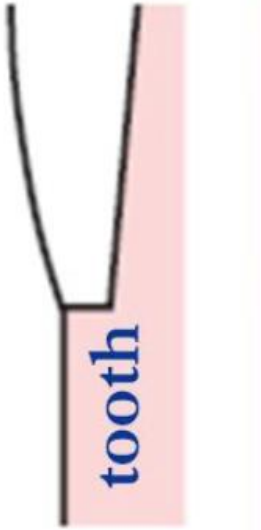
- Lead to subgingival extension

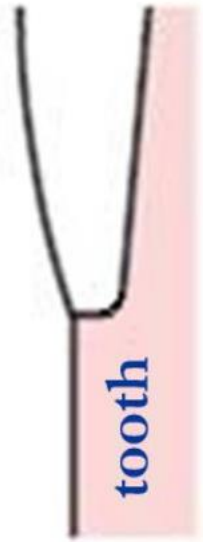
Biological Factors

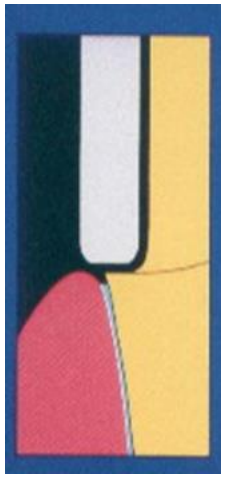
Margin/finish lines

3) Shoulder

- Margin for all materials
- Easy to prepare and finish well
- Easy to judge impressions
- Frequently used for metal crowns, metal ceramic crowns and all ceramic crowns





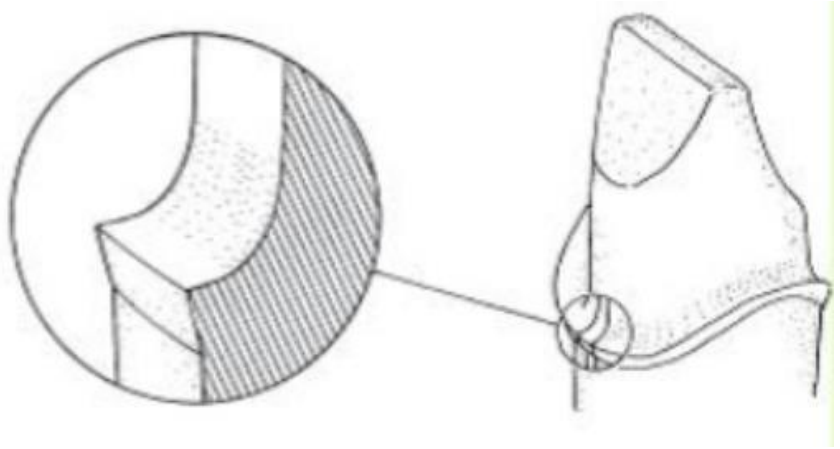


Modified Shoulder
CAD-CAM all ceramic

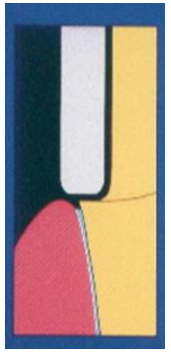
Biological Factors

Margin/finish lines

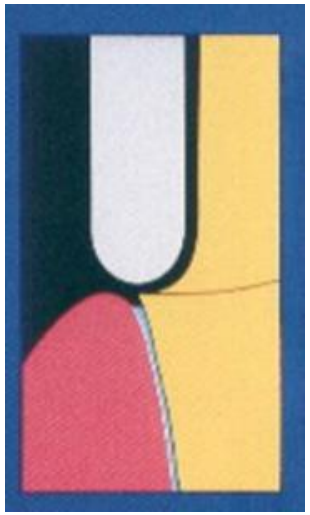
4) Chamfer

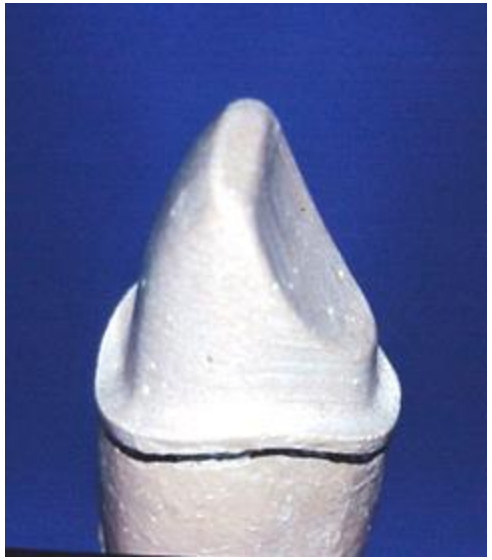


- Can be used margin for all metal and all ceramic restorations
- Preserves tooth tissue whilst providing distinct finish line
- Easy to read in impressions



Shoulder





Biological Factors

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Margin/finish lines

5) Shoulder with bevel

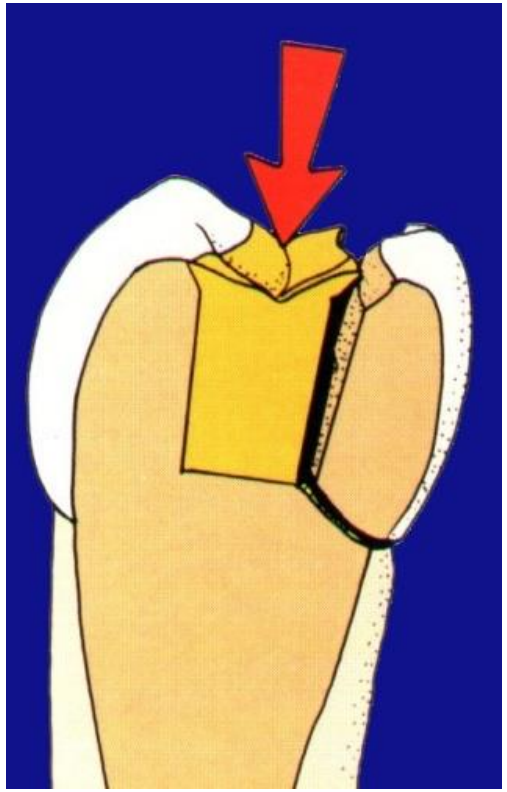
Harmonious Occlusion

- Confirmative or reorganized approach
- Decide upon a satisfactory occlusal scheme prior to tooth preparation
- Especially important with overerupted & tilted teeth
    - Eventual occlusal plane ajustment
    - Possibility of elective endodontic treatment
    - Possibility of crown lengthening surgery
- Diagnostic wax-ups can be extremely helpful

Biological Factors

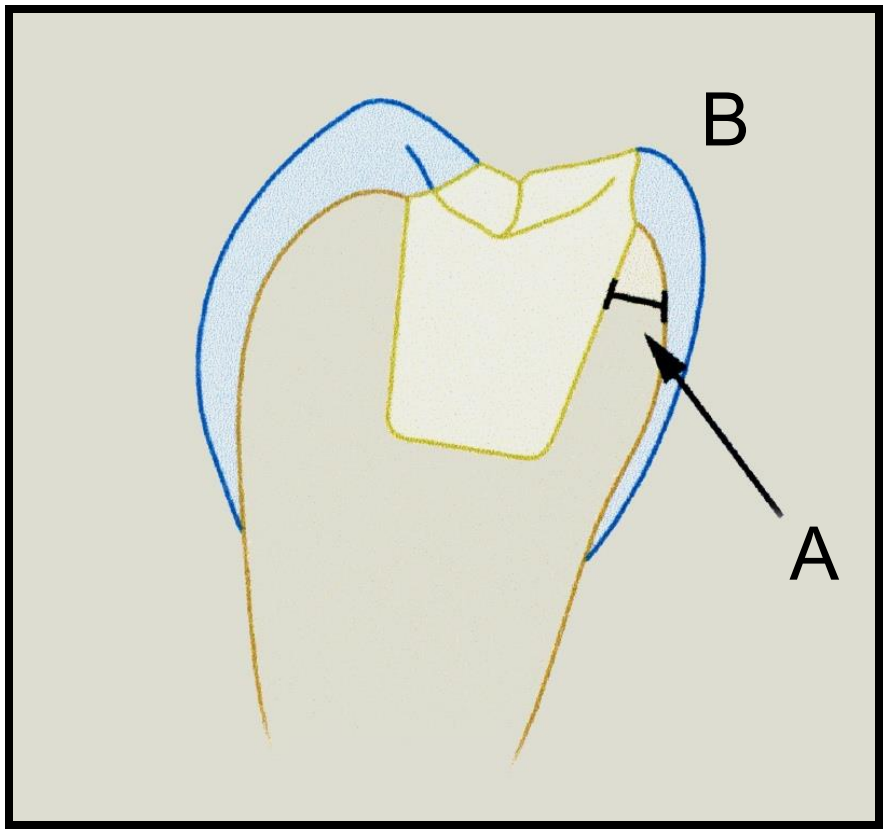
Protection of Remaining Tooth Structures

- Ensure all weakened tooth structure is removed prior to core placement



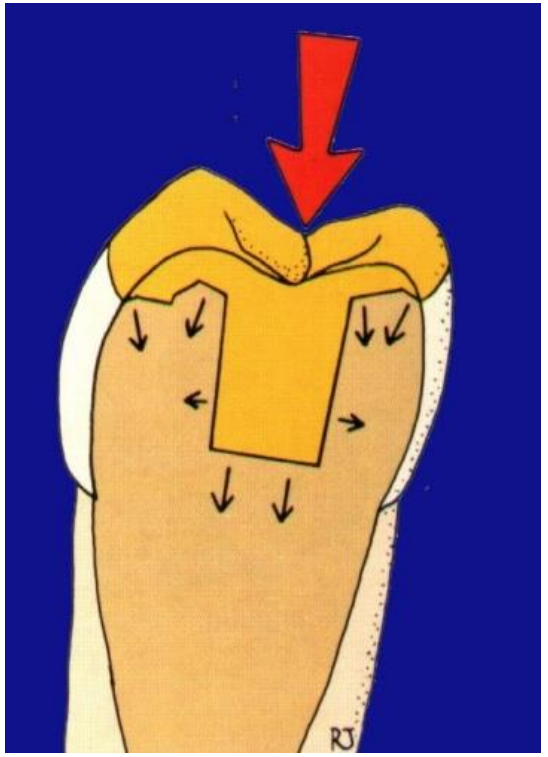
Biological Factors

Protection of Remaining Tooth Structures
CUSPAL COVERAGE



A) Tooth structure less than 2 mm

B) Low quality of the enamel covering the cusp



Biological Factors

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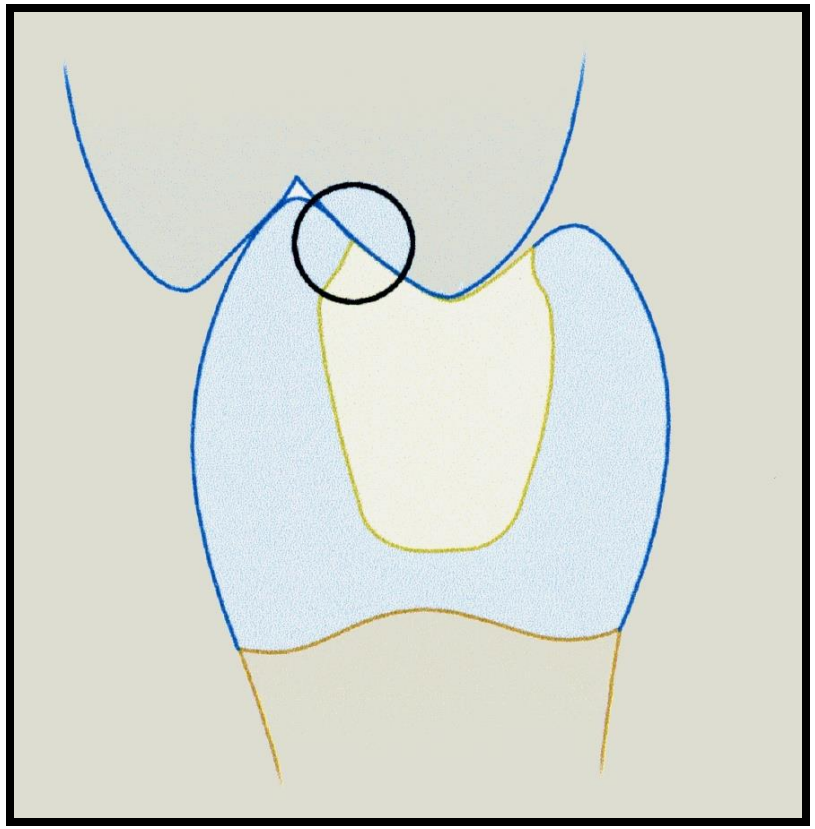
Protection of Remaining Tooth Structures
CUSPAL COVERAGE



Occlusal contacts on the margin of the preparation

Biological Factors

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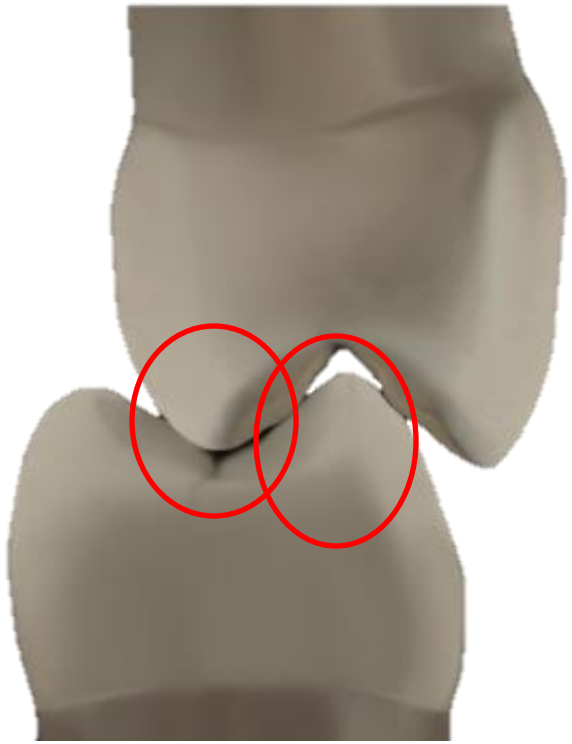
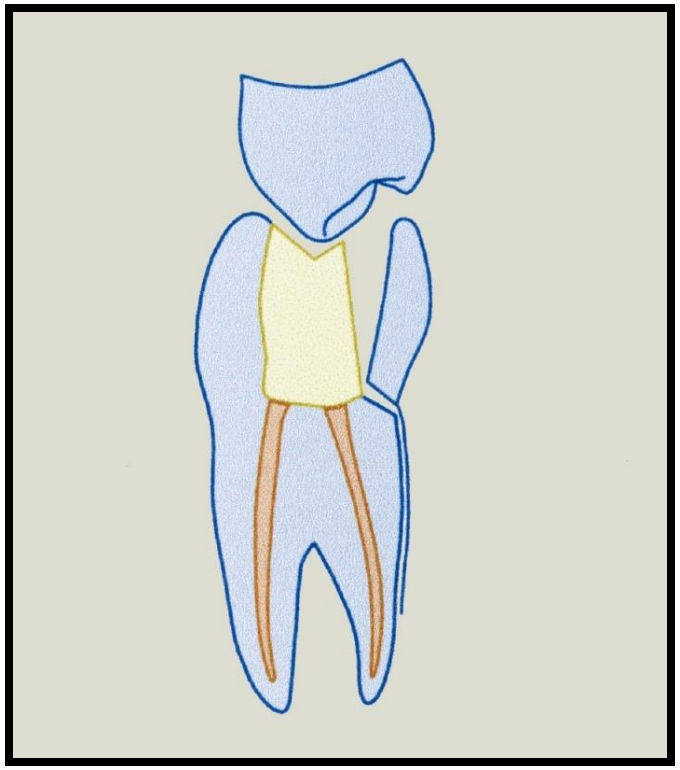
Protection of Remaining Tooth Structures
CUSPAL COVERAGE



Functional cusps:
Buccal – IP
Lingual – SP

Biological Factors

Protection of Remaining Tooth Structures
CUSPAL COVERAGE



Endodontically treated tooth

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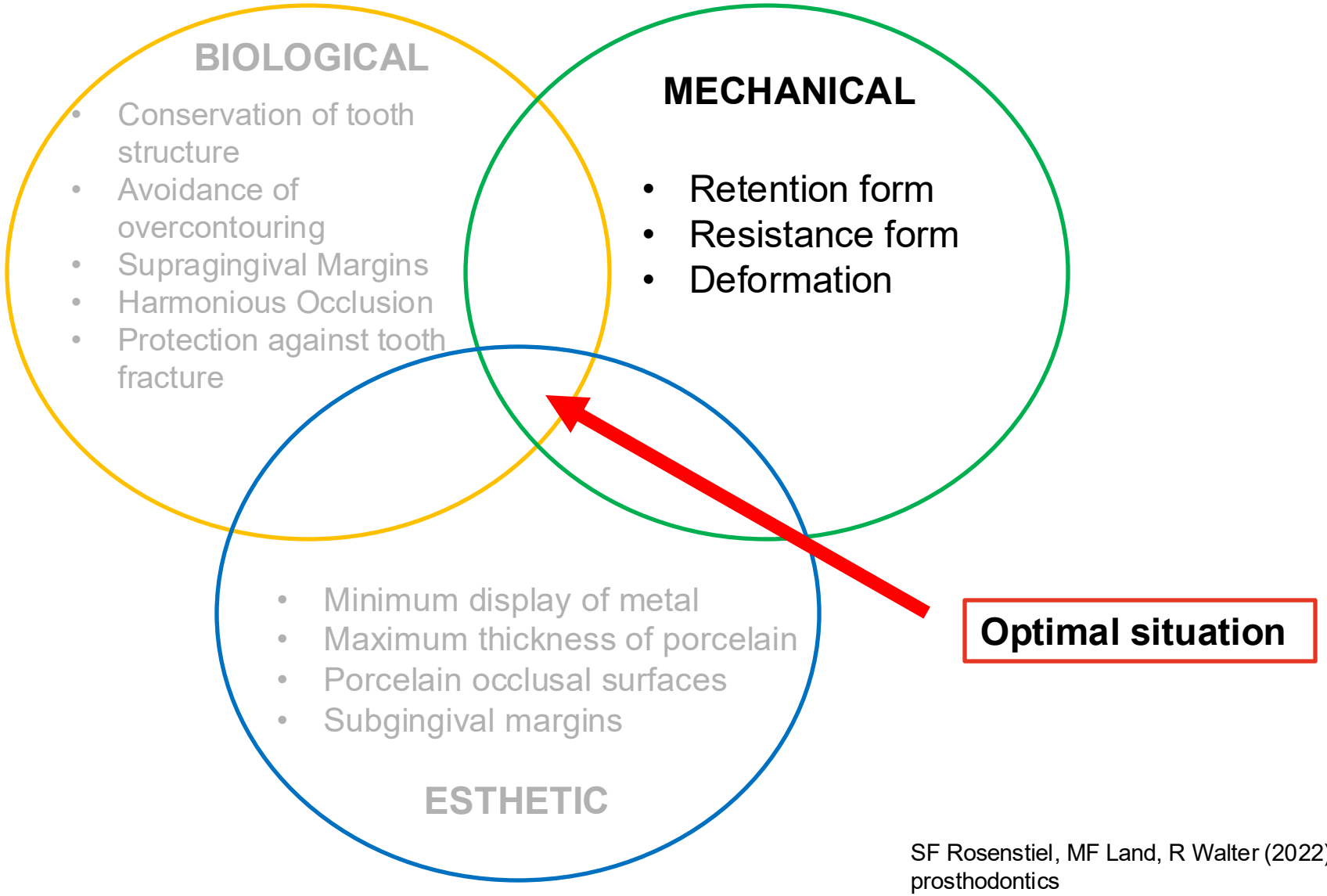
Weakness of cusp

Principles of Tooth Preparation

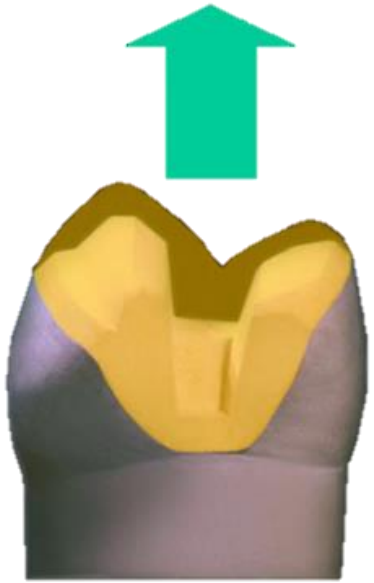


SF Rosenstiel, MF Land, R Walter (2022) Contemporary fixed prosthodontics

Mechanical Factors

Retention form

- Preparation feature which resists displacement occlusally
- Avoid relying on cements alone to retain the restoration
- Purpose: placing the cement shear instead of tension
- Retention form depends on:
    - Preparation height
    - Degree of taper
    - Freedom of displacement
    - Roughness of the surfaces
    - Physical properties of luting cement



Mechanical Factors

Retention form

Geometry of Tooth Preparation

- Enhance the cement function
- Cement:
  - Fills the crown-tooth space and creates friction
  - Prevents surface from sliding

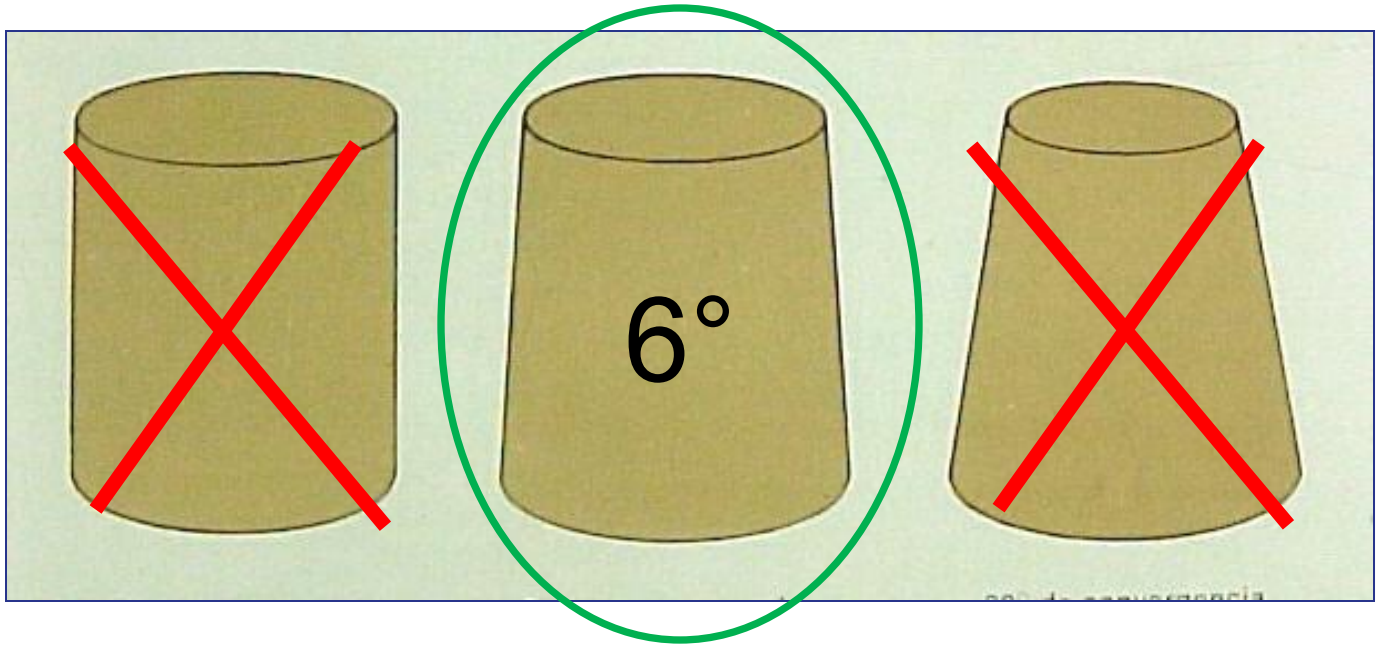
Mechanical Factors

Retention form

Geometry of Tooth Preparation

Parallels: Best retention, but difficult to fit

Overtapered: unsatisfactory retention



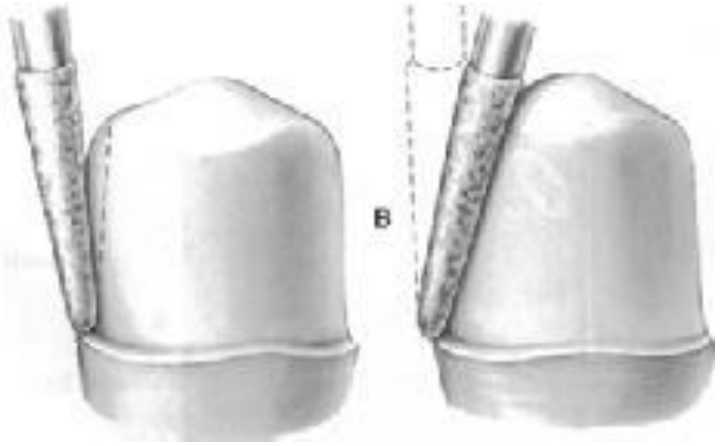
Mechanical Factors

Retention form

Geometry of Tooth Preparation

The axial walls must taper to:

- Permit more complete seating of the restoration
- Prevent undercuts
- Visualize preparation walls and finish line
- Compensate for inaccuracies during fabrication



Undercuts Overtapared

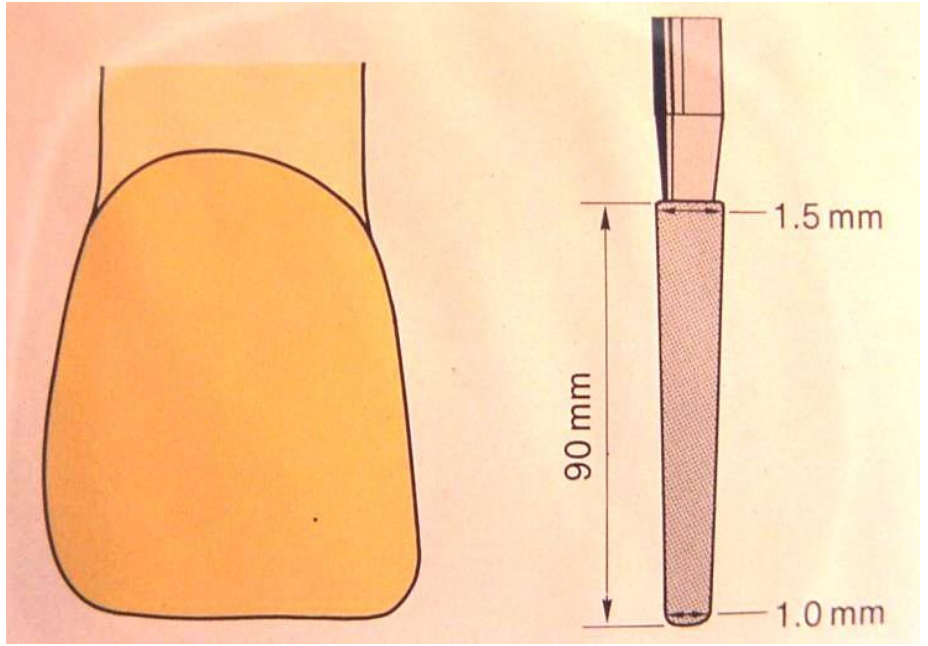
Mechanical Factors

Retention form

Degree of taper

- ideal taper 6°
- Clinically 6–20° is acceptable

- Tapered burs are designed to cut a 3° taper on each wall and should be hold parallel to the long axis of the tooth



Mechanical Factors

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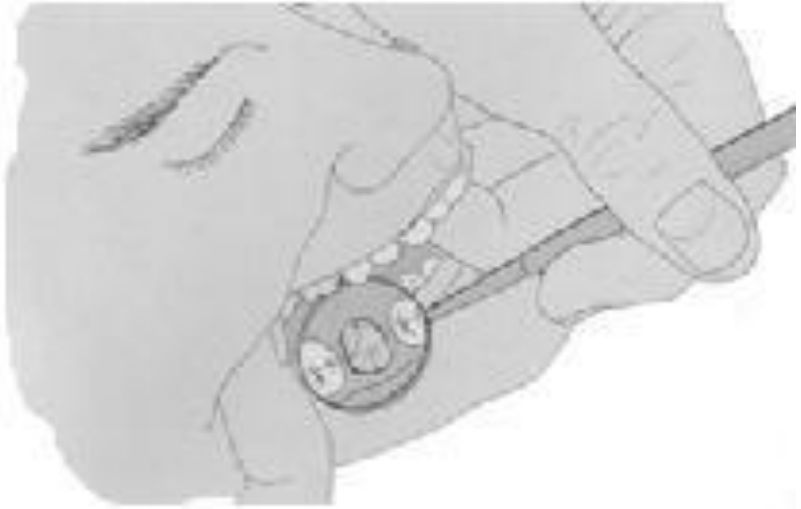
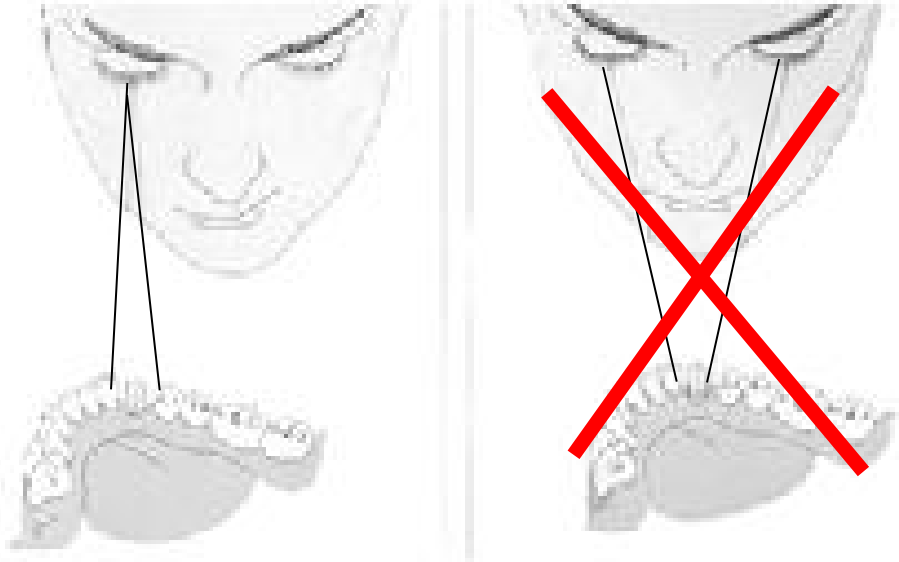
Retention form

Degree of taper

- One eye vision
- All the margins should be clearly visible

- In the mouth by mirror
- On the cast (distance of 30 cm)





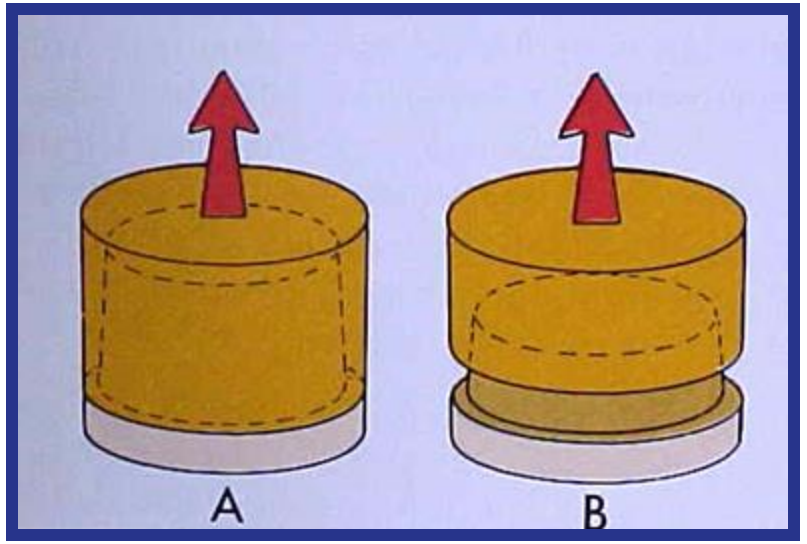
Mechanical Factors

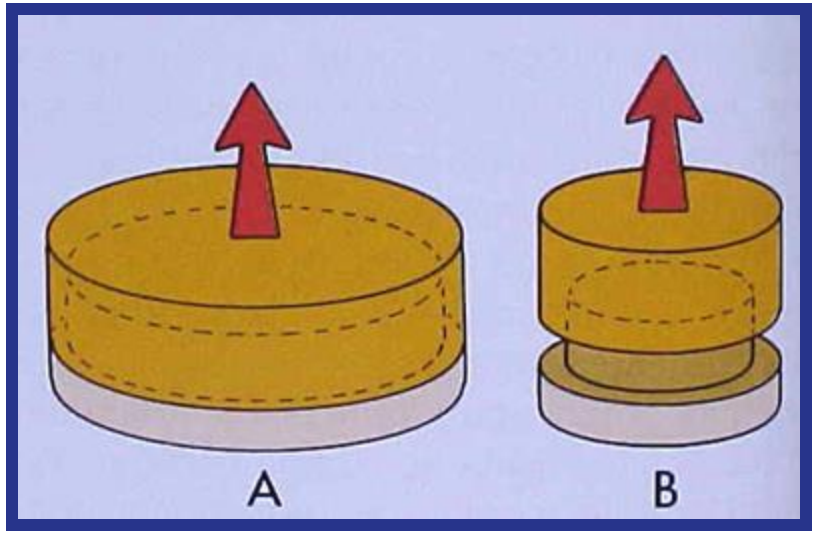
Retention form

Preparation Surface

1) Surface area
- The greater the surface area, the greater the retention
- Molars are more retentive than premolars with similar degree of taper

2) Surface roughness enhances retention



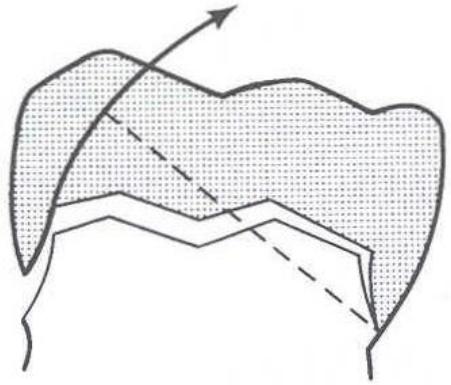


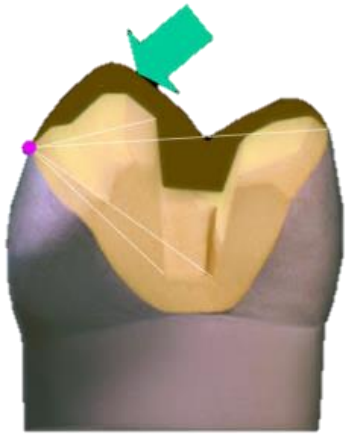
Mechanical Factors

Resistance form – Stability

- Preparation features which resist displacement in all directions other than occlusal (horizontal and oblique forces)

- Depends on:
- Magnitude and direction of dislodging forces
- Geometry of the tooth preparation:
  - Height
  - Degree of taper
- Cementation material
- Resistance to deformation



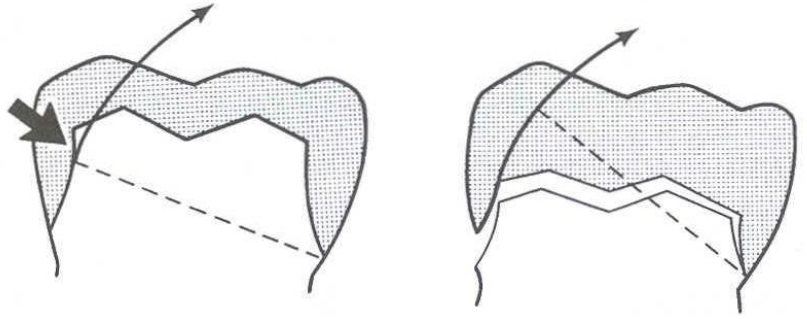


Mechanical Factors

Resistance form

- Increasing the proportion of axial surfaces: More surface area interfering with dislodgement:
  - Reduced taper
  - Increased preparation length

Higher preparations show more stability

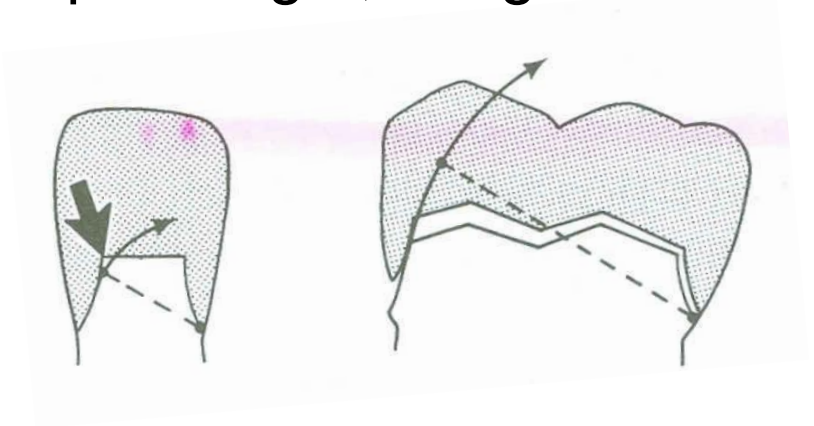


- Less resistance with partial coverage

Mechanical Factors

Resistance form

- Tooth with smaller diameter resists more to rotating movements than preparation with equal height, but greater diameter.



Short perps - Molars require more parallel surfaces than premolars or anterior teeth

Mechanical Factors

Resistance form

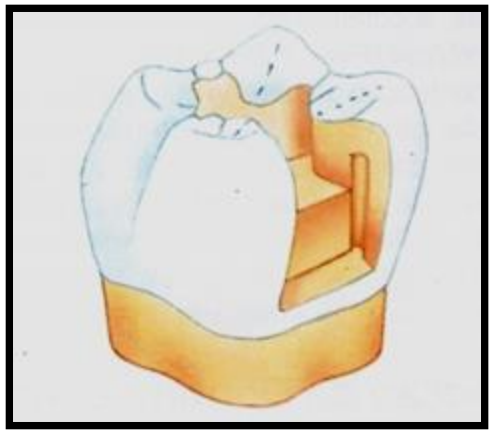
- Consider additional features

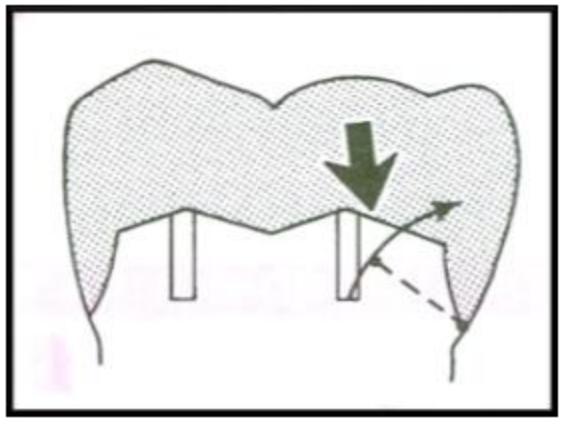
Pin holes

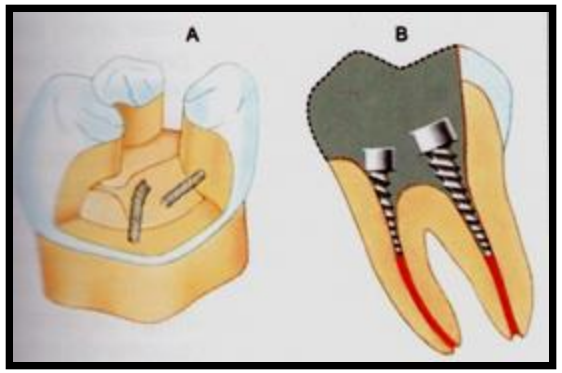
Boxes

grooves

All in natural tooth structure







Mechanical Factors

Resistance to Deformation (Structural Durability)

Depends

- Depth of preparation (space for restoration)
- Type of prep margin
- Type of restorative material

Mechanical Factors

Resistance to Deformation (Structural Durability)

- Sufficient strength to prevent permanent deformation
- Failure at cement-restoration interface or metal-ceramic interface

May result from:

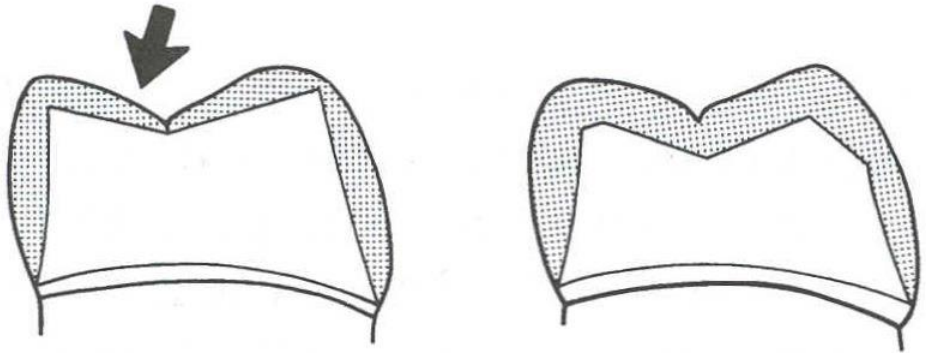
- Inappropriate material selection
- Inadequate preparation
- Poor restoration design

Mechanical Factors

Resistance to Deformation (Structural Durability)

Adequate Tooth Reduction

- Sufficient reduction to accommodate the restoration material
- Controlled by diagnostic procedures
- Occlusal position (MIP) and excursive movements (Lateroprotrusion)



Mechanical Factors

Resistance to Deformation (Structural Durability)

Margin Design

- Enough restoration bulk to resist distortion
- Avoid occlusal contact on the margin of partial coverage restoration
- Avoid feather edge
- boxes enhance the rigidity

Aesthetics Considerations

Natural looking restoration depends on:

- Facial tooth reduction
- Incisal reduction
- Proximal reduction
- Material selection
- Substratum color

Aesthetics Considerations

Labial margin placement

- Consider intracrevicular placement: especially for high smile line
- Inform the patient of the anticipated margin location
- Healthy periodontal tissues is mandatory
- Sufficient time after periodontal surgery

For each case, select the ideal combination of tooth preparation principles
Some principles are non-negotiable