

Sri Aurobindo College of Dentistry

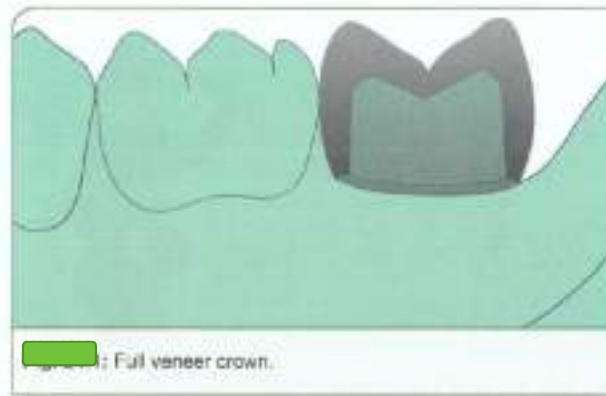
Indore, Madhya Pradesh
INDIA



MODULE PLAN

- TOPIC :PRINCIPLES OF TOOTH PREPARATION
- SUBJECT:PROSTHODONTICS
- TARGET GROUP: UNDERGRADUATE DENTISTRY
- MODE: POWERPOINT – WEBINAR
- PLATFORM: INSTITUTIONAL LMS
- PRESENTER: DR. KAVITA MARU

- **Fixed partial denture (FPD) or fixed dental prosthesis:** A dental prosthesis that is luted, screwed or mechanically attached or otherwise securely retained to natural teeth, tooth roots and/or dental implant abutments that furnish the primary support for the dental prosthesis. They are commonly referred to as *bridges* and cannot be removed by the patient.
- **Crown:** An artificial replacement that restores missing tooth structure by surrounding part or all of the remaining structure with a material such as cast metal, porcelain, or a combination of materials such as metal and porcelain (GPT8).



- **Laminate veneer:** A thin bonded restoration that restores the facial surface and part of the proximal surfaces of teeth requiring aesthetic restoration (GPT8).
- They are fabricated from resin or dental porcelain and are bonded (adhesively cemented) to etched enamel with a composite resin luting agent .
- **Resin-bonded restorations:** It is a fixed dental prosthesis that is luted to the tooth structure, primarily enamel, which has been etched to provide mechanical retention for the resin cement (GPT8).
- Tooth preparation is limited to the lingual/palatal surface and is minimal.
- **Radicular retained restorations:** It consists of a post or dowel with an attached core. The post is in the prepared radicular space of the endodontically treated tooth. The core offers support to the crown.

- **INLAY-** It is an intracoronal restoration, which is used for medium sized single tooth proximo-occlusal and gingival lesions. They are usually made of gold alloy or ceramic material.
- **ONLAY-** It is an intracoronal restoration, which is used to restore a more extensively damaged posterior tooth with a wide mesio-occluso - distal lesion. An onlay can be termed as an inlay supplemented (fused) with an occlusal veneer in order to restore large lesions.



- **ABUTMENT-** It is any tooth, root or implant which, gives attachment and support to the fixed partial denture.
- **PONTIC-** The artificial tooth that replaces a missing tooth in a fixed partial denture is called a pontic. Pontics are attached to the retainers. All forces acting on the pontic are transferred to the abutment through the retainers.
- **CONNECTOR-** It is the connection that exists between the pontic and retainer. They may be rigid or non-rigid. Rigid connectors are immovable attachments between the pontic and retainer.
- *Example:* Solder joints. Non-rigid connectors are movable attachments with a key-keyway mechanism.
- *Example:* Precision attachments (stress breakers)



INDICATIONS

A fixed partial denture is preferred for the following situations-

1. Short span edentulous arches
2. Presence of sound teeth that can offer sufficient support adjacent to the edentulous space.
3. Cases with ridge resorption where a removable partial denture cannot be stable or retentive.
4. Patient 's preference.
5. Mentally compromised and physically handicapped patients who cannot maintain the removable prosthesis.

CONTRAINDICATIONS

Fixed partial dentures are generally avoided in the following conditions-

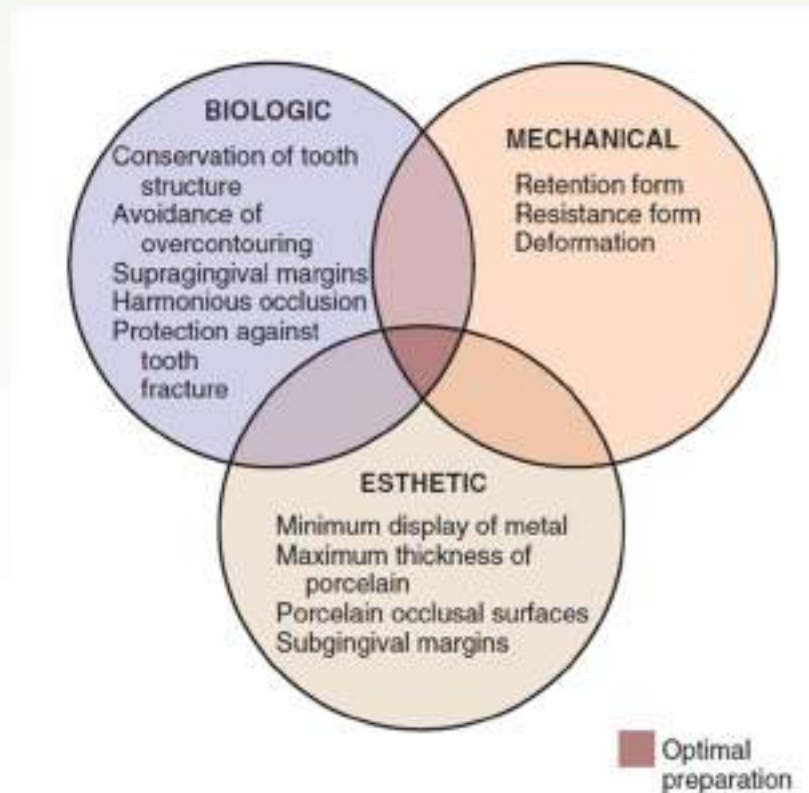
1. Large amount of bone loss as in trauma.
2. Very young patients where teeth have large pulp chambers.
3. Presence of periodontally compromised abutments.
4. Long span edentulous spaces.
5. Bilateral edentulous spaces, which require cross arch stabilization.
6. Congenitally malformed teeth, which do not have adequate tooth structure to offer support.
7. Mentally sensitive patients who cannot cooperate with invasive treatment procedures.
8. Medically compromised patients (e.g. leukemia, hypertension).
9. Very old patients.
10. Distal extension denture bases as in class I and II cases.

- **TOOTH PREPARATION** is defined as “The mechanical treatment of dental caries or injury to hard tissues that restores the tooth to original form”.

OBJECTIVES-

- Reduction of tooth in miniature to provide retainer support.
- Preservation of healthy tooth structure to secure resistance form.
- Provision of acceptable finish line to encourage favorable tissue response from artificial crown contours.

The principles of tooth preparation can be divided into three broad categories: (According to [Rosenstiel](#))



Tooth preparation must be based on fundamental principles –{Shillinberg}

- Preservation of tooth structure
- Retention and resistance form
- Structure durability of restoration
- Marginal integrity
- Preservation of periodontium

- Teeth do not possess the regenerative ability.
- Therefore, once enamel or dentin is lost as a result of caries , trauma or wear, restorative materials must be used to reestablish form and function.
- Teeth require preparation to receive restorations.
- These preparations must be based on fundamental principles from which basic criteria can be developed to help predict the success of prosthodontic treatment.
- Careful attention to every detail is imperative during tooth preparation.

BIOLOGIC CONSIDERATIONS

- Surgical procedures involving living tissues must be performed carefully to avoid unnecessary damage.
- The adjacent teeth, soft tissues, and the pulp of the tooth being prepared are easily damaged during preparation.
- If poor preparation leads to inadequate marginal fit or deficient crown contour, plaque control around fixed restorations becomes more difficult.
- This, in turn, impedes the longterm maintenance of dental health.

Prevention of Damage during Tooth Preparation

Adjacent Teeth-

- Iatrogenic damage to an adjacent tooth is a common error in dentistry.
- Even if a damaged proximal contact area is carefully reshaped and polished, it is more susceptible to dental caries than the original undamaged tooth surface was.
- This is presumably because the original surface enamel contains higher fluoride concentrations and the interrupted layer is more prone to plaque retention.
- Sound tooth preparation technique avoids and prevents damage to the adjacent proximal surfaces.

- A metal matrix band placed around the adjacent tooth for protection may be helpful; however, the thin band can be perforated and the underlying enamel damaged.
- The preferred method is to use the proximal enamel of the tooth that is being prepared for protection of the adjacent structures.
- Teeth are 1.5 to 2 mm wider at the contact area than at the cementoenamel junction.
- Therefore, a thin, tapered diamond can be passed through the interproximal contact area while leaving a slight “lip” or “fin” of enamel without resulting in excessive tooth reduction or necessitating undesirable angulation of the rotary instrument.



Metal matrix band used to protect adjacent tooth.



Thin tapering diamond used to produce a lip of enamel for protection.

Soft Tissues

- Damage to the soft tissues of the tongue and cheeks can be prevented by careful retraction with an aspirator tip, a mouth mirror or a flanged saliva ejector.
- Great care is needed to protect the tongue when the lingual surfaces of mandibular molars are being prepared.



Mouth mirrors used to retract cheek and tongue.

Pulp

- Great care also is needed to prevent pulpal injuries during fixed prosthodontic procedures, especially when significant amounts of tooth structure are being removed.
- Extreme temperatures, chemical irritation, or microorganisms can cause an irreversible pulpitis, particularly when they occur on freshly sectioned dentinal tubules.
- Prevention of pulpal damage necessitates selection of techniques and materials that reduce the risk of injury while teeth are prepared.
- Pulp size can be evaluated on a radiograph, and it decreases with age. Up to about age 50, it decreases more so occlusocervically than faciolingually.

Causes of Injury

Temperature

- Considerable heat is generated by friction between a rotary instrument and the surface being prepared .
- Excessive pressure, higher rotational speeds, and the type, shape, and condition of the cutting instrument may all increase generated heat .
- With a high-speed handpiece, a feather-light, intermittent touch allows efficient removal of tooth material with minimal heat generation.
- Nevertheless, even with the lightest touch, the tooth overheats unless a water spray is used.
- The spray must be accurately directed at the area of contact between tooth and rotary instrument.
- It also washes away debris, which is important because rotary instrument clogging reduces cutting efficiency.
- Irrigation also prevents desiccation of the dentin (which may cause severe pulpal irritation)



(A) Proper use of water spray directed towards the tip of the diamond. **(B)** Improperly directed water spray.

Chemical Action

The chemical action of certain dental materials (bases, restorative resins, solvents, and luting agents) can cause pulpal damage, particularly when applied to freshly cut dentin.

- Chemical solvents and surfactants are sometimes used for cleaning and degreasing tooth preparations.
- However some of these have been shown to be pulpal irritants.
- Thus their use is generally contraindicated, particularly because they do not improve the retention of cemented restorations.

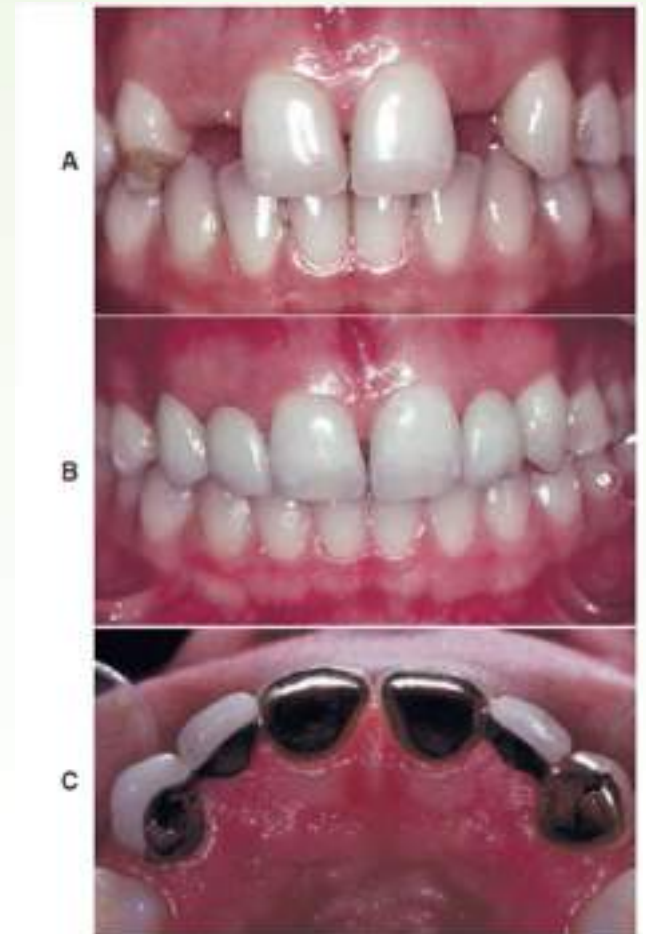
Bacterial Action

Pulpal damage under restorations has been attributed to bacteria that either were left behind or gained access to the dentin because of microleakage.

- However, many dental materials, including zinc phosphate cement, have an antibacterial effect.
- Because vital dentin seems to resist infection, the routine use of antimicrobial agents may not be advantageous.
- Many dentists now use an antimicrobial agent, such as chlorhexidine gluconate disinfecting solution (Consepsis, Ultradent Products, Inc.), after tooth preparation and before cementation, although the benefit has not been documented in clinical trials.

Conservation of Tooth Structure

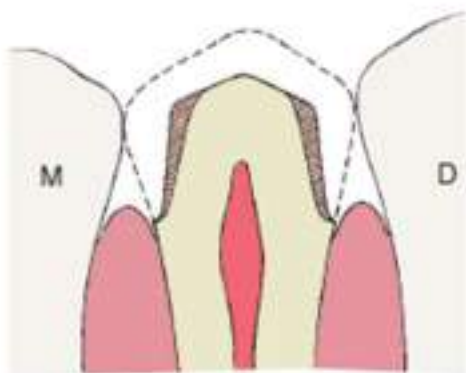
- One of the basic tenets of restorative dentistry is to conserve as much tooth structure as possible while preparation design remains consistent with the mechanical and esthetic principles of tooth preparation.
- Tooth structure is conserved through adherence to the following guidelines:
 1. Use of partial-coverage rather than complete coverage restorations



Conservation of tooth structure by using partial coverage restorations. In this case, they are used as fixed dental prosthetic abutments to replace congenitally missing lateral incisors.

2. Preparation of teeth with the minimum practical convergence angle (taper) between axial walls.

3. Preparation of the occlusal surface so that reduction follows the anatomic planes and produces uniform thickness in the restoration.



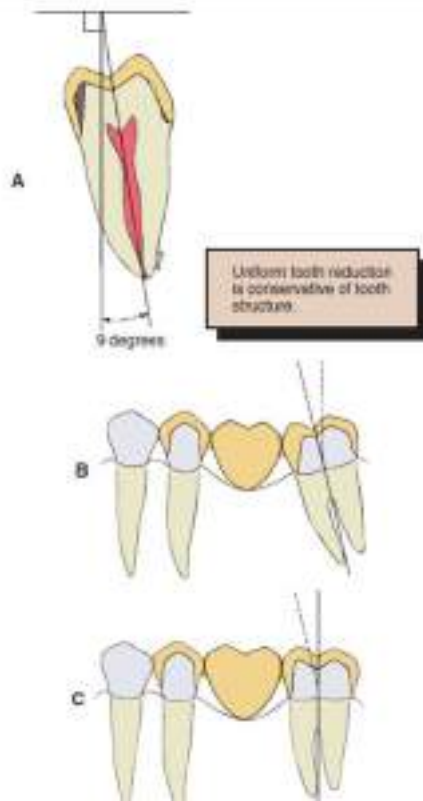
■ Excessive taper results in considerable loss of tooth structure (*cross-hatched area*).



Minimally required clearances:
Buccal cusp—1.5 mm
Lingual cusp—1.0 mm
Marginal ridges and fossae—1.0 mm

■ An anatomically prepared occlusal surface results in adequate clearance without excessive tooth reduction. A flat occlusal preparation will result in either insufficient clearance (1) or an excessive amount of reduction (2).

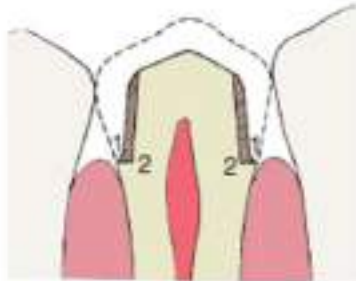
4. Preparation of the axial surfaces so that a maximal thickness of residual tooth structure surrounding pulpal tissues is retained; if feasible, teeth may be orthodontically repositioned, which allows less axial convergence than necessary when tooth alignment is less than optimal to accommodate preparations for fixed dental prosthetic retainers



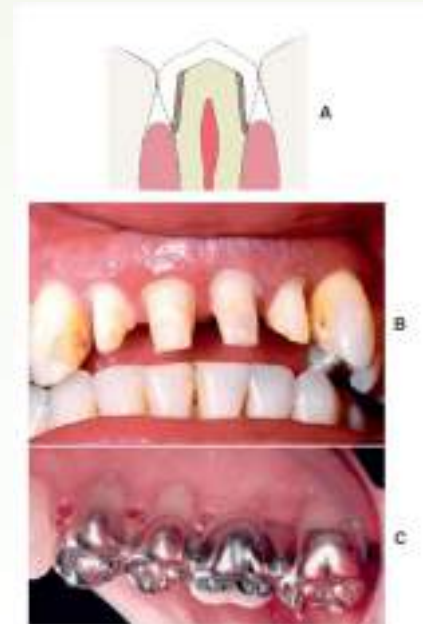
To conserve tooth structure, the preparation of axial walls should be as uniform as possible. **A**, The path of placement should coincide with the long axis of the tooth, which for a mandibular molar is typically inclined 9 to 14 degrees lingually. Preparing such a tooth with a path of placement that is perpendicular to the occlusal plane of the mandibular arch is a common clinical error that results in additional unnecessary removal of tooth structure (*cross-hatched area*). **B**, Malaligned teeth, such as a mesially tipped molar, necessitate additional removal of tissue on the mesial aspect of the molar abutment to achieve compatible paths of placement for a planned fixed dental prosthesis. **C**, If the molar abutment is orthodontically uprighted before tooth preparation, crown preparation can be more conservative.

5. Selection of a margin geometry that is conservative and yet compatible with the other principles of tooth preparation.

6. Avoidance of unnecessary apical extension of the preparation, which would result in loss of additional tooth structure.



■ A shoulder margin (2) is indicated when esthetic restorations are planned to achieve sufficient material thickness for a lifelike appearance, but it is much less conservative than a chamfer margin (1).



■ A, Apical extension of the preparation can necessitate additional tooth reduction because coronal diameter becomes smaller. B, Preparations for periodontally involved teeth may necessitate considerable reduction if the margins are to be placed subgingivally for esthetic reasons. C, Supragingival margins are preferred where applicable.

Considerations Affecting Future Dental Health

- Improper tooth preparation may have adverse effects on long-term dental health. For example, insufficient axial reduction inevitably results in overcontoured restorations that hamper plaque control. This may cause periodontal disease or dental caries.
- Alternatively, inadequate occlusal reduction may result in poor form and subsequent occlusal dysfunction. Poor choice of margin location, such as in the area of occlusal contact, may cause chipping of enamel or cusp fracture.
- **Margin:** The outer edge of a crown, inlay, onlay or other restoration (GPT8).
- **Finish line:** Terminal portion or peripheral extension of the prepared tooth (GPT8)

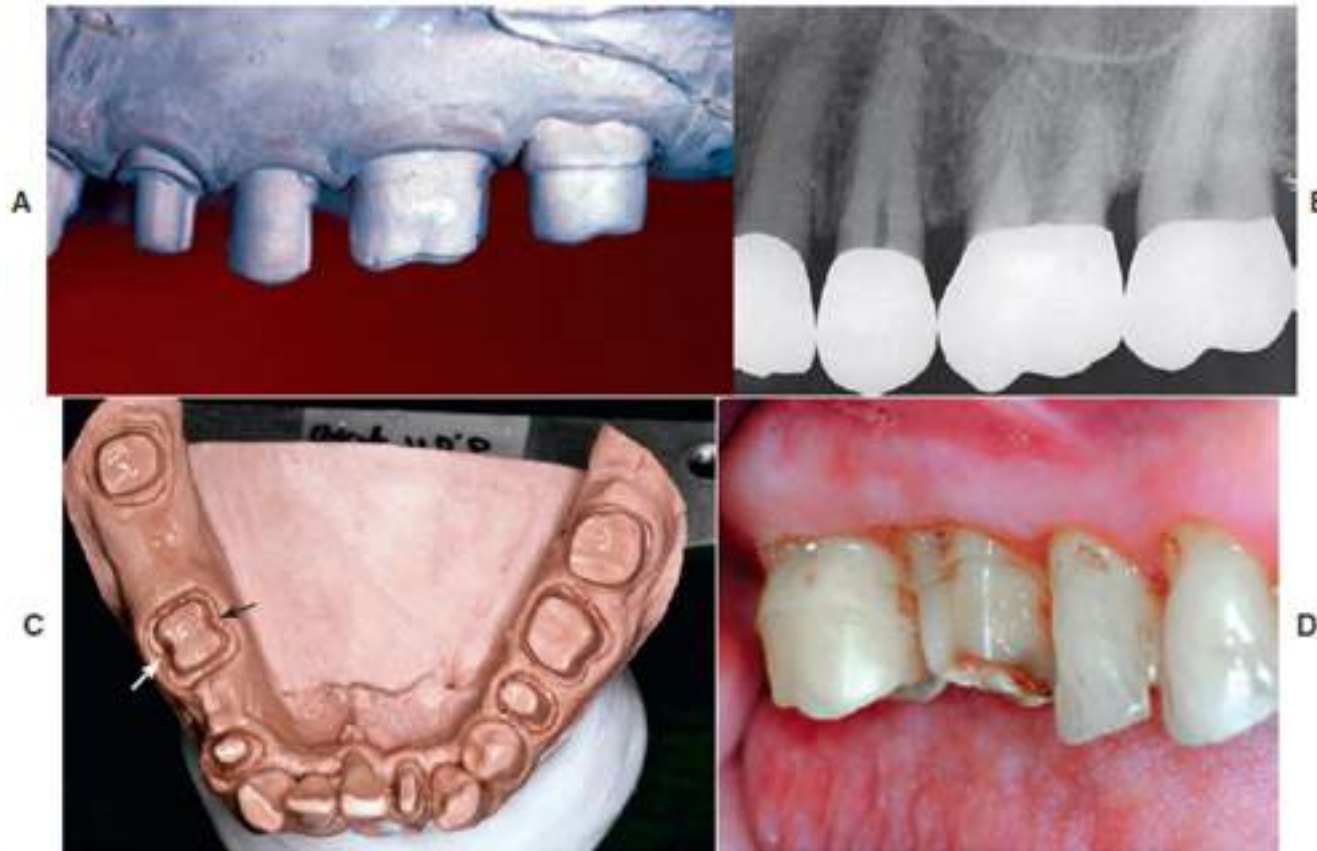


Axial Reduction

- Gingival inflammation is commonly associated with crowns and fixed dental prosthetic abutments that have excessive axial contours, probably because it is more difficult for the patient to maintain plaque control around the gingival margin.
- Successful preparations provide sufficient space for the development of anatomically correct axial contours.
- The junction between the restoration and the tooth must be smooth and free of any ledges or abrupt changes in direction.
- In most circumstances, a crown should duplicate the contours and profile of the original tooth (unless the restoration is needed to correct a malformed or malpositioned tooth).
- If an error is made, a slightly undercontoured flat restoration is better because it is easier to keep free of plaque; however, increasing proximal contour on anterior crowns to maintain the interproximal papilla may be beneficial from an esthetic perspective.



A. Unhealthy gingival tissue as a result of overcontoured restorations. **B.** The tooth preparations are underreduced. **C.** Once the restorations are recontoured, gingival health returns.



■ A and B, Tooth preparations with adequate axial reduction allow the development of properly contoured embrasures. Tissue is conserved through the use of partial coverage and supragingival margins where possible. C, Preparing furcation areas adequately is important (*arrows*); otherwise, the restoration is excessively contoured, which makes plaque control difficult. D, Note the additional preparation of the buccal axial wall of the first molar to allow for improved access for plaque control in the furcation area.

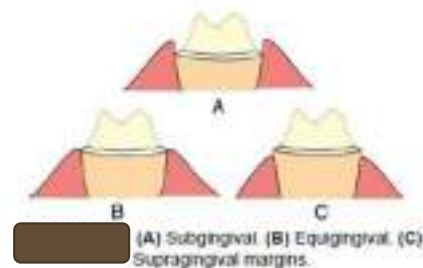
Margin Placement

Margins can be placed by:

- i. **Supragingival (at or above the gingival crest):** Margins placed at the level of gingival crest are referred to as *equigingival margins*.
- ii. **Subgingival** (below the gingival crest)

Whenever possible, the margin of the preparation should be supragingival.

- Supragingival margins are easier to prepare accurately without trauma to the soft tissues and facilitate impression making or optical capture.
- They can usually also be situated on hard enamel, whereas subgingival margins are often on dentin or cementum.



Advantages of supragingival margins include the following:

1. They can be easily finished without associated soft tissue trauma.
2. They are more easily kept plaque free.
3. Impressions are more easily made, with less potential for soft tissue damage.
4. Restorations can be easily evaluated at the time of placement and at recall appointments.

Subgingival margins , however, are indicated if any of the following conditions are present:

1. Dental caries, cervical erosion, or restorations extend subgingivally, and a crown-lengthening procedure is contraindicated.
2. The proximal contact area extends apically to the level of the gingival crest.
3. Additional retention, resistance, or both are needed
4. The margin of an esthetic restoration is to be hidden behind the labiogingival crest.
5. Root sensitivity cannot be controlled by more conservative procedures, such as the application of dentin bonding agents.
6. Axial contour modification is indicated: for example, to provide an undercut to provide retention for a partial removable dental prosthesis clasp



■ Examples of situations in which subgingival margins are indicated, A, To include an existing restoration. B, To extend apical to the proximal contact (adequate proximal clearance). C and D, To hide the metal collar of metal-ceramic crowns.

Margin Adaptation

- The junction between a cemented restoration and the tooth is always a potential site for recurrent caries because of dissolution of the luting agent and inherent interface roughness.
- The more precisely the restoration is adapted to the tooth, the lower is the risk for recurrent caries or periodontal disease.
- Although a precise number for acceptable marginal gap width is not known, a skilled technician can routinely make castings that fit to within 10 μm ³⁴ and porcelain margins that fit to within 50 μm ,³⁵ provided that the tooth was properly prepared.
- A well-designed preparation has a smooth and even margin. Rough, irregular, or “stepped” junctions between tooth and restoration greatly increase overall margin length and substantially reduce the adaptation accuracy of the restoration.
- Smooth, accurately placed preparation margins are particularly important when restorations are fabricated with a computer-aided design and computer-aided manufacturing (CAD/CAM) process.



A

A smooth margin is considerably shorter than a jagged one.



C



B



D

FIGURE 7-19 ■ A and B. Poor preparation design, leading to increased margin length. C. A rough, irregular margin makes the fabrication of an accurately fitted restoration almost impossible. D. An accurately fitting margin is possible only if it is prepared smoothly.

Margin Geometry

For evaluation, the following guidelines for margin design should be considered:

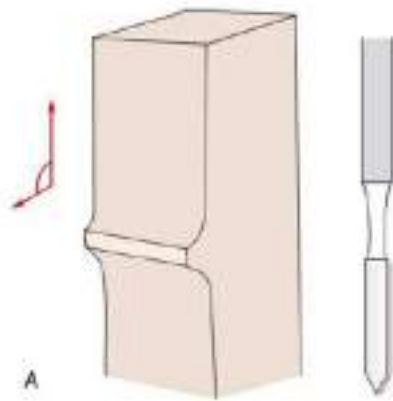
1. Ease of preparation without overextension or unsupported enamel at the cavosurface line angle.
2. Ease of identification in the impression or optical scan and on the (virtual) die
3. A distinct boundary to which the wax pattern can be finished or the design terminated
4. Sufficient bulk of material (to enable the pattern to be handled without distortion and to give the restoration strength and, when porcelain is used, esthetic appearance)
5. Conservation of tooth structure.

- *The shape of the diamond point/bur determines the finish line configuration and the taper.*

Finish line configurations

1. Chamfer

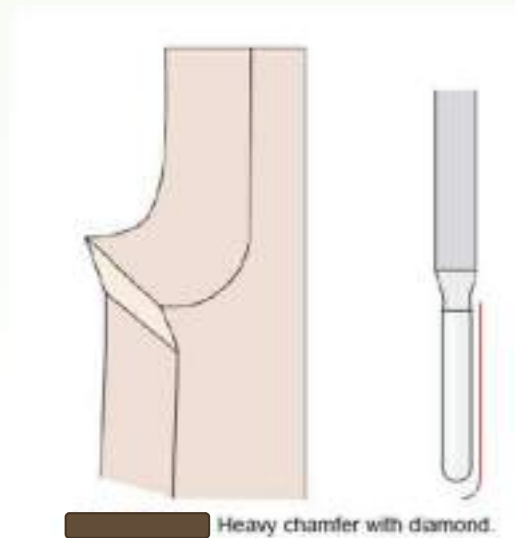
- It is an obtuse-angled finish line.
- It is distinct.
- Exhibits least stress.
- Most conservative.
- Indicated where metal forms the margin of a restoration, e.g. complete metal crown. Should not be given for porcelain restorations as the obtuse angle produces shearing forces which is not well tolerated by porcelain.
- It is prepared using a round-end tapering diamond. This is produced by sinking in half the diamond into the tooth. The tip produces the chamfer while the sides give the necessary taper to the axial surface.



(A) Chamfer finish line – obtuse-angled finish line obtained by sinking half the width of rotary. **(B)** Round-end tapered diamond and chamfer diamond.

2. Heavy chamfer

- Similar to chamfer but prepared with a diamond of greater diameter than that used to produce the chamfer.
- Indicated for all-ceramic crowns.
- Can produce an unsupported lip of enamel.



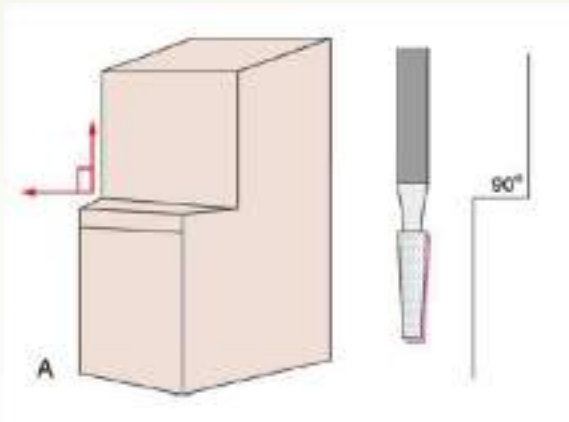
3. Shoulder

- It is a right-angled finish line.
- Produces a wide ledge which resists compressive occlusal forces.
- Requires more preparation, hence it is not conservative.
- Indicated for ceramic restorations – all ceramic and metal ceramic (where ceramic forms the margin).
- It is prepared using a flat-end tapering diamond .

This is produced by sinking in the entire diamond into the tooth. The tip produces the shoulder while the sides give the necessary taper to the axial surface.

End-cutting diamond is used to finish the shoulder. It has a cutting tip and noncutting sides.

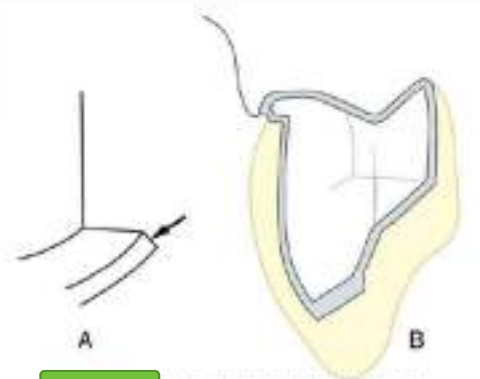
- Sharp internal line angle can produce stresses in all-ceramic crowns.



(A) Shoulder finish line – right-angled finish line. Produced by sinking the entire rotary into the tooth. **(B)** Flat-end tapered diamond and end cutting diamond, arrow showing the tip which is the only cutting/abrasive area.

4. Shoulder with bevel

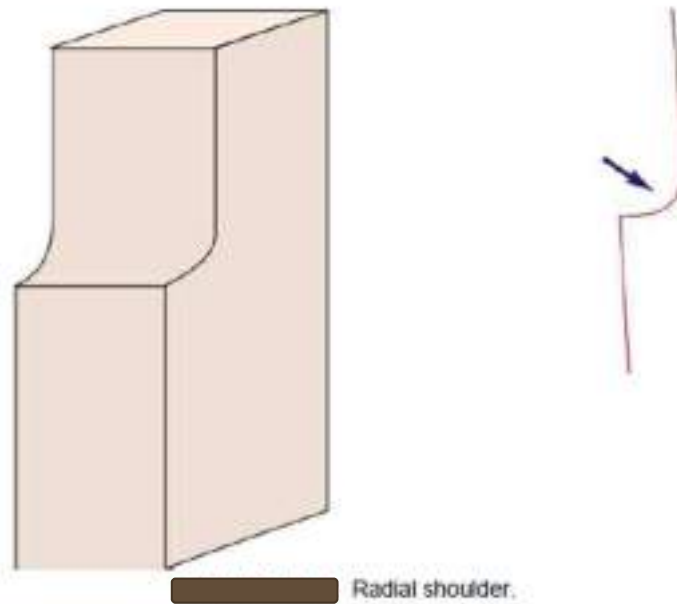
- It is a shoulder with a bevel on the external edge.
- It reduces the marginal discrepancy of the restoration as it can be burnished; however, only gold alloys can be burnished.
- Protects the edge of finish line preventing chipping.
- Primarily indicated to hide the supragingival facial metal margin of metal-ceramic restorations.
- It is also used as the gingival finish line on inlays and onlays, and as occlusal finish line for onlays and partial veneer crowns.



(A) Shoulder with bevel. (B) Metal on the beveled portion is placed subgingivally in metal-ceramic restorations.

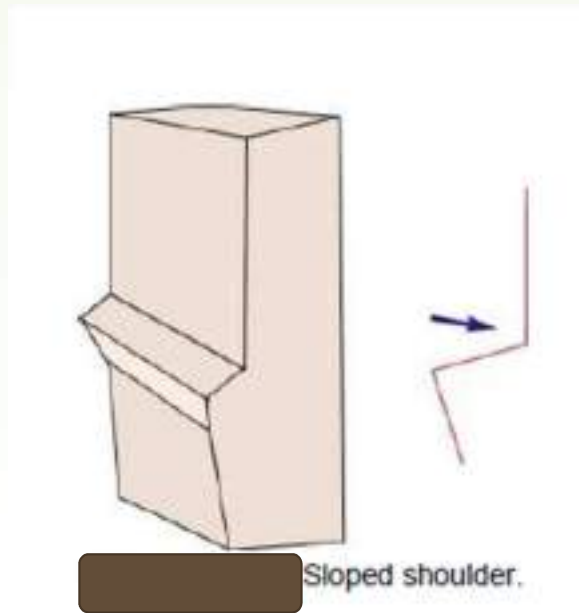
5. Radial shoulder

- It is a shoulder finish line with rounded internal line angle.
- The internal angle is rounded using an end-cutting diamond and finished with a bin-angle chisel.
- Indicated for all-ceramic crowns.



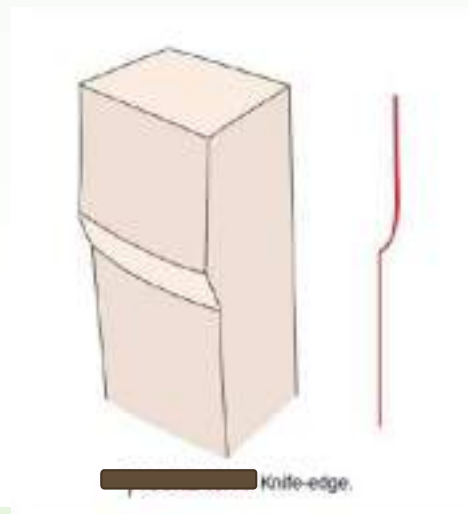
6. Sloped shoulder

- Similar to shoulder but with an obtuse angle.
- Indicated for facial margin of metal-ceramic crowns.



7. Knife-edge

- It is a thin finish line.
- Highly conservative.
- It is difficult to wax and cast and susceptible to distortion.
- It can lead to overcontoured restorations.
- May be used for metal restoration in adolescent patients, lingual surface of mandibular posteriors, very convex axial surfaces and tilted teeth where preparation is minimal.
- Rarely used.



Advantages and Disadvantages of Different Margin Designs

Margin Design	Advantages	Disadvantages	Indications
Feather edge	Conservative of tooth structure	Does not provide sufficient bulk	Not recommended
Chisel edge	Conservative of tooth structure	Location of margin difficult to control	Occasionally on tilted teeth
Beveled	Removes unsupported enamel, allows finishing of metal	Extends preparation into sulcus if used on apical margin	Facial margin of maxillary partial-coverage restorations and inlay/onlay margins
Chamfer	Distinct margin, adequate bulk, easier to control	Care needed to avoid unsupported lip of enamel	Cast metal restorations, lingual margin of metal-ceramic crowns
Shoulder	Bulk of restorative material	Less conservative of tooth structure	Facial margin of metal-ceramic crowns, complete ceramic crowns
Sloped shoulder	Bulk of material, advantages of bevel	Less conservative of tooth structure	Facial margins of metal-ceramic crowns
Beveled shoulder	Bulk of material, advantages of bevel	Less conservative, extends preparation apically	Facial margin of posterior metal-ceramic crowns with supragingival margins

Mechanical considerations

- Retention form.
- Resistance form.
- Structural durability.

RETENTION FORM

➤ DEFINITION

The quality of a preparation that prevents the restoration from becoming dislodged by forces parallel to the path of placement is known as *retention*.

- ✓ *In practice* retention and resistance are closely related and they are not always clearly distinguishable
- ✓ Only dental caries and porcelain failure outrank lack of retention as a cause of failure of crowns and fixed dental prostheses.

Factors affecting retention

- Magnitude of dislodging forces

- Geometry of tooth preparation

 - Taper

 - Surface area

 - Stress concentration

 - Type of preparation and secondary retentive features

- Roughness of surfaces being cemented

- Materials being cemented

- Type of luting agent

- Film thickness of luting agent

MAGNITUDE OF DISLODGING FORCES

- ✓ Forces that tend to remove a cemented restoration along its path of placement are small in comparison with those that tend to seat or tilt it.
- ✓ A fixed dental prosthesis or splint can be subjected to such forces by pulling with floss under the connectors.
- ✓ magnitude of the dislodging forces exerted depends on the stickiness of the food and the surface area and surface texture of the restoration.

Geometry of tooth preparation

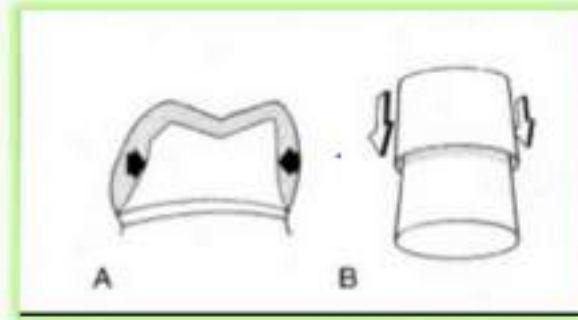
Essential elements of retention

- ❑ Opposing vertical surfaces in same preparation
- ❑ Path of insertion
- ❑ Area under shear stress
- ❑ Freedom of displacement

□ OPPOSING VERTICAL SURFACES IN SAME PREPARATION

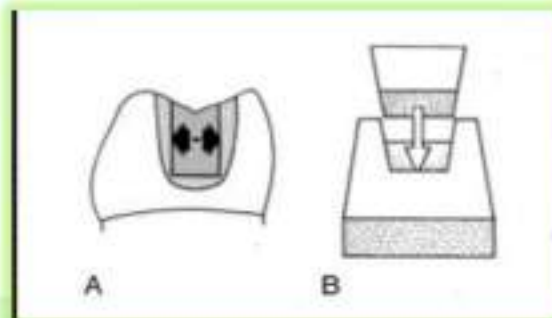
1) External surfaces:- eg. facial & lingual walls of full veneer crown.

An extracoronal restoration is an example of veneer, or sleeve retention.



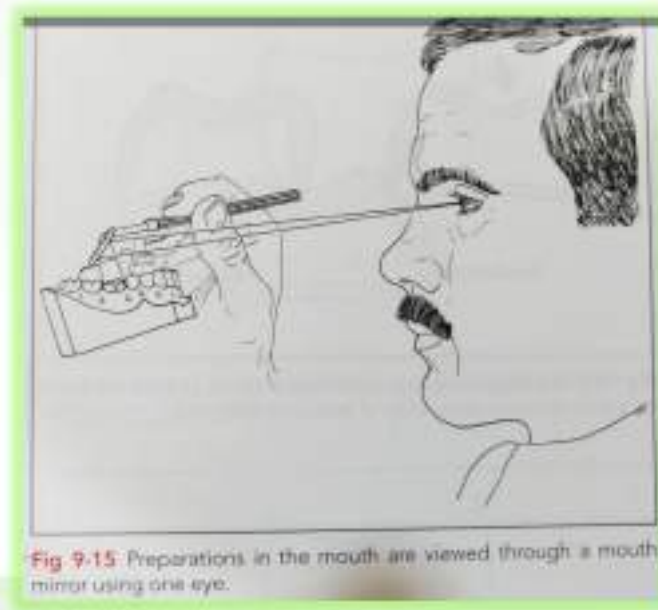
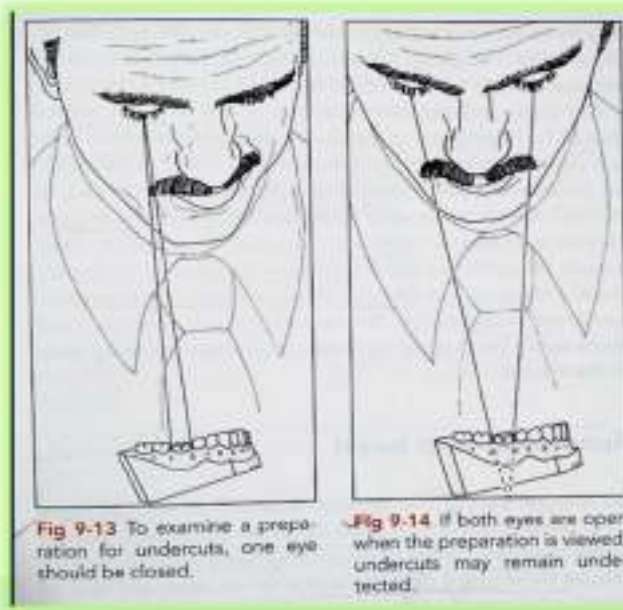
2) Internal surfaces:- eg. Facial & lingual walls of the proximal box of a proximo-occlusal inlay.

An intracoronal restoration resists displacement by wedge retention



□ PATH OF INSERTION

- It is an imaginary line along which the restoration will be placed onto or removed from the preparation.
- It is of special importance when preparing teeth to be fixed partial denture abutments, since the paths of all the abutment preparations must parallel each other.
- Surveying is done visually, since it is the primary means of insuring that the preparation is neither undercut nor over-tapered.



- The path of insertion must be considered in two dimensions -Faciolingually
 - Mesiodistally
- The faciolingual orientation of the path can affect the esthetics of metal-ceramic or partial veneer crowns

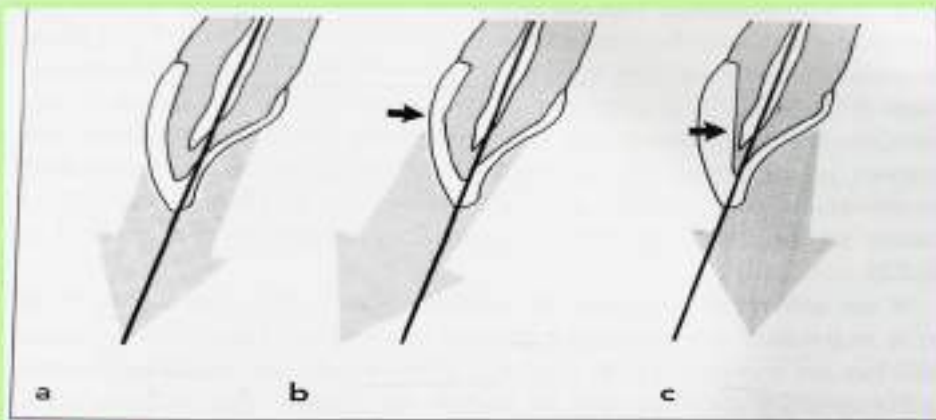


Fig 9-16 (a) The path of insertion of a preparation for a metal-ceramic crown should parallel the long axis of the tooth. (b) If the path is directed facially, the prominent facioincisal angle may create esthetic problems of overcontouring or opaque show-through. (c) However, if the path is directed lingually, the facial surface will intersect the lingual surface, creating a shorter preparation. It also may encroach on the pulp.

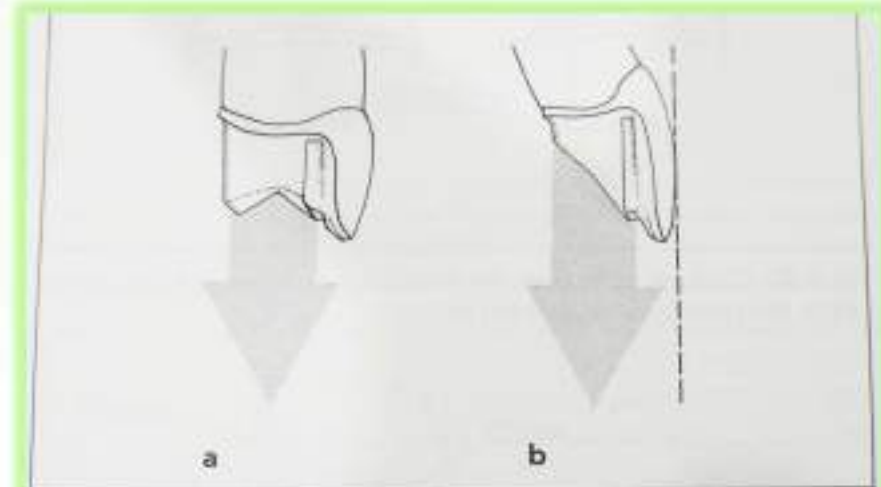


Fig 9-17 The path of insertion of a three-quarter crown on a posterior tooth parallels the long axis of the tooth (a), whereas on an anterior tooth it parallels the incisal one-half to two-thirds of the labial surface (b).

- The mesiodistal inclination of the path must parallel the contact areas of adjacent teeth.
- So if the path is inclined mesially or distally, the restoration will be held up at the proximal contact areas & be “locked out. This is a particular problem when restoring a tilted tooth.

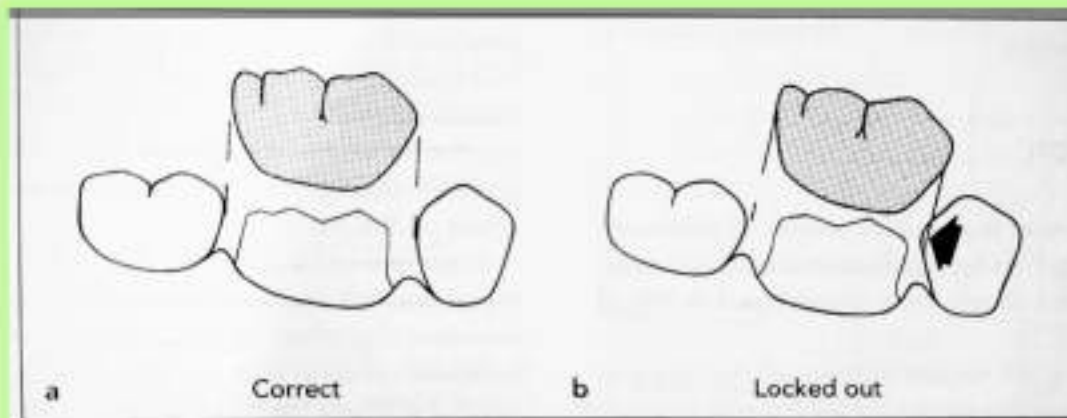
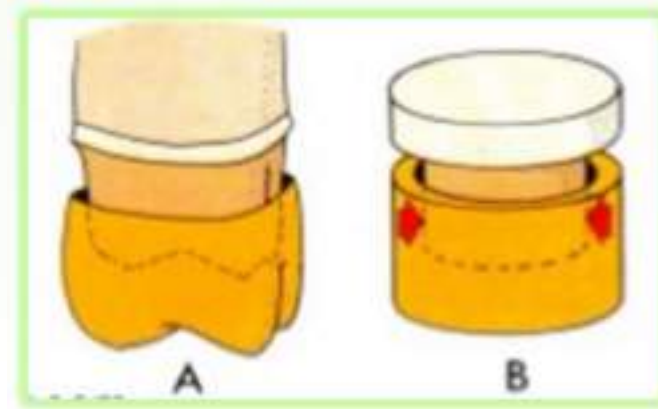
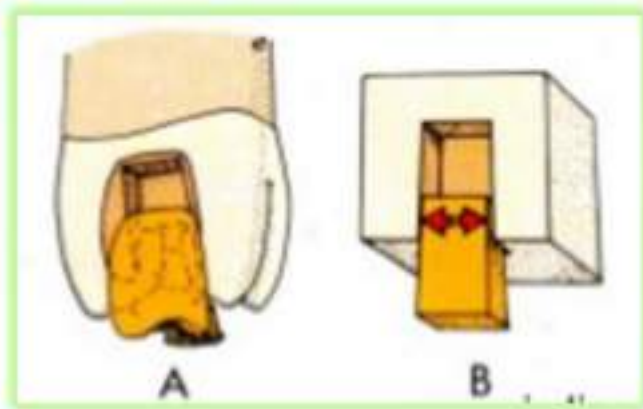


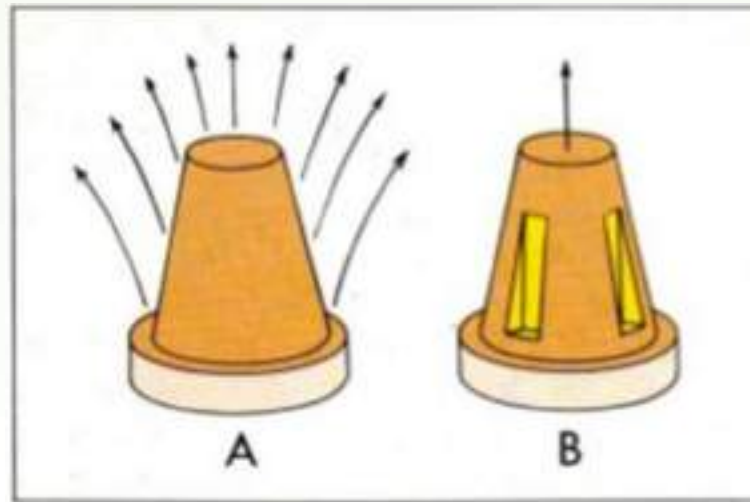
Fig 9-18 The path of insertion of a preparation must parallel the adjacent proximal contacts (a) or it will be prevented from seating (b).

□ AREA UNDER SHEAR STRESS

- Most important feature for retention is that the total surface area of cement which will experience shearing rather than tensile stress.
- To achieve this the preparation must have opposing walls nearly parallel to each other.

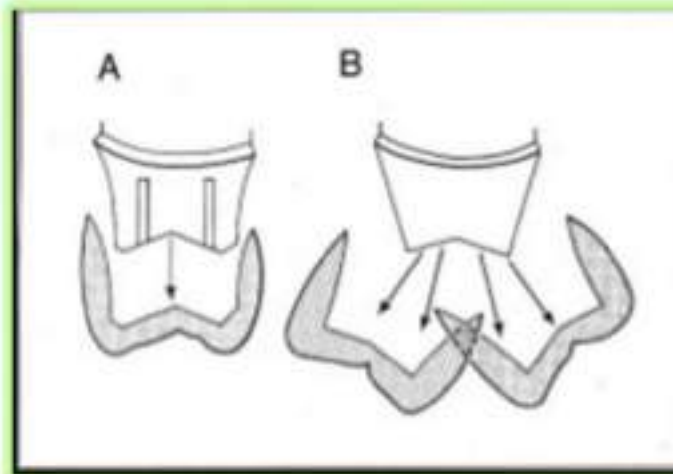


- To obtain the greatest area of cement under shear stress, the direction in which a restoration can be removed must be limited to one path



□ FREEDOM OF DISPLACEMENT

- Retention is improved by geometrically limiting the numbers of paths along which a restoration can be removed from the tooth preparation.
- Maximum retention is achieved when there is only one path.
- A full veneer preparation with long, parallel axial walls and grooves would produce such retention.



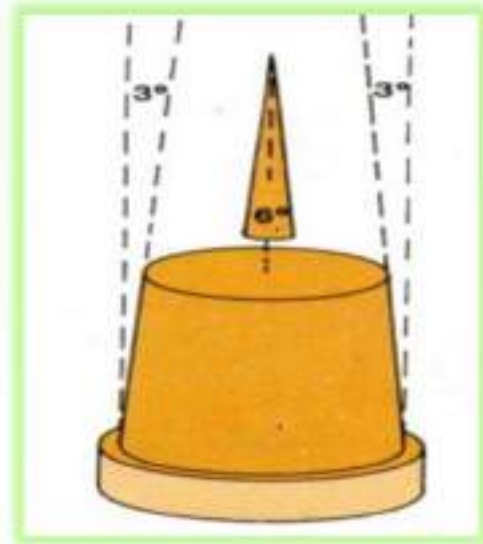
A] by limiting the path of withdrawals, retention is improved
[B] a preparation with unlimited freedom of displacement is much less retentive

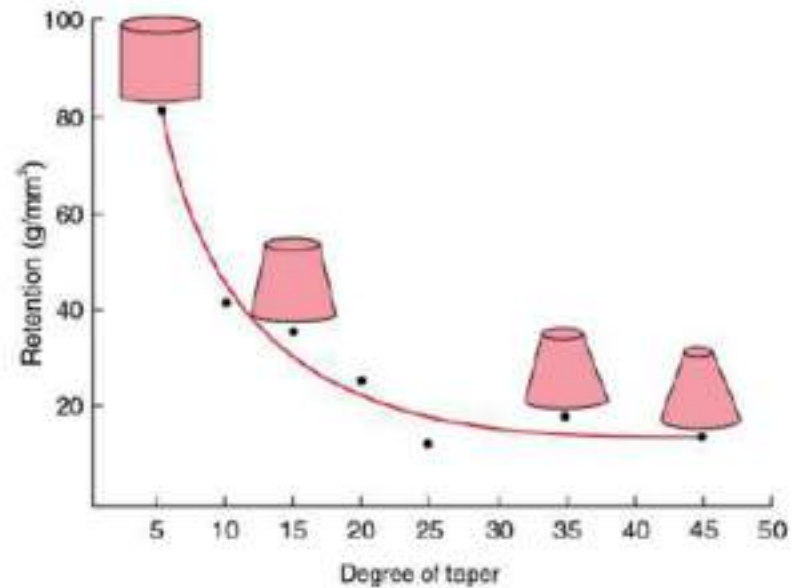
TAPER OR TOTAL OCCLUSAL CONVERGENCE[TOC]

- The axial walls of the preparation must taper slightly to permit the restoration to seat i.e.
- ✓ two opposing external walls must gradually converge – ANGLE OF CONVERGENCE.
- ✓ two opposing internal surfaces of the tooth structure must diverge occlusally – ANGLE OF DIVERGENCE.
- The relationship of one wall of a preparation to the long axis of that preparation is the INCLINATION of that wall.
- A tapered diamond bur will impart an inclination of 2 to 3 degrees to any surface it cuts if the shank of the instrument is held parallel to the intended path of insertion of the preparation.

- The more nearly parallel the opposing walls of a preparation, the greater should be the retention.
- Preparation walls are tapered to allow their visualization , prevent undercuts , compensates for inaccuracies in the fabrication process and permit more nearly complete seating of restorations during cementation
- Most retentive preparation should be one with parallel walls, but the parallel walls are impossible to create in the mouth without producing preparation undercuts.
- An undercut on a complete crown preparation is defined as any irregularity in the wall of a prepared tooth that prevents the withdrawal or seating of a wax pattern or casting.

- A taper of 2.5 to 6.5 degrees has been suggested as optimum.
- A taper of 16 degrees has been proposed as being achievable clinically while still affording adequate retention
- It can be as low as 10 degrees on preparation on anterior teeth and as high as 22 degrees on molars





The relation between degree of taper and retention. Source: Courtesy: Jorgensen KD: The relationship between retention and convergence angle in cemented veneer crowns. Acta Odontol Scand 1955; 13:35-40.

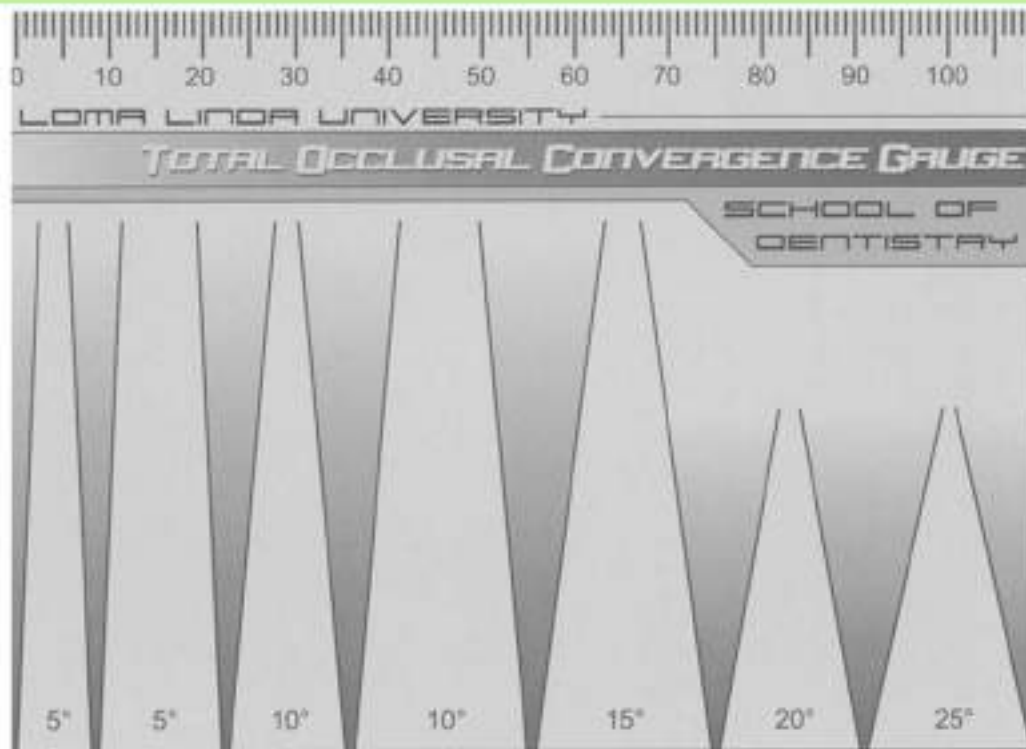


Fig. 3. This diagram can be used to measure the TOC of a die by aligning axial walls of the die so they become superimposed over the converging lines on the diagram that most closely match the axial convergence of the die.

The dental literature has also presented data on several factors likely to create greater TOC-

1. Posterior teeth were prepared with greater TOC than anterior teeth



A, Facial view of maxillary central incisor prepared for all-ceramic crown . Smallest TOC angles typically are produced on anterior teeth because of their access and visibility.

2. Mandibular teeth were prepared with greater convergence than maxillary teeth.
3. Mandibular molars were prepared with the greatest TOC.

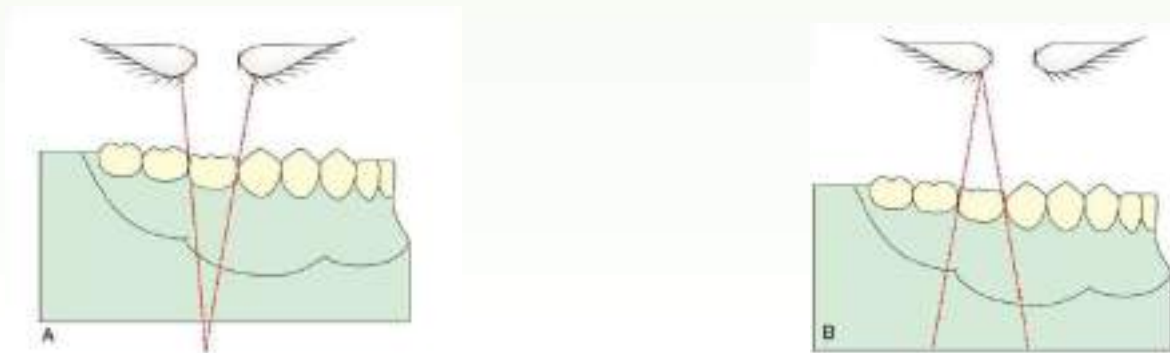


D, Casts of mandibular premolar and molar . Greater convergence was created on less accessible teeth (molars) than on premolars . Premolar TOC is 12 degrees and molar TOC is 22 degrees.

4. Faciolingual surfaces had greater convergence than mesiodistal surfaces . However, another study determined that mesiodistal convergence was greater than faciolingual convergence.

5. Fixed partial denture (FPD) abutments were prepared with greater TOC than individual crowns.

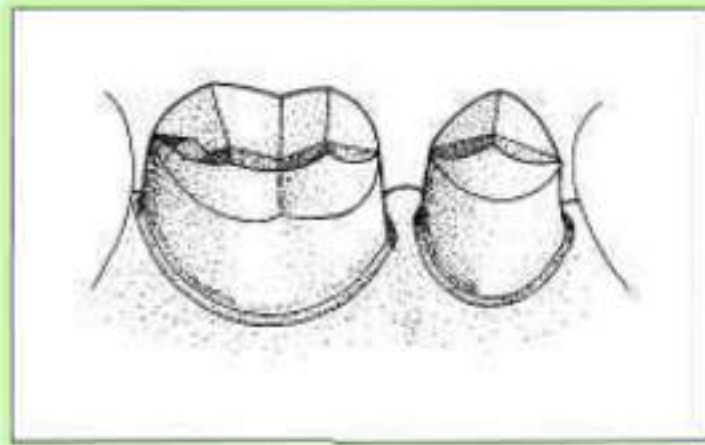
6. Monocular vision (1 eye) created greater TOC than binocular vision (both eyes).



(A) Improper technique to view tooth preparation. **(B)** Correct technique to view tooth preparation.

SURFACE AREA

- If the restoration has a limited path of placement, its retention depends on the length of this path or, more precisely, on the surface area that is in sliding contact.
- Therefore, crowns with tall axial walls are more retentive than those with short axial walls
- Molar crowns are more retentive than premolar crowns of similar taper, because of the greater diameter of the molar.



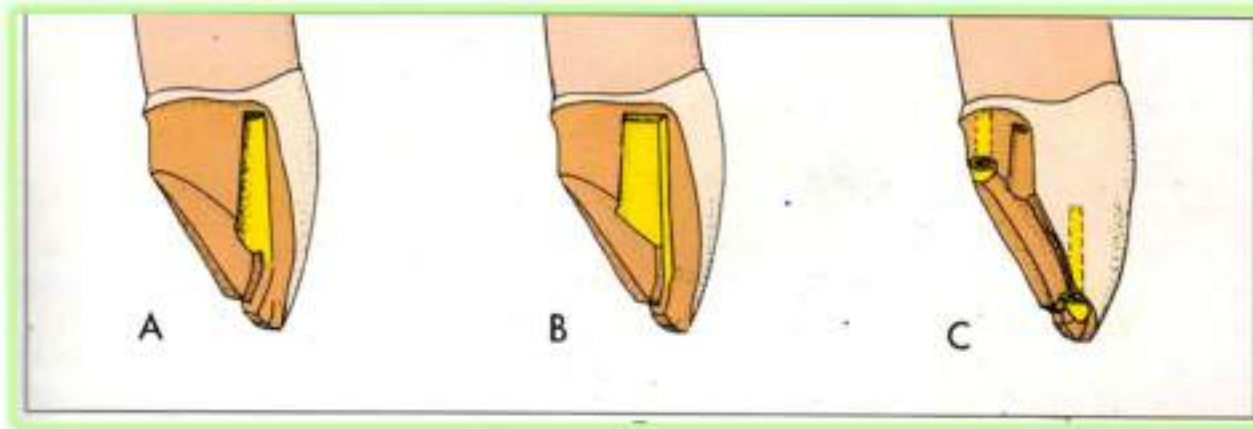
a full crown preparation is more retentive on molar than on premolar because the molar preparation has greater surface area

STRESS CONCENTRATION

- If line angle between axial and occlusal surface is sharp, it leads to concentration of stresses around that junction
- Induced stresses exceeds the strength of the cement which leads to cohesive failure of cement
- Rounding the internal line angles reduces the stress concentration and thus increases the retention of restoration

TYPE OF PREPARATION AND SECONDARY RETENTIVE FEATURES

- Full veneer crown has excellent retention when compared to partial veneer crown because four walls limit the path of insertion to a narrow range.
- If axial wall left unveneered, retention is achieved by substituting a grooves[A], boxes[B] or pinholes[C] for the missing wall.



- Secondary retentive features does not significantly affect the retention because the surface area is not increased significantly.
- But where addition of these features limits the path of withdrawal, retention is increased

ROUGHNESS OF SURFACES BEING CEMENTED

- **Retention increases** when restoration is **roughened or grooved**.
- Failure rarely occurs at the cement tooth interface. So roughening tooth preparation hardly influences retention.
- Some surface roughness improves retention when using zinc phosphate cement but does not seem to have as substantial of an effect when adhesive cements are used [polycarboxylate , glass ionomer , and resin

MATERIALS BEING CEMENTED

Retention is affected by both the casting alloy and the core material.

More reactive the alloy is more adhesion.

Base metal alloys are better retained than less reactive high gold content metals

FILM THICKNESS OF THE LUTING AGENT

Conflicting evidences about the effect of increased thickness of the cement film on retention of a restoration.

This may be important if a slightly oversized casting is made using die spacers

Stanley G. Vermilyea, Michael J. Kuppler, Eugen F. Hugger, JPD, 50, 1983

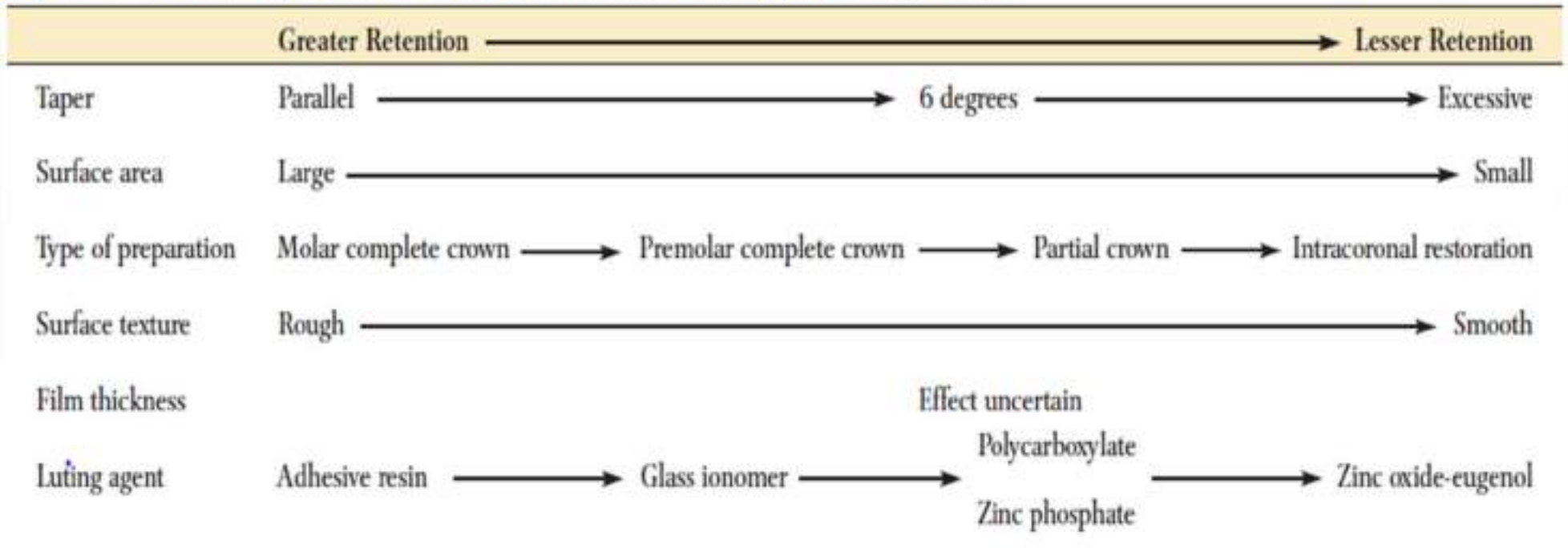
Conducted a study to determine the influence of die relief agent on the retention of cast restorations using 3 cementing mediums. They concluded that forces required to dislodge unspaced castings were higher when ZnPO₄ as luting medium. Die relief agents resulted in a 32% reduction in the dislodging forces.

Steven M. Carter, Peter R. Wilson, IJP, vol. 9, 1996

Conducted a study to see the effect on die spacing on pre and post cementation crown removal and crown elevation. Different layers of die spacer was used. They observed that the force required to remove a crowns before cementation decreased with increased layers of die spacers. Following cementation the mean crown elevation decreased and the removal force is increased



Figure 7-4 FACTORS INFLUENCING THE RETENTION OF A CEMENTED RESTORATION



According to the article **RETENTION IN CONVENTIONAL FIXED PARTIAL DENTURES**
Journal of clinical and diagnostic research,2011 October,vol-5;1128-1133

FACTORS AFFECTING RETENTION IN FIXED PARTIAL DENTURES

- ❖ **Length of Span**
- ❖ **Curvature of Arch**
- ❖ **Type of Bridge**
- ❖ **Occlusion**
- ❖ **Periodontal Condition**
- ❖ **Tooth or Teeth Being Replaced**
- ❖ **Type of Retainer Used**
- ❖ **Materials Employed in the Construction of Retainers**
- ❖ **Arch Position of the Abutment Teeth and Retention**
- ❖ **Spring Cantilever Bridges and Retention**

1. Length of Span In addition to the increased load placed on the periodontal ligament by long span bridge, the longer spans are less rigid and so less retentive.

2. Curvature of Arch Arch curvature has its effect on stresses occurring in a fixed bridge. When pontics lie outside the inter abutment axis line, the pontics act as a lever arm which will produce a torquing movement which leads to loss of retention of bridge.

3. Type of Bridge-There are two types of bridges made according to the prevalent condition and position of abutments in the arch.

a. Rigid connector

b. Non-rigid connector.

A completely rigid restoration is not indicated for all situations requiring a fixed prosthesis. In many instances, an edentulous span will occur on both sides of a tooth creating alone free standing pier abutment. The use of a form of non-rigid connector can lessen these hazards. The non-rigid connector is a broken stress mechanical union of the retainer and pontic instead of usual rigid solder joint.

4. Occlusion-Interference with undesirable occlusal contacts produce deviation during closure of maximum intercuspation , hinder smooth passage to and from the intercuspation position and lead to deflective occlusal force on the bridges which may lead to damaging effects on abutment and also on the retention of the casting. All these interferences should be removed on suitable articulator and a harmonious occlusion should be achieved in the final casting.

5. Periodontal Condition-The abutment tooth must be able to provide good support for the bridge. This support is related to both the amount of root and the amount of bond present.

6. Tooth or Teeth Being Replaced-A bridge replacing a maxillary canine is subjected to more stresses than the mandibular since forces are transmitted outward (labially) on the maxillary arch against the inside of the curve (its weakest point).When a cantilever pontic is employed to replace a missing tooth, the forces applied to the pontic have an entirely different effect on the abutment tooth. The pontic acts as a lever which tend to be depressed under forces with a strong occlusal vector.

7. Type of Retainer Used -There are two types of retainers which are generally used

Intra coronal

Extra coronal

In the intra coronal retainers, the retention is obtained between the inner wall of the tooth preparation i.e. the internal wall of the prepared cavity and the casting. On the other hand, in extra coronal retainers, the retention is obtained between the outer wall of the tooth preparation and the inner wall of the retainer.

8 . Materials Employed in the Construction of Retainers- The material used in the construction of the fixed partial dentures calls for certain requirements which help to increase the longevity of the restoration.

Cobalt chromium or nickel chromium alloys generally used for making fixed bridges fulfill majority of these ideal requirements. On the other hand acrylic is generally weak, is not rigid and cannot provide strong connectors.

It also has lower compressive and tensile strength compared to other alloys and is thus easily subjected to fracture. Hence acrylic is used for interim on temporary restorations in the mouth.

9. Arch Position of the Abutment Teeth and Retention -When the abutment teeth are more or less parallel to each other, complete or partial crown retainers can be made. If the abutment teeth are not parallel, complete crown retainers with a common path of insertion are not feasible.

10. Spring Cantilever Bridges and Retention-This bridge provides a method of supporting a pontic at some distance from the retainers. This type of bridge is both tooth and tissue supported. A gold bar which fits in contact with the palatal mucosa connects the pontic to the retainers.

DIFFERENT TOOTH PREPARATION AND WAYS OF ACHIEVING RETENTION IN EACH

Complete Cast Crown Preparation

Ways of Gaining Retention While Tooth Preparation:

After the occlusal reduction is completed, the guiding grooves are placed on the axial walls. When these guiding grooves are placed, the dentist should be sure that the shank of the diamond is parallel to the proposed path of withdrawal of restoration.

A diamond taper bur with a taper of 3-6° should be used and thus an identical taper on the preparation wall will result. Place the cervical chamfer concurrently with axial reduction.

Width of the chamfer should be approximately 0.5mm which will allow adequate bulk of metal at the margin.

The Metal Ceramic Crown Preparation

Factors affecting retention that should be taken into consideration while preparation

1. The completed reduction of the incisal edge on an anterior tooth should allow 2mm of adequate material thickness to permit translucency in the completed restoration. Caution must be used here to prevent over reduction because excessive occlusal reduction shortens the axial wall and thus is a common cause of inadequate retention and resistance form of completed restoration.
2. Labial reduction of 1.5mm should be done for the adequate retention of metal and porcelain and the shoulder preparation should have a 90° butt joint.
3. Reduction of the proximal and linguo-axial surfaces should be done with a diamond held parallel to the path of withdrawal of the restoration giving an approximate taper of 6°. If this is not followed, a slightly more taper or discrepancy in taper of two walls will result thus affecting retention.
4. In a completed restoration, all the line angles and point angles should be rounded. This will help in reducing the stress concentration and thus will enhance retention.

The Partial Veneer Crown Preparation

Posterior Teeth Three Quarter Crown

1. During axial reduction place grooves for axial alignment in the centre of the lingual surface and in the mesiolingual and distolingual transitional line angles. These grooves should be made parallel to the long axis of tooth.
2. During proximal reduction the proximal grooves are placed parallel to the path of withdrawal. The groove should not be deeper than 1mm and is best done with a tapered carbide bur. The grooves prepared should resist lingual displacement of the periodontal probe.
3. If additional bulk is needed to ensure rigidity of the restoration it can be provided with an occlusal offset. This V-shaped groove extends from the proximal grooves along the buccal cusp.

Anterior Partial Veneer Three Quarter Crown Preparation

With the advent of metal ceramic restorations the use of partial veneers on anterior teeth has lessened somewhat during recent years. However two types of partial veneer anterior crown preparations are still done.

1. Maxillary canine three quarter crown.
2. Pin ledge preparations.

To enhance the retention and resistance form of the preparation a slightly exaggerated chamfer on the lingual aspect of the tooth should be placed and a guiding groove in the middle of the cingulum wall.

The mesial and the distal proximal grooves provide most of the retention form for the anterior partial veneer crowns. They are made with a 170L carbide bur and coverage at an angle of 3-5 degree.

Pin Ledge Preparation and Retention

A pin ledge is occasionally used as a single restoration generally to re-establish anterior guidance, in that case only the lingual surface is prepared.

More commonly, however, it is used as a retainer for an fixed partial denture or to splint periodontally compromised teeth

RETENTIVE FEATURES FOR ALL CERAMIC RESTORATION

An all ceramic restoration remains the most aesthetic restoration for duplicating individual anterior teeth. Adequate tooth reduction is created to achieve space for the porcelain bulk required for the strength of the restoration.

Retentive Features To Be Taken Into Consideration During Each Step Of The Preparation

Incisal Reduction

There should be an adequate incisal reduction of 2mm otherwise brittle failure of the material occurs.

Facial Reduction

The facial reduction is performed with a coarse flat end diamond to remove the labial surface while establishing a preliminary shoulder.

The incisal $2/3_{rd}$ of the facial surface should be inclined lingually to provide uniform porcelain and ensure suitable aesthetics.

Insufficient tooth reduction on the facial surface can lead to either a tooth thin coverage contoured restoration. This can also lead to the failure of the restoration.

Proximal Reduction

Excessive taper of proximal surface should be avoided which can also lead to loss of retention by decreasing the surface area and also the parallelism of walls.

Lingual Reduction

Proper lingual reduction is very important for the strength and retention of the restoration. The lingual surface of the tooth is generally reduced in two planes.

First cingulum shoulder is placed with a flat ended tapered diamond to crest a 0.75mm shoulder in the cingulum with a 2-5° taper. The cingulum reduction is now completed.

A flame shaped or wheel shaped diamond is used to form the lingual concavity of the anterior teeth.

Inadequate tooth reduction of the lingual surface can lead to loss of clearance and also diminished strength for the porcelain which can over all lead to loss of retention of the restoration.

Proper Finish Line

A proper marginal finish line is very important for the retention. Inadequate finish line in some areas of the preparation can lead to microleakage thus leading to the loss of retention.

Sharp Points and Undercuts

All the sharp points and undercuts should be removed or rounded off to prevent the accumulation of the stresses and thus prevent the subsequent failure of the restoration.

Retention In Endodontically Treated Teeth

It has been demonstrated experimentally that endodontically treated teeth are weaker and more brittle than vital teeth. So for this reason attempts have been made to strengthen the teeth by removing part of the root canal filling and replacing it with a metal post.

Also when the teeth will be serving as an FPD abutment, a complete crown becomes mandatory. Under these circumstances, the retention and support must be derived from within the root canal.

Canal Retention

It is recommended that the root canal should be enlarged only to amount necessary to enable the post to fit snugly for strength and retention.

Retention In Porcelain Laminate Veneers

To ensure a uniform thickness and the retention of the laminate veneer, the following criteria must be met:

- a. There should be a uniform reduction on the labial surface of the tooth and the preparation should remain within the enamel whenever possible.
- b. The margin of the porcelain laminate veneer should generally be hidden within the embrasure area.

A modified chamfer finish line ensures correct enamel preparation exposing correctly aligned enamel rods for increased bond strength at the cervical margin thus increased retention. It also ensure an adequate bulk at the margins and hence it increases the strength.

Etching the porcelain is also said to be a predominated factor in producing the retention.

RETENTION FOR CERAMIC INLAYS AND ONLAYS

Ceramic inlays and onlays provide a durable alternative to posterior composite resins for patients demanding aesthetic restoration.

For maximum retention following points should be taken cared of:

- The outline and the reduction of the tooth is governed by existing restorations and caries. Now here is resin bonding, the axial wall undercuts can be blocked out with GI cement preserving additional enamel for adhesion and thus the increased retention of the restoration.
However undermined and weakened enamel should always be removed.
- The outline should avoid occlusal contacts. Areas to be onlayed need 1.5mm of clearance in all excursions to prevent ceramic fracture and thus increase the longevity of the restoration.

- In this preparation, it is preferred that the margin is kept supragingival, if this is not possible, crown lengthening is advisable.
- All the internal line angles should be rounded to prevent stress concentration and to thus enhance retention.
- A 90° butt joint should be given for ceramic inlay margin.
- Bevels are contraindicated because bulk is needed to prevent fracture and thus increase the longevity.
- Final retention is achieved during the bonding of the inlay as it is done with a resin luting cement. In this procedure acid etching is done which creates micro tags and help in mechanical retention.

RETENTION IN RESIN BONDED BRIDGES

The retention of this prosthesis depends on the adhesive bonding between the etched enamel and the metal casting. To enhance retention in these restorations, significant clinical crown length should be present. If there is insufficient moisture control, retention is minimized.

Short clinical crown and narrow embrasures are also a contraindication for resin retained FPD because in these type of teeth, surface area is reduced and thus the retention.

If a patient has parafunctional habits, this restoration should not be given because they lead to early failure of the restoration.

RESISTANCE FORM

- The features of a tooth preparation that enhance the stability of restoration and resist dislodgement along an axis other than the path of placement (GPT).
- It prevents dislodgement of a restoration by forces directed in an apical, oblique or horizontal direction.
- The geometric configuration of tooth structure must place the cement in compression to provide the necessary resistance.
- Lateral forces tend to displace the restoration by causing rotation around gingival margin
- Rotation is prevented by any areas of the tooth preparation that are placed in compression and are called as RESISTANCE AREA

METHODS TO ANALYZE RESISTANCE FORM

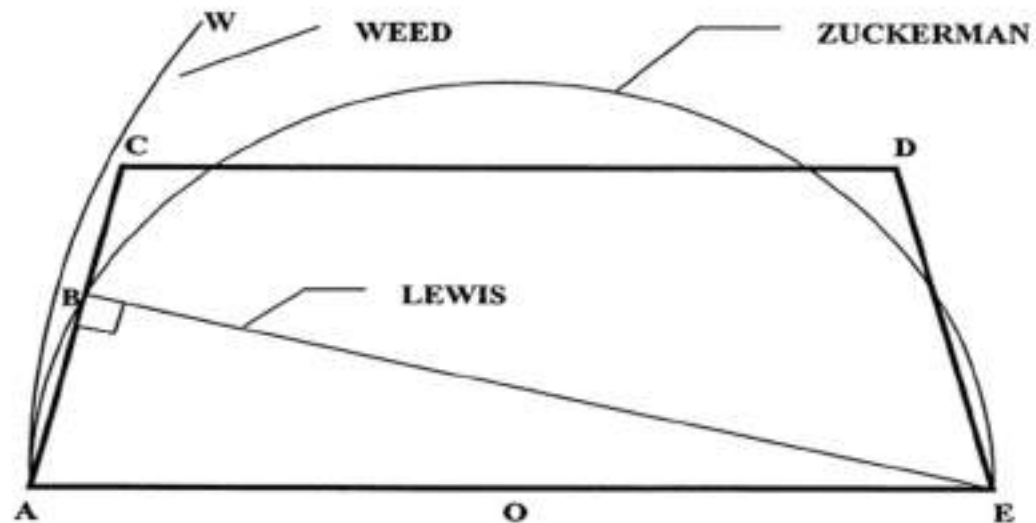


Fig. 2. Three techniques for evaluating the resistance form of side AC. The Lewis method of evaluating resistance form of side AC is applied by extending a perpendicular line to side AC from the center of rotation E at the opposite margin. The intersection of the Lewis line and side AC is point B, so all points occlusal to B (section BC) are resistive and all points gingival to B (section AB) are not resistive. The same results are obtained with the Zuckerman circle, where all points outside of the circle (section BC) are resistive and all points inside (section AB) are nonresistive. The Weed technique predicts that all points on side AC are not resistive because they are inside the Weed circle. This contradicts the Lewis and Zuckerman results, indicating that the Weed hypothesis is not valid.

Resistance form depends on-

- Magnitude and direction of dislodging forces
- Leverage
- Preparation length or occlusocervical / incisocervical dimension
- Preparation width
- Ratio of occlusocervical/incisocervical dimension to faciolingual dimension
- Circumferential morphology
- Taper
- Type of preparation
- Rotation about vertical axis
- Physical properties of luting agent

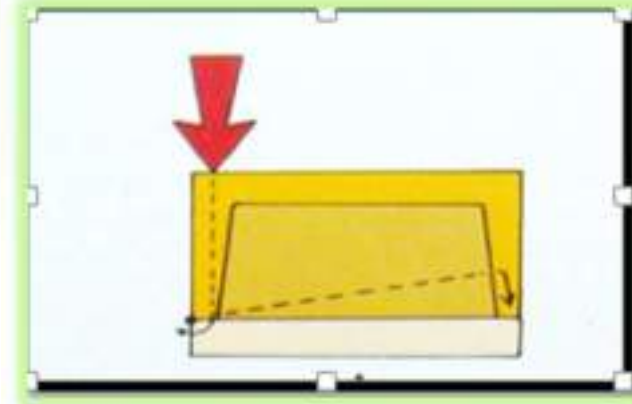
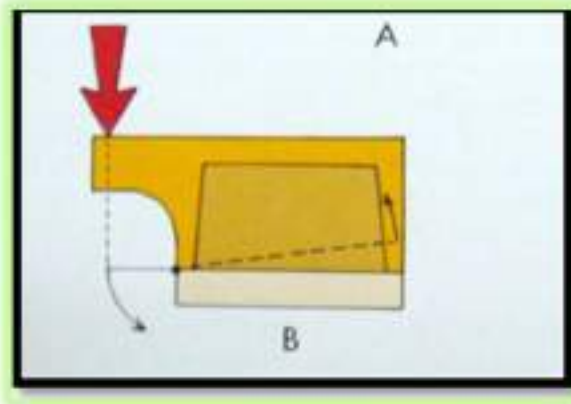
MAGNITUDE AND DIRECTION OF DISLODGING FORCES

- ✓ In normal occlusion biting force is directed axially
- ✓ If fixed prosthesis is designed with proper occlusion , load will be well distributed
- ✓ If patient have biting habits such as pipe smoking or bruxing it is difficult to prevent large oblique forces from being applied to restoration.
- ✓ Therefore for adequate resistance form restoration should be able to withstand axial and oblique forces.

LEVERAGE

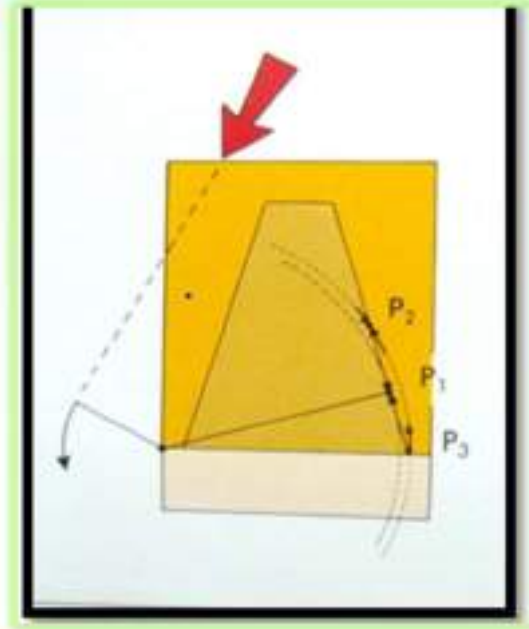
Leverage occurs when the line of action of a force passes outside the supporting tooth structure.

If the force passes within the margin of a crown no tipping of the restoration when compared to the line of action passing outside the margins of the restoration

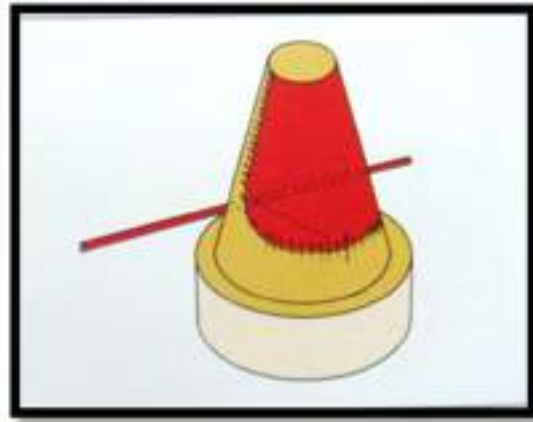


- Forces are outside the margin in the following cases:
 - wide occlusal table of restoration
 - crowns on tipped teeth
 - retainers for cantilever bridge
 - force at an oblique angle
- Fulcrum point – the point on margin that lies closest to the line of action
- Lever arm – the closest distance between line of action and fulcrum
- Torque - force \times lever arm
- In equilibrium, this torque is balanced by the sum of all the resisting forces (tensile, shear, compressive)
- The farther these resisting forces lie from the fulcrum, greater is their mechanical advantage

If a line drawn from the center of rotation perpendicular to the cement film on the opposite wall of the preparation the point where the line intersects the cement film is known as tangent point.



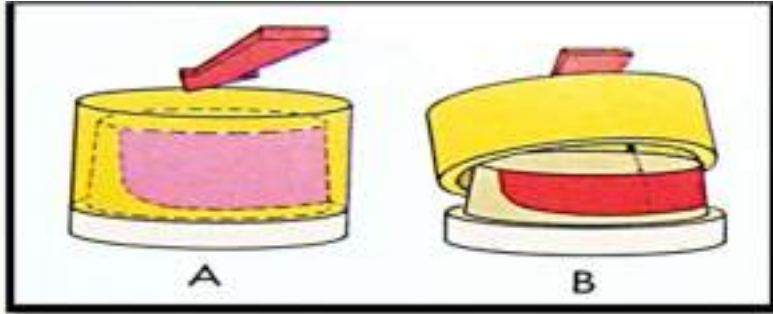
- ✓ If the tangent points of all the arcs of rotation around a given axis are connected they form the tangent line. The area above the tangent line is resisting area.



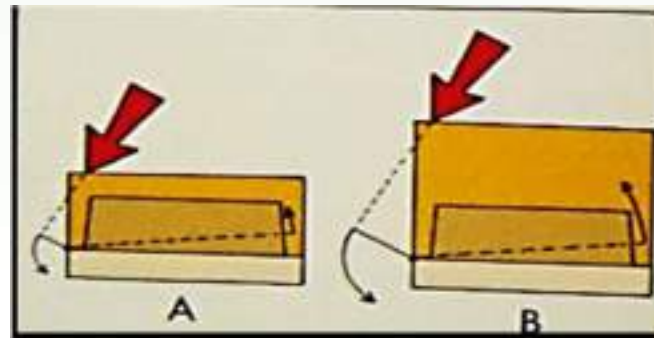
- ✓ To have effective resistance the tangent line should extend at least halfway down the preparation.

PREPARATION LENGTH OR OCCLUSOCERVICAL / INCISOCERVICAL DIMENSION

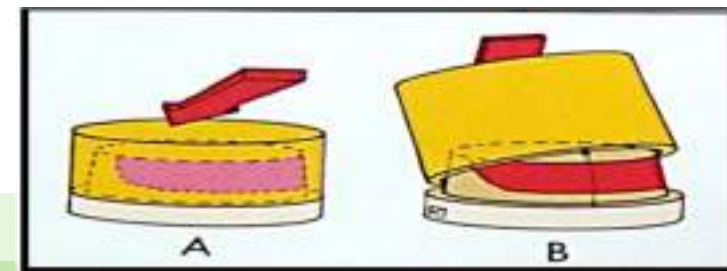
- Shortening of preparation will reduce the resistance area.



- In short crown lifting force is small when compared to long crown.



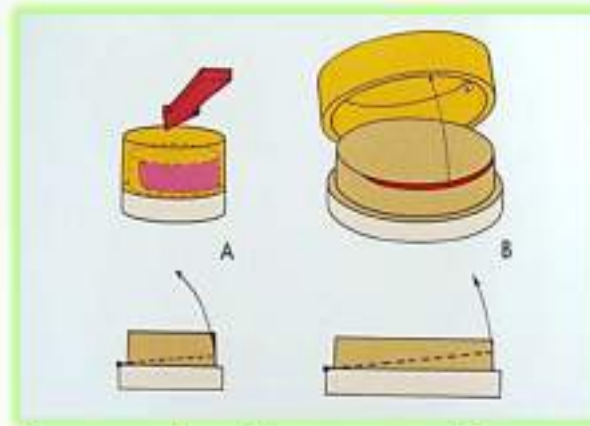
- Small restoration is less likely to fail through tipping than long restoration (on preparation of equal length).



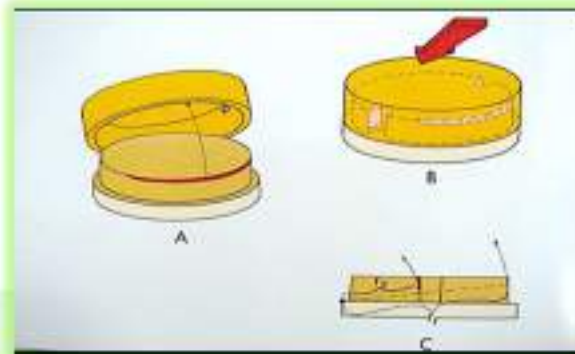
- 3mm is the minimal OC dimension for premolars and anterior teeth that are prepared within the recommended TOC range of 10 to 20 degree.
- Because molars usually prepared with greater convergence than anterior teeth, have a greater diameter than other teeth and are located where occlusal forces are greater, 4mm is proposed as the minimal OC dimension for prepared molars.

PREPARATION WIDTH

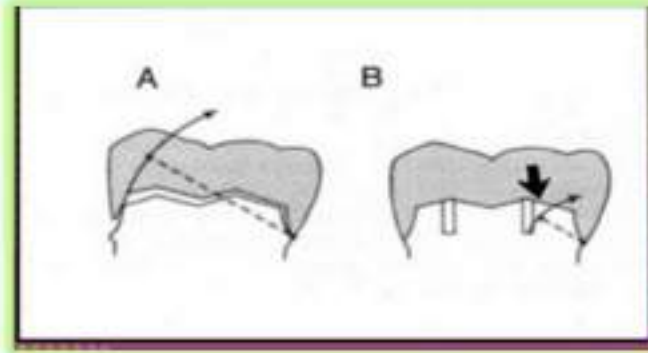
- A wider preparation has a greater retention but a narrow tooth can have greater resistance to tipping.
- Because of smaller diameter a tangent line falls low on the wall opposite to axis of rotation resulting in a large resisting area.



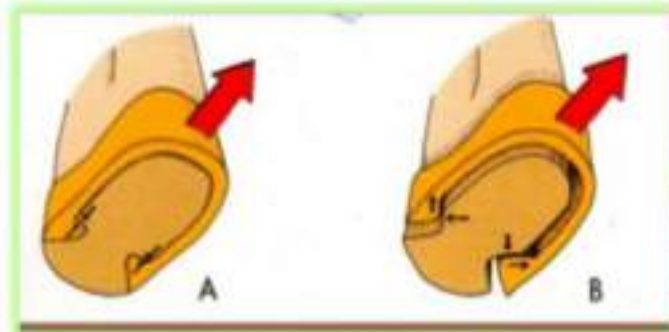
- Weak resistance can be enhanced by placing vertical grooves/ boxes/ pinholes.



- So U- shaped grooves or flared boxes provides more resistance than V-shaped ones



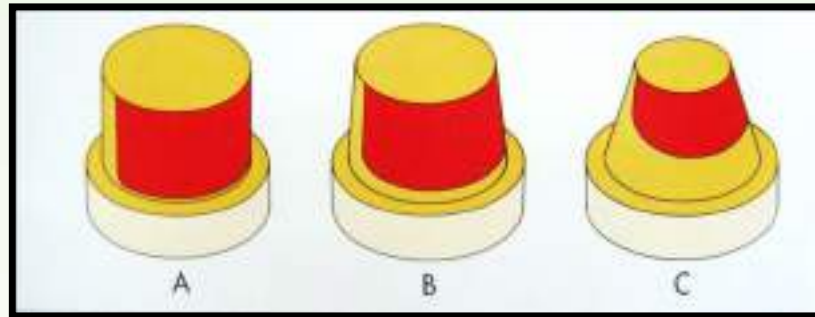
- So U- shaped grooves or flared boxes provides more resistance than V-shaped ones



CIRCUMFERENTIAL MORPHOLOGY

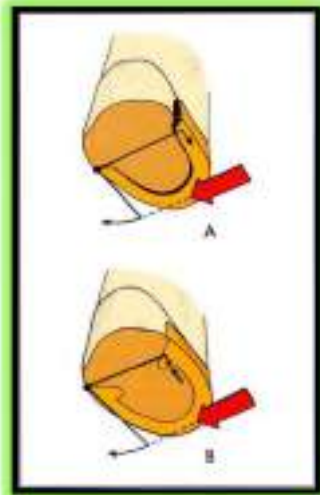
- After anatomic reduction , most teeth have specific geometric forms when viewed occlusally .
- For example , prepared mandibular molars are rectangular in form , maxillary molars are rhomboidal and premolars and anterior teeth frequently possess an oval form.
- These geometric shapes have traditionally provided resistance to dislodging forces on individual crowns and FPDS.

TAPER



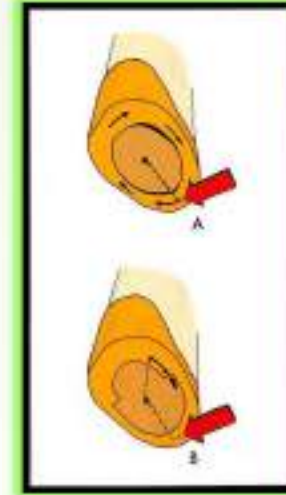
- The resistance area decreases as the preparation taper increases. As the degree of taper increases, the tangent line approaches the occlusal surface and the resisting area decreases.
- ✓ No taper the resisting area cover half the axial wall [A].
- ✓ Ideal taper the resisting area cover less than $\frac{1}{2}$ the axial wall [B]
- ✓ Over tapered small resisting area near the occlusal surface. [C]

ROTATION AROUND A VERTICAL AXIS



A.- The partial veneer crown which has no grooves has little resistance to rotation around a vertical axis.

B.- When grooves are present, their lingual walls provide resistance by blocking the arc of rotation.



A.- In full veneer crown preparation, rotation of the restoration can occur around the preparation.

B.- Resistance can be obtained by forming vertical planes (wings) which are perpendicular to the arc of rotation.

RATIO OF OCCLUSOCERVICAL/INCISOCERVICAL DIMENSION TO FACIOLINGUAL DIMENSION

- ✓ Theoretical calculations indicate that adequate resistance can be achieved with an OC/FL ratio of 0.1 when the TOC is less than 5.8 degrees.
- ✓ A ratio of 0.2 requires the TOC to be less than 11.6 degrees
- ✓ A ratio of 0.3 requires less than 17.4 degrees of TOC and
- ✓ The ratio of 0.4 provides adequate resistance as long as the TOC angle is 23.6 degrees or less.

TYPE OF PREPARATION

- ✓ Partial coverage restoration may have less resistance than a complete crown because it has no buccal resistance area

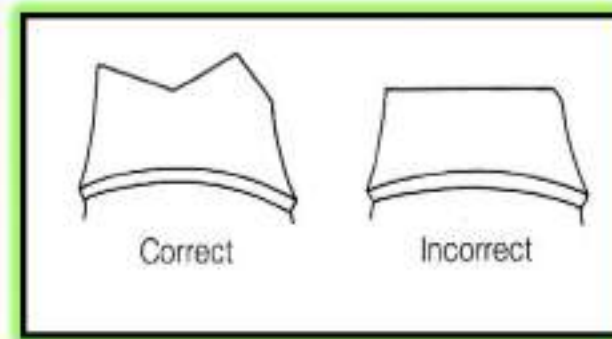
PHYSICAL PROPERTIES OF LUTING AGENT

- ✓ Resistance to deformation is affected by physical properties of the luting agent, such as compressive strength and modulus of elasticity
- ✓ Adhesive resin > GIC > ZnPO₄ > Polycarboxylate > ZOE

STRUCTURAL DURABILITY

- A restoration must contain a bulk of material that is adequate to withstand the forces of occlusion. There are three preparation features that contribute to the durability of restoration
 - ❑ Occlusal reduction
 - ❑ Axial reduction
 - ❑ Provision for reinforcing struts
- Only in this way can the occlusion on the restoration be harmonious and the axial contours normal, preventing periodontal problems around the restoration.

- The restoration must be thick enough to prevent wearing or distortion .
- Occlusal thickness vary with the restorative material . The gold crown requires approximately 1.5mm clearance over functional cusp and 1mm over non functional cusp.
- Harder metal requires slightly less reduction. For porcelain if extended onto occlusal surface, an additional 0.5mm of space is needed.

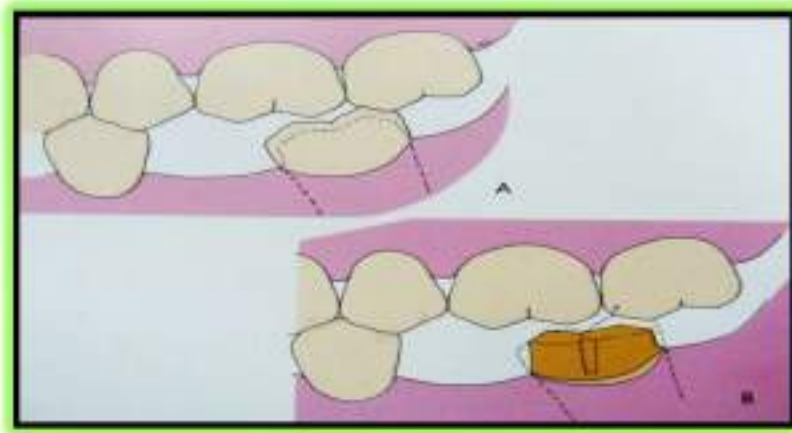


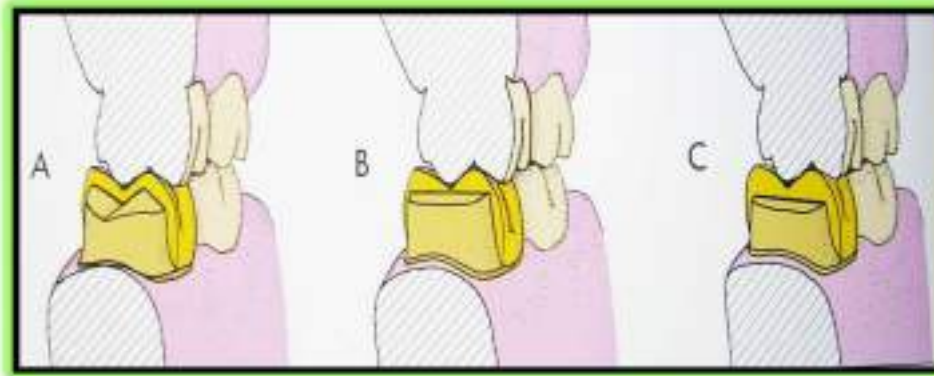
- ✓ Sufficient occlusal clearance should be provided to provide adequate bulk of metal and strength to the restoration.

MATERIAL	Recommended reduction	
	Functional cusp	Non- functional cusp
PFM	2mm	1.5mm
Metal	1.5- 2mm	1mm
Gold	1.5mm	1mm

The interocclusal space -

- The interocclusal space is sufficient over the mesial cusp of tilted molar.
- Uniform reduction of occlusal surface will lead to excessive occlusal reduction and unnecessarily shortened mesial wall[A].
- Some of original occlusal surface may not need to be cut at all.[B]



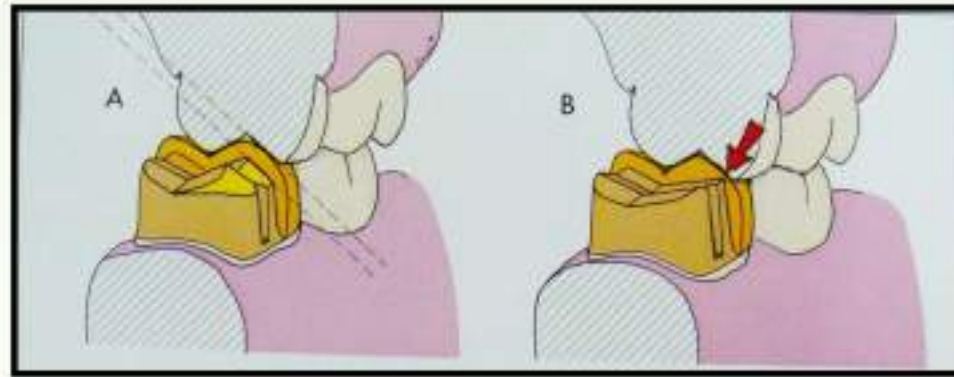


A. Correct occlusal reduction

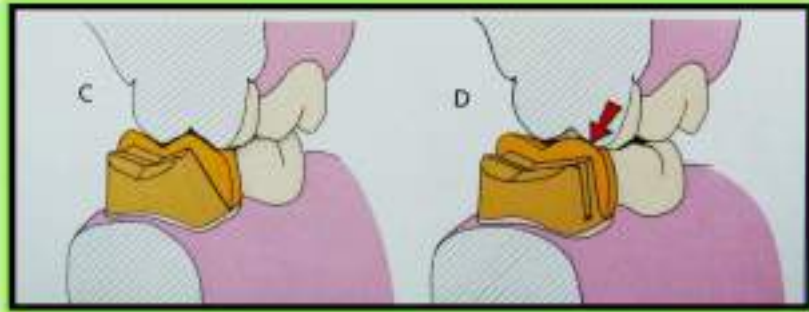
B. Flat , single plane reduction will lead to sufficient thickness over the grooves and fossae.

C. Deep , single plane reduction to compensate thickness over grooves will lead to unnecessary loss of dentine over pulp horns and excessive shortening of axial wall with loss of retention.

FUNCTIONAL CUSP BEVEL-



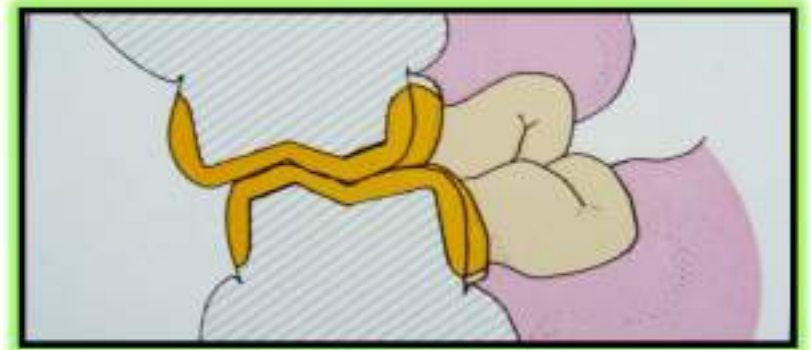
- A functional cusp bevel in a plane paralleling that of the opposing cusp allows for adequate restoration thickness
- If the functional cusp bevel is omitted, the restoration is likely to be too thin in this stress bearing area
- IT IS ALWAYS PLACED ON FUNCTIONAL CUSPS



- If restoration thickness is achieved by over tapering the axial wall, retention will be compromised[C]
- In the absence of functional cusp level, the technician may over bulk the crown[D]

In Cross Bite Relation

Functional cusp level is placed on buccal cusp of maxillary teeth and lingual cusp of mandibular teeth.



AXIAL REDUCTION

Adequate axial reduction is required to make space for restorative material & to develop good axial contour. If restorations are made with inadequate axial reduction they will have thin walls that will be subjected to distortion.

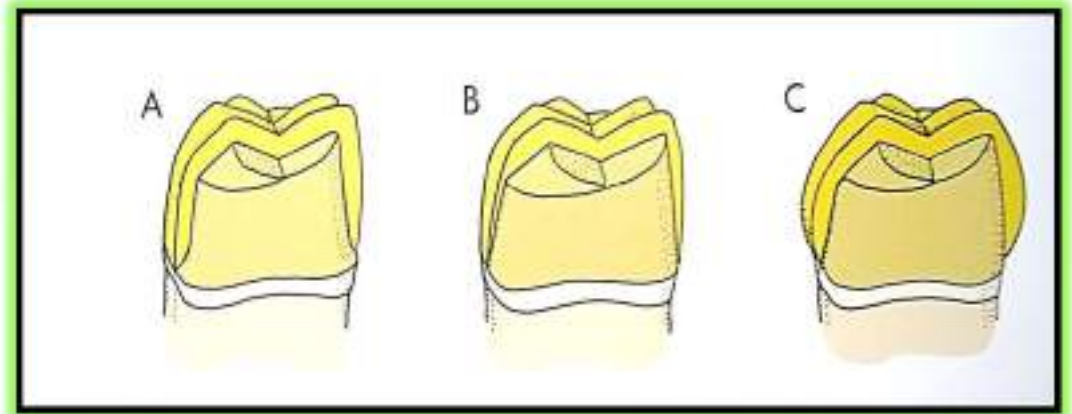
If technician compensates by over contouring, gingival inflammation results as it becomes difficult for patients to maintain plaque control around gingival margin.

A slight undercontoured restoration is better, as it is easy to keep free of plaque.

A. Adequate bulk of metal

B. inadequate axial reduction

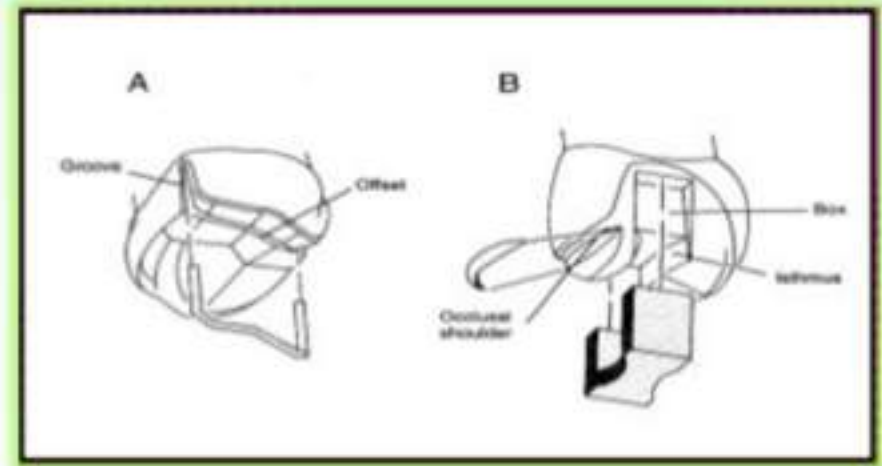
C. can lead to bulky, plaque promoting contours



REINFORCING STRUTS-

➤ other feature that provide rigidity and durability-

- Offset
- Occlusal shoulder
- Isthmus
- Proximal box
- Groove

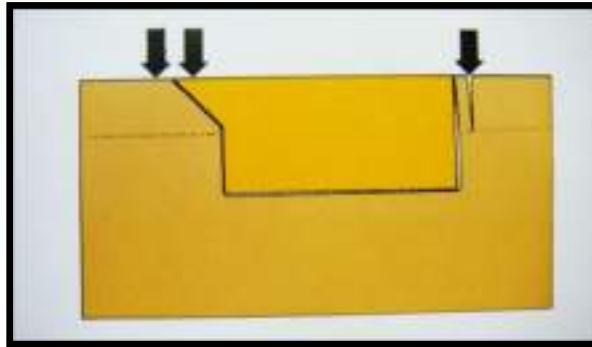


➤ Space for the reinforcing ribs of metal across the occlusal surfaces of posterior three quarter crowns are created by cutting occlusal offsets into the non-functional buccal cusps of maxillary teeth and shoulders into the functional buccal cusps of mandibular teeth.

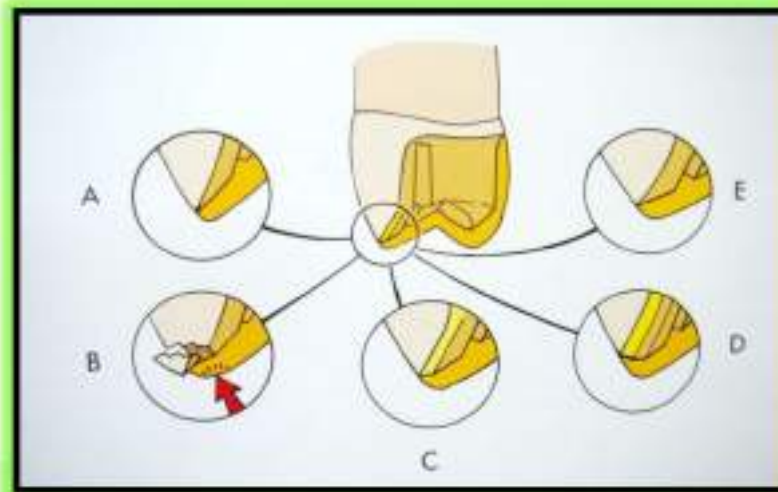


OCCLUSAL BEVEL

Impacts striking enamel next to a bevel can be withstood without damage [left]. Where there is no bevel, the unprotected enamel rods near the restoration can be more easily fractured [right]



- ✓ Without a bevel , the preparation would have an acute edge of unsupported enamel[A]
- ✓ Occlusal forces can deform the thin overlying gold sufficiently to fracture the brittle enamel[B]
- ✓ The margin can be strengthened by placing a simple finishing bevel[C]
- ✓ If esthetic situation allows,a contrabevel is given[D]
- ✓ If the inclination of the occlusal surface is relatively flat,the cavosurface angle may be so obtuse that a bevel for strength is unnecessary[E]



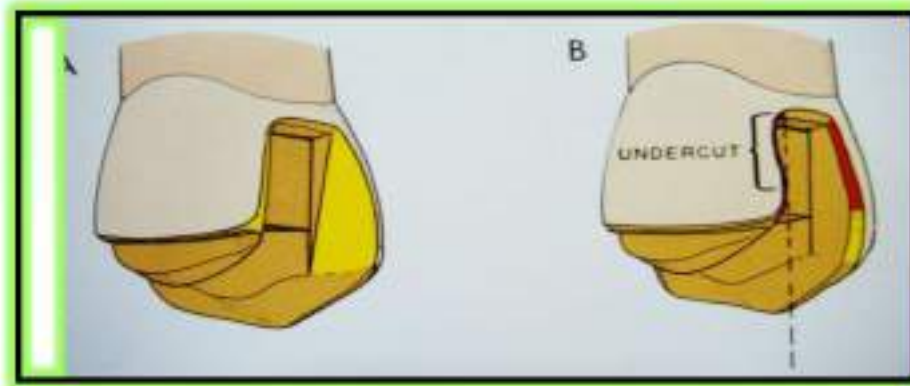
FLARES-

The vertical finish line of inlay, onlay and partial veneer crown preparation must be finished with a flare.

It forms an acute edge of metal in the casting and extends it in accessible area.

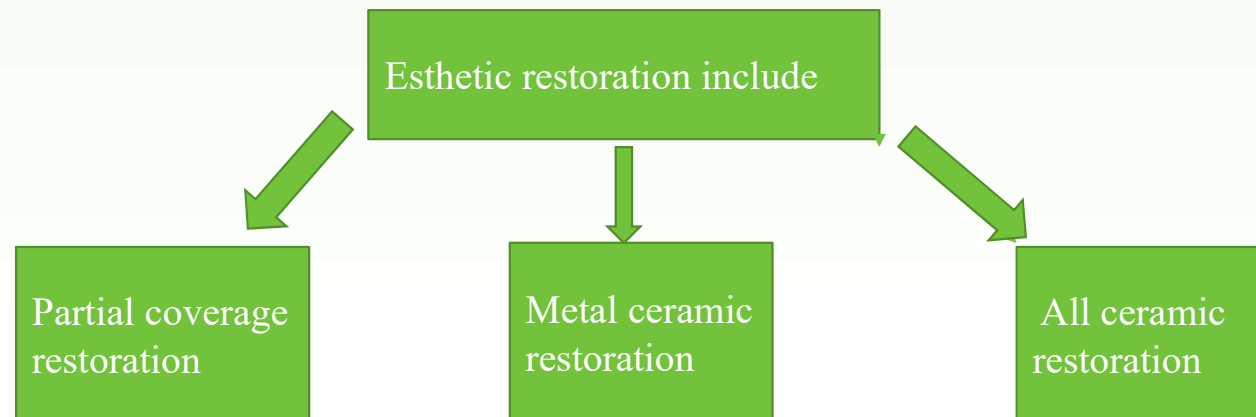
A.-The properly formed flare

B.-The incorrect bevel in place of flare on vertical finish line will produce undesirable undercuts because of natural contour of tooth.



ESTHETIC CONSIDERATIONS

- ✓ The restorative dentist should develop skill in determining the esthetic expectations of the patient.
- ✓ At initial examination a full assessment should be made of patients appearance (areas of teeth shown during speech, smiling, & laughing)
- ✓ The patient's esthetic expectations must be discussed
- ✓ The final decision regarding an appropriate restoration can then be made with the full cooperation and informed consent of the patient.

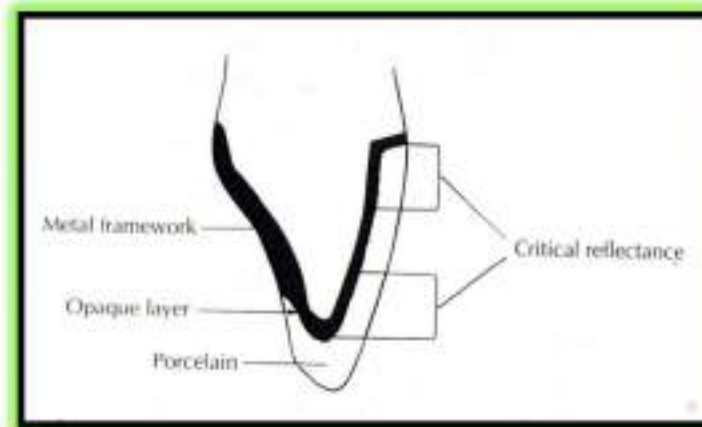


ALL- CERAMIC RESTORATIONS

- ❑ Most pleasing esthetic restorations
- ❑ Mimic original tooth color better than other restorative options.
- ❑ Greater risk of brittle fracture, new materials with improved physical properties can be strengthened along with use of resin-bonded luting agents.
- ❑ Wide 90-degree heavy chamfer margins are needed for material thickness (1-1.2mm) this limits use of this material on faciolingually thin teeth and on teeth with large pulps, as in young individual

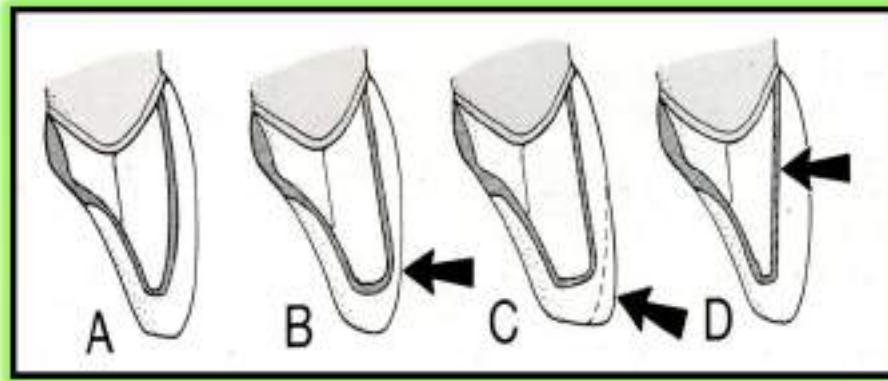
METAL-CERAMIC RESTORATION

- Usually poor appearance is due to insufficient porcelain thickness
- In addition, the labial margin of metal ceramic crown is not always accurately placed
- To correct all these deficiencies, certain principles are recommended during tooth preparation



FACIAL REDUCTION

- ❑ Adequate thickness of porcelain is needed to create a sense of color depth and translucency
- ❑ Adequate reduction → sufficient bulk of porcelain for appearance and metal for strength
- ❑ Minimum reduction of 1.5 mm is required
- ❑ Shade problems → incisal and cervical 3rd of restoration (here direct light reflection from the opaque layer can make the restoration appear very noticeable)
- ❑ Opaque porcelain generally have a different shade from body porcelain, they often need to be modified with special stains in these areas. with very thin teeth like mandibular incisor.



If labial surface is reduced in 1 plane :

B. Opaque porcelain may show through.

C. Labial surface may be over contoured.

B. Pulp may be encroached upon.

INCISAL REDUCTION

- Incisal edge → no metal backing. So, it can be made with a translucency similar to that of natural tooth structure
- reduction → 2 mm
- Excessive reduction – reduces retention and resistance

PROXIMAL REDUCTION

- Esthetics depends on exact location of the metal ceramic junction in complete restoration
- Proximal surface of anterior tooth will look most natural if they are restored as the incisal edges without metal backing.
- In FPD, connectors makes it impossible



LABIAL MARGIN PLACEMENT

- Should follow the contour of gingiva
- High lip line → sub gingival margin
When there is no discoloration of root surface – Supragingival porcelain labial margin
- Low lip line → metal supragingival collar given. Metal collars can be hidden below the gingival crest

PARTIAL COVERAGE RESTORATION

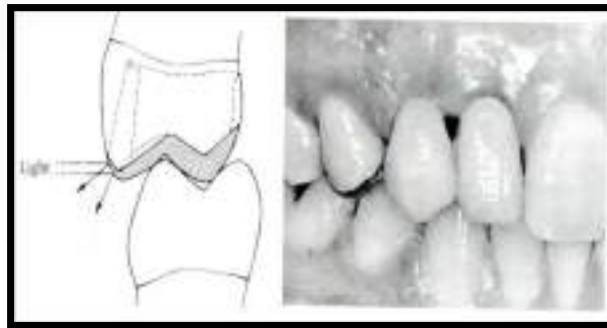
- No restorative material can achieve the appearance of intact tooth enamel
- Esthetic depends on accurate placement of potentially visible facial and proximal margins

PROXIMAL MARGIN

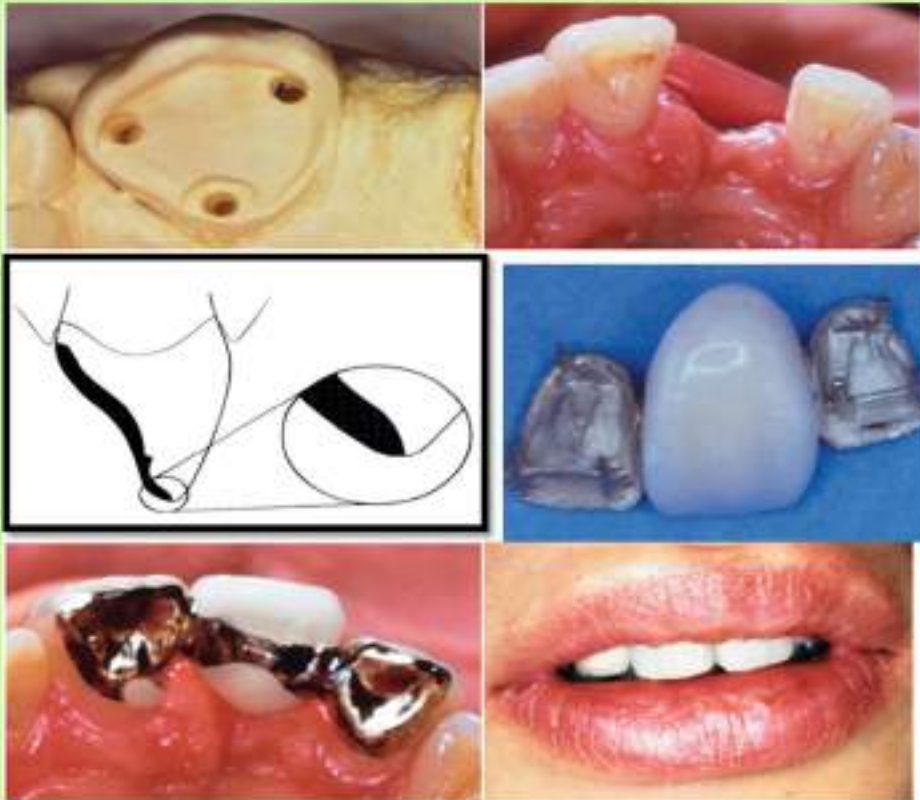
- Mesial margin → buccal to contact area
- Distal margin → can be extended beyond the contact point
- Tooth preparation angulation → long axis of posterior teeth and incisal 2/3rd of facial surface of anterior

FACIAL MARGIN

- Maxillary → margin should be extended just beyond the occlusofacial line angle
- If buccal margin is correctly shaped following the original cuspal contour, it will not reflect light to an observer and tooth will appear merely a little shorter than normal
- Mandibular → metal display is unavoidable because If unacceptable to the patient → metal ceramic restoration with porcelain coverage on occlusal surface



- Anterior partial coverage → facial margin is extended between highest contour of the incisal edge and incisolabial line angle



A, Teeth can be prepared for partial-coverage restorations that do not show any metal. Success depends on very careful margin placement.

B, The incisal edge is not completely covered. The restoration margin is located between the highest point of the incisal contour and the incisofacial angle.

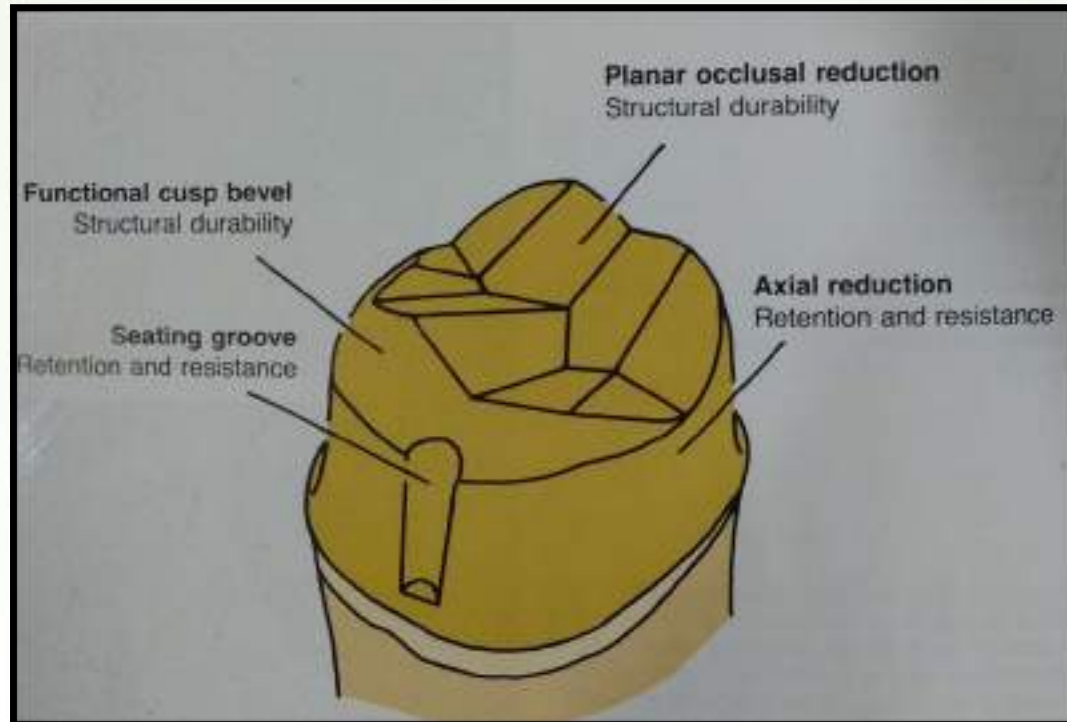
C, Intact anterior teeth on either side of an edentulous space.

D, Three-unit fixed dental prosthesis with pinledge retainers and a metal-ceramic pontic.

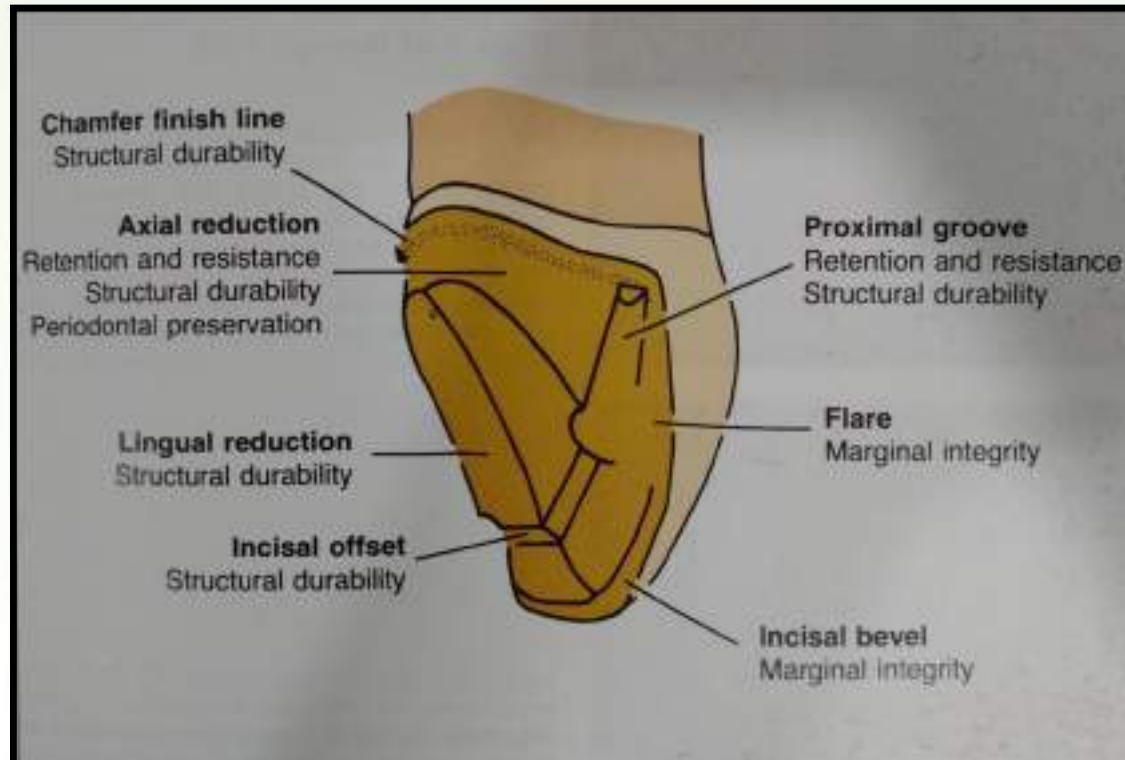
E, Occlusal view of fixed dental prosthesis.

F, Acceptable esthetic result is obtained

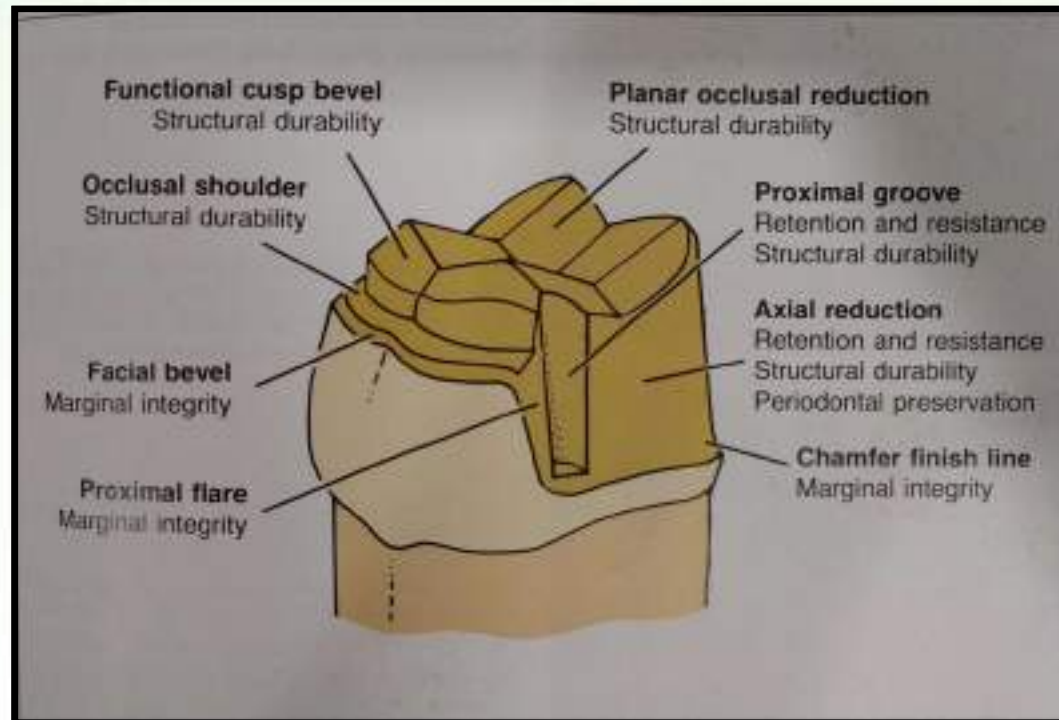
TOOTH PREPARATION FOR DIFFERENT RESTORATIVE MATERIAL



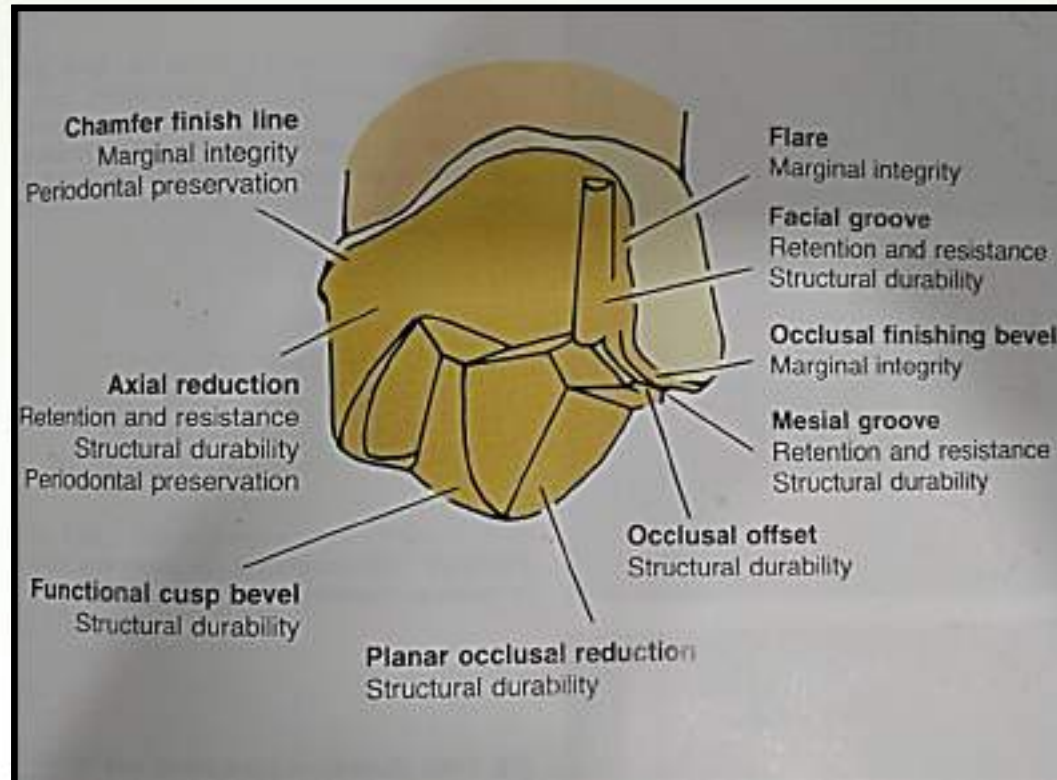
FULL VENEER CROWN



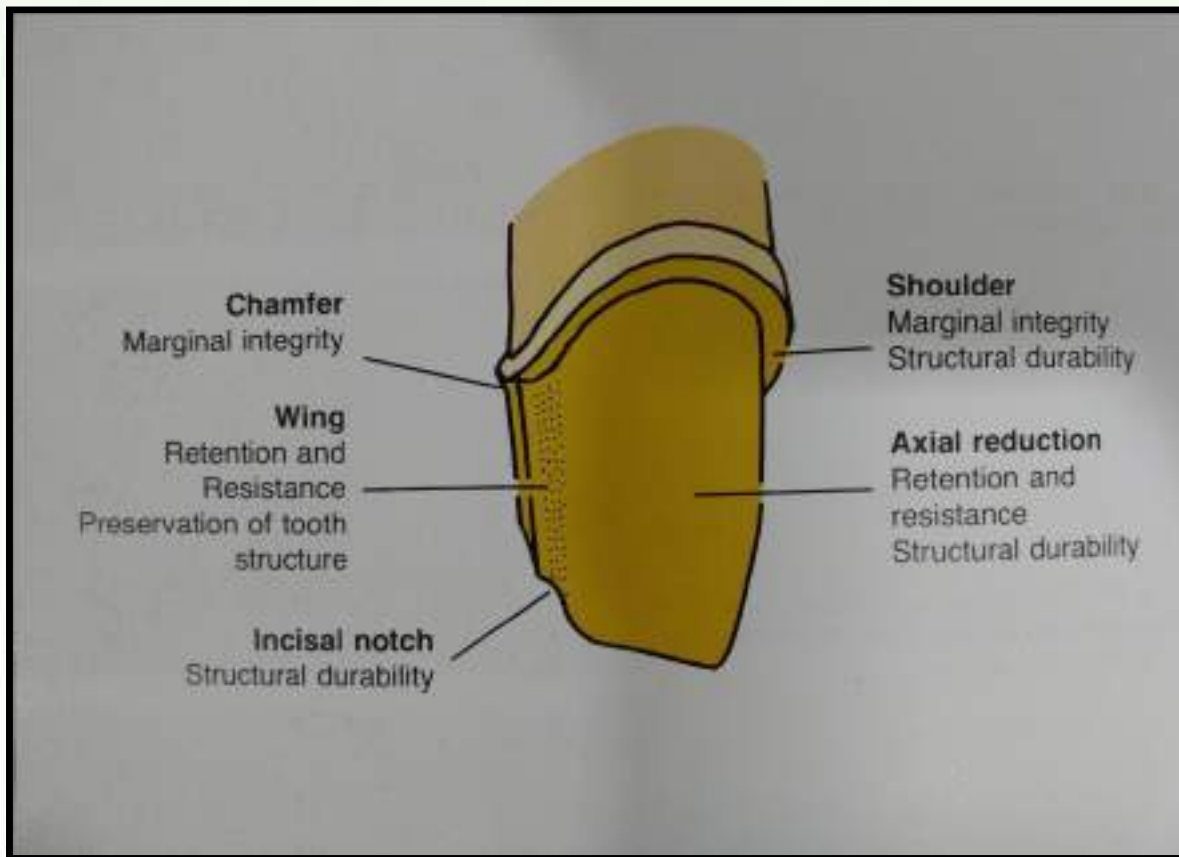
THREE QUARTER CROWN [ANTERIOR TOOTH]



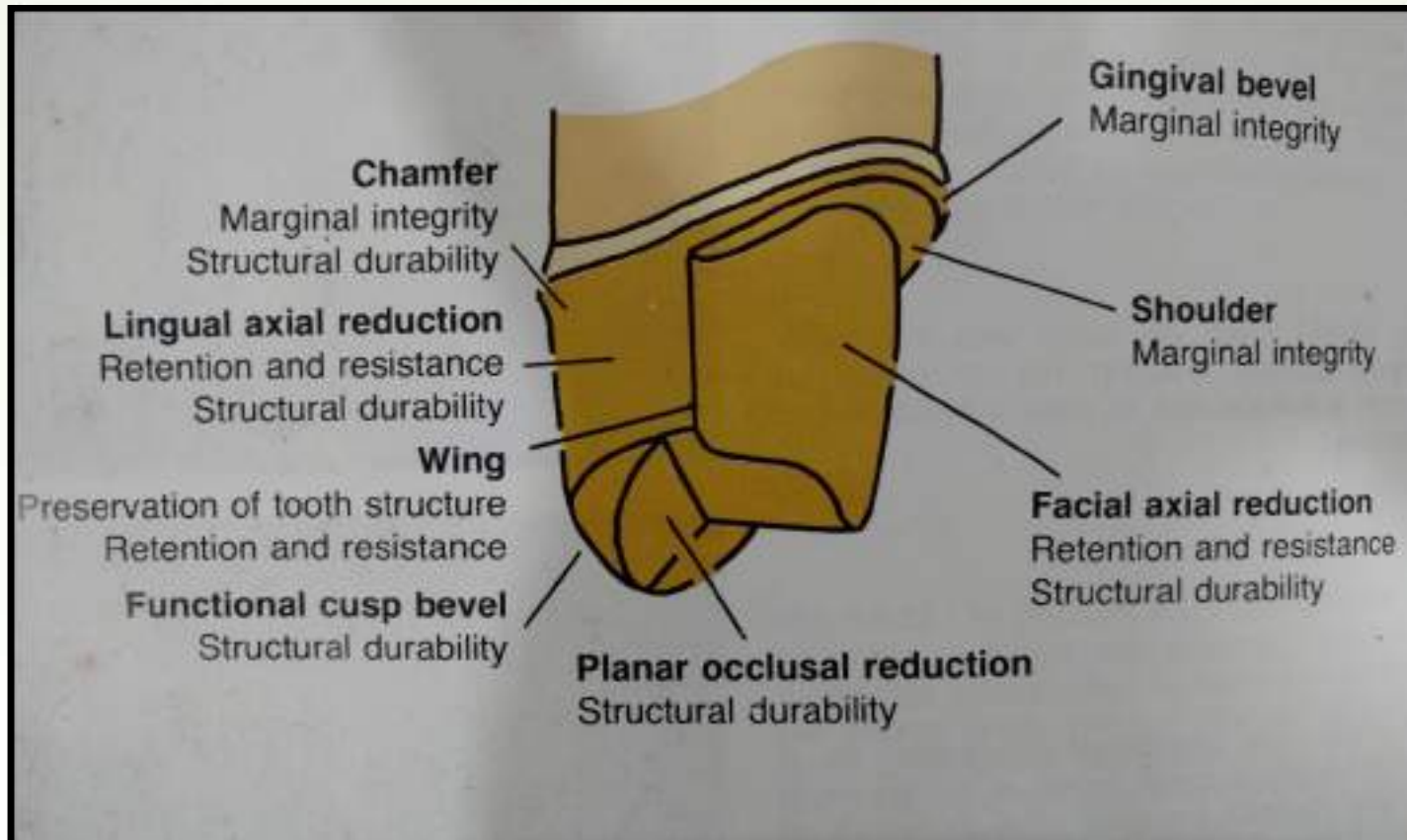
THREE QUARTER CROWN[POSTERIOR TOOTH]



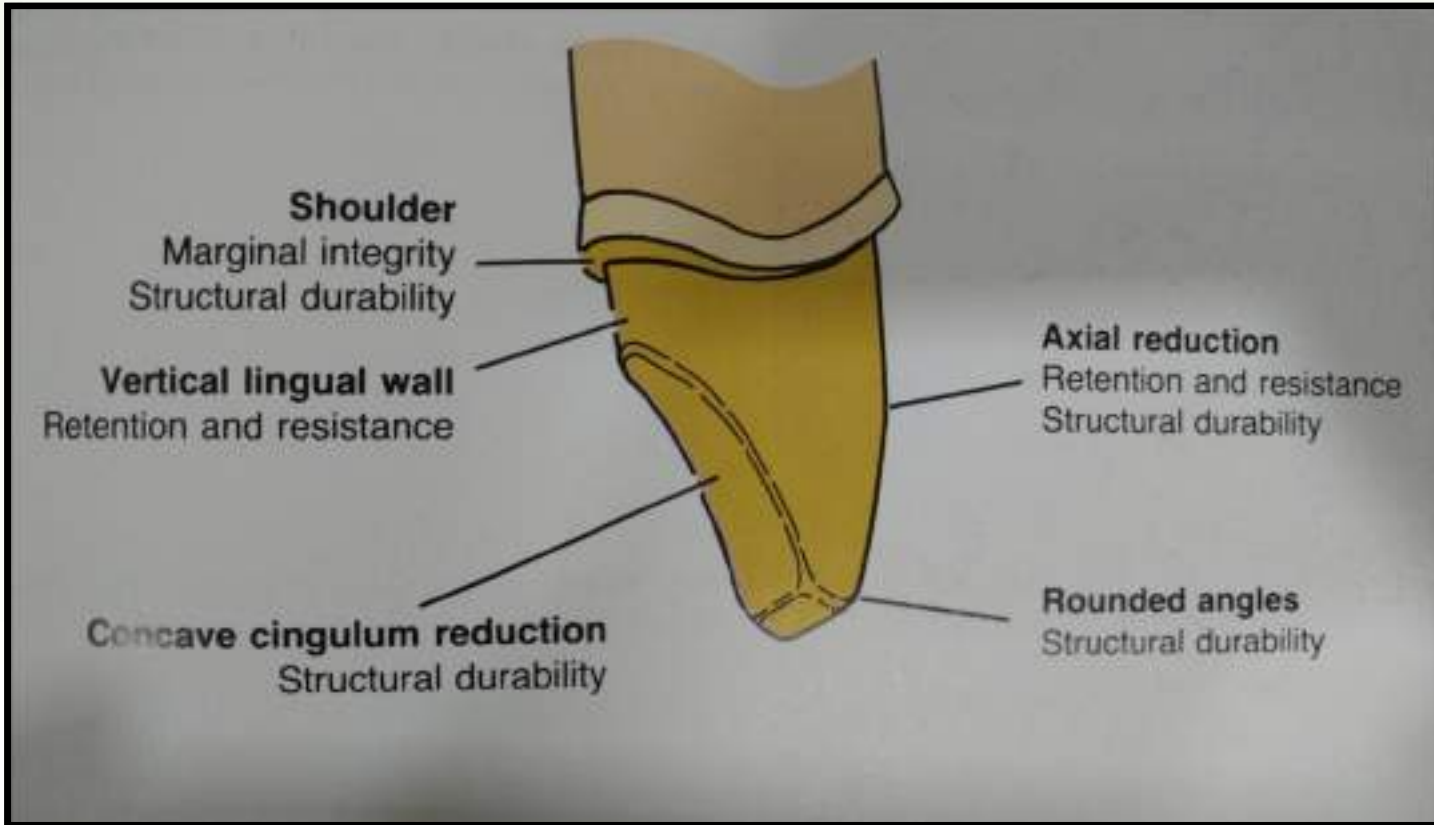
SEVEN-EIGHTHS CROWN



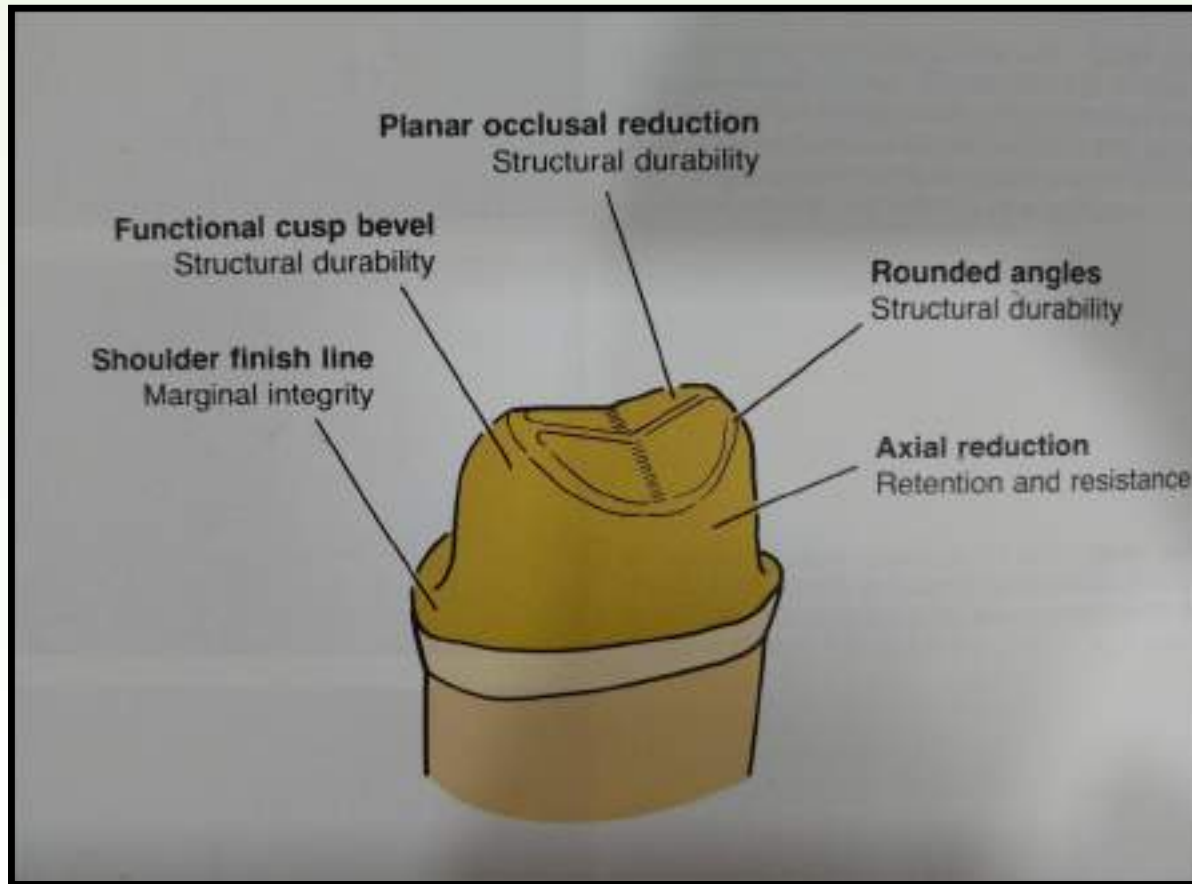
PORCELAIN FUSED TO METAL CROWNS [ANTERIOR TOOTH]



PORCELAIN FUSED TO METAL CROWN (POSTERIOR TOOTH)



ALL CERAMIC CROWN(ANTERIOR TOOTH)



ALL CERAMIC CROWN (POSTERIOR TOOTH)

ESTHETIC CONSIDERATIONS

The restorative dentist should develop skill in determining the esthetic expectations of the patient.

Most patients prefer their dental restorations to look as natural as possible. However, esthetic considerations should not be pursued at the expense of the prognosis of the patient's long-term oral health or function.

The patient's esthetic expectations must be discussed in relation to oral hygiene needs and to the potential for development of future disease.

Options for esthetic restorations include partial veneer crowns, which maintain an intact labial or buccal surface in original tooth structure; metal-ceramic restorations, which consist of a metal cast substructure that in visible areas has an esthetic porcelain veneer; and all-ceramic restorations

All-Ceramic Restorations

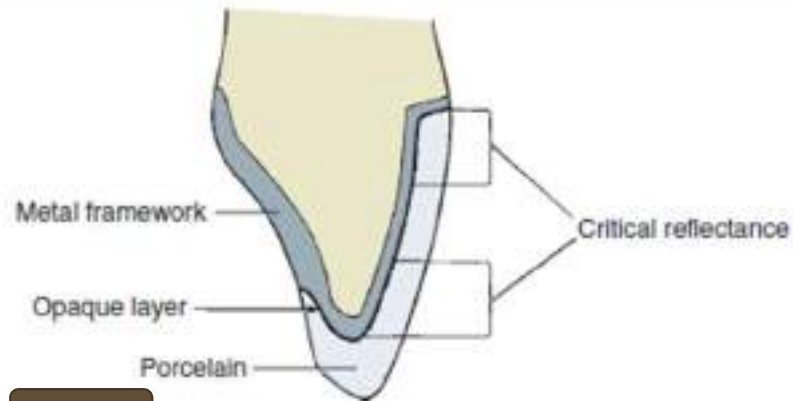
- Some of the most pleasing esthetic restorations are all ceramic crowns, inlays, onlays, and veneers.
- They can mimic original tooth color better than the other restorative options can.
- Although all-ceramic restorations are at somewhat greater risk of brittle fracture than are other restorations, the newest materials have improved physical properties and can be strengthened through the use of resin-bonded luting agents.
- Not all ceramic crown preparations are conservative of tooth structure, inasmuch as a wide 90-degree heavy chamfer margin must be prepared around the entire tooth to ensure increased material thickness and material strength.
- For the same reason, additional reduction on the lingual surface is needed for these restorations.
- A minimal material thickness of approximately 1 to 1.2 mm is necessary to ensure optimal esthetics.
- This limits the use of these restorations on faciolingually thin teeth and on teeth with large pulps, as in young individuals

Metal-Ceramic Restorations

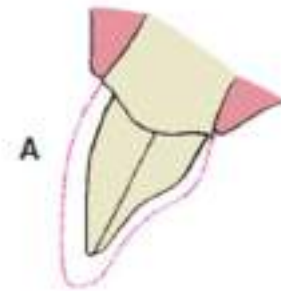
- The appearance of some metal-ceramic restorations is often compromised by insufficient porcelain thickness.
- On the other hand, adequate porcelain thickness is sometimes obtained at the expense of proper axial contour (such overcontoured restorations almost invariably lead to periodontal disease).
- In addition, the labial margin of a metal-ceramic crown is no always accurately placed.
- To correct all these deficiencies, certain principles are recommended during tooth preparation that ensures sufficient room for porcelain and accurate placement of the margins.

Facial Tooth Reduction

- If there is to be sufficient bulk of porcelain for appearance and metal thickness for strength, adequate reduction of the facial surface is essential.
- The exact amount of reduction depends to some extent on the physical properties of the alloy used for the substructure, as well as on the manufacturer and the shade of the porcelain.
- A minimum reduction of 1.5 mm is typically required for optimal appearance.
- Adequate thickness of porcelain is needed to create a sense of color depth and translucency.
- The labial surfaces of anterior teeth should be prepared for metal-ceramic restorations in two distinct planes.
- If they are prepared in a single plane, the reduction in either the cervical or the incisal area of the preparation is insufficient.



■ Adequate porcelain thickness is essential for preventing direct light reflection from the highly pigmented opaque porcelain. The most critical areas are the gingival and incisal thirds; in practice, opaque modifying stains are often used in these areas. (Redrawn from McLean JW: The science and art of dental ceramics, vol 1. Chicago, Quintessence Publishing, 1979.)



■ Recommended tooth preparation for maxillary (A) and mandibular (B) metal-ceramic restoration. In each case, the facial reduction has two distinct planes.

Incisal Reduction

- The incisal edge of a metal-ceramic restoration has no metal backing and can be made with a translucency similar to that of natural tooth structure. An incisal reduction of 2 mm is recommended for good esthetics.
- Excessive incisal reduction must be avoided because it reduces the resistance and retention form of the preparation.

Proximal Reduction

- The extent of proximal reduction is contingent on exact predetermination of the location of the metal-ceramic junction in the completed restoration.
- The proximal surfaces of anterior teeth look most natural if they are restored at the incisal edges, without metal backing. This allows some light to pass through the restoration in a manner similar to what occurs on a natural tooth



■ Optimal esthetics require proximal light transmission through the esthetic veneer. Occluding lingual surfaces are in metal, which extends into the proximal aspect.

Labial Margin Placement

- Supragingival margin placement has many biologic advantages. The restorations are easier to prepare properly and easier to keep clean.
- Nevertheless, subgingival margins may be indicated for esthetic reasons, particularly when the patient has a high lip line and when the use of a metal collar labial margin is contemplated.
- Patients with a high lip line, which exposes considerable gingival tissue, present the greatest problem if complete crowns are needed.
- Where the root surface is not discolored, appearance can be restored with a metal-ceramic restoration with a supragingival porcelain labial margin.
- If the patient has a low lip line, a metal supragingival collar may be placed because the metal is not seen during normal function.

- Metal margins generally have a more accurate fit than porcelain margins.
- Metal collars can be hidden below the gingival crest, although there is some discoloration if the gingival tissue is thin.
- Successful margin placement within the gingival sulcus requires care to ensure that inflammation and recession, with resulting metal exposure, are avoided or minimized
- Margins should not be placed so far apically that they encroach on the attachment; extension to within 1.5 mm of the alveolar crest leads to bone resorption.
- The margin should follow the contour of the free gingiva, being further apical in the middle of the tooth and further incisal interproximally.
- A common error is to prepare the tooth so that the margin lies almost in one plane, with exposure of the collar labially and irreversible loss of bone and papilla proximally.



FIGURE 7-55 ■ Poor preparation design. **A**, The treatment plan for these badly damaged incisors was to use metal-ceramic crowns. **B** and **C**, The apical margin of the preparation does not follow the free gingival contours. **D**, The restoration displays a metal collar labially, and the deep proximal margins have led to periodontal disease.

Partial-Coverage Restorations

- Whenever possible, an esthetically acceptable result without the use of complete crowns is preferred because tooth structure is conserved and because no restorative material can approach the appearance of intact tooth enamel.

Proximal Margin

- Precise placement of the proximal margins (particularly the mesial, generally more visible, margin) is crucial for the esthetic result of a partial-coverage restoration.
- The rule is to place the margin just buccal to the proximal contact area, where metal is hidden by the distal line angle of the neighboring tooth and yet provides adequate access to the tooth-restoration interface for plaque control.
- The distal margin of posterior partial-coverage restorations is less visible than the mesial margin.
- In this area, it is often advantageous to extend the preparation farther beyond the contact point for easier preparation and finishing of the restoration and to facilitate access for oral hygiene.

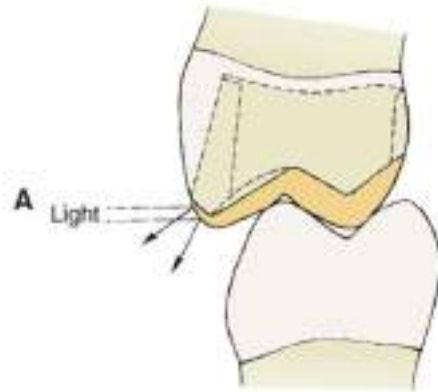


Clearance must be sufficient to permit fabrication of a die system but should minimize the display of metal.

■ A. Correct placement of the mesial margin of a partial-coverage restoration is essential for good esthetics. To allow proper access for finishing, the restoration must extend just beyond the contact area, but the metal must remain hidden from the casual observer. B. The tooth should be prepared in its long axis; otherwise, metal is displayed.

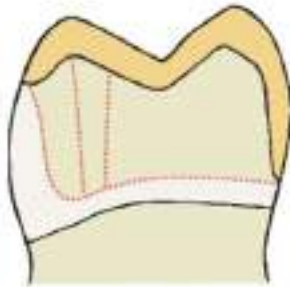
Facial Margin

- The facial margin of a maxillary partial-coverage restoration be extended just beyond the occlusofacial line angle.
- A short bevel is needed to prevent enamel chipping.
- A chamfer margin can be placed in areas where appearance is less important (e.g., on molars) because this provides greater bulk of metal for strength.
- If the facial margin of metal is correctly shaped it does not reflect light to an observer.
- As a result, the tooth appears to be merely a little shorter than normal and not as though its buccal cusp is outlined in metal.
- If the buccal margin is skillfully placed so as to follow the original cuspal contour, the appearance of the final restoration is acceptable.



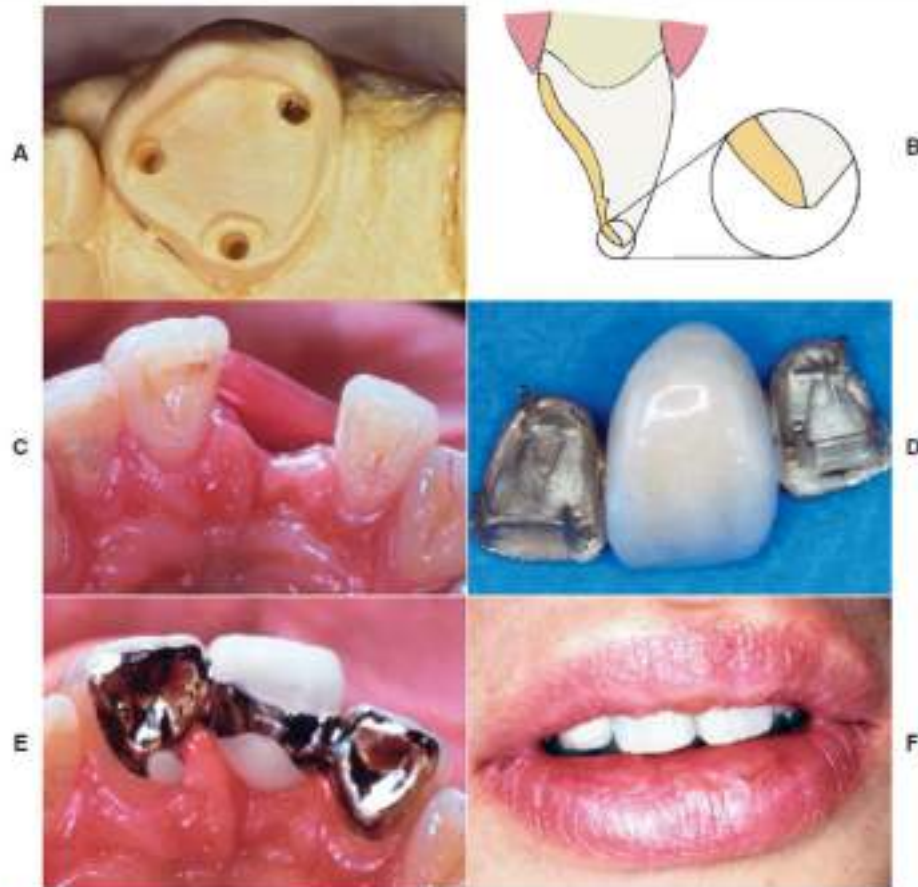
■ **A.** The facial margin of a partial cast crown should be shaped so that light is not reflected directly to the observer. **B.** A three-unit fixed dental prosthesis. The mesial abutment is a canine, shaped to look like a lateral incisor. The distal abutment is a partial cast crown, which proved to be esthetically acceptable because the metal had been correctly contoured.

- When mandibular partial cast crowns are made, metal display is unavoidable because the occlusal surface of mandibular teeth can be seen during speech.
- A chamfer margin, rather than a beveled margin, is recommended for the buccal margin because it provides a greater bulk of metal around the highly stressed functional cusp.
- If the appearance of metal is unacceptable to the patient, a metal-ceramic restoration with porcelain coverage on the occlusal surface can be made.



■ A substantial chamfer margin is recommended for the functional buccal cusp of a mandibular partial cast crown. It provides greater bulk of metal in a stressed area.

- Anterior partial-coverage restorations can be fabricated to show no metal, but their preparation requires considerable care.
- The facial margin is extended just beyond the highest contour of the incisal edge but not quite to the incisolabial line angle.
- In this case, the metal protects the tooth from chipping but is not visible.



■ A. Teeth can be prepared for partial-coverage restorations that do not show any metal. Success depends on very careful margin placement. B. The incisal edge is not completely covered. The restoration margin is located between the highest point of the incisal contour and the incisofacial angle. C. Intact anterior teeth on either side of an edentulous space. D. Three-unit fixed dental prosthesis with pinledge retainers and a metal-ceramic pontic. E. Occlusal view of fixed dental prosthesis. F. Acceptable esthetic result is obtained.

SUMMARY AND CONCLUSION

Proper attention should be given during margin placement and the principle of “Do no harm” to the soft tissues should be followed.

All preparations require the incorporation of factors to prevent the dislodgement of restoration by functional stresses.

If too much emphasis is given on any one of the principles then the success of the procedure may be limited by a lack of consideration of the other factors.

An analysis of these principles and factors should enable the dentist to effectively apply them during the design of any preparation.

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THANK YOU