An Introduction to Fixed Prosthodontics

Prosthodontics: It is the dental specialty concerned with the making of artificial replacements for missing parts of the mouth and jaw. It is also named "Prosthetic Dentistry" or "Prosthodontia".

Fixed Prosthodontics (Crown and Bridge Prosthodontics); It is a branch of dental science that deals with restoration of damaged teeth with artificial crown and replacing the missing natural teeth by a dental prosthesis permanently cemented in place [Fixed partial denture].

Fixed Prosthodontics includes:

- Inlays
- Onlays
- Veneers
- Crowns
- Fixed partial dentures

Crown: It is a fixed extra-coronal artificial restoration of the coronal portion of a natural tooth. It must restore the morphology, contour and function of the tooth and should protect the remaining tooth structure from further damage.

Types of crowns (Classification of crowns):

I. According to coverage area

1. Complete crown : It is the crown that covers all the coronal portion of the tooth such as full metal crown, porcelain fused to metal crown and All Ceramic crown.
2. Partial crown : It is a crown that covers part of the coronal portion of the tooth such as 3/4 crown, 7/8Crown.
3. Complete replacement: It replaces the natural crown entirely. This type of crown retains itself by means of a dowel (post) extended inside the root canal space of the tooth such as a post crown.

Three-quarter crown which is a partial crown covering all tooth surfaces except the buccal surface.

Post crown which replaces the natural crown entirely and retains itself by means of a dowel (post) extended inside the root canal space.

II. According to the materials used in the fabrication of the crown

1. Metal crown: made from gold alloy and its alternatives such as full metal crown and 3/4 crown.

2. Non- metal crown: made from acrylic resin, zirconium or porcelain as in jacket crown.

3. A combination of metal and plastic materials such as porcelain fused to metal crown.

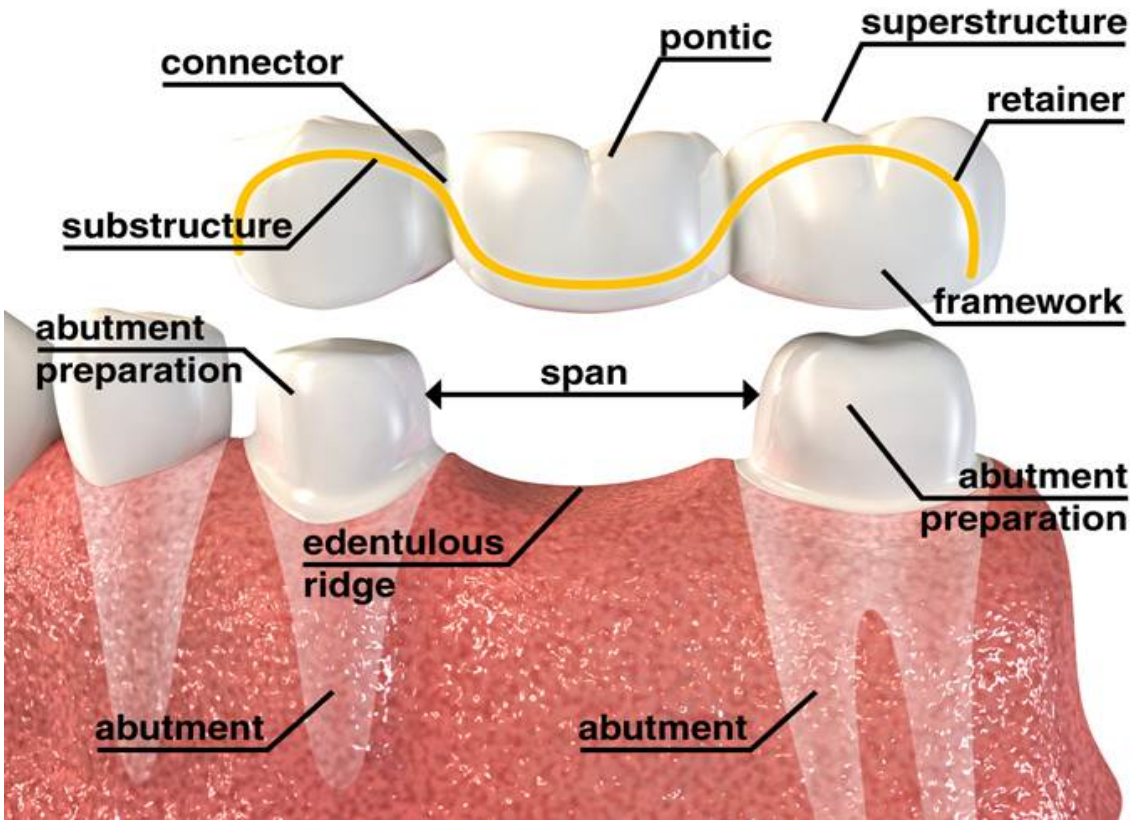
Bridge: It is a fixed dental prosthesis which replaces and restores the function and esthetic of one or more missing natural teeth and can't be removed from the mouth by the patient. It is primarily supported by natural teeth or root. The tooth that gives support to the bridge is called "abutment tooth".

Components of bridge:

1. Retainer: It's the part that seats over (on or in) the abutment tooth. It could be major or minor (will be explained later).

2. Pontic: It is the suspended member of fixed partial denture that replaces the missing tooth or teeth. It usually occupies the position of the missing natural tooth.

3. Connector: It is that part of fixed partial denture that joins the individual components of the bridge together (the retainer and the pontic). It could be fixed (rigid) or movable (flexible) connector. When the retainer is attached to a fixed connector, it is called "major retainer", but when it is attached to a flexible (movable) connector it is called "minor retainer".



Components of bridge.

Purposes of crown construction:

1.To restore the grossly damaged tooth, fractured tooth or a tooth with a heavy filling (amalgam or composite).

2.To restore the masticatory function and speech.

3.To restore the esthetic (hypoplastic condition whether heredity defect or acquired defect).

4.To maintain the periodontal health by recontouring the occlusion and prevents food impaction.

5. To alter the occlusion (occlusal relationship) as a part of occlusal reconstruction to solve occlusal problems or to improve function.

6. As a retainer for the bridge.

Steps in the construction of cast restorations

1. Diagnosis.
2. Tooth preparation.
3. Final impression.
4. Temporary restoration (Provisional restoration).
5. Construction of working model.
6. Waxing.
7. Investing.
8. Burn-out (Wax elimination).
9. Casting.
10. Cleaning and finishing.
11. Try-in and cementation.

Note: Steps (1-4, and 11) are clinical steps, while steps (5-10) are laboratory steps carried out in the lab by the laboratory technician.

Note: The steps mentioned above concern the fabrication of cast restorations which are restorations made entirely from metal or a combination of metal and plastic material. All ceramic restorations are fabricated using other laboratory procedures such as CAD/CAM (Computer Aided Design / Computer Aided Manufacturing).

Diagnosis

The first step should be the diagnosis of the case whether it is indicated for crown and bridge work or not. This is decided after a thorough examination of the tooth and surrounding structures, which includes:

(a) Periodontal Examination: The patient should have proper oral hygiene to ensure that no plaque accumulation would occur on the crown margins which might lead, if left, to caries.

(b) Dental examination: which includes:

-*Visual examination:* we should examine the occlusion of the patient, the presence of crowding, spacing, rotation of teeth, tilting (drifting) and supra-eruption of the abutment tooth (or teeth). Meanwhile, the condition of the remaining tooth structure, the presence of caries and the quality of existing old fillings in the abutment tooth (or teeth) all should be checked.

-*Radiographic examination:* The radiograph reveals the shape and number of the roots, the condition of the surrounding structures, and the bone support of the tooth (crown/root ratio). The ideal crown/root ratio of a tooth to be used as an abutment for fixed partial denture is 1:2.

The radiograph also reveals the presence of a lesion in the bone, root canal treatment, fracture in the tooth or root, bone loss, unerupted teeth, etc…These information will affect the prognosis of the treatment.

Tooth Preparation

It is the cutting or instrumentation procedure that is carried out on the tooth during crown construction procedure.

The prepared tooth is the final form or shape of the tooth after the cutting (preparation) procedure. Rotary instruments are used to reduce the height and contour of the tooth. The tooth is prepared so that the crown restoration can slide into place and be able to withstand the forces of occlusion.

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

Objectives of tooth preparation

The main objectives of tooth preparation in fixed prosthodontics includes:

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

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

2-To provide enough space for the crown restoration to withstand the force of mastication. This space depends on the material used; metal needs little space while plastic materials need more space.

3-Not to enlarge the size of the tooth.

4-To provide good esthetic.

Disadvantages of crowns

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

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

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

Biomechanical Principles of Tooth Preparation

The design of the preparation of a tooth for cast metal or porcelain restorations is limited by five principles:

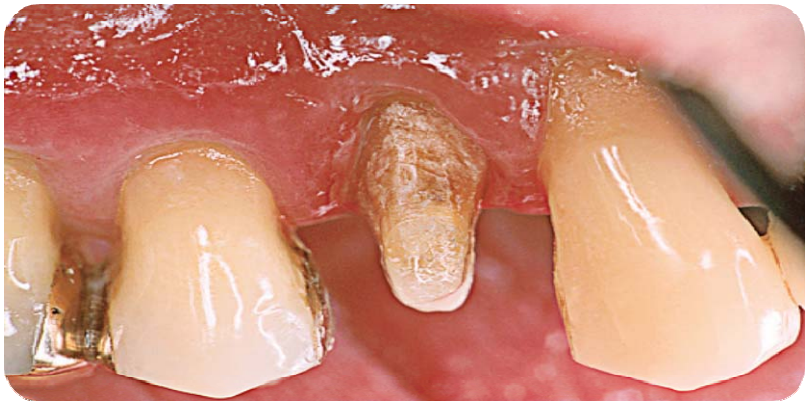
1- Preservation of tooth structure.
2- Retention and resistance from.
3- Structural durability of the restoration.
4- Preservation of periodontium.
5- Marginal integrity.

1. Preservation of the tooth structure

The preparation of the tooth must be conservative, minimal amount of tooth structure must be removed. Excessive amount of tooth structure removal, in addition to be destructive phenomenon, it has many harmful effects:

-Excessive reduction will lead to thermal hypersensitivity, pulpal inflammation and necrosis may result from approaching to the pulp closely.

-The tooth might be over tapered or shortened and this might affect the retention and resistance of the prepared tooth.

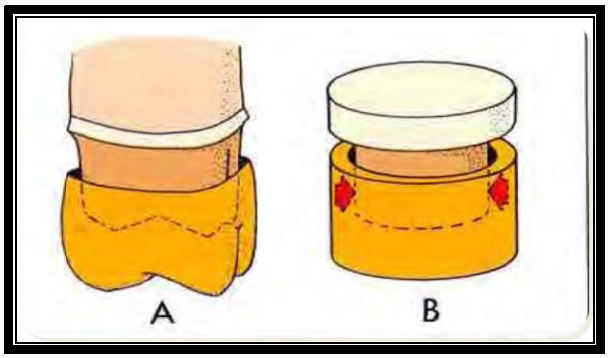


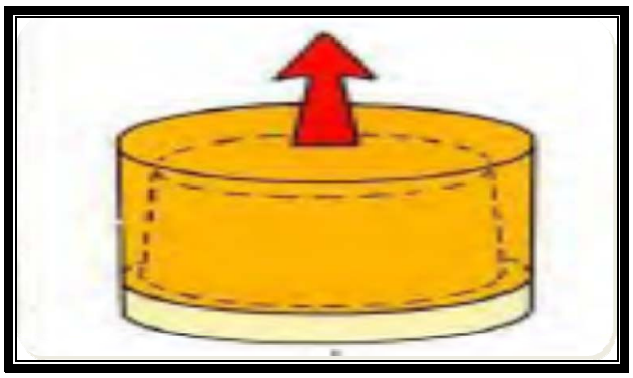
Excessive tooth reduction: The tooth is over tapered and shortened and this will affect the retention and resistance of the prepared tooth.

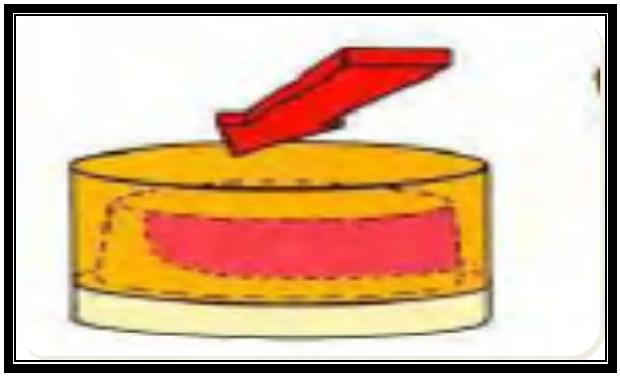
2. Retention and resistance form

Retention is the ability of the preparation to resist the dislodgement of the crown restoration by forces directed along its path of insertion.

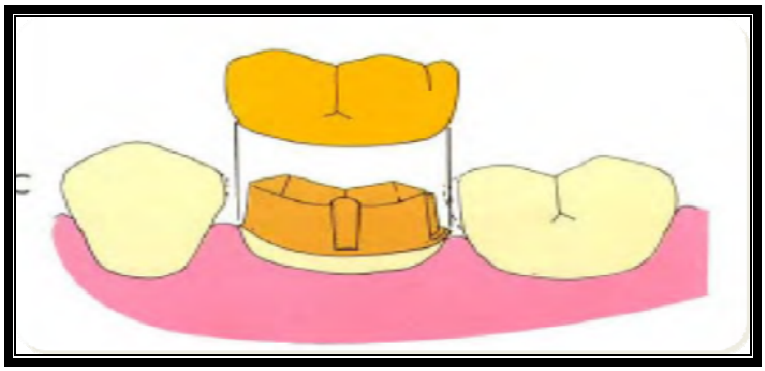
Resistance is the ability of the preparation to resist the dislodgment of the restoration by forces directed obliquely or horizontally to the restoration.







Path of insertion is an imaginary line along which the restoration can be inserted and removed without causing lateral forces on the abutment. The crown restoration should have a single path of insertion to be retentive. Most of the time, the path of insertion of the crown restoration is parallel to the long axis of the tooth, but this is not a rule as in three-quarter crown for the anterior teeth where the path of insertion should be parallel to the incisal two-thirds of the crown not to the long axis.



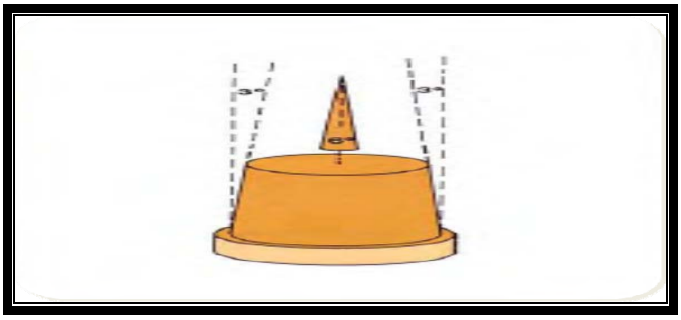
By limiting the path of withdrawal of the restoration, the retention is improved. A preparation with unlimited freedom of displacement is much less retentive.

Factors affecting retention and resistance

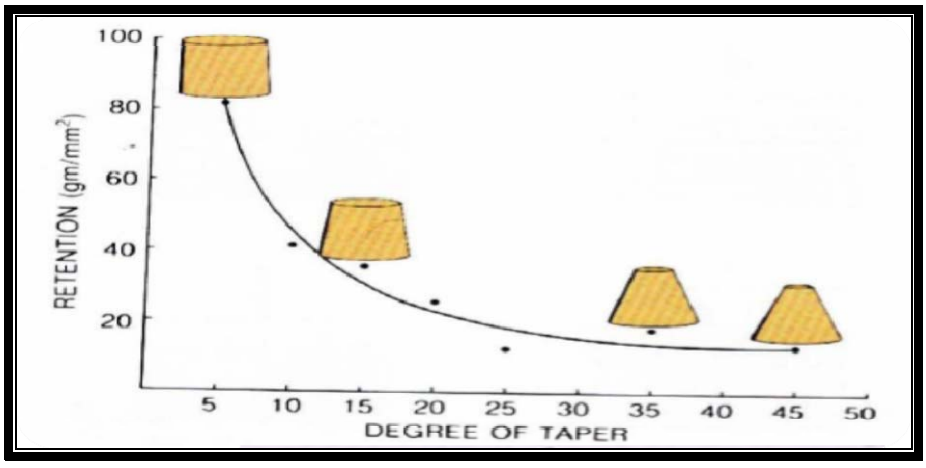
1. Taper of the preparation.
2. Surface area of the preparation.
3. Length and height of the preparation.
4. Diameter of the tooth (tooth width).
5. Texture of the preparation.
6. Accessory means.

1. Taper of the preparation

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



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

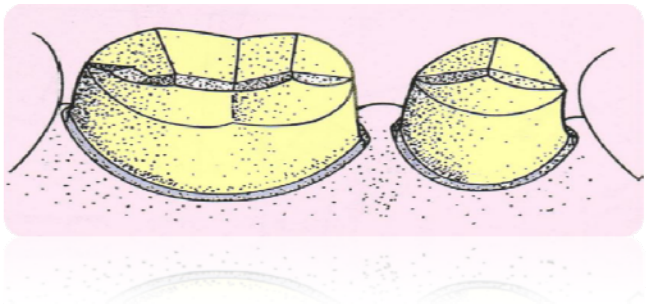


Taper and Resistance: The more parallel the axial walls of the preparation, the more will be the resistance of crown restoration. The walls of a short wide preparation must be kept nearly parallel to achieve adequate resistance from.

2. Surface area of the preparation

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

(a) Size of the tooth: The larger the size of the tooth, the more will be the surface area of the preparation, and thus the more will be the retention. In this issue, a full metal crown on a molar tooth will definitely be more retentive than that on a premolar tooth.

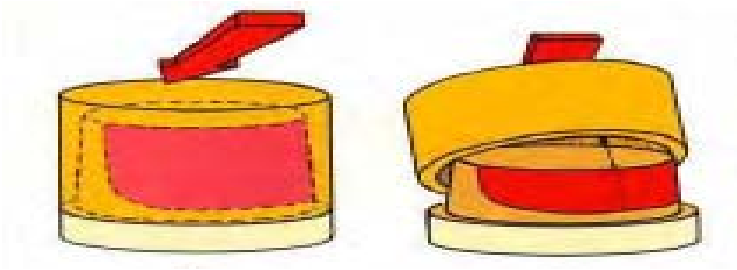


(b) Extent of tooth coverage by the restoration: The more the area that will be covered by the crown restoration, the more will be the retention. Thus full metal crown on a molar tooth is more retentive than a three-quarter crown on the same tooth.

(c) Accessory features: such as boxes, grooves, and pin holes.

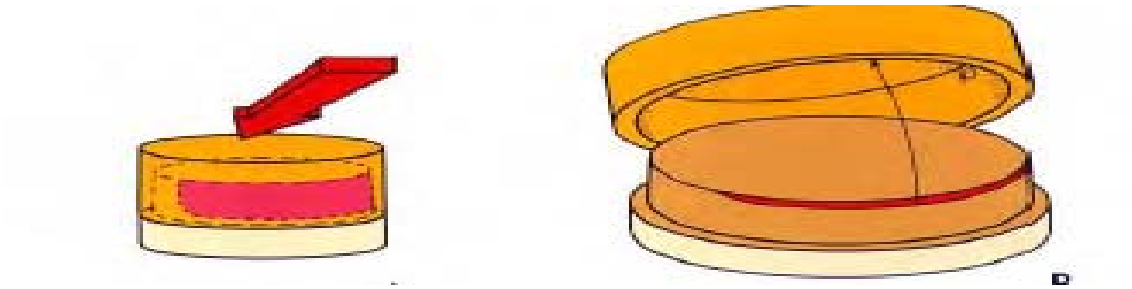
3. Length (height) of the preparation

Increasing the length of the preparation will increase the retention and resistance and vice versa.



4-Diameter of the tooth (tooth width)

Under some circumstances, a crown on a narrow tooth can have greater resistance to tipping than the one on a wider tooth. This occurs because the crown on the narrower tooth has a shorter radius for rotation resulting in a lower tangent line and a larger resisting area.

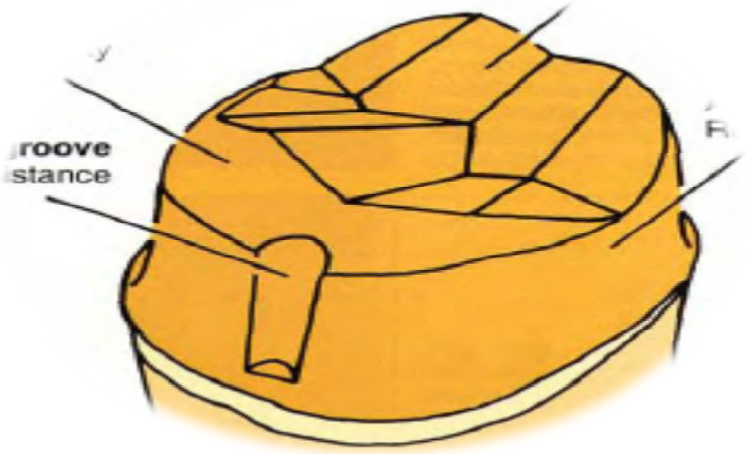


5.Texture of the preparation

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

6. Extra retention means

The retention of the preparation can be greatly enhanced by the addition of grooves, pin holes or boxes.

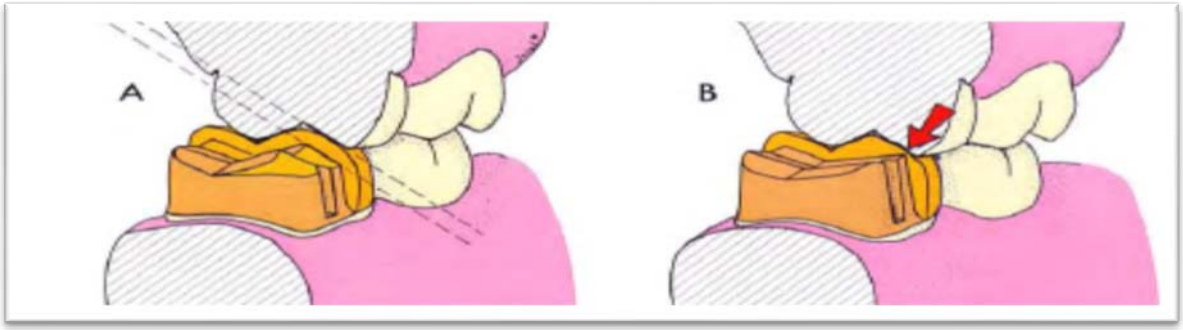


3. Structural Durability

The preparation must be designed so that it can provide structural durability to the restoration. i.e. the crown restoration must be rigid enough to not flex, perforate (if made of metal) or even fracture (if made of plastic material).

For the restoration to be rigid it needs bulk. To provide enough bulk to the crown restoration, sufficient tooth structure must be removed from the prepared tooth to create enough space. By doing so, the restoration will be allowed to withstand the forces of occlusion, preventing wearing holes in the metal and allowing proper contouring and carving of occlusal anatomy in the restoration. The preparation features related to structural durability are:

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

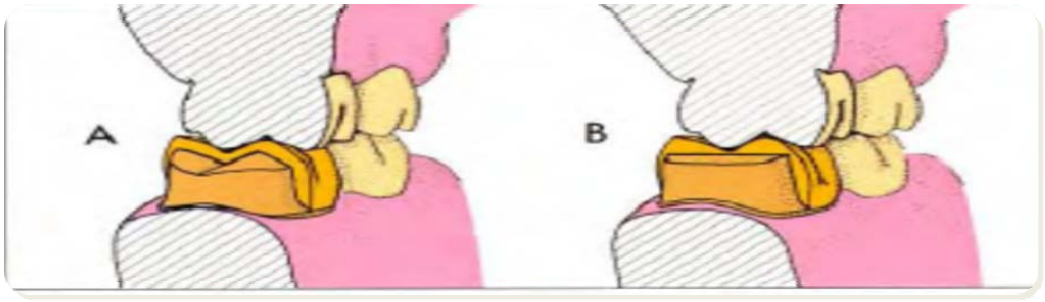


Occlusal clearance: is the space between the occlusal surface of the prepared tooth and that of opposing tooth. It should be evaluated in centric and eccentric relation. Enough tooth structure must be removed occlusally so that when the restoration is built back to ideal occlusion it will be thick enough to prevent wearing or distortion.

Functional cusps: are the cusps that give centric stops of occlusion (Palatal of upper posterior teeth and buccal of lower posterior teeth).

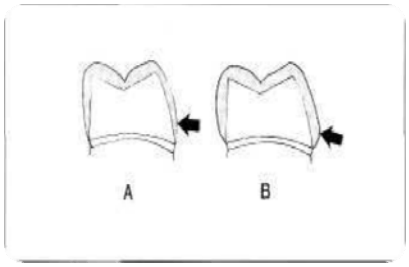
Occlusal reduction must reflect the geometric inclined planes of the occlusal surface (the so called "planar occlusal reduction" or "anatomical occlusal reduction").

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



Functional cusp bevel (FCB): is a wide bevel placed on the functional cusps of posterior teeth to provide structural durability. It allows adequate thickness of restoration at this critical area without undue scarifying of tooth structure. If FCB is omitted, the restoration is likely to be too thin in this stress bearing area. In the absence of FCB, the laboratory technician overbuilds the crown restoration in attempt to provide structural durability for the restoration; this will lead to premature contact with the opposing tooth.

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

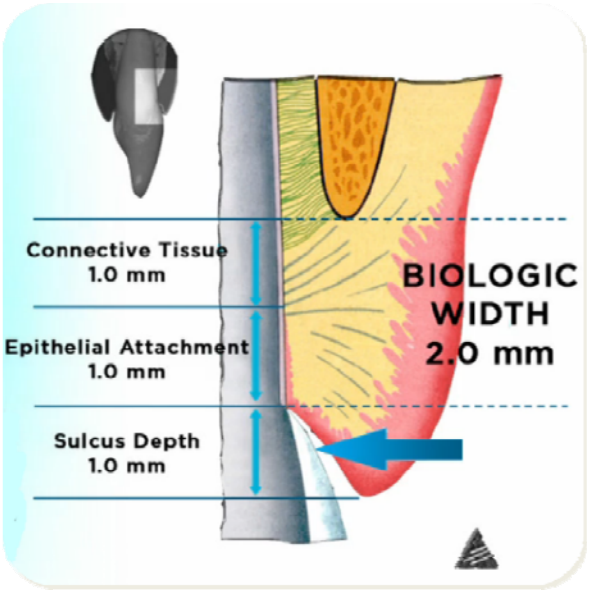


4. Preservation of the periodontium

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

(a) Whenever possible, the margin of the preparation should be placed supra-gingivally.

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



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

Placing the margin of the preparation above the gingival tissue offers the following advantages:

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

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

c- the impression can be easily made.

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

e- most of the time such a position is situated on hard enamel.

f- less destructive

So, as mentioned above and for the reasons formerly mentioned, it is better to place the margin of the preparation supra-gingivally whenever possible. However, there are some situations which require sub-gingval placement of the finishing line as listed below:

a- for esthetic.

b- when we need extra retention as in teeth with short crowns.

c- when there is caries or filling at the area of finish line (the preparation margin should be placed on sound tooth structure).

5. Marginal Integrity

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

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

(b) it must have sufficient strength.

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

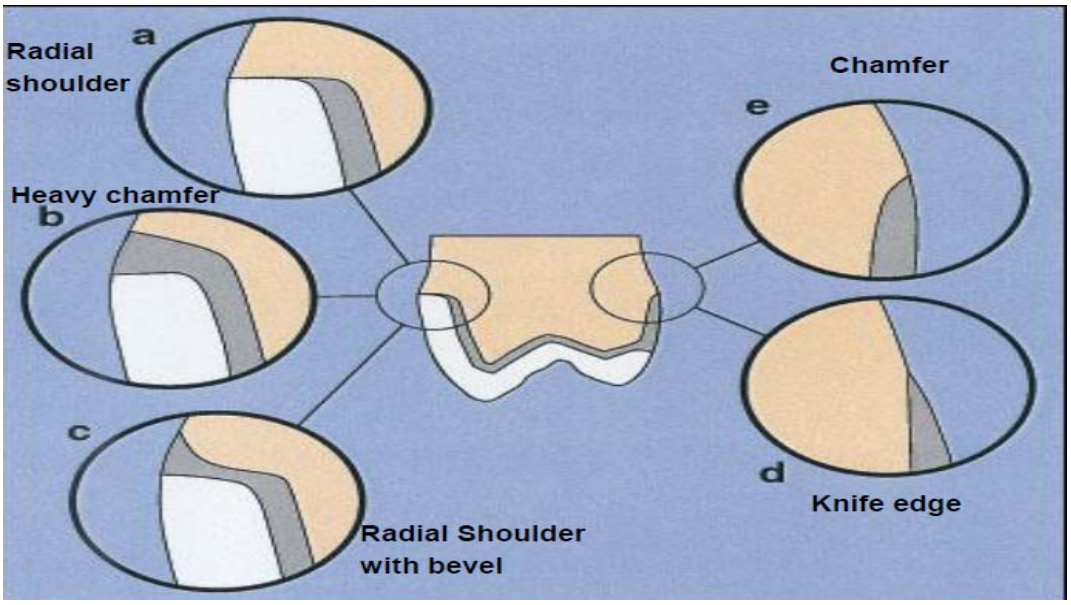
Finishing line of the preparation

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

Types of finishing line according to its design or configuration

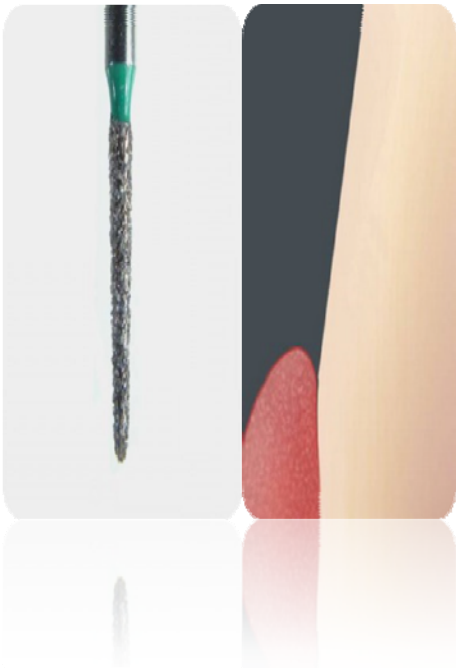
The following designs for finishing line could be used depending on the type of the crown restoration:

1. *Knife edge* (also named *"feather end"*)
2. *Chamfer*
3. *Heavy chamfer*
4. *Shoulder*
5. *Radial shoulder*
6. *Shoulder with bevel*



1. Knife edge or feather end finishing line

A pointed end tapered fissure bur (long needle diamond fissure bur) is used to provide this type of margin design. It is the most conservative type of finishing line since the least amount of tooth structure is removed, but the margin is weak since this margin design does not provide enough bulk or thickness for the material. It forms >135° cavo-surface line angle.



Advantages of knife edge finishing line

1. It is the most conservative type of finishing line.
2. It is easy to prepare.
3. It is a burnishable type of finishing line. i.e. it provides a burnishable margin.

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

Disadvantages of knife edge finishing line

1. Difficult to be identified by the laboratory technician.
2. It provides a thin margin that is difficult to accurately wax and cast.
3. The margin of the restoration is susceptible to distortion since this type of margin design does not provide enough thickness.

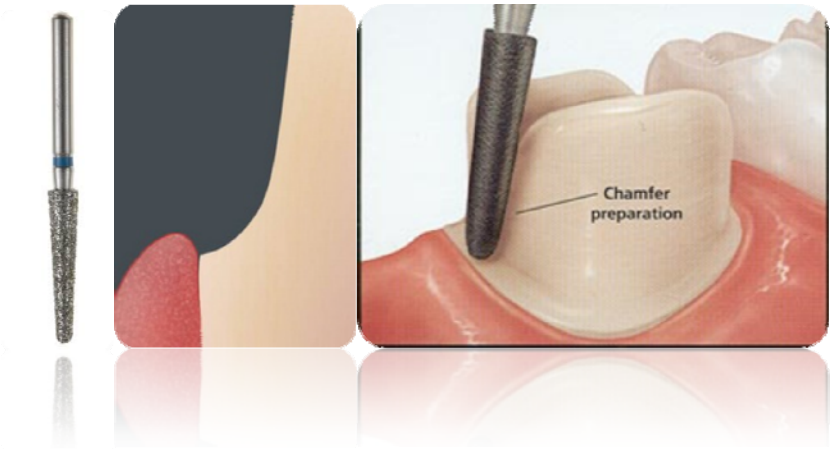
Indications of knife edge finishing line

It is mainly used for:

1. Full Metal Crown (All the surfaces).
2. The lingual and proximal surfaces of full veneer crown, three-quarter crown and post crown.

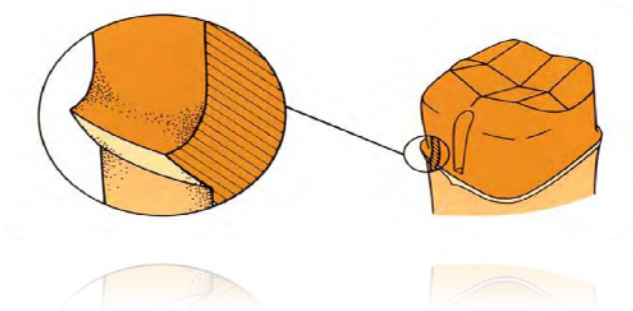
2. Chamfer finishing line

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



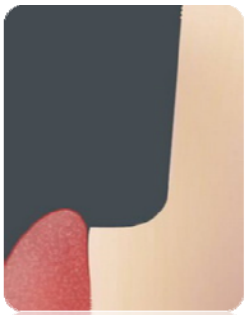
This type of finishing line is indicated for areas to be covered by metal only as the knife edge finishing line, so it is mainly used for:

1. Full Metal Crown (All the surfaces).
2. The lingual and proximal surfaces of full veneer crown, three- quarter crown and post crown.



3. Heavy chamfer finishing line

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



4. Shoulder finishing line (Butt shoulder)

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

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

5. Radial shoulder finishing line

Radial shoulder is a modification of the shoulder finishing line. It is a shoulder finishing line with rounded internal line angles. This will reduce the shoulder slightly and minimize stress concentration on the tooth structure from one hand and on the restoration itself from the other hand. This type of finishing line was introduced with the ongoing development in all ceramic materials in an attempt to increase the fracture strength of all ceramic crowns by decreasing stress concentration.

6. Shoulder with bevel finishing line

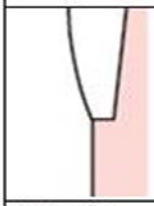
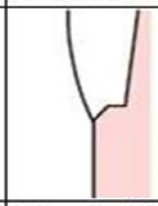
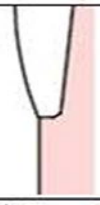
Shoulder with bevel is another modification of the shoulder finishing line by adding a bevel to the shoulder. The bevel is at 45° angle.

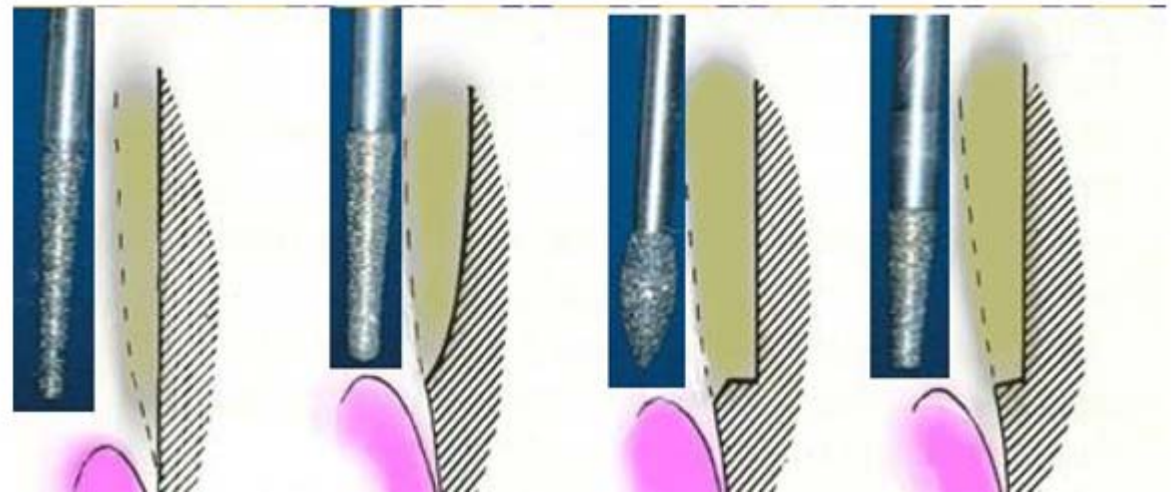
Objectives of adding a bevel to the shoulder finishing line

1. The bevel provides a burnishable margin for the metal that may extend sub-gingivally (The thinner it is, the more adaptable to the tooth surface).
2. To provide enough space for shape and contour.
3. To reduce marginal discrepancies.
4. To remove unsupported enamel.

Indications of shoulder with bevel finishing line

1. It is indicated when we use a combination of metal with facing material (acrylic or porcelain) as in full veneer crown, where it is used for the labial surface.
2. Shoulder with bevel is recommended for extremely short walls.

Shoulder	Bevelled Shoulder	Heavy Chamfer	Chamfer
			
Metal Ceramic Crown, All Ceramic/ Porcelain Jacket Crown	Buccal of Metal Ceramic Crown	High Strength Porcelain Crowns, Buccal of Metal Ceramic Crowns	Full Metal Crowns, Palatal/Lingual of MCC's, Resin Bonded Crowns



FULL METAL CROWN

Full metal crown is a full crown covering all axial surfaces of the tooth as well as the occlusal surface and made of metal. It is one of the most commonly indicated crown restorations for posterior teeth. Because it made of metal, it should be used when the patient doesn't mind the appearance of metal or when esthetic is not a factor. It can be used as a single unit or as a retainer for a F.P.D, especially when we have a small abutment tooth with long span edentulous area to overcome the occlusal forces and prevent bridge displacement.

Since it is a full crown, it has better retention and resistance than other crown restorations such as 3/4 Crown and 7/8crown because all the axial walls are included as well as the occlusal surface.

Types of metal alloys used for full metal crown

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

Indications of full metal crown

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

Contra-indications of full metal crown

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

Advantages of full metal crown

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

Disadvantages of full metal crown

1. Extensive tooth structure removal as compared with partial crown such as 3/4crown.
2. Difficulty to test the vitality of the tooth especially by electrical pulp tester.
3. May interfere with taste.
4. Display of metal.

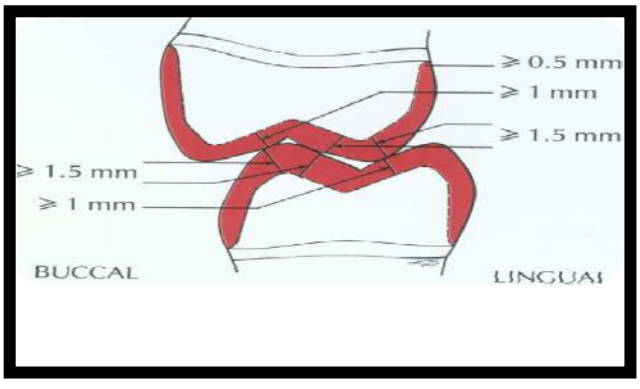
- Preparation steps:

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

Depth Orientation grooves (D.O.G) are grooves prepared in the surface of the tooth to act as a guide or reference to determine the amount of tooth structure removed by preparation. If the preparation is done without these grooves, under and over preparation is possible, and more time will be spent by repeated checking of the preparation.

The type of finishing line recommended for full metal crown is chamfer finishing line; therefore, a round end tapered fissure bur is used in the preparation. Knife edge finishing line may also be used.

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



Occlusal surface preparation

The aim of the occlusal surface preparation is to create 1.5mm occlusal clearance over the functional cusps and 1 mm over the non-functional cusps.

Planar occlusal reduction (anatomical reduction) following the geometric inclined planes of the occlusal surface should be done for the following objectives:

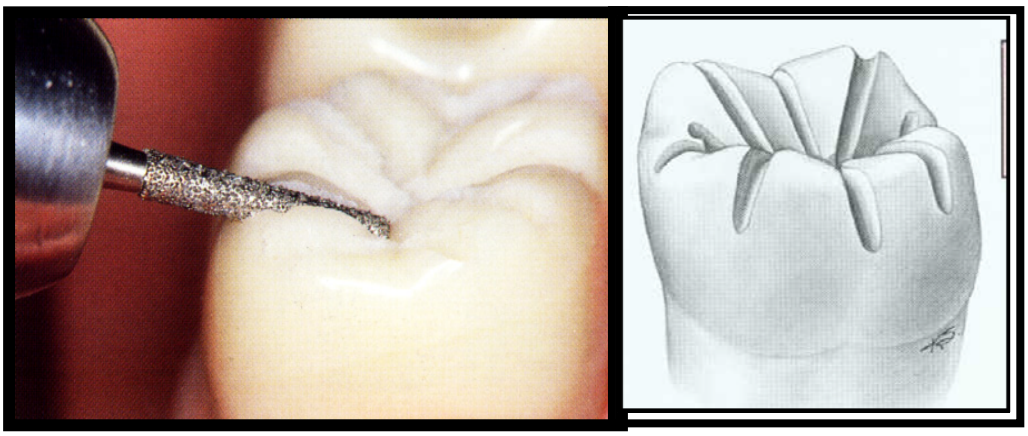
-To provide a restoration with uniform thickness.

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

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

The sequence of the occlusal surface preparation is as follows:

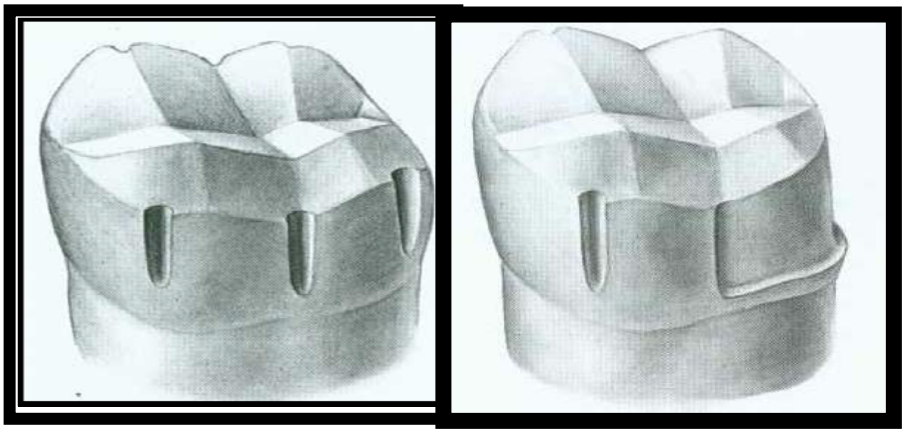
1. Depth orientation grooves (D.O.G) are prepared in the occlusal surface by a fissure bur to follow the inclines of the cusps. A D.O.G is prepared in each cusp extending from the cusp tip to the central groove, which represents the deepest part of the occlusal surface. The depth of each groove corresponds to the diameter of the fissure bur used. i.e. a fissure bur with 1.5 mm diameter is used to prepare D.O.G on the functional cusps, while a fissure bur with 1 mm diameter is used to prepare D.O.G on the non-functional cusps.
2. Any tooth structure between D.O.G should be removed following the normal contour of the cusps.
3. A wide bevel is placed on the functional cusps.
4. The occlusal clearance is then checked in centric & eccentric occlucal relations.



Buccal surface preparation

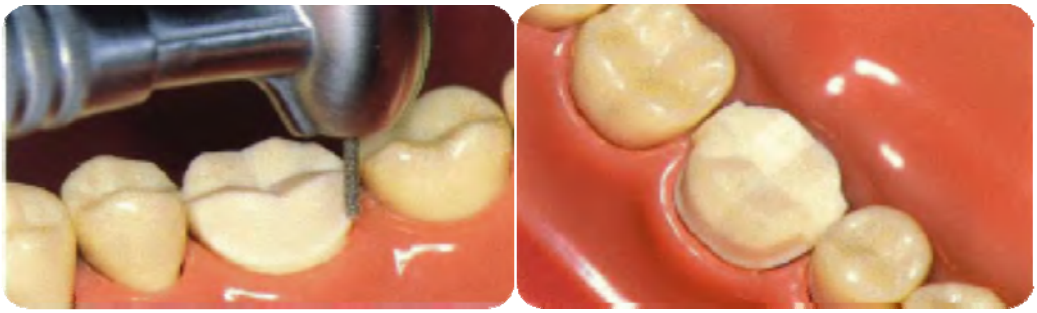
1. Three D.O.G with 1 mm depth are prepared in the buccal surface of the tooth, one placed in the center of the wall and one in each medial and distal transitional line angles. These grooves are prepared parallel to the long axis of the tooth or to the proposed path of insertion of the restoration.

2. Move the bur mesially and distally following the inclination of this surface to remove any islands of tooth structure between D.O.G. The gingival extent of the preparation will determine the position of the margin (whether to be placed supra-gingivally, which is preferable, or there is a need to extend the finishing line sub-gingivally. A round-end tapered fissure bur is used during axial reduction to obtain chamfer finishing line.



Lingual surface preparation

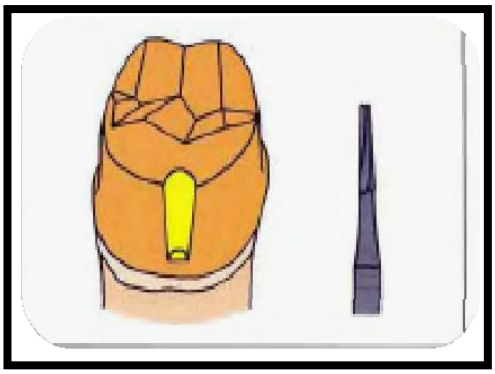
The preparation of the lingual surface is the same as that of the buccal surface.

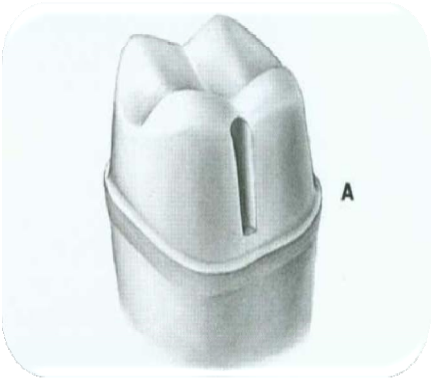


Proximal surfaces preparation

Using a very thin long pointed tapered diamond bur (long needle), the contact is removed carefully with the bur rested on the prepared tooth (to prevent any damage to the adjacent tooth), moving the bur up & down, the contact will be opened bucco-lingually. Once the contact is opened, a round-end tapered fissure bur is used to plane the wall while forming a chamfer finishing line. Safe-sided disc can also be used during the proximal reduction in order to prevent any damage to the adjacent tooth. Placing a matrix band on the adjacent tooth can also help.

After completing the preparation of the occlusal and axial surfaces, smoothening of all surfaces is done to remove sharp line and point angles because they act as stress concentration areas.



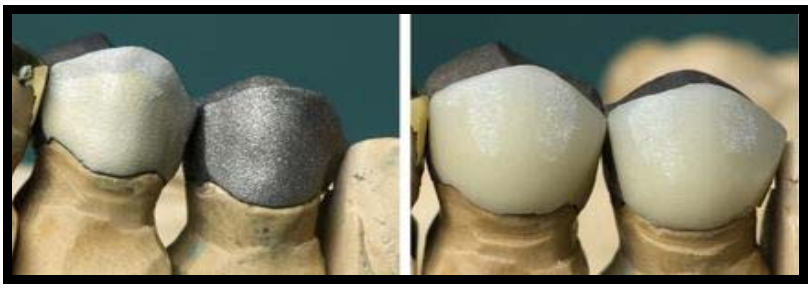


A seating groove is finally placed in the buccal surface of the lower molar and the palatal surface of the upper molar. The advantages of placing a seating groove are:

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

Porcelain Fused to Metal Crown

Porcelain fused to metal (PFM) crown is the most widely used fixed restoration. It is a full metal crown having a facial surface (or all surfaces) covered by ceramic material. It consists of a ceramic layer bonded to a thin cast metal coping. It combines the strength and accurate fit of cast metal coping with the cosmetic of ceramic.



So, this type combines the advantages of the strength of full metal crown and esthetic of all ceramic crown.

Disadvantages of PFM crown

1. Removal of substantial amount of tooth structure.

2. Subject to fracture because of the brittle nature of porcelain.

3. Shade selection can be difficult.

4. Inferior esthetic compared to porcelain jacket crown.

5. Discoloration of the gingival margin may occur with time.

6. More expensive.

Indications of PFM crown

1. Teeth need to be completely covered for esthetic demand.

2. As a retainer for fixed partial denture.

3. Similar to those of full metal crown.

Contra-indications of PFM crown

1. Teeth with large pulp (because of the possibility of pulp exposure during preparation).

2. Intact buccal wall where a more conservative retainer can be used.

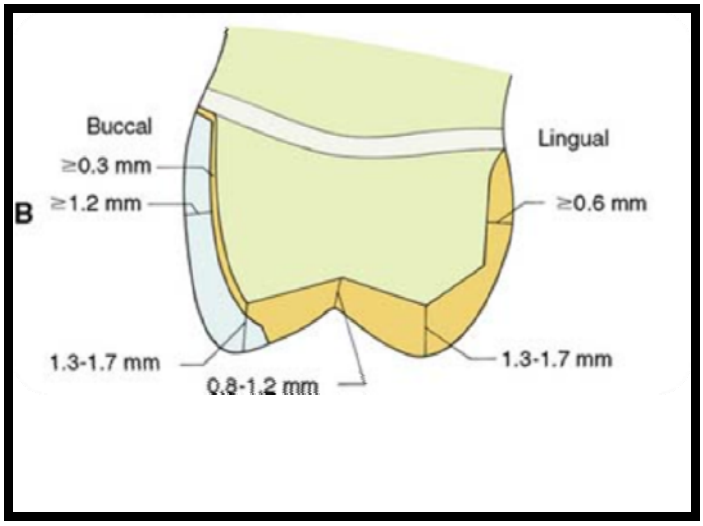
3. Teeth with short crowns.

4. Patient with bad oral hygiene.

Preparation Requirements:

- Deep facial reduction to provide enough space for the metal coping and porcelain and shallower reduction on the other surfaces covered with metal only.
- Shoulder, radial shoulder, or heavy chamfer can be used as a gingivo-facial finishing line, whereas chamfer or knife edge finishing line is used for the remaining surfaces covered with metal only.

Since this restoration is a combination of metal & porcelain, tooth preparation likewise is a combination.



Tooth preparation of PFM crown (for anterior teeth)

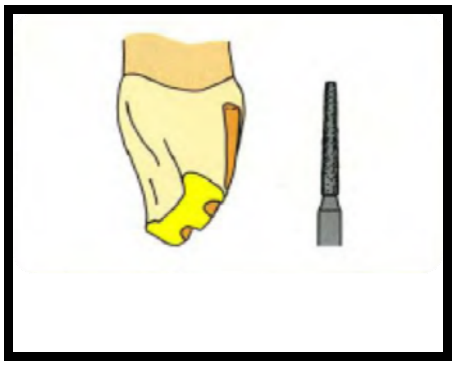
Fabrication of silicone index

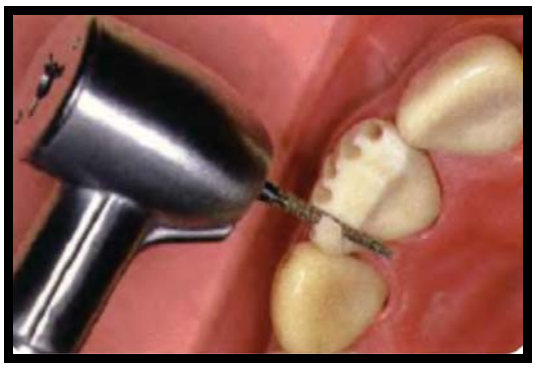
The silicone index acts as a guide to check the amount of tooth structure removal.

Incisal reduction

2 mm should be removed from the incisal edge to allow for adequate translucency of the restoration.

Flat-end tapered diamond bur is used, placed parallel to the incisal inclination (with a slight palatal inclination in the upper incisors and labial inclination in the lower incisors).





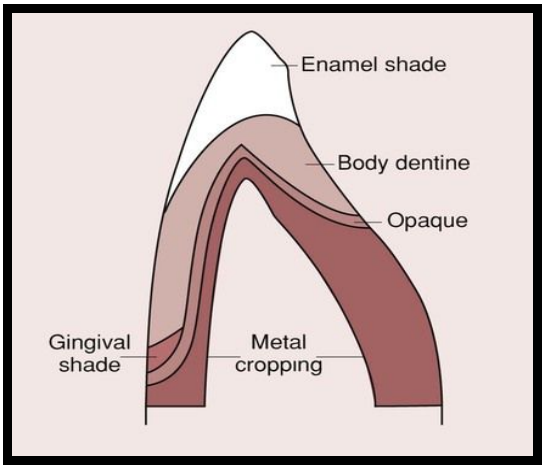
Labial reduction

PFM crown preparation requires deep facial reduction to give enough space for metal and porcelain, and thus avoiding over contouring and poor esthetic which would inevitably occur when no enough tooth structure is removed. The amount of labial reduction is 1.5-2 mm.

Advantages of adequate reduction (deep facial reduction)

1. The restoration will properly contour (effect on esthetic & gingival health).
2. The shade & translucency of the restoration will match that of the adjacent natural tooth.

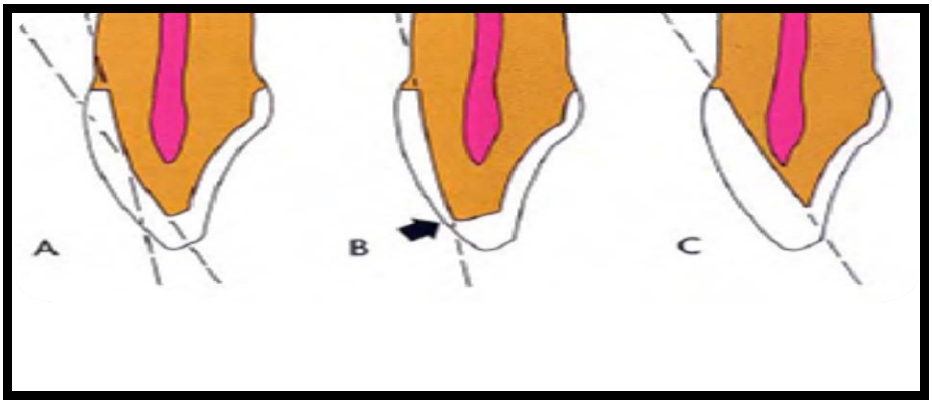
- 0.5 mm for the metal coping.
- 1 mm for porcelain (0.2 mm opaque layer, 0.5 mm body “dentin” layer, and 0.3 mm incisal “enamel” layer).



Because of the anatomy of the tooth labially, it should be reduced in two planes corresponding to the two geometric planes of the labial surface: a gingival plane and an incisal plane.

Advantages of two plane reduction

1. To follow the anatomy of the surface.
2. To avoid hitting the pulp.
3. To give enough space for the metal and porcelain layers, so that avoiding poor esthetic or over contour.



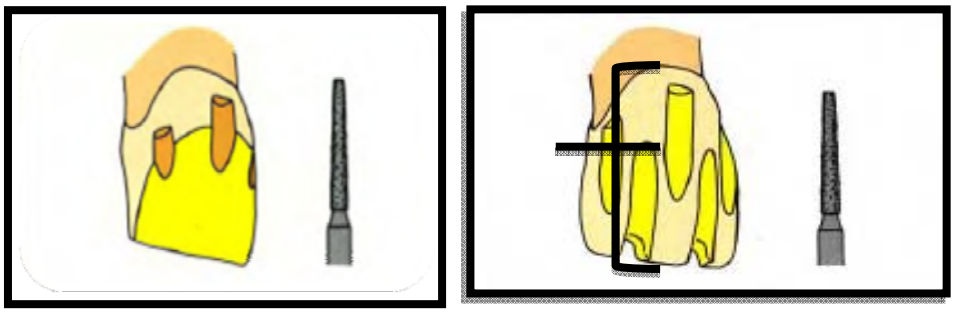
a.Gingival plane

Three D.O.G (1.5 mm in depth) are placed in the gingival third of the labial surface parallel to the long axis of the tooth.

b.Incisal plane

Three D.O.G (1.5 mm in depth) are prepared parallel to the inclination of this area.

Flat-end tapered fissure bur is used to create a shoulder finishing line extended 1mm lingual to the contact.



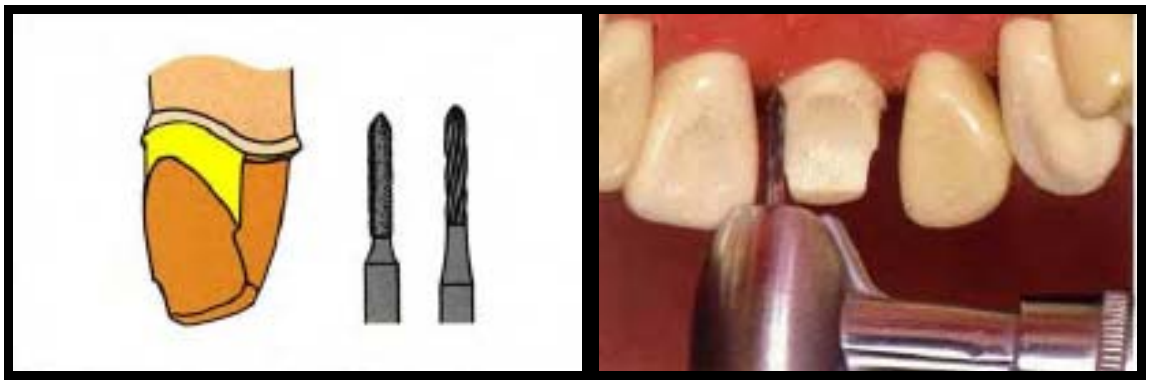
Palatal (lingual) reduction

a. Cingulum area reduction

D.O.G. of 1mm in depth is placed in the center using a round bur 1 mm in diameter. A small wheel diamond bur is then used to reduce this area following the concavity of this part of tooth surface.

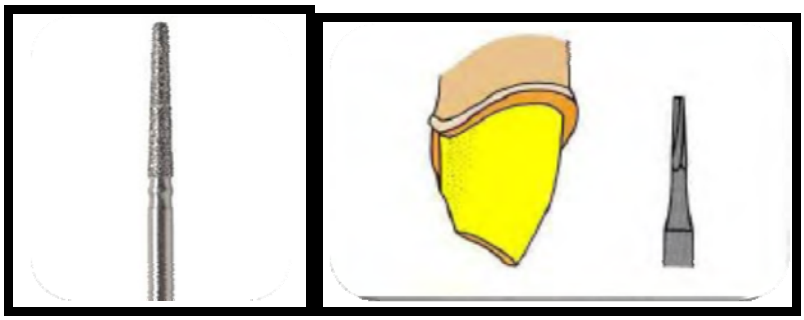
b. Lingual axial reduction

D.O.G. of 1mm in depth is placed parallel to the long axis of the tooth. A round- end tapered fissure bur is then used to reduce this area parallel to the long axis of the tooth to create chamfer finishing line.

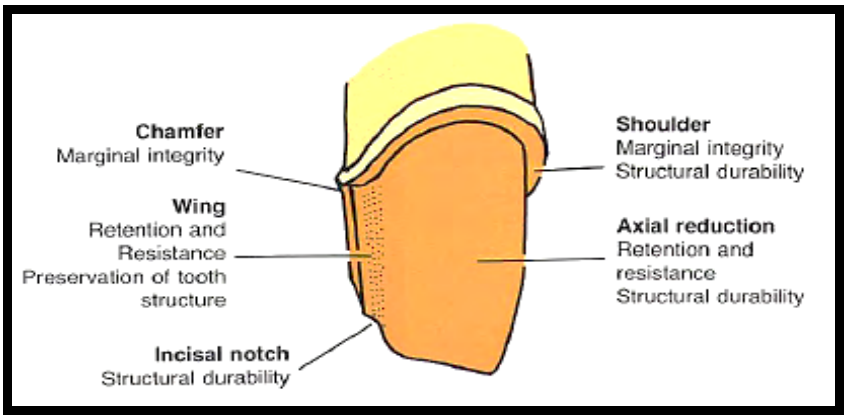


Proximal reduction

A pointed tapered fissure bur (long needle) is used to break the contact with the adjacent tooth, moving the bur up and down from the palatal to the labial. A round-end tapered fissure bur is then used to create a chamfer finishing line continuous with the chamfer finishing line of the palatal surface and joining the shoulder finishing line of the labial surface at a line angle called "wing".



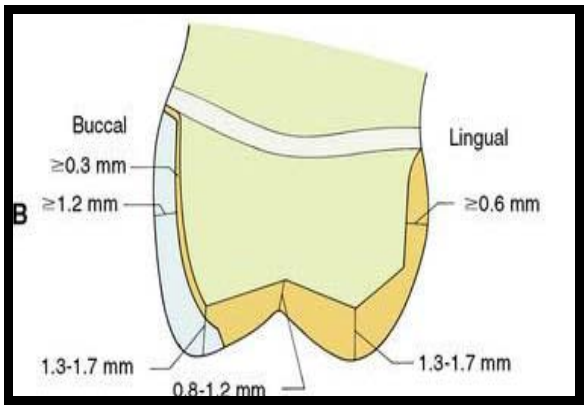
Checking of the amount of tooth reduction using the silicone index.



Tooth preparation of PFM crown for posterior teeth

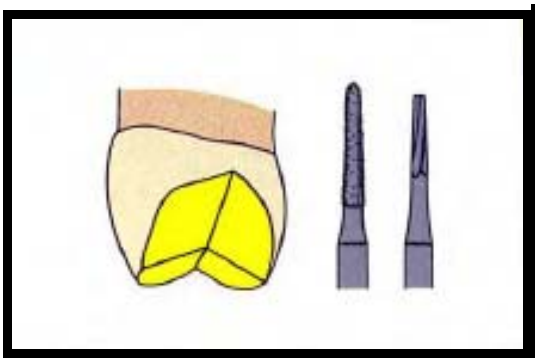
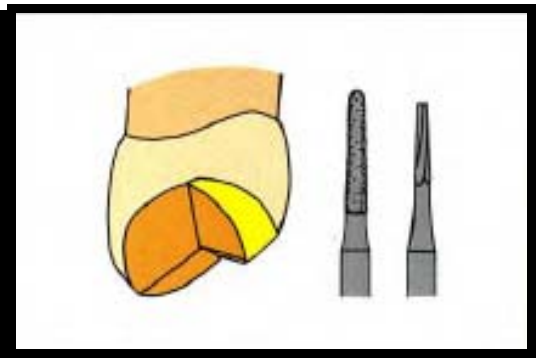
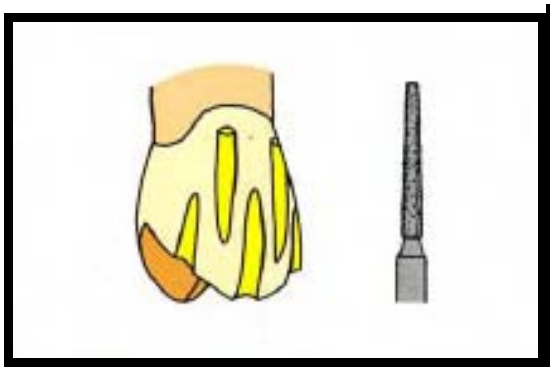
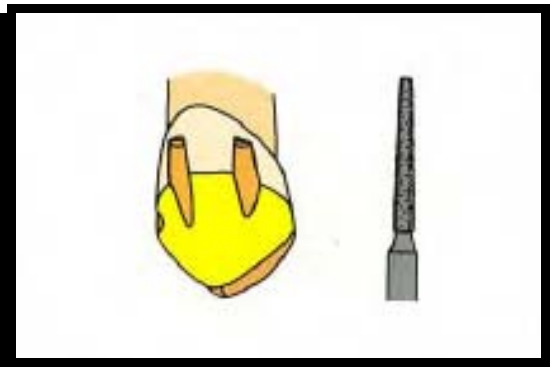
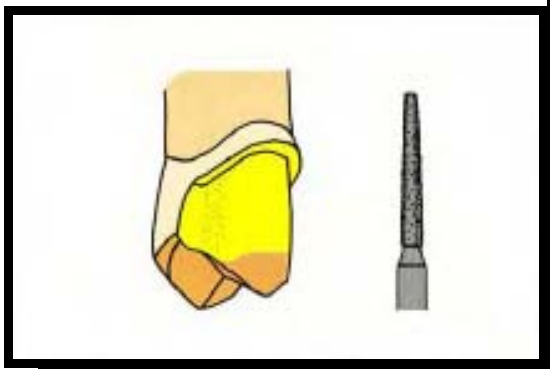
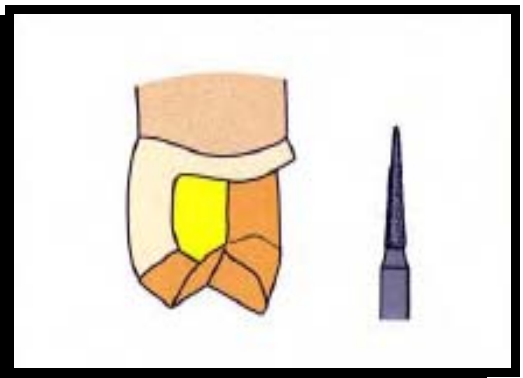
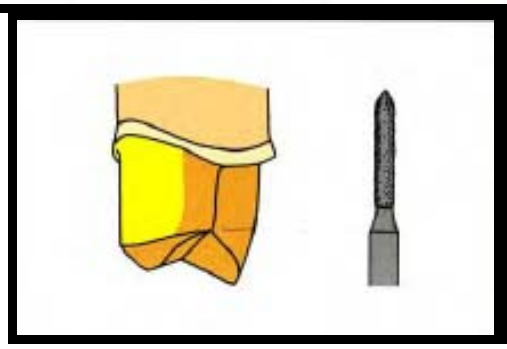
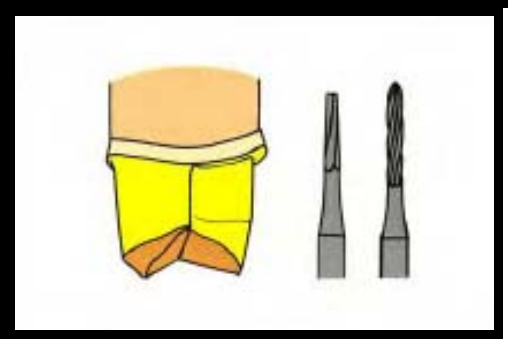
The same principles of full metal crown preparation are used with exception of providing a deep reduction in the area that is to be covered with both metal and porcelain.

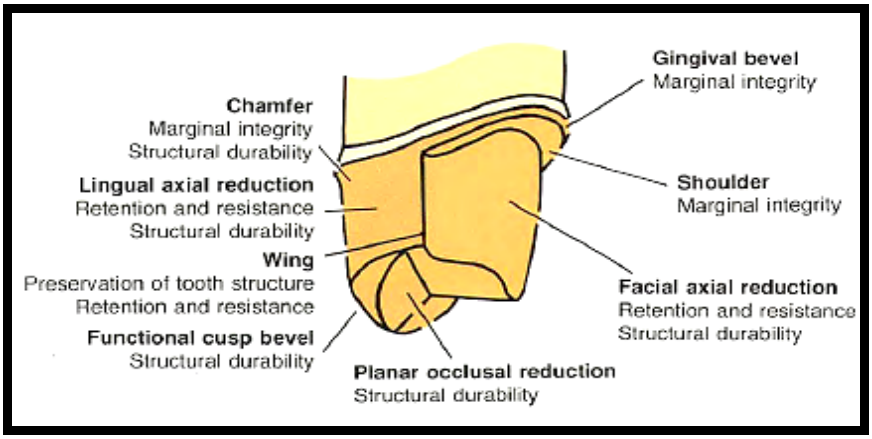
- 1.5 mm for the non-functional cusps.
- 2 mm for the functional cusps.
- 1.5-2 mm for the facial reduction.



The same steps of PFM crown preparation for the anterior teeth are used for the posterior teeth starting with fabrication of a silicone index.





Full metal crown with acrylic facing

- It is a full metal crown whose labial or buccal surface is covered with tooth-colored acrylic resin. It has been widely used previously before the use of porcelain as a facing material, but still used nowadays due to its lower cost as compared to PFM.
- It combines the strength and accuracy of full metal crown with the esthetics of tooth-colored acrylic resin.
- It is less expensive than PFM crown.
- The preparation involves deep facial reduction to provide enough space for both metal and facing material.
- The finishing line is shoulder with bevel facially (labially or buccally) and chamfer or knife edge for the other surfaces. When esthetic is critical, sub-gingival positioning of the finish line is recommended.

The main disadvantages of this type of crown are related to the acrylic facing material, including discoloration with time, wearing, and poor compatibility of the acrylic resin with the gingival tissue.

Lec.7 Crown &Bridge

Partial Veneer Crown(Three quarter crown)

It is a cast metal crown restoration that cover only a part of the clinical crown, most commonly used type of partial veneer crown is ¾ (three quarter) crown.

Three quarter (¾)crown:

It is a cast metal crown restoration that cover three quarter of crown (occlusal or incisal, palatal or lingual and proximal) leaving the labial or buccal surface unprepared, it tend to be less retentive and resistance than full veneer crown .It can be used for anterior or posterior teeth. It can be used as single restoration or as a retainer for short span bridge.

Uses:

1. As a retainer for short span bridge.
2. As a single restoration.
3. As a splint in anterior teeth.

Indications

---- For posterior teeth;

1. Lost moderate amount of tooth structure with intact and well supported buccal surface.
2. Retainer for fixed partial denture.

----- For anterior teeth;

1. Suitable for teeth with a sufficient bulk and intact labial surface.
2. Retainer for F.P.D. or splinting of anterior teeth.

Contraindication:

1. Short clinical crown.
2. High carries index.
3. Extensive destruction
4. Poor alignment.
5. Thin teeth
6. Long span bridge.
7. Non-vital teeth.

Advantages of 3/4 crown:

1- Conservative of tooth structure.

2- Easy access of margins.

3- Less gingival irritation than complete crown.

4- Easy escape of cement and good seating.

5- Electrical pulp test is possible.

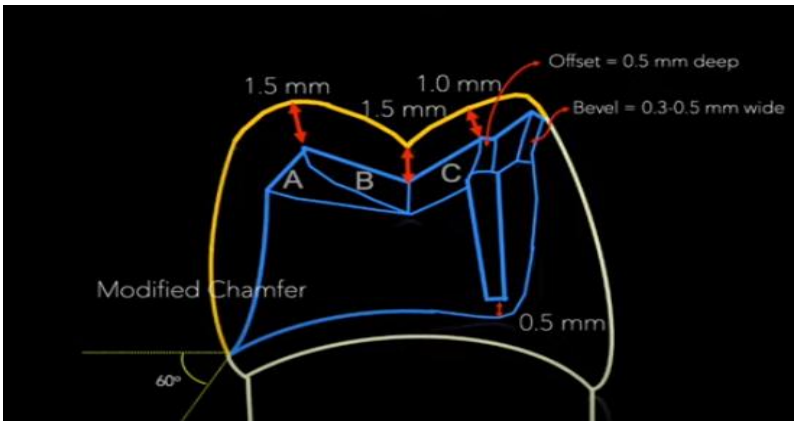
6- Complete seating of the crown can be easily seen by direct observation.

Disadvantages:

1-Difficult in preparation compared to other types of crown restorations.
2- Possibility of recurrent caries more along the cavo-surface line angle.
3- Possibility of showing metal especially in the lower anterior &posterior teeth.
4-Less retention and resistance than complete cast crown.
5-Limited adjustment can be done in the path of withdrawal.

Tooth Preparation :

Recommended dimensions



- *1.5 mm on functional cusp (lingual)*
- *1.0 mm on non-functional cusp (facial)*
- *Less than 0.5 mm on facial cusp tip if sufficient horizontal overlap*
- 1.5 mm clearance
- Follow contours of opposing tooth
- Maintain contours of tooth being prepared
- Extend bevel into lingual embrasure

Steps in preparation on maxillary posterior teeth ;

1.Occlusal surface preparation

1. D.O.G. placed on the anatomic ridge and grooves of occlusal surface using round end taper fissure bur, the grooves should extend through occluso-buccal line angle but only with 0.5mm deep to prevent metal display.
2.Occlusal reduction were then complete by removing tooth structure between grooves reproducing the geometric inclined plan pattern of cusps, the depth of reduction should be decrease at the OB line angle.
3.Awide bevel is placed on the functional cusps using the same bur .
4.Occlusal clearance were then check in centric & eccentric mand.relations.

2.Lingual surface preparation;

It is done similar to other types of crown:

- D.O.G. are placed using the same bur, they should be placed parallel to the long axis of the tooth.

-Reaming tooth structure between grooves were then removed following the contour of the tooth holding the bur parallel to the long axis at the tooth

-A round –end tapered fissure bur is used to obtain Chamfer finish line that 0.5 mm supragingival

3.Interproximal Reduction

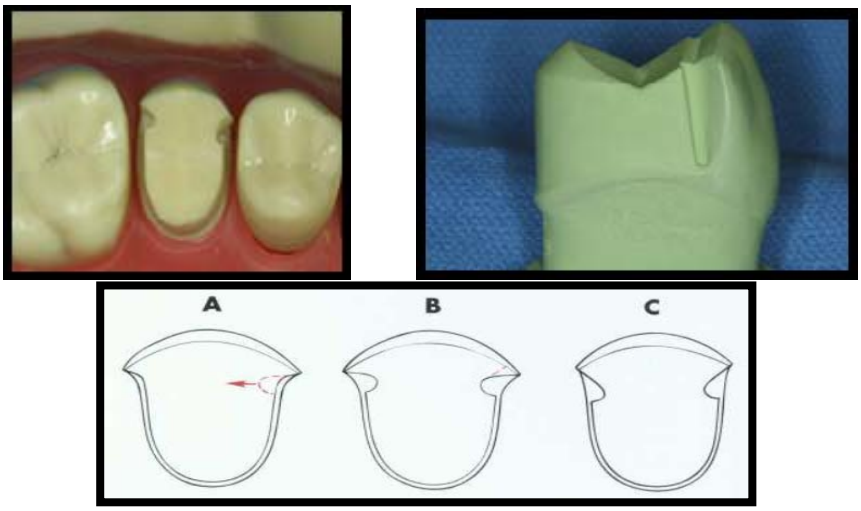
- Proximal access is gained by short needle diamond, up and down movement, this continue until contact with adjacent tooth is broken & access for larger bur is produced .
- extend facially and gingivally to break contact with adjacent tooth
- Proximal grooves (mesial and distal) are placed parallel to the path of withdrawal and parallel to each other using carbide fissure bur. Normally, unsupported tooth structure will remain on the buccal side, and this side is flared to remove it.
- Avoid damage to adjacent tooth and excessive axial reduction

Proximal grooves:

As a part of proximal reduction& in order to improve retention feature of the preparation &as a substitution for the uncover wall, proximal grooves should be placed on each proximal wall. It should be parallel to the long axis of the tooth or path of insertion & parallel to each other. Carbide fissure bur is used to place these grooves.

-Requirements:

1.It should cut to full diameter of carbide bur No.171(0.5mm) to create defiant lingual wall.
2.It should extend to the full length of proximal wall (ending about 0.5mm to the chamfer).
3.It should be placed as far as facially as possible without underming facial surface (bet. Middle &labial third).
4.It should be parallel to the long axis of the tooth.



Advantages of Proximal grooves;

1.Increase retention.
2. Prevent rotation (resistance).
3.Reinforce the margin of restoration at this area.
4.They act as a guide during placement.

Occlusal offset;

1mm.wide groove made on the lingual incline of the facial cusp, it is V shape inverted lie at uniform distance from occlusal finish line.

Advantages;

1. Improve the strength of the casting.
2. Reinforce the margin of the restoration at this area.

Finishing line :

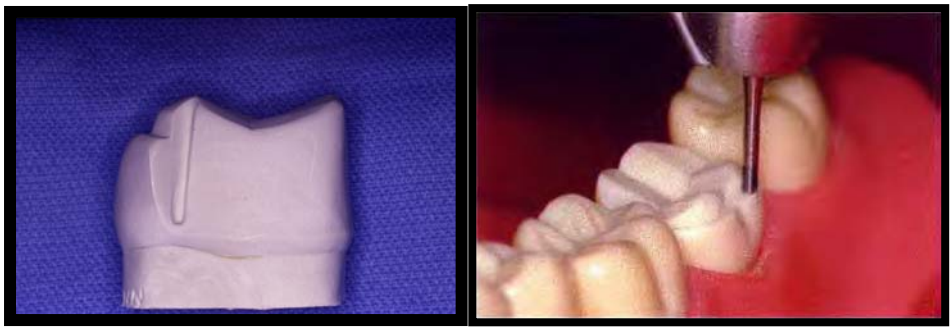
- *Chamfer is used as gingival finish line on lingual &proximal surfaces*
- *45 degree bevel F.L. were used on proximofacial & occlusofacial margins*

Mandibular posterior 3/4 Crown

Differences between upper &lower posterior ¾ crown preparation:

1. Big difference is the position of FL on facial surface, for max.pos. teeth it terminate near the bucco-occlusal line angle while in mand.pos. teeth the occlusal FL is 1mm. gingival to the lower occlusal contact with the upper teeth, this is because the buccal cusps in lower are the functional cusps.

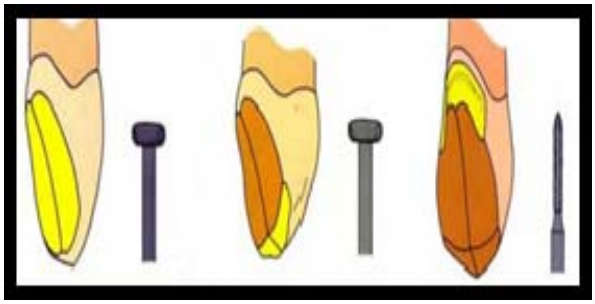
2.In upper, there should be occlusal offset however , for the lower there is no offset, in state, there is bucco-occlusal shoulder (occlusal shoulder on the buccal aspect of the buccal surface), it serve the same purpose as the offset.



3/4 Crown Maxillary Anterior

1-lingual reduction: **t**his is done by two steps similar to other types of crowns.

a. Cingulum area reduction;
b. Lingual axial reduction;



2.Incisal termination:

For max. ant. teeth lingo-incisal bevel is place using diamond bur at 45˚to the path of insertion, this termination should not be extended labially to

prevent showing of metal, however, for lower anterior a reverse bevel is placed on the labial surface . This means that, the metal will extend to cover the incisal edge in order to;

1. Protect the area of unsupported enamel from fracture.

2. To prevent the dislodgment of the crown in lingual direction.

3.Proximal reduction:

The area is prepared similar to the full veneer crown except that the preparation should have a path of insertion parallel to the incisal 2/3 of the labial surface(not to the long axis of the tooth).

Two proximal grooves should be placed ,at the junction between the labial and middle third of the proximal surface, parallel to the incisal 2/3 of the labial surface (path of insertion) using a carbide fissure bur **, this is because;**

1. *We can place the longest groove in this direction (better retention).*
2. *to avoid over cutting to the labial surface (if we do it parallel to the long axis) that effect on esthetic.*

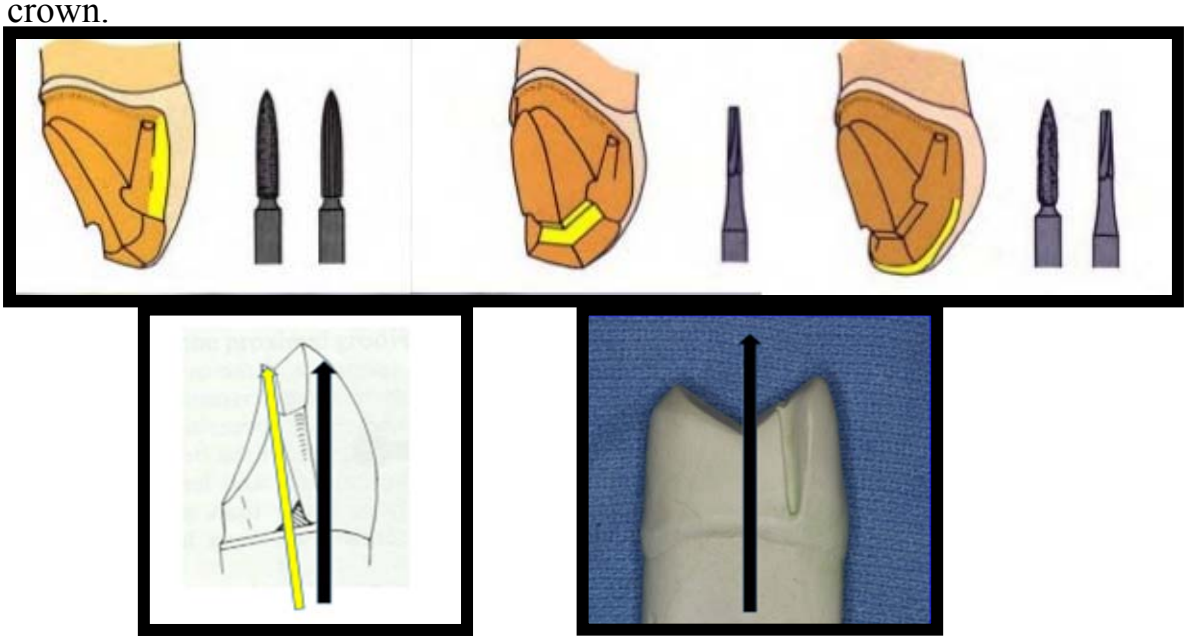
The mesial and distal grooves should be connected with V shape groove incisal offset. **The advantage of the incisal offset are;**

1. *improvement of the strength of casting at this area*

2*.reinforcement of margin by connecting the two proximal grooves together*

Differences between anterior and posterior teeth preparation

In the anterior teeth the retentive proximal groove should be parallel to the incisal 2/3 of the labial surface while in the posterior teeth it is parallel to long axis to get the longest groove for better retention of crown.



Lecture. 8&9 **Crown & Bridge**

Post crown

It is a fixed artificial cast restoration which replaces the coronal portion of the natural tooth completely; retains itself by a mean of post (dowel) that extended and cemented into the root canal space of endodontically treated tooth.

The dowel post serves two functions;

1) Intra-canal retentive mean for the coronal restoration.
2) It increases the horizontal fracture resistance of the remaining tooth structure.

Indications:

1. It is commonly indicated on endodontically treated teeth that have;
a) Remaining tooth structure unsuitable for any other mean of restoration.
b) Core reconstruction is needed.
c) Intra-canal retention is the only mean for retention possible for the coronal restoration.
2. Re-alignment of malposed tooth.
3. As bridge retainer.
4. Tooth with short clinical crown.

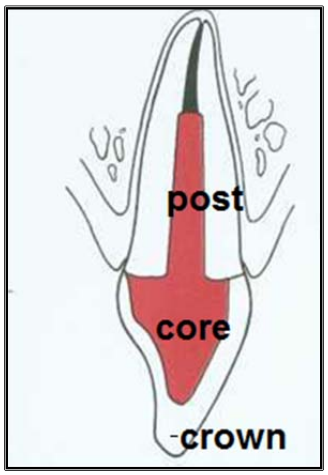
Contraindications(Custom Cast Dowel Core)

1. Unsuccessful endedontic treatment.
2. Significant coronal tooth structure remain
3. Inadequate root length
4. Caries on root or in canal

***Factors to be considered in assesment of a tooth for post crown*:**

1. Quality of the root filling, it should be filled with a well condense gutta percha filling material especially at the apical third of root space.
2. The root should have proper alignment, because any abnormality in the alignment of the root in relation to the adjacent teeth make the construction of post crown difficult. .
3. The root should be without internal or external resorption
4. Periodontal condition and mobility of the tooth.
5. Occlusal relationship should be evaluated.

Basic components of post crown :



a)Crown:

It is the final restoration that placed over the core, it could be a full metal, full veneer or jacket crown.

b) Core:

It is the coronal extension or addition to the dowel post necessary to provide the desire retention for the final crown restoration.

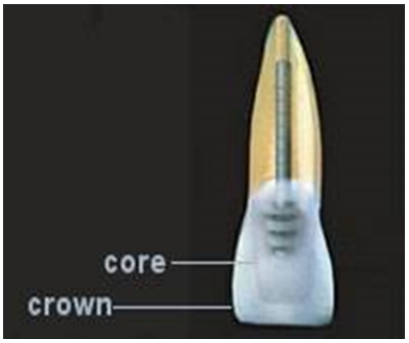
c) Post (dowel):

It is the part of the restoration that extended into the root canal and give support and retention for the coronal restoration.

There are two types of post- crowns

1-Two unit post crown (post and core +crown)

2-One unit post crown (post + core + crown one piece).



One unit post-crown

Two unit post crown

One unit post-crown

The final crown restoration is direct extension of the dowel post. It indicated in some cases , for example tooth with very short clinical crown (as with lower incisor) in such a case there is insufficient space within the crown of the tooth to make both retentive core and separated crown so one piece post crown often the solution.

Two unit post-crown

Advantages and indications

1) Crown restoration can replaced at some future time, if necessary, without disturbing the dowel core part of restoration. That is why two units post crown indicated in young patient (under 18 year age).

2) When the endodontically treated tooth is to be used as abutment for fixed bridge (bridge retainer), it is not necessary to make the post crown preparation parallel to the 2ed abutment.

3) Marginal adaptation and fit of the crown restoration are independent of any dowel that must be used

Post classification;

1) Prefabricate or ready-made dowel post

One advantage of using prefabricated posts is the simplicity of the technique it doesn't need a negative reproduction of the prepared canal. Stainless steel, Carbone fiber or fibro glass material might be used in it construction, it come in different size, design (parallel side, taper, parallel with taper end…etc). A post is selected to match the dimensions of the canal, and only minimum adjustment is needed for seating it to the full depth of the post-space.

2) Customized Cast Post :

It is fabricate from a negative reproduction of the prepared canal, it constructed from metal alloy. The main advantage of this type that is it conform closely to the configuration of the prepared canal. It indicated on avoid canal and contraindicated in narrow and severely curved canal.

Prefabricate dowel post

Customized Cast Post

Tooth Preparation

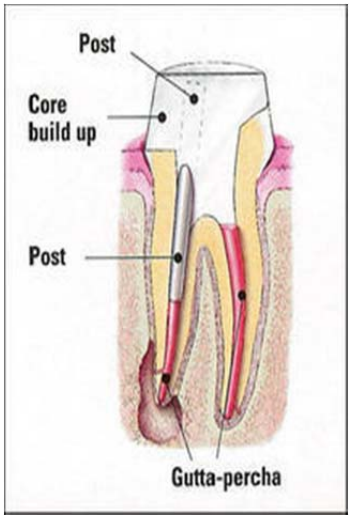
1)Preparation of the coronal portion:

1. Remove any existing restoration, caries, and any thin or unsupported wall of tooth structure. Most of the time, this will end with leaving about 2—5 mm. of sound tooth structure super gingivally.
2. The coronal portion (remaining) were then prepared according to the type of the final crown restoration. For example, if the final restoration was Jacket crown; shoulder F.L. should be created all around.

2) Preparation of the Canal:

The instrument of choice for removing gutta percha and enlarging the canal are Pesso reamers, they come in different size ranging from 07—1.7mm , **advantage of using this bur**, it has a blunt non cutting end so it will follow the path of least resistance without perforating the root.

The steps will be as following:



1) Taking a radiograph to show the length, width, shape of the canal in addition to the type and the quality of the filling material especially in the apical third of the root.

2) Removal of gutta percha filling material from the pulp champers using hot instrument (endodontic condenser).

3) Measure a Pesso reamer against radiographic film of the tooth being restored to determine the length to which the bur will be inserted into the canal (2/3 of root length).

The length of the dowel should be equal to 2/3 of root length or equal to the crown length, whichever is greater keeping in your mind you should have at least 3-5 mm filling at the apex to get the maximum retention and support for the post and to prevent the dislodgment of the apical gutta-percha filling material on the other side this if happen will lead to the leakage followed by failure of the case

4) Remove gutta percha with Pesso reamer up to 2/3 of root length, the canal sides should be parallel to each other with slight flaring toward the outside**.**

In short teeth accessory retention means may be used as pins, where the pin hole should be placed parallel to the post canal preparation. Diameter of the prepared canal should be no more than one third the root diameter at C.E.J.and should be at least 2mm less than root diameter at mid root area.

5) A **key way** is done about 1 mm width and 4 mm extended into the orifice of the canal using a flat ended fissure bur; it should be placed in the area of the greatest bulk**.**

Advantages of Key Way:

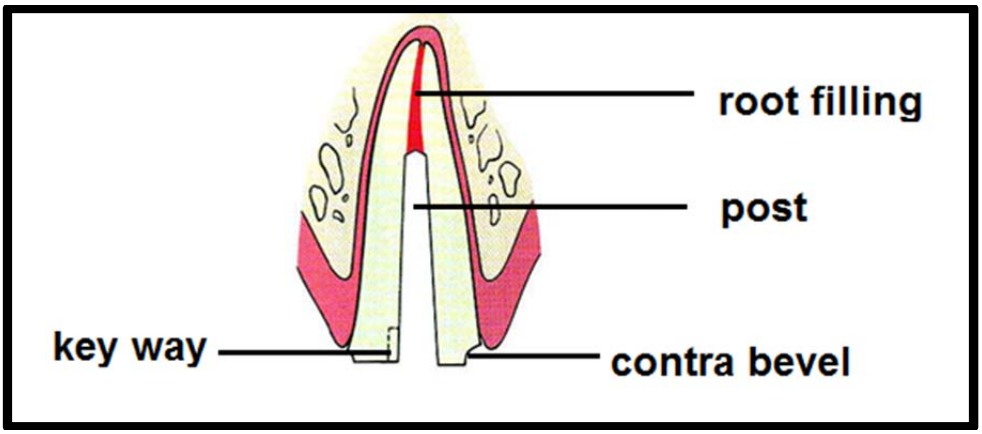
1. It acts as a guide during placement of the dowel post restoration.
2. It acts as ant-rotational device by preventing the post from rotation.
3. Improve the retention.

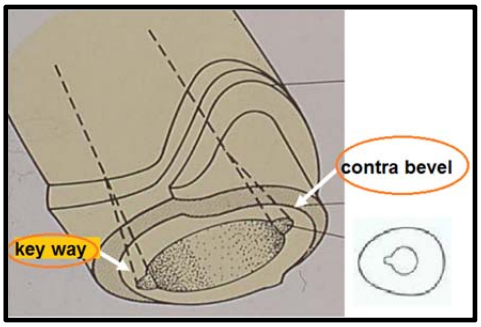
For multirooted teeth, the post dowel should place in the largest canal, usually it's the palatal canal for upper molar, distal canal for lower molar and the buccal canal for the maxillary premolar. The other canal used for the keyway.

6) If there is supra gingival tooth structure a flame bur is used to place **contra bevel**; It is the bevel placed around the occlusal external surface of the periphery of the preparation, this will provide a good collar around the occlusal surface periphery of the preparation which will help in holding the tooth structure together and preventing the fracture of the remaining tooth structure.

Antirotation devices

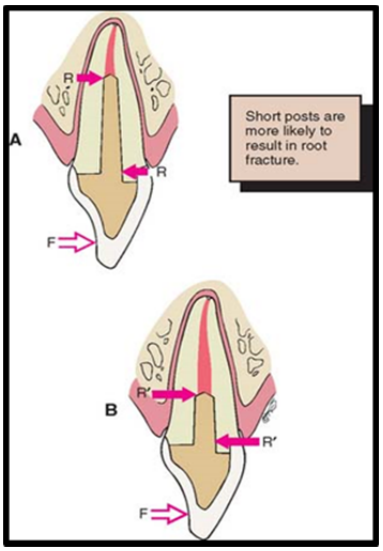
A. Keyway.
B. Triangular shape for the incisors and elliptical shape for upper canine.
C. Pins.





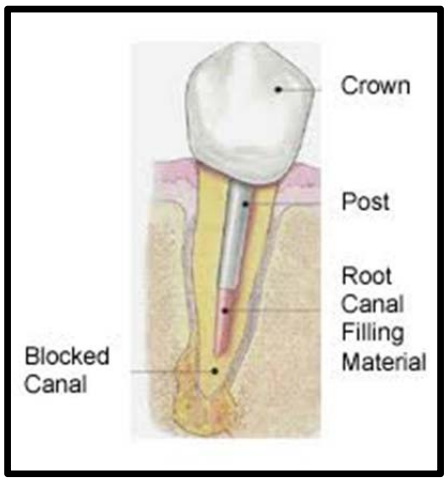
Factors affecting on retention of Post Crown;

1. Length of the dowel post. (2/3 length of root, Equal to length of clinical crown, 4-5 mm from apex, 8 mm deep from CEJ)
2. Diameter of dowel post. (No more than one third the root diameter at C.E.J .and should be at least 2mm less than root diameter at mid root area)
3. Shape of the prepared canal. (Parallel sided prep. more retentive than tapered)
4. Accessory means. (Pin, groove, keyway)
5. Post surface texture, a post with rough surface is more retentive than post with smooth surface.



Post Prep. Requirements;

1) The length of post should be the greatest length provided that the apical seal not to be jeopardised.
2) Whenever possible the occlusal surface of the tooth is prepared with contra bevel.
3) Diameter of the prepared canal should be no more than one third the root diameter at C.E.J .and should be at least 2mm less than root diameter at mid root area .
4) Leaving 1mm.vertical wall between core margin and the shoulder of the preparation to provide sufficient support and prevent the root fracture.
5) Avoid using of burs in canal preparations which may penetrate dentine causing undesirable undercut.



Lec.9 Crown & Bridge

Impression for crown and bridge work

Definition: an impression is a negative reproduction or likeness of an object, from which, a positive reproduction (or cast) could be obtained.

Objective of taking an impression

Because it is neither possible nor desirable to make patterns for fixed prostheses directly in the mouth, an impression or negative likeness of the teeth and surrounding structures is necessary to obtain a cast. This cast is then used to make a restoration in the laboratory. To obtain the cast, an elastic impression material is placed in a tray that is inserted into the patient's mouth. When the material has set, it is removed from the patient's mouth. A suitable dental stone is then poured into the "negative" impression, and a positive likeness or working cast is obtained.

Requirements of an acceptable impression

1. An acceptable impression must be an exact record of all aspects of the prepared tooth. This means that it must include sufficient unprepared tooth structure immediately adjacent to the margins so that the restoration could be fabricated with proper contour by the laboratory technician.
2. All teeth in the dental arch and the soft tissues immediately surrounding the prepared tooth must be reproduced in the impression. This will allow the cast to be accurately articulated and contribute to proper contouring of the planned restoration.
3. The impression must be free of air bubbles, tears, thin spots, and other imperfections that might induce inaccuracy.

Requirements of an impression material

1. It should be *elastic* after its placement in the patient's mouth so that it can be removed from the undercut areas that exist on the external tooth surfaces adjacent to the prepared tooth without distortion or fracture.
2. It should have adequate *strength* to resist breakage or tearing on removal from the patient's mouth *(adequate tear strength).*
3. It should have adequate *dimensional stability* over temperature and humidity ranges normally found in clinical or laboratory procedures for a period long enough to permit the production of a cast or die.

4. It should have adequate *accuracy* for the production of the fine details so that it is an exact negative reproduction of the prepared and unprepared teeth.
5. It should be *easy to use with the minimum of equipment.*
6. It should be *free of toxic or irritating components.*

Classification of impression materials

1. Non-elastic impression materials:

a. Impression compound.
b. Impression plaster.
c. Zinc-oxide eugenol paste.

These materials are not used routinely in crown and bridge work because when they set they become rigid, so upon removal from the undercut areas they will fracture.

2. Elastic impression materials:

a. Hydrocolloids (water-based systems):
-Reversible hydrocolloids (agar impression material).
-Irreversible hydrocolloids (alginate impression material).
b. Elastomers:
-Polysulfide impression material.
-Condensation silicone impression material.
-Polyether impression material.
-Addition silicone impression material.

Hydrocolloids

-Reversible hydrocolloids (agar impression material)

Agar hydrocolloid impression material is compounded from reversible agar gel. It is termed *reversible* because as the agar gel is heated, it will liquefy or go into a sol state, and on cooling it will return to the gel state. Because this process can be repeated, a gel of this type is described as *reversible*.

Chemical composition of agar impression material

The main active constituent of reversible hydrocolloid impression product is agar, which is a sulfuric ester of a galactan complex, potassium sulfate, borax, alkyl benzoate, water, coloring agent and flavors. This material forms a colloid with water, which liquefies between 71ºC and 100ºC and sets again to a gel again between 30ºC and 50ºC, varying with the concentration of the agar.

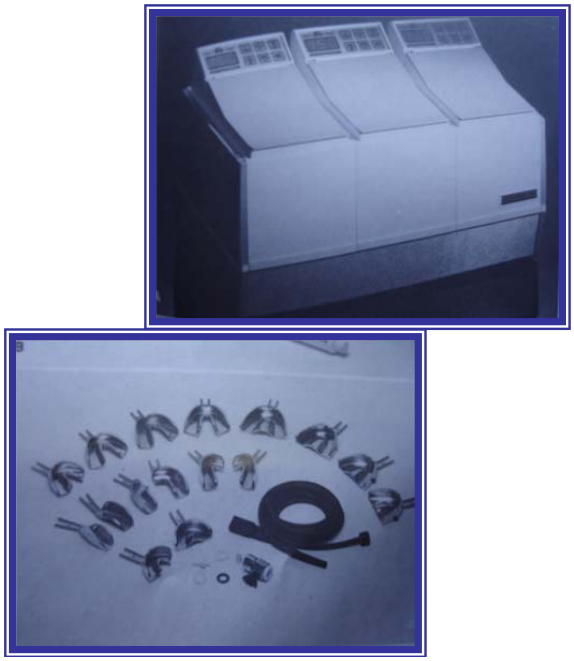
The material is supplied as a tray type and a syringe type. The tray type is considerably stiffer at the time of making the impression than the syringe type. The agar content is reduced in the syringe type, so it is much more fluid at the time of injection than is the tray material at the time of insertion.

Advantages of agar impression material

1. If poured immediately, it produces casts of excellent dimensional stability, accuracy, and surface details.
2. A special tray is not required when agar impression material is used. This is because its accuracy is improved if the material has as much bulk as possible. This is in contrast with the elastomeric impression materials (polysulfide and condensation silicone) whose accuracy is improved by minimizing the bulk by using a special tray.

Disadvantages of agar impression material

1. Special equipment and water-cooled impression trays are needed.
2. If the agar impression is not poured immediately, it will undergo dimensional changes. This is due primarily to the ease with which water can be released from or absorbed by the material (syneresis and imbibition). In order to avoid this, the impression should be poured immediately, or if this cannot be done immediately, the impression should be stored in 100% relative humidity.



The special equipment and the water-cooled impression trays needed for the agar impression material.

-Irreversible hydrocolloids (alginate impression material)

Chemical composition of alginate impression material

It is supplied as a powder which is composed of sodium or potassium alginate, salts of alginic acid, fillers (diatomaceous earth), calcium sulfate, and modifiers. On mixing the powder with water a sol is formed, a chemical reaction takes place and a gel is formed.


Properties

-Good surface detail.
-Reaction is faster at higher temperatures.
-Elastic enough to be drawn over the undercuts, but tears over the deep undercuts.
-Not dimensionally stable on storing due to evaporation.
-Non toxic and non irritant.
-Setting time can depend on technique.
-Alginate powder is unstable on storage in presence of moisture or in warm temperatures.

Advantages

1. Non-toxic and non-irritant.
2. Good surface details.
3. Easy to use and handle.
4. Cheap and has good shelf-life.
5. Its setting time can be controlled by controlling the temperature of water used.

Disadvantages

1. Poor dimensional stability (syneresis and imbibition); therefore, an alginate impression should be cast within 15 minutes.
2. It does not adhere to the impression tray.
3. Setting time very dependent on operator handling.

Polysulfide impression material

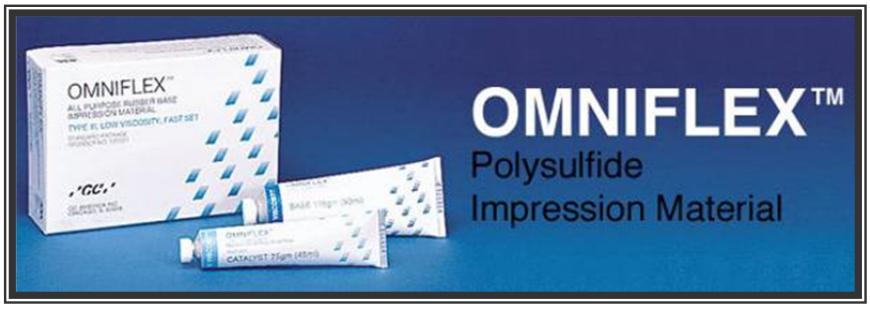
The polysulfides, commonly known as "rubber bases", were introduced in the early to middle 1950s and used widely by dentists because of their better dimensional stability and tear strength than hydrocolloids. Nevertheless, it was important that the polysulfide impression be poured as soon as possible after impression taking since delay of over an hour resulted in clinically significant dimensional change.

Chemical composition of polysulfide impression material

The material is supplied as a two-paste system (*base* and *accelerator* or *catalyst*) in three consistencies (heavy, medium, and light bodies)

which differ only in the amount of filler loading. The base is composed of polysulfide polymer, titanium dioxide, zinc sulfate, copper carbonate, or silica. The accelerator or catalyst is composed of lead dioxide, dibutyl or dioctyl phthalate, sulfur, and other ingredients as magnesium stearate and deodorants.

Water is a by-product of polysulfide polymerization. Its evaporation results in a slight contraction of the polymerized material, which can be minimized through the use of a special tray as this reduces the material's thickness.



Advantages of polysulfide impression material

1. It has high tear resistance and high elastic properties which facilitate impression making in sulcular areas and pinholes.
2. It has improved dimensional stability over hydrocolloids but inferior to polyether and addition silicone.
3. It is the least expensive of elastomers.

Disadvantages of polysulfide impression material

1. It has dimensional instability which is due to the mode of polymerization of polysulfide which is of condensation type which gives off water as a by-product, whose evaporation from the set material causes dimensional contraction.
2. It has a long setting time in the mouth (typically 10 minutes) which induces poor patient's acceptance (especially in view of its unpleasant sulfide odor).
3. Humidity and temperature dramatically reduce its working time which may be so short that polymerization begins prior to insertion in the mouth with resultant severe distortion.
4. Most polysulfide materials are polymerized with the aid of lead peroxide (catalyst) which gives the material its typical brown color and the polymerized material is so sticky and should be handled carefully since it could stain the clothes permanently.

Condensation silicone impression material

Condensation silicone has been developed to overcome some of the disadvantages of polysulfide. It is odorless and can be pigmented to virtually any shade. An additional advantage of condensation silicone

over polysulfide is its relatively short setting time in the mouth (typically 6-8 minutes). As a result patient acceptance is better than polysulfide. It is also less affected by high operatory temperatures and humidity. Unfortunately, its dimensional stability is less than that of polysulfide although greater than that of reversible hydrocolloid.

Chemical composition of condensation silicone impression material

The material is supplied as a *base* and an *accelerator* in a low consistency and putty-like consistency. The base is composed of a linear silicone called *polydimethylsiloxane* and fillers (either calcium carbonate or silica). The accelerator may be a liquid that consists of stannous octoate suspension and alkyl silicate, or it may be supplied as a paste by adding a thickening agent.

(A)

(B)

The condensation silicone impression material: The putty-like (A), and the low consistency (B).

Disadvantages of condensation silicone impression material

1. The main disadvantage of condensation silicone is its poor wetting characteristics because it is extremely hydrophobic; therefore, the prepared teeth and gingival sulci must be completely free of moisture for a defect-free impression.
2. It has dimensional instability which is due to the mode of polymerization which is of condensation type which gives off ethyl alcohol as a by-product, whose evaporation from the set material causes dimensional contraction.
3. Pouring the impression made of condensation silicone without trapping air bubbles is more difficult than with other impression materials.

Polyether impression material

Polyether impression material has a polymerization mechanism unlike those of the other elastomers. No volatile by-product is formed, and thus it has excellent dimensional stability.

Chemical composition of polyether impression material

The material is also supplied as a two-paste system (*base* and *accelerator* or *catalyst*) in three consistencies (low, medium, and heavy bodies). The base paste consists of a long-chain polyether copolymer, silica fillers, compatible plasticizers of a non-phthalate type, and triglycerides. The catalyst paste consists of an aliphatic cationic initiator (as a cross-linking agent), silica fillers, and plasticizers. Coloring agents are added to the base and catalyst to aid in the recognition of different materials types.

Advantages of polyether impression material

1. It has high dimensional stability since no volatile by-product is formed and its polymerization shrinkage is unusually low compared with most room temperature-cured polymer systems. Therefore, an impression made of polyether can be poured more than a day after the impression has been made and still having accurate casts. This is especially useful when it may be impossible or inconvenient to pour the impression immediately. The new polyether materials can be poured up to fourteen days after impression taking.
2. It has short setting time in the mouth (typically 5 minutes, or less than half the time required for polysulfide).

Disadvantages of polyether impression material

1. The set material is stiff. This causes problems when separating a stone cast from the impression, especially in thin and single teeth as in the mandibular incisors. However, this problem has been recently solved with the introduction of soft polyether materials such as Impregum Penta Soft.
2. The polyether is stable only if stored dry since it will absorb moisture (imbbition) and significantly change dimensionally.
3. There are reported cases of allergic hypersensitivity to polyether, manifested as a sudden onset of burning, itching, and general oral discomfort.

Addition silicone impression material (polyvinylsiloxane)

The main difference between the addition silicone and the condensation silicone is that it has much greater dimensional stability than the condensation type as its polymerization reaction does not give off any by-product.

Chemical composition of addition silicone impression material

The material is also supplied as a two-paste system (*base* and *accelerator* or *catalyst*) in extra low, low, medium, heavy, and very heavy (putty) consistencies. The base paste consists of dimethylsiloxane with vinyl terminal groups, plus fillers. The accelerator (catalyst) also

contains dimethylsiloxane with vinyl terminal groups, fillers, and platinum catalyst.

Advantages of addition silicone impression material

1. It has high dimensional stability which is equivalent to polyether.
2. The set material is less rigid than polyether.

Disadvantages of addition silicone impression material

1. Like other materials, adverse tissue responses have been reported.
2. Setting inhibition by some brands of latex gloves.

Digital impression

Digital impression represents the most recent development in Dentistry. The basics of digital impression start with capturing an image of the prepared teeth. This system uses an intra-oral camera (scanner) to capture the desired image (optical impression). This image is then electronically transferred to a manufacturing facility which fabricates a working, articulated model. On this model, a multitude of different restorations can be designed (crowns, bridges, inlays/onlays, and veneers) with a special computer software, which is connected with a milling machine. This procedure is termed CAD-CAM (Computer Aided Designing - Computer Aided Manufacturing).

Advantages of digital impression

1. Digital impressions eliminate the uncomfortable experience of making a physical impression.
2. The image on the monitor shows you if you have captured all the needed details before sending it to the lab.
3. The accuracy of the mounting, bite registration, and stability of the dies create a model that allows the laboratory technician to fabricate a final restoration that has excellent marginal fit and incredibly accurate occlusion.
4. The ability to see if proper occlusal reduction has been achieved.

Chairside CAD-CAM unit.

Laboratory CAD-CAM unit.

Final impression

To take a final impression, we need a special tray (custom tray), impression syringe, and an impression material.

The special tray is constructed on the study cast.

The impression syringe.

Advantages of the study cast

1. It is useful for the diagnosis and treatment planning.
2. It is used for the construction of a provisional restoration.
3. It is used for the construction of a special tray.

The study cast after its removal from the impression and its trimming,

Advantages of the special tray

1. It allows the use of the impression material in minimum thickness, so it reduces its dimensional changes.
2. It reduces the discomfort of the patient because it is well-fitted to the patient's mouth.
3. Its small size prevents the forcible opening of the mouth.
4. It allows free snap removal of the impression from the patient's mouth without applying rotary movement.

Materials used to construct the special tray

1. Auto-polymerizing acrylic resin (mostly used).
2. Shellac base plate.
3. Vacuum thermoplastic material.

Requirements of the special tray

1. It should be rigid enough to resist breakage; therefore, it should have a thickness of 2-3 mm.
2. It should extend about 5 mm cervical to the gingival margin.
3. It should be stable on the cast with stoppers.
4. It should be constructed at least 9 hours prior to its use.

To construct a special tray, we need:
1. Study cast.
2. Pink base plate wax.
3. Self-cured acrylic resin.

Construction of the special tray

1. With a pencil, we draw a line on the study cast around the dental arch about 5 mm cervical to the gingival margin. This line represents the finishing line of our special tray.
2. We adapt two layers of base plate wax on the study cast. Then we remove the wax from the periphery until we see the line that we have drawn (cut back).
3. After that, we create two perforations in the occlusal surface of the wax (2 posterior and 1 anterior) to obtain stoppers for our special tray. The stoppers are created in the area of non-functional cusps. The stoppers serve the following advantages:
-They help to equalize the pressure that is going to be applied on the tray.
-They help to localize the tray in the patient's mouth during impression taking.
-They maintain even space for the impression material.
-They prevent sinking down of the impression tray.

4. A layer of tin foil is adapted on the two layers of the wax.
5. Auto-polymerizing acrylic resin is mixed according to the manufacturer's instruction. When it reaches the dough stage, it is adapted on the wax that has been covered with the tin foil. The excess acrylic resin beyond the line previously drawn is removed. The excess acrylic resin removed can be used to construct a handle for the special tray.

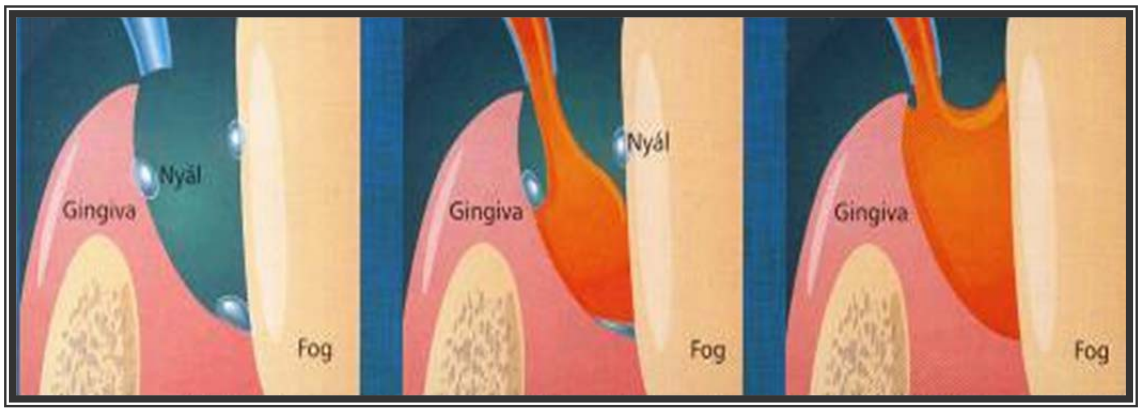
After complete polymerization of the acrylic resin, the tray is removed from the cast. Removal is facilitated by the presence of the tinfoil which will prevent the acrylic resin from sticking to the wax. Then the margins of the special tray can be finished, smoothed, and polished.

Gingival retraction

In cases when the finishing line is located below the level of the gum (subgingivally) or with the level of the gum, we need to do gingival retraction, which is a procedure by which the finishing line is temporarily exposed by enlarging the gingival sulcus so that we can take a good impression which involves the details of the end margin of the preparation that is located subgingivally.

Objectives of gingival retraction

1. To create an access for the impression material to the area of the preparation that is located subgingivally.
2. To provide enough thickness of the impression material at the area of the finishing line to prevent tearing and distortion of the impression material.
3. To control the amount of fluid in the gingival sulcus (crevicular fluid) that will cause voids in the impression.



The objectives of gingival retraction: (1) to create an access, and (2) to provide enough thickness for the impression material at the area of the preparation that is located subgingivally.

Techniques of gingival retraction

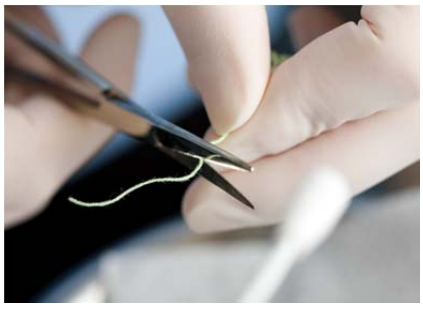
1. Mechanical.
2. Chemo-mechanical.
3. Gingival retraction paste (cordless technique).
4. Electrosurgical.
5. Laser.

1. Mechanical:

In this technique, we apply pressure on the gingival to open the gingival sulcus. It might be done by either of the followings:

-Construction of a temporary crown with a slightly long margin leaving it in place for 24 hours, or

-Using a plane retraction cord (free of any medicament) which is the most common. The retraction cord is a special cord made of cotton which comes either plane (free of medicament), or is pre-impregnated with a medicament (usually a vasoconstrictor). Using a plane retraction cord is considered as a mechanical means only.



2. Chemo-mechanical:

In this technique, we use a retraction cord that is pre-impegnated with a medicament, usually a vasoconstrictor (adrenaline, aluminum chloride, or ferric sulfate). By packing this cord with a plastic instrument (Ash No.6 or Ash No.49) in the gingival sulcus between the gingival tissue and the prepared tooth, the cord will mechanically push the gingiva away from the finishing line, and the combination of the chemical action of the medicament and the pressure exerted by the cord will cause a transient

gingival ischemia. This will lead to shrinkage of the gingival tissue and control the fluid seepage from the gingival sulcus.

The retraction cord is left inside the gingival sulcus all around the tooth for 10 minutes. The working area should be kept dry during this period. Then the cord can be removed leaving the gingival tissue in an expanding state. This will provide a space to inject the impression material all around the tooth at the area of the finishing line by the use of an impression syringe.

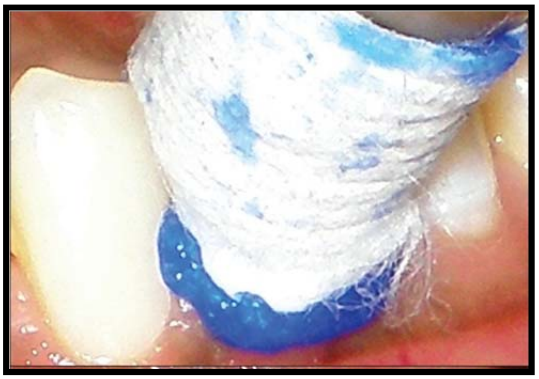
The retraction cords in place inside the gingival sulci of the prepared teeth.

3. Gingival retraction paste (Cordless technique):

In most cases, gingival retraction cord is the most effective method for retracting tissue to the depth of the sulcus. Unfortunately, gingival retraction cord may injure the gingival sulcular epithelium and the gingival bleeding is difficult to control when packing a cord into the sulcus making impression difficult or impossible. Using a retraction cord requires proper tissue manipulation and is technique sensitive. For this reason a new class of gingival retraction materials has been introduced in the form of retraction paste like Expasyl (Aluminum chloride 15%) and Magic Foam Cord (Polyvinylsiloxane, addition type silicone elastomer).

The advantage of cordless retraction technique is providing a non-traumatic, non-invasive tissue management and excellent hemostasis in the gingival sulcus for fixed prosthodontic impressions.

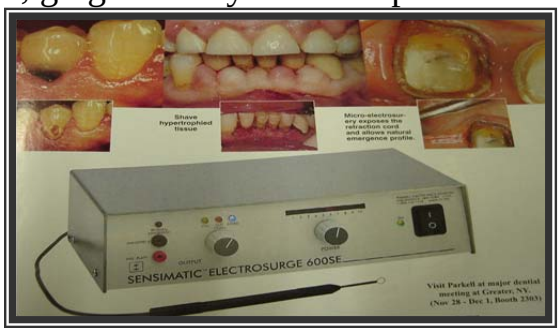
The Expasyl gingival retraction paste injected in place inside the gingival sulcus of the prepared tooth.



Magic Foam Cord gingival retraction paste injected in place inside the gingival sulcus of the prepared tooth.

4. Electro-surgical:

In this technique, an electro-surgical unit could be used to remove the gingival tissue from the area of the finishing line with the advantage of controlling the post-surgical hemorrhage. However, electrosurgery is contraindicated when there is gingival inflammation or periodontal disease. In this case, gingivectomy could be performed.



The electrosurgical unit.

5. Laser : For gingival retraction, Nd- YAG lasers are used.

Advantages of laser:

1. Certain laser dentistry procedures do not require anesthesia.
2. Laser procedures minimize bleeding because the high-energy light beam aids in the clotting (coagulation) of exposed blood vessels, thus inhibiting blood loss.
3. Bacterial infections are minimized because the high-energy beam sterilizes the area being worked on.
4. Damage to surrounding tissue is minimized.
5. Wounds heal faster and tissues can be regenerated.

Disadvantages:

1. Slow technique.
2. Expensive.

The Nd-YAG laser unit used in dentistry.

Gingival retraction obtained by laser.

Impression Techniques

1. Single mix technique (monophase technique).
2. Double mix technique.
3. Putty-wash technique.

1. Single mix technique

Most of the time, this technique is used when we have an impression material with single viscosity (such as the medium body consistency of polyether or addition silicone impression materials). This is because both materials are pseudoplastic materials and have the capacity for shear thinning. Pseudoplastic materials demonstrate a decreased viscosity when subjected to high shear rates such as occurs during mixing and syringing. When the medium viscosity material is forced through an impression syringe, the viscosity is reduced, whereas the viscosity of the same material residing in the tray is unaffected. In this manner, such materials can be used for syringing and for trays.

In this technique, after mixing the material, part of the material is loaded in the tray and the remaining part is loaded in the impression syringe. i.e., the same mix of the material is used to load the tray and the syringe. The impression material is injected from the impression syringe around the preparation area starting with the most critical parts such as the finishing line, then the prepared teeth and the other teeth in the dental

arch. Then the special tray loaded with the impression material is inserted inside the patient's mouth and seated over the whole dental arch. After complete setting of the material, the impression tray is removed from the patient's mouth.

2. Double mix technique

This technique is usually used with materials that have two viscosities (heavy and light bodies). We mix the heavy body and the light body at the same time. The light body is loaded in the syringe, while the heavy body is loaded in the tray. We start to inject the light body on the dental arch starting with the prepared tooth, and then the tray loaded with the heavy body is inserted inside the patient's mouth and seated over the dental arch. The pressure created by the heavy body after seating of the tray will cause a direct flow of the light body into the details of the preparation including the finishing line.

3. Putty-wash technique

This technique requires the use of a high viscosity material. We take an impression with the heavy body either before or after tooth preparation:

-*Before preparation:* we take a preoperative impression with the heavy body only prior to tooth preparation, and after complete setting of the heavy body we remove the impression tray from the patient's mouth and leave it aside. Then we do tooth preparation. After completion of tooth preparation, we mix the light body and load it in the syringe and inject it over the preparation area. Then we reseat the impression tray inside the patient's mouth and wait for the complete setting of the light body.

-*After preparation:* in this technique, after mixing of the heavy body and loading it in the tray, a spacer made of polyethylene is placed over the heavy body and the tray is inserted inside the patient's mouth. After complete setting of the heavy body, the tray is removed and the spacer is removed. The light body is then mixed and part of it is loaded in the syringe and the other part loaded in the tray over the heavy body. Then the light body is injected over the whole dental arch starting from the area of tooth preparation, and the tray is reseated inside the patient's mouth. After complete setting of the light body, the tray is removed from the patient's mouth.

This technique was developed for condensation silicones to minimize the effects of dimensional changes during polymerization. Most of the shrinkage during polymerization takes place in the putty material when the preliminary impression is made, confining final shrinkage to the thin wash portion of the impression.

Impression for post crown

In case of post crown, we need to take an impression for the inside of the root canal. Most of the time, it is difficult to insert the impression material inside the tiny root canal, and even when it is inserted inside the canal it might tear during removal or become distorted during pouring of the impression. Therefore, the impression material needs a type of reinforcement. Such reinforcement could be obtained either by the use of a plastic post (impression post) or by using a stainless steel wire. After injection of the light body inside the root canal, the impression post or the stainless steel wire is inserted inside the canal. This will support the impression material and prevents its tearing or distortion during removal of the impression.

An impression for the post crown with the plastic post (impression post) recording the inside of the canal.

After removal of the impression from the patient's mouth, it should be inspected for the following:

1. The finishing line should be continuous all around the prepared tooth.
2. No air bubbles should be present at the area of tooth preparation.
3. The impression material should be attached well to the impression tray.

Disinfection of the impression

Disinfection of the impression is a concern with respect to viral diseases such as hepatitis B, AIDS, and herpes simplex, because the viruses may be transferred to the gypsum models and present a risk to dental laboratory and operating personnel.

The most common form of disinfection is spraying or immersion in disinfectants like 1% sodium hypochlorite or 2% potentiated glutaraldehyde solutions and iodophor.

Remember that you need the following requirements to obtain a good final impression:

1. Special tray.

2. Impression syringe.
3. Gingival retraction when needed.
4. Good understanding of the physical properties of the impression material which results in good handling of the material.
5. Dry field of operation. This is because all elastic impression materials, except hydrocolloids, are hydrophobic. i.e., they don't displace moisture; therefore, any moisture if present will result in voids or folds within the final impression.

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Provisional Restoration (Temporary Restoration)

Definition: A crown restoration that is used in fixed prosthodontics during the interim between tooth preparation and final placement of the definitive crown restoration.

Objectives of provisional restoration:

1. To protect the tooth from pain stimuli as a result of thermal (hot and cold), chemical, and osmotic changes in the mouth.
2. To prevent sensitivity and further irritation to the pulp since a certain degree of pulp trauma is inevitable during tooth preparation because of the sectioning of the dentinal tubules.
3. To prevent movement of the prepared, adjacent, and opposing teeth. i.e., to prevent supraeruption and drifting.
4. To protect the gingival tissue from irritation and food impaction.
5. To provide esthetic, phonetic, and function.
6. To prevent tooth fracture.

Requirements of an optimum provisional restoration:

1. A provisional restoration must seal and insulate the prepared tooth surface from the oral environment to prevent sensitivity and further irritation to the pulp.
2. A provisional restoration must have good marginal fit, proper contour, and a smooth surface to maintain the health of the gingival tissue and facilitate plaque control by the patient.
3. A provisional restoration should maintain proper contacts with the adjacent and opposing teeth to prevent Supraeruption and horizontal movement (drifting).
4. A provisional restoration should have enough strength and retention to withstand the forces to which it is subjected without fracture or coming off the tooth. In addition, it should remain intact during its removal so that it can be reused again-if necessary.
5. A provisional restoration should provide esthetic, phonetic, and function.

Types of provisional restoration:

1. Preformed temporary crowns.
2. Customized temporary restorations (chairside temporary restorations).
3. Laboratory-made temporary restorations.

1. Preformed temporary crowns:

Generally, preformed temporary crowns consist of a shell of plastic or metal that could be cemented directly on the prepared tooth following adjustment, or after its lining with a resin material. They could be used for single or multiple preparations.

Types of preformed temporary crowns:

a. Metal temporary crowns.

6. Plastic temporary crowns.

c. Celluloid crown forms.

a. Metal temporary crowns:

Metal temporary crowns are mainly indicated for use in the posterior teeth. They are made of stainless steel, nickel-chromium, or aluminum. The most commonly used type is aluminum temporary crowns, which are of two types:

1. Non-anatomical or flat-topped cylindrical temporary crowns.
2. Anatomical or morphological aluminum temporary crowns.

Clinical procedure:

1. Select ·the proper size and shape of the temporary crown according to the prepared tooth.

2. Trim the cervical margin of the temporary crown using a scissor to conform to the gingival margin of the preparation (finishing line) and to accommodate the vertical height of the prepared tooth.

3. Seat the temporary crown on the prepared tooth and ask the patient to bite on it. Check the margins and the occlusion (centric and eccentric).

4. Smooth the margins with a stone bur.

5. Cement the temporary crown on the prepared tooth using zinc oxide-eugenol cement.

b. Plastic temporary crowns:

Plastic temporary crowns are used mostly for the anterior teeth. The clinical procedure for the use of plastic temporary crown is nearly the same as that for metal temporary crown.

Types of plastic temporary crowns:

1. Acrylic temporary crowns: Acrylic resins restorations have been widely used in dentistry in the past but since higher quality materials have emerged, they have lost ground .These are made from acrylic resin and are available in different sizes and colors. Preformed acrylic temporary crowns are used for the anterior teeth.

2. Polycarbonate temporary crowns: these are made from polycarbonate plastic combined with micro glass fibers. Preformed polycarbonate temporary crowns are available for the anterior and posterior teeth.

In case we need to improve the fitness of the temporary crown or if there is no size which approximately fits the prepared tooth, we can reline the temporary crown with a resin material to improve its fitness after the selection of the most suitable size and shade (color) of the temporary crown and cutting its margin according to the finishing line of the prepared tooth.

The procedure of relining could be done either directly on the prepared tooth in a manner similar to that of celluloid temporary crown (will be discussed later) or could be done indirectly on a study cast of the prepared tooth.

C. Celluloid crown forms:

They are mainly used for the anterior teeth, but can be used for the posterior teeth also. They are made from a very thin translucent layer of cellulose acetate. They act as a mold for the construction of the temporary crown. They come in different sizes.

Clinical procedure:

1. Coat the prepared tooth with Vaseline to facilitate removal of the temporary crown.
2. Select the proper size and shape of the celluloid crown.
3. Make two holes in the corners of the temporary crown to provide an escape way for the excess material.
4. Cut the gingival margin of the crown to accommodate that of the prepared tooth.
5. Fill the celluloid crown with a provisional crown material (Bis-acryl composite resin or composite resin) of the same shade of the tooth and seat it over the prepared tooth until setting.

If Bis-acryl composite resin is used as a provisional material, the celluloid crown should be removed at its semi-plastic stage so that the polymerization reaction of the acrylic resin will occur outside the

mouth to prevent pulpal irritation since the polymerization reaction of the acrylic resin is exothermic.

6. Take the crown out and remove the excess material. Then place it again on the prepared tooth and check the occlusion, contact with the adjacent teeth, fitness, and extension.

2. Customized temporary crown and bridge:

The fabrication of customized temporary crowns requires the construction of a mold of the patient's teeth before their preparation. This may be obtained from any type of elastic impression material, into which resin polymer material (Bis-acryl or composite) is placed and the mold is held either directly on the prepared tooth (or teeth) or indirectly against a cast of the patient's teeth.

Indications of customized temporary restoration:

1. Coverage of multiple individual crown preparations.
2. Coverage of a single tooth preparation which is usually large or of a special design. i.e., when a preformed temporary crown is not fit to the tooth.
3. Abutment preparations for fixed partial denture to construct a temporary bridge.

Methods of construction of customized temporary restorations:

Impression method (over-impression method):

-Indirect impression method (indirect chairside technique).

-Direct impression method (direct chairside technique).

Clinical procedure of the indirect impression method:

1. A preoperative over-impression with alginate or silicone impression material is made from the patient's teeth or from a study model and carefully stored until completing tooth preparation.

2. After completing the preparation of teeth, another alginate impression was

then taken and poured with fast-setting plaster or stone. After setting of the plaster or stone, the cast is separated from the impression.

3. Coat the prepared tooth (or teeth) on the cast with a separating medium (such as petroleum jelly).

4. Mix tooth colored resin according to the manufacturer's instructions and place the mixed resin in the over-impression at the area of tooth preparation only.

5. Seat the cast into the over-impression in an upright position and maintain constant pressure until the resin sets completely. It is important to note that the cast is correctly seated in the over impression.

6. After complete polymerization of the resin, separate the cast from the over-impression. The formed crown is then removed from the prepared tooth in the cast.

7. Trim any excess material from the formed crown. Then the crown is seated on the prepared tooth inside the patient's mouth. Check the occlusion and remove any premature contact in centric and eccentric occlusion.

8. Cement the temporary crown on the prepared tooth using zinc oxide-eugenol cement.

Clinical procedure of the direct impression method:

The clinical procedure of the direct impression method is the same as that of the indirect method except that it is done directly inside the patient's mouth. In this method, we need a preoperative over-impression but there is no need to have a study cast. Prepare the tooth (or teeth), mix the resin, place it in the over-impression in the area of tooth preparation, and seat the over-impression inside the patient's mouth. Then follow the same steps that are used in the indirect method.

Advantages of the indirect method over the direct method:

1. There is no direct contact of the free monomer of the resin with the prepared tooth or gingival tissue which might cause tissue irritation or allergic reaction.

2. The indirect method avoids subjecting the prepared tooth to the heat of polymerization of the resin since the polymerization reaction of the resin is exothermic.

3. The indirect method saves the clinician's chair time.

Visible Light-Activated (VLA) Composites (no need for a preoperative impression)

***Maleable composites*:**

These are light-cured composites with a clay- or dough-like consistency allowing them to be molded over tooth preparation and then cured. The simplest system, Revotek LC™, GC, consists of a UDMA putty stick from which a portion can be cut.

Revotek LC™ is a VLA, single-component, sculptable resin composite. It is supplied in a Putty Stick form in a lightproof plastic tray. To make a provisional restoration, a small portion of the material is cut from the stick and adapted to the preparation directly in the mouth. It is then sculpted using hand instruments after which the patient is instructed to occlude into it to establish a functionally-generated occlusal scheme. The provisional is then light-activated for 10 seconds in the mouth, removed, and given a final 20-second light exposure. After finishing and polishing, the restoration is cemented with temporary cement.

Advantages:

1. There's no methyl methacrylate so there's no exothermic heat, odor or irritation.

2. Fast and Easy to use.

3. There's no mixing required, no messy powder-liquids and no wasteful cartridges and mixing tips.

4. Unlike bis-acrylics, there's no heavy oxygen-inhibited layer to contend with.

5. There's no need for a preoperative impression, stent fabrication, wax-ups or model modifications.

Temporary restoration for a tooth prepared to receive a post crown:

It is often difficult to fabricate a temporary crown for a tooth that has been prepared to receive a post crown because there is so little tooth structure supragingivally that cannot give support to the temporary crown, so in such a case

we need intracanal retentive means to give retention to the temporary crown.

A piece of stainless steel wire could be used as an intracanal retentive means. The wire should be adapted to the prepared root canal and should extend coronally at least 4 mm. i.e., 4 mm of the wire should extend supragingivally outside the canal prior to the construction of the temporary crown. After that, a temporary crown could be constructed and the stainless steel wire will be part of the temporary crown.

Cementation of the temporary restoration:

Zinc oxide-eugenol cement is the most commonly used cement for temporary crowns and bridges. This cement promotes healing and allows easy removal of the temporary restoration.

Lec:18 Crown & Bridge

Clinical Try-In & Adjustment procedure

After the laboratory procedure has been completed, the casting restoration is now ready to be tried in (checked on the prepared tooth inside patient mouth) prior to final finishing and cementation.

- ***With or Without Anesthesia***

The procedure can be accomplished in most patient without anesthesia, it give us the benefit of unimpaired tactile sensation that is of great value during occlusal adjustment. So Without Anesthesia Try-in procedure is better but sometime we use anesthesia if the patient uncooperative.

Seating the Casting

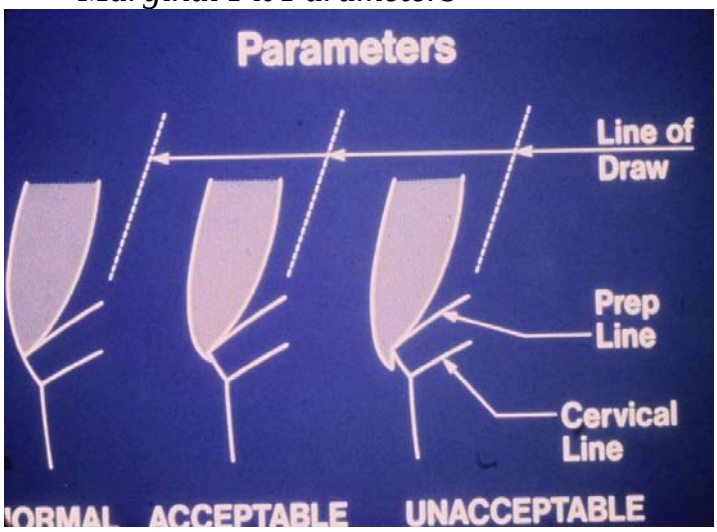
1. **Remove temporary restoration** and clean the prepared tooth from any remnant of cement because it will interfere with seating of restoration. Instruments use to remove temporary restoration;
    a. Backhaus towel clamp or
    b. GC Pliers
2. **Seat the restoration** on the prepared tooth with pressure.
3. **Examine the interproximal contact area;** it should be tight as the other in the mouth. Dental floss is used to check the interproximal contact by passing it between the restoration and the adjacent natural teeth, it should have slight resistance otherwise we have either;
    a) Heavy resistance; the dental floss can't pass through the contact, this indicate that the contact is heavy and it must be reduced.
    b) No resistance; however if the floss passes easily, it indicate that the contact area is under contoured (deficient contact) -- either you have to repeat the restoration or to correct this defect by adding solder to that area.
4. If the contact area is perfect and the crown is not seat completely this might mean that**, there is interference from inside** (metal bubbles or undercut) we use pressure indicating past (silicon wash) or spray to identify the interferences. We place it into the inner surface of the crown restoration, the crown were then seated on the prepared tooth with pressure , the restoration were then removed and inspected for any pressure (shiny) area which indicates an interference area that should relieved
5. **Evaluating Complete Seating**; the margin of the restoration is the most critical area of the restoration, we should have complete

fitness between the restoration margin and finishing line of the preparation.

Evaluating marginal integrity

To check the marginal integrity of the crown restoration, we use sharp pointed probe, the probe should be move in a two direction, the direction of the movement during checking is very important. **We should have complete fitness between the restoration margin and finishing line of the preparation.**

Marginal Fit Parameters



Types of Marginal Defects

1. Short margin (under extension, Shoulder or ledge);
margin of the crown restoration lies short of finish line of prepared tooth

2. Long margin (overextension, Overhang);
margin of the crown restoration lies beyond finish line of the prepared tooth.

3. Open margin;
margin within finish line but there is space between the restoration margin and the prepared tooth

4. Overcontoured;
margin within finish line furthermore , they are bulky (overcontoure).

How to check ;

1) Move probe from the restoration toward tooth surface, if it passed smoothly without any interpretation the margin is OKY however if there is any interpretation during this movement--- this indicate under extended margin.

2) Move from tooth surface toward restoration margin , if the probe catch by the margin, this indicate over extended margin (correction might lead to open margin)

3) If the probe passes smoothly in the two direction this mean the margin extension is correct.
4) if there is space between the restoration and tooth surface at area of f.l. & probe can go in ,this mean open margin

The restoration should then be examined for stability , it should not rock or rotate on the prepared tooth when force is applied on.

6. **After complete seating,** adjust the occlusal relationship in all mandible movements (centric and eccectric) using articulating paper. Any occlusal prematurity should be relieved using green stone bur**.** *Now the casting restoration is ready for the* ***next step***
7. **Margin finishing;**

Objectives; is to obtain at least one mm wide margin that is closely adapted to the tooth surface at the area of finish line--- micro leakage.

a. Sub gingival margin can be finish on the die using burnisher, no intra oral finishing is desirable because of the risk of damaging the tooth and the periodontal tissue.
b. Supra gingival margin can be finished directly on the tooth; margin adaptation can be improved by using burnisher or dull bur.

8. **The restoration now is ready for final polishing.**

Objective is to provide smooth shiny restoration surface that will be less susceptible to plaque accumulation or deposition.

Purpose of Polishing;

Polishing is performed in order to provide a restoration that have;

1) Glossy surface
2) Plaque resistant
3) Tarnish/corrosion resistant
4) Good appearance

Surface defects and roughness are removed by grinding with abrasive particles bound on grinding stone or rubber wheel or paper discs or it applied as abrasive paste. The most commonly used abrasive is Tripoli on soft Robinson bristle brush

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Cementation

Permanent Cementation

Dental cement designed to produce a mechanical interlocking effect upon hardening inside the mouth. Dental cement materials provide sealing to prevent marginal leakage and have good esthetics and proper thermal and chemical resistance in the oral environment and should be non-irritating to pulp and gingiva. They are used in dentists' offices as luting (cementing) agents, as protective, insulating, or sedative bases, and as temporary restorative materials.

Factors affecting the retention of the cemented cast restoration:

1. Geometrical relations of the preparation;
   Retentive properties of the preparation (taper, height, surface area…..etc.).
2. Biophysical factors relating to the casting;
   Such as accuracy of fit, metallurgical characters, inside surface texture of the casting restoration
3. Mechanical properties of the luting agent;
   Such as compressive strength, tensile strength, shear strength, adhesive property and film thickness
4. Difference in the co efficient of thermal expansion between tooth, casting and cement.

Function of cement:

1) To secure a lasting retention of the restoration to the prepared tooth.
2) To seal the gap against penetration of fluid and bacteria from oral cavity.
3) To act as an insulating barrier against the thermal and galvanic activity.

Properties of ideal luting agent:

1) Should have good working and setting property.
2) Adequate strength.
3) Compressible into a thin layer.
4) Should provide good sealing. And must be non-toxic to the pulp.
5) Should adhere well to the inner surface of the restoration.
6) Low viscosity and solubility.

Dental Cementing (luting) Agents may be classified as soft or hard.

1) ***Soft cements*;** used for provisional cementation of definitive crowns when a trial assessment period is needed, for example if the occlusion or aesthetics is being significantly altered.
2) ***Hard cements*;** used for definitive (permanent) cementation. There are essentially three types of hard cement: conventional, resin or a hybrid of the two.
    a) ***Conventional cements*,** rely on an acid-base reaction resulting in the formation of an insoluble salt (the cement) and water (e.g. zinc phosphate, zinc polycarboxylate and glass ionomer).
    b) ***Resin cements*,** set by polymerization**.**

In fact we have different types of cement that are used as luting agents:

Zinc phosphate cement

It is composed of ZnO powder and phosphoric acid, it has compressive strength of 14000-16000 PSI, with low PH at the time of cementing (about 3.5) which might irritate the pulp.

Advantages:-

1. Good compressive strength (if correctly proportioned).
2. Good film thickness.
3. Reasonable working time.
4. Resistant to water dissolution.
5. Long track record.
6. No adverse effect on pulp although initially acidic.

Disadvantages:-

1. Low tensile strength
2. No chemical bonding
3. Not resistant to acid dissolution

Recommendations:-

1. Good default cement for conventional crowns and posts with retentive preparations.
2. Working time can be extended for cementation of multiple restorations by incremental mixing and cooled slab.

Zinc silicophosphate cement

Has compressive strength of 22000 PSI but it has highly acidic PH and affect the health of the pulp (irritant).

1. Mixture of zinc phosphate & silicate cement.
2. Film thickness, compressive strength & tensile strength in the range of ZPC with slight lower solubility.

3. Anti-cariogenic property due to fluoride content.
4. Low PH & pulpal irritation.

Poly-carboxylate cement

adhere to enamel, dentine and stainless steel but not to gold alloy, the setting PH is (4.8) but because of the large size of poly-acrylic acid molecule, it has less effect on the pulp, high bond strength to enamel (1300 PSI) but its binding to dentine is considerably less 480 PSI.

Advantages:-

1. Good compressive strength (if correctly proportioned).
2. Adequate working time.
3. Bonds to enamel and dentine.
4. Adequate resistance to water dissolution (but less good than zinc phosphate).
5. Reasonable track record.
6. No adverse effect on pulp and less acidic than zinc phosphate on mixing.

Disadvantages:-

1. Low tensile strength
2. Can deform under loading
3. It is difficult to obtain low film thickness
4. Not resistant to acid dissolution

Recommendations:-

- ☒ Traditionally used for vital or sensitive teeth, but no evidence to support efficacy (dentine bonding agents used to seal preparation prior to cementation may be a better option).
- ☒ Occasionally useful to retain an unretentive provisional crown.

Glass ionomer cement

has compressive strength of 18600 PSI and it bonds to enamel and dentine (to enamel more), it releases fluoride after setting which is indication of an ability to inhibit secondary caries.

Advantages:-

1. As for polycarboxylate cement but cement has similar acidity to zinc phosphate on mixing.
2. Fluoride release.

Disadvantages:-

1. Sensitive to early moisture contamination.
2. Low tensile strength.
3. Not resistant to acid dissolution.
4. Has been accused of causing post-operative sensitivity but a controlled trial reports it is no worse than zinc phosphate

Recommendations:-

- ☒ Used empirically for conventional crowns where patient has had a previously high caries rate.
- ☒ May be used as an alternative to zinc phosphate.

Resin luting cement

They have wide range of formulation, can be classified basis of polymerization method (chemical, light cure, dual cure) & the presence of dentin bonding mechanisms. Chemical cure for metal restoration, light cure for ceramic restorations.

Advantages:-

1. Good compressive and tensile strengths.
2. High tensile strength (relative to conventional cements).
3. Resistant to water dissolution.
4. Relatively resistant to acid dissolution.
5. Can enhance strength of ceramic restoration if bond obtained.

Disadvantages:-

1. Film thickness varies substantially between materials.
2. Excess material extruded at margin may be difficult to remove especially proximally.

Recommendations:-

- ☒ Must be used with or incorporate an effective dentine bonding agent.
- ☒ Material of choice for porcelain veneers, ceramic onlays and resin bonded ceramic crowns.
- ☒ May be used to improve retention where preparation geometry sub-optimal, but clinical studies needed to determine long-term success.

Resin modified glass ionomer cements and compomers

Resin modified glass ionomer (RMGI) cements are a hybrid of traditional glassionomer cement with small additions of light curing resin and generally have the advantages of both , combine the strength and insolubility of resin with the fluoride release of GIC. They were introduced with the aim of overcoming the moisture sensitivity and the low strength of conventional glassionomers. Compomers are also composed of resin and glass ionomer but are more closely related to composites with the glassionomer setting reaction occurring slowly as moisture is absorbed into the set resin matrix.

The use of RMGIs for luting purposes is becoming more popular because of their relatively high bond strength to dentine, and their ability to form a very thin film

layer. RMGIs leach fluoride, but it is unclear how useful this is in preventing secondary caries formation.

Advantages:-

1. Good compressive and tensile strengths (if correctly proportioned).
2. Reasonable working time.
3. Resistant to water dissolution.
4. Fluoride release.

Disadvantages:-

1. Short track record.
2. May expand and crack overlying porcelain because of water absorption.

Recommendations:-

- ☒ Worth trying for metal or metal ceramic crowns especially where preparation retention is border line.
- ☒ Currently unclear which RMGI cements can be used safely with ceramic crowns.

Conclusion: no one cement material is perfect. Selection of luting agent to be used for a given restoration should be based on a basic knowledge of the materials available, the type of restoration to be placed, the requirements of the patient and the expertise & experience of the clinician.
The selection of cement for placement of **cast restoration** is not clear cut decision. Zinc phosphate cement is mainly used Because of its long-time use and excellent clinical performance.
Resins are useful for **all-ceramic, veneers** and for metal or metal-ceramic restorations where retention and resistance form is compromised.

Plain ZnOE Cements based on zinc oxide and eugenol, is classical soft cements. is **not used for permanent cementation** because:

1. It has poor oral durability due to continuous eugenol loss.
2. Also it possesses low compressive strength, so we use it for temporary cementation.

To improve the properties of ZOE, modified ZOE cement was introduced by adding 2-ethoxybenzoic acid (EBA),aluminum oxide and PMM

Cementation Technique

Cementation procedure for ZPC:

1. Remove the temporary crown, cleaning of the prepared tooth from any residues of cement.
2. Isolate the prepared tooth or teeth with cotton roll (dry field of operation).

3. Partial protection of pulp can be provided by application of two layer of cavity varnish.
4. Start mixing cement, mix slowly and over a wide area on a cool glass slab to insure that a maximium amount of powder can be incorporated to reduce acidity.
5. Apply a coating of the cement to the inside of clean dry casting restoration, if there is any internal prep. Features such as grooves or boxes apply some cement on these areas of prep.
6. Seat the casting crown on the tooth with pressure and have the patient to apply force to the occlusal surface of the casting by biting on wooden stick or cotton roll for 3-4 minutes (to ensure complete seating).

7. After cement setting, remove any excess cement from the interproximal area, gingival cervix and underneath the bridge using dental probe and dental floss.
8. Check occlusion

(Definition, Classification, Principles)

DEFINITION OF TOOTH PREPARATION

Tooth preparation is defined as the mechanical alteration of a defective, injured, or diseased tooth to best receive a restorative material that will reestablish a healthy state for the tooth with normal form and function

OBJECTIVES OF TOOTH PREPARATION

In general terms, the objectives of tooth preparation are to:

-To remove diseased tissue as necessary

-To restore the integrity of the tooth surface

-To restore the function of the tooth- (**so that under the force of mastication the tooth or the restoration or both will not fracture and the restoration will not be displaced**

-To restore the appearance of the tooth-

NOMENCLATURE: Nomenclature refers to a set of terms used in communication by persons in the same profession that enables them to better understand one another**.**

CARIES TERMINOLOGY

Dental caries is an infectious microbiologic disease that results in localized dissolution and destruction of the calcified tissues of the teeth.

Morphologic types of caries:

Carious lesions originating:

(1) on enamel pits and fissures,

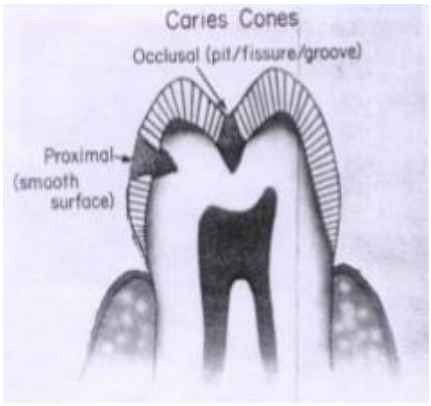
(2) on enamel smooth surfaces, or

(3) on root surfaces (Senile caries).

1-Caries of Pit-and-Fissure Origin. The caries forms a small area of penetration in the enamel at the bottom of a pit or fissure and does not spread laterally to a great extent until the *dentinoenamel junction (DEJ)* is reached. In diagrammatic terms, pit-and-fissure caries may be represented as

two cones, base to base, with the apex of the enamel cone at the point of origin and the apex of the dentin cone directed toward the pulp.

2-Caries of Enamel Smooth-Surface Origin. The disintegration in the enamel in smooth-surface caries also may be pictured as a cone, but with its base on the enamel surface and the apex at, or directed to, the DEJ. The caries again spreads at this junction in the same manner as in pit-and-fissure caries. Thus, the apex of the cone of caries in the enamel contacts the base of the cone of caries in the dentin. (Double inverted cone).



TOOTH PREPARATION TERMINOLOGY:A tooth preparation is termed

1-simple if a tooth preparation only one tooth surface is involved

2-compound if a tooth preparation two surfaces are involved

3-complex if a tooth preparation involving three (or more) surfaces

Abbreviated Descriptions of Tooth Preparations. the description of a tooth preparation is abbreviated by using the first letter, capitalized, of each tooth surface involved. Examples are:

(1) an occlusal tooth preparation is an O; (2) a preparation involving the mesial and occlusal surfaces is an MO; and (3) a preparation involving the mesial, occlusal, and distal surfaces is an **MOD.**

Tooth Preparation Walls

Internal Wall. An internal wall is a prepared (cut) surface that does not extend to the external tooth surface (Fig. 10).

Axial wall. An axial wall is an internal wall parallel with the long axis of the tooth (see Fig. 10).

Pulpal wall. A pulpal wall is an internal wall that is both perpendicular to the long axis of the tooth and occlusal of the pulp.

External Wall. An external wall is a prepared (cut) surface that extends to the external tooth surface, and such a wall takes the name of the tooth surface (or aspect) that the wall is toward (see Fig. 10).

Floor (or Seat). A floor (or seat) is a prepared (cut) *wall* that is reasonably flat and perpendicular to the long axis of the tooth). Examples are the pulpal and gingival walls.

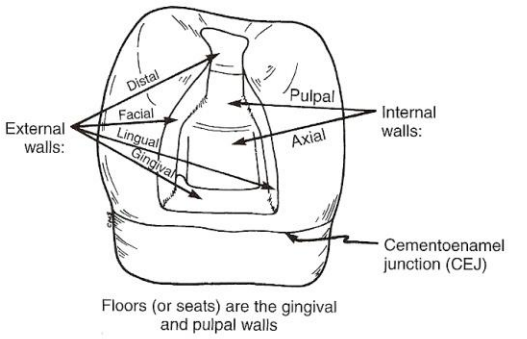


FIG 6-10 Illustration indicating external and internal walls.

Tooth Preparation Angles: the junction of two or more prepared (cut) surfaces is referred to as an angle

Line Angle. A line angle is the junction of two planal surfaces of different orientation along a line. An internal line angle is a line angle whose apex points into the tooth. An external line angle is a line angle whose apex points away from the tooth

Point Angle. A point angle is the junction of three planal surfaces of different orientation.

Cavosurface Angle and Cavosurface Margin. The cavosurface angle is the angle of tooth structure formed by the junction of a prepared (cut) wall and

the external surface of the tooth.The actual junction is referred to as the cavosurface margin.

Proximal surface: is the surface that face the adjacent tooth

Marginal ridge: border the lingual surface of anterior teeth and the occlusal surfaces of posterior teeth

DENTAL ROTARY AND HAND INSTRUMENTS

Lec. 2

د. العلاء جمال

The removal and shaping of tooth structure are essential aspects of restorative dentistry. Initially this was a difficult process accomplished entirely by the use of

- Hand instruments.
- Rotary, powered cutting instruments.

Hand instruments

Definition:

It is hand-powered dental instruments.

- G.V. Black is credited with the first acceptable nomenclature and classification of hand instruments. His classification system enabled both dentists and manufacturers to communicate more clearly and effectively in regard to instrument design and function.
- For many years, carbon steel was the primary material used in hand instruments because they were harder and maintained sharpness better than stainless steel.
- Stainless steel is now the preferred material because stainless steel instrument remains bright with steam or dry heat sterilization, and because the properties of stainless steel have improved by incorporating a significant amount of chromium imparts corrosion resistance and carbon imparts hardness.
- Hand instruments used in operative dentistry may be categorized as:

1. Cutting instruments and,
2. Non cutting instruments.

Cutting instruments

These instruments are used to cut hard or soft tissue of the mouth.

Hand cutting instruments are composed of three parts: handle, shank and blade (Fig 1).

For non cutting instruments; the part corresponding to the blade is termed the nib or working end.

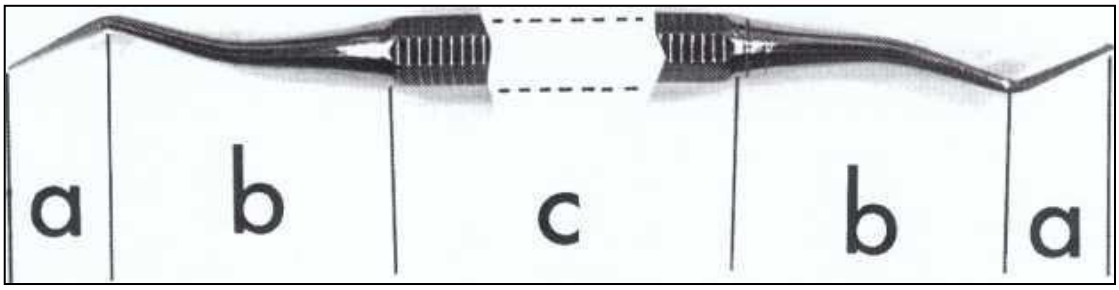


Fig. (1) Double-ended instrument illustrating three component parts of hand instrument: blade (a), shank (b), and handle (c)

- **The blade or nib;** is the working end of the instrument and is connected to the shank. Some instrument have a blade on both ends of the handle and are known as double ended instrument. The blades have many designs and sizes, depending on the function they are to perform.
- **The Shank;** serves to connect the handle to the blade of the instrument. The shank may be straight, mon-angle (with one angle), bin-angle (with two angles) , triple-angle (three angles) , or quadr-angle (four angles) as in Fig(3&4&5).

  The term contra-angle refers to shank in which two or more angles are present.

  The angles in the shank are important to keep the blade edge within 1-2 mm to the long axis of the instrument. This is a basic factor to concentrate the force onto the blade for balancing the instrument during use and prevent its rotation
- **The Handle;** is the part that is grasped by the operator hand while he is using the instrument.

Instrument Formula Given by G.V.Black:

3 Number instrument formula: Cutting edge of the Instrument is at a right angle to the blade.

a. First number- Width of the blade in tenths of a millimeter.
b. Second number - Length of the blade in millimeter.
c. Third number - Angle the blade forms with the axis of the handle in centigrade.

Example: Enamel hatchet. Fig2

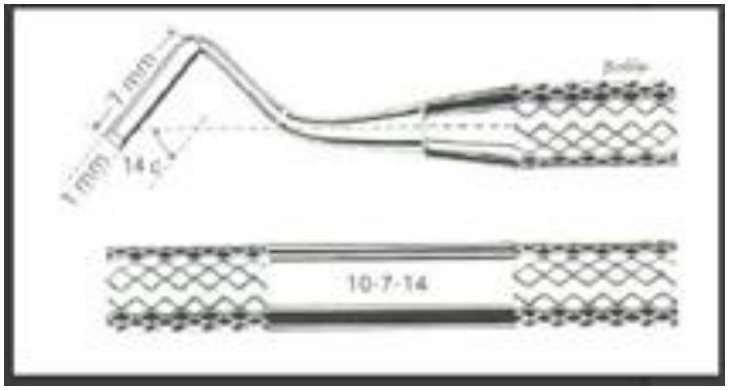


Fig (2): Enamel hatchet formula

4 Number instrument formula: Cutting edge of the instrument is at an angle other than a right angle to the blade.

a. First number - Width of the blade in tenths of a millimeter.
b. Second number - Angle the cutting edge forms with the axis of the handle in centigrade.
c. Third number - Length of the blade in millimeter.
d. Fourth number - Angle the blade forms with the axis of the handle in centigrade.

Example: Gingival marginal trimmer & angle former. Fig3

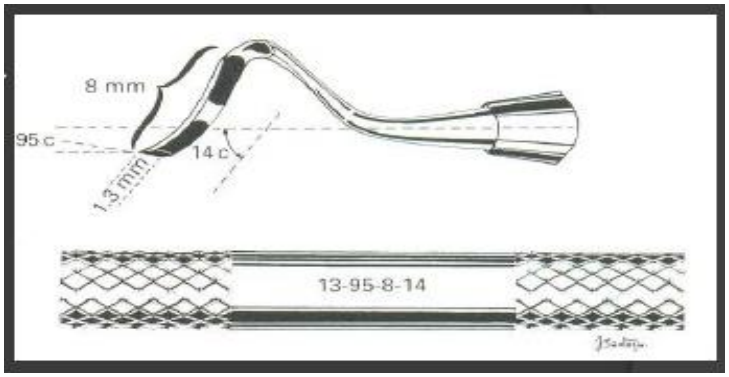


Fig3 Gingival marginal trimmer formula

Examples of the cutting instruments are:

1. **Chisel: -** either has a straight shank or with slight blade curvature or bin-angle chisel, and the blade has bevel only on one side of the edge. Its cutting edge is perpendicular to the axis of the handle. The chisels are used for cutting enamel and dentin with pushing motion. The shank and blade of the chisel. (Fig. 4 A , B, C).

2. **Hoe: -** It is like chisel with cutting edge is perpendicular to the axis of the handle (Fig. 4 D), however its blade has a greater angle from the long axis of the handle than does that of the chisel. It has the same uses of the chisel.

3. **Hatchet: -** also called enamel hatchet. The cutting edge of the hatchet is parallel to the long axis of the handle and beveled only from one side (Fig. 5 A). It is used for cutting enamel and dentin and comes as right or left types for using on opposite sides of the preparation.

4. **Gingival margin trimmer: -** This instrument is used for beveling of the gingival enamel margin of proximo-occlusal preparations. Also it is used for beveling of axiopulpal line angle of two surface preparation as in class II cavities.

It is similar in design to the hatchet, except the blade is curved, and cutting edge is at an angle (other than parallel) to the long axis of the blade (Fig. 5, B and C). It is made as right and left types. Also it is made either a mesial pair or a distal pair.

5. **Spoon excavator:-** The blade is curved and the cutting edge at the end of the blade is in the form of a semicircle. This gives the instrument an outer convexity and inner concaving that makes it looks like a spoon Fig. (6). Like the hatchet the cutting edge at the end of the blade is parallel to the handle, therefore there are left cutting and right cutting spoons. The shank of some spoons holds a small circular (disk blade) or claw – like blade at its end. The disk blade is known as a discoid, where the claw - like blade is termed a cleoid (Fig 7, A and B).

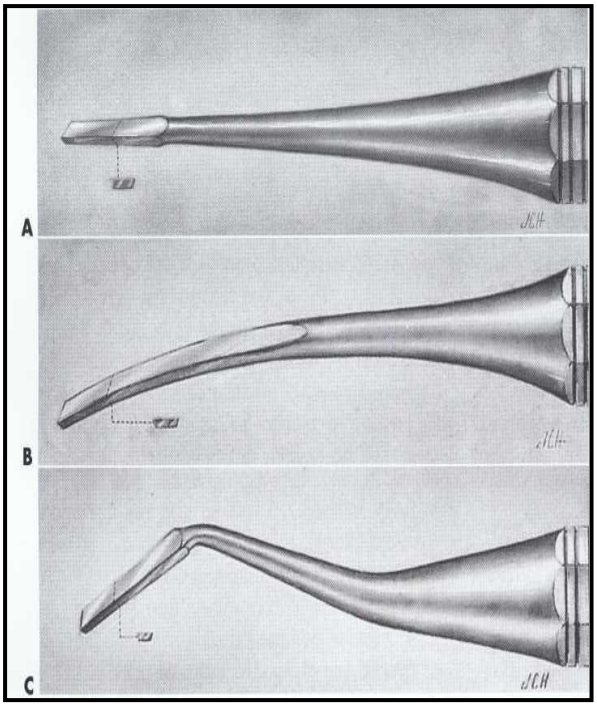
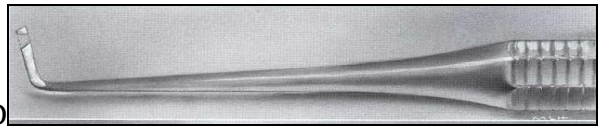


Fig . (4) Examples of hand instrument called chisels (with corresponding instrument formulas). A, Straight (12-7-0). B, Wedelstaedt (11'/2-15-3). C, Bin-angle (10-7-8) , D,Hoe.

D 

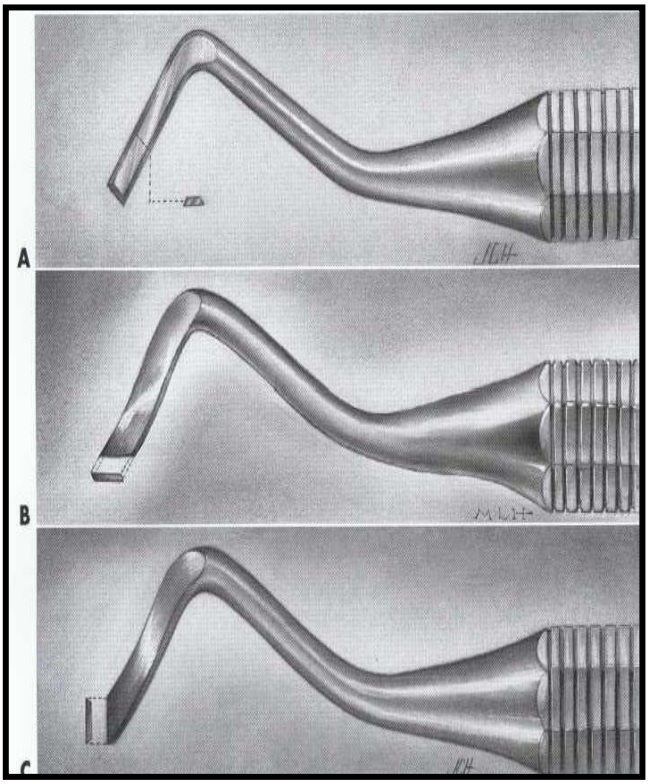


Fig .(5) Examples of hand cutting instrument (with corresponding instrument formulas). A, Enamel hatchet (10-7-14). B, Gingival margin trimmer (12 1/2-100-7-14). C, Gingival margin trimmer (12'/2-75-7-14).

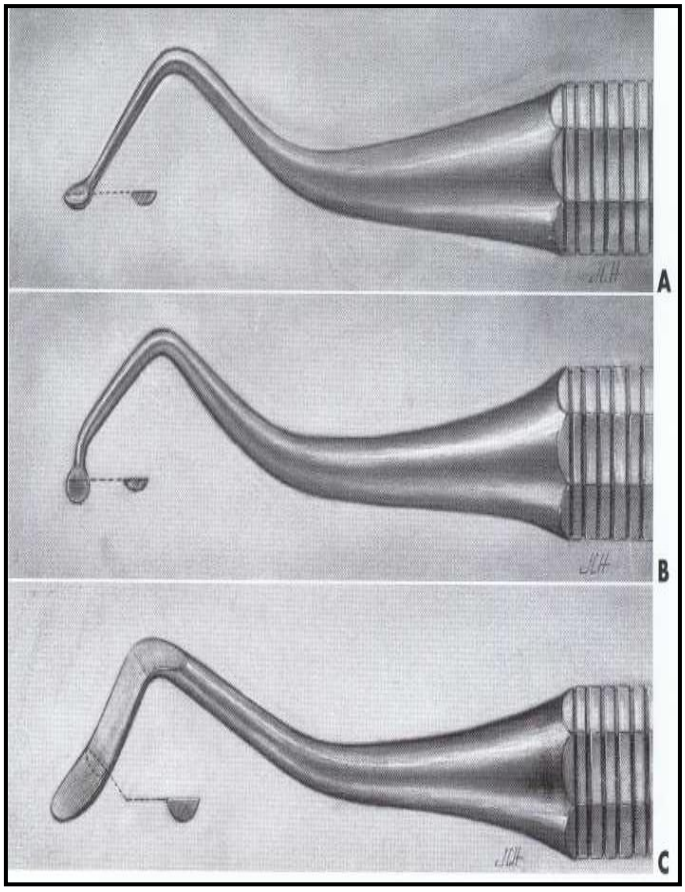
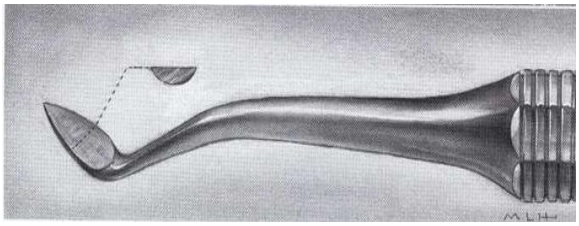


Fig. (6) Examples of hand instrument called spoon excavators (with corresponding instrument formulas). A, Binangle spoon (13-7-14). B, Triple-angle spoon (13-7-14). C, Spoon (15-7-14).



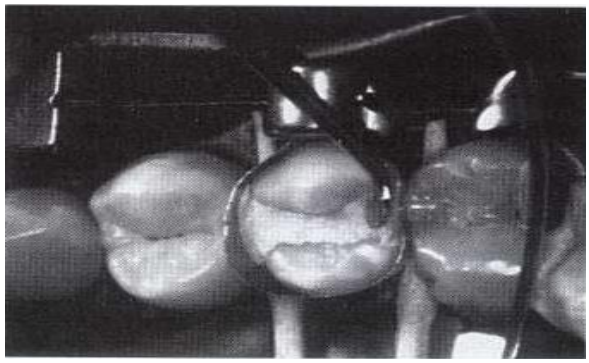


Fig . (7) Examples of other hand instrument for cutting (spoons) 1st picture is Cleoid blade.
2nd picture is Discoid blade carving amalgam.

Non-cutting instruments

In these instruments the blade is replaced by a nib or point. These are divided according to **function** into: -

1- Diagnostic instruments

2- Plastic instruments

3- Amalgam instruments

Diagnostic instruments

These are basic instruments that will be needed during each appointment for diagnosis and treatment.

1. **Mirror**: used for:

- indirect visualization of any tooth surface that cannot be seen by the eye.
- reflection of light into the area being examined or treated.
- retractor of soft tissue (tongue, cheek and lip) to aid access and visualization.

2. **Probe or explorer:** pointed instruments used:

- to feel tooth surface for irregularities
- to determine the hardness of exposed dentin and caries detection.

- Probes have different shapes either sickle, straight or angled

3. **Tweezer or cotton forceps**: used for aiding the operator to carry small items to the mouth of the patient.

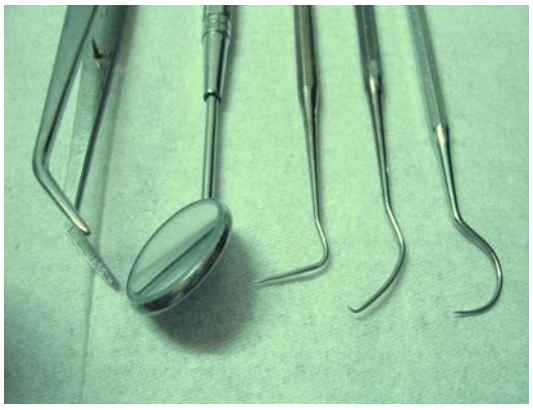


Fig. (8): diagnostic instruments

Plastic instruments: Or plastic filling instrument are used to:

- carry and shape tooth colored restorative material such as composite resin and glass ionomer.
- packing temporary filling material inside unfilled cavities preparation.
- or for placing of basing and lining material into the cavities. In past these instruments are made of plastic.

Ash 49: - is double ended instrument with cylindrical nibs and rounded ends. Fig. (9): A

Ash 6: - is one of plastic instrument similar to carver but the margin of its working end is not sharp. Fig. (9): B

Dycal applicator: - is small hand instrument with small round nib used for mixing and placing dycal lining material in the cavity. Fig. (9): C

Cement spatula: - it is used for mixing variety of material which required mixing (such as cement or temporary filling material) on glass or on a paper pad. Fig. (9): D

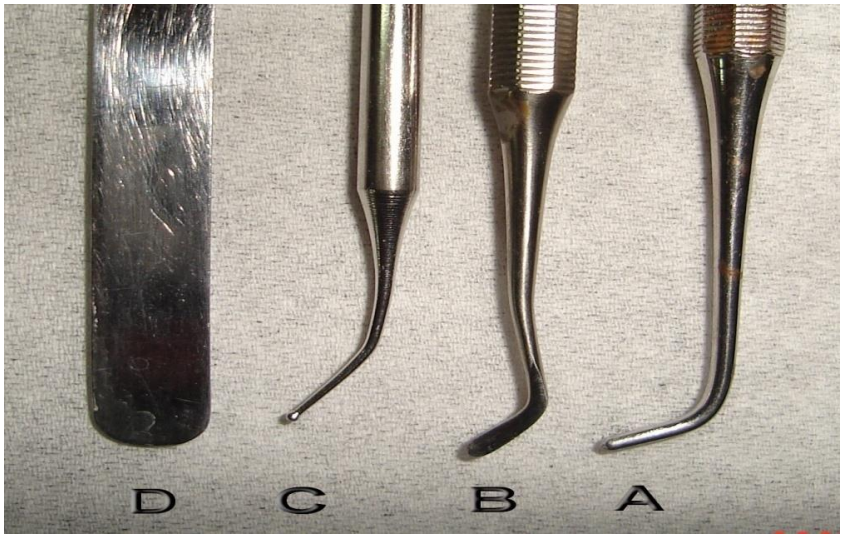


Fig.(9): Plastic instruments

Amalgam instruments

Those instruments used to place dental amalgam, and to a certain extent, resin composite restorative material.

Condensers: - condensers are used to compress the amalgam into all areas of the prepared cavity. The working end or nib of the condenser is usually round with flat end (face). The nibs have different shapes triangular, rectangular or diamond shape ends.

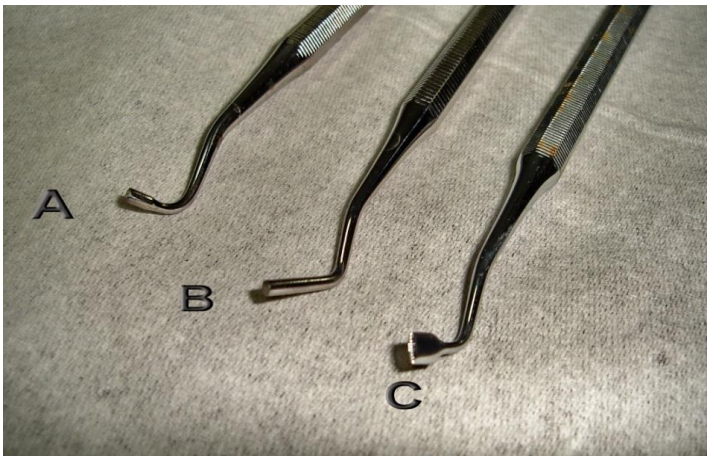


Fig.(10): Condenser

Burnisher: It have different nib shapes: round, oval or rounded cone shapes, also with different sizes, used for several functions such as;

- burnishing of the amalgam on the margins of the cavity.
- smoothing of the carved amalgam surface.
- shaping metal matrix band to have more desirable contours for restoration.
- bend cast gold restoration (inlay or onlay) near the margin of the prepared cavity to narrow the gap between gold and the tooth.

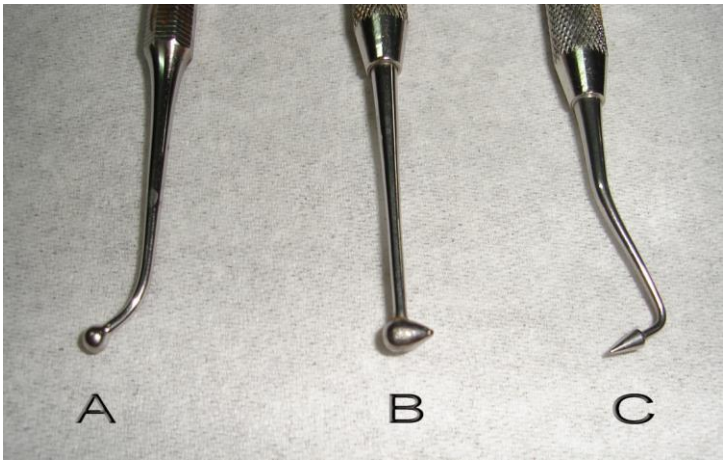


Fig.(11):Burnisher

Carver: - carvers are used to shape amalgam or resin composites (tooth colored) material after they have been placed in the tooth preparations. Carvers have many shapes but usually the nibs are flat with sharp margins for carving.

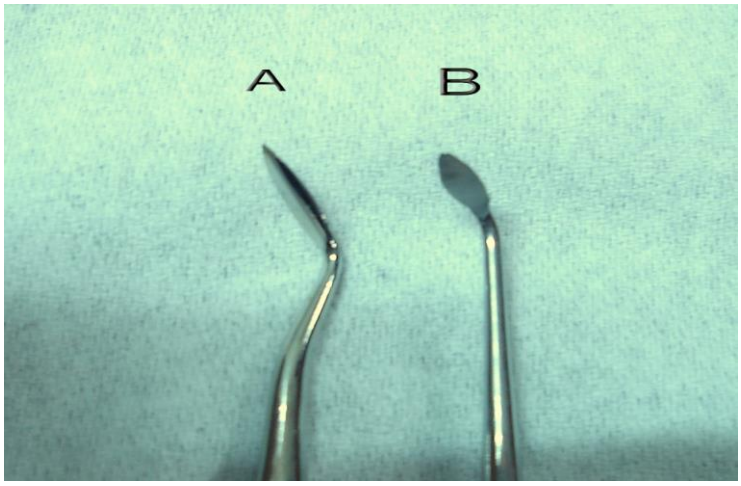


Fig.(12): Carver

Amalgam carrier:- used to carry the amalgam and place into the prepared cavities.

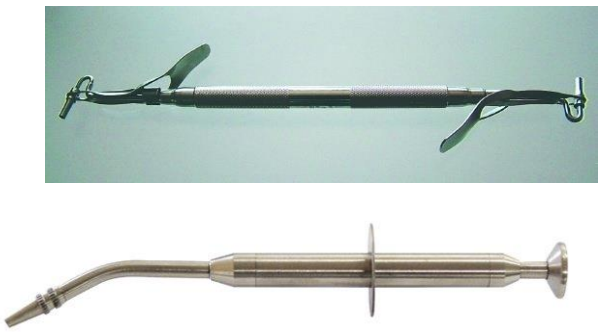


Fig.(13): Amalgam carrier

Hand instrument grasping

1. Pen grasp: - It is similar to that used in holding a pen. Pads of the thumb, index and middle fingers hold the instrument, while the tip of the ring finger , or tips of ring and little fingers, is placed on a nearby tooth surface of the same arch as arrest. The palm of the hand generally is facing away from the operator.

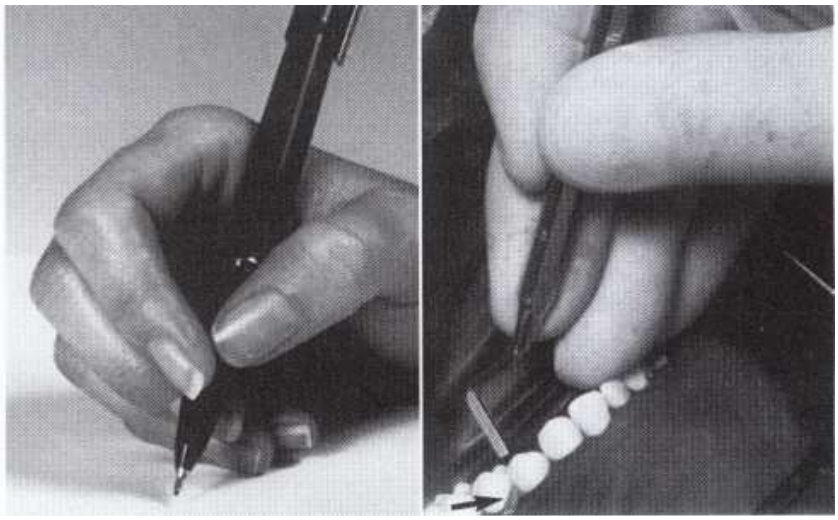


Fig. (14): Pen grsp

2. Inverted pen grasp: - The finger position is the same as of pen grasp, but the hand is rotated so that the palm more toward the operator. This grasping is used mostly for preparing of upper teeth with indirect viewing technique.

Fig.(15) : Inverted pen grasp

Palm and thumb grasp: - The handle of the instrument is placed in the palm of the hand and grasped by all fingers, while the thumb is free of the instrument and used for resting on a nearby tooth of the same arch

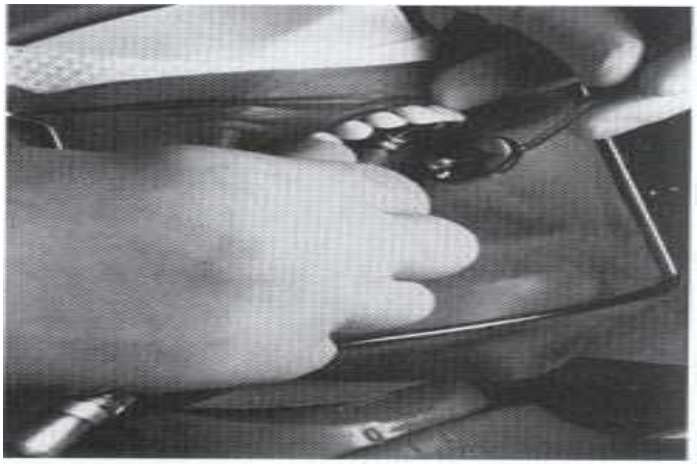


Fig (16):Palm and thumb grasp

Rotary instruments:-

Handpieces:-

Two basic types of handpieces:

- Straight handpiece: used for laboratory work

- contra angle handpiece: used in the mouth.

The contra – angle handpiece are classified according to their speed of rotation into:-

Low speed handpiece: have a free running speed range from 500 to 15,000 rpm (revolution per minute).

- used for removal of carious dentin with round bur rotating slowly.
- used with different bur shapes to finish the prepared cavity (e.g. rounding of sharp edges, or flatting of the floor).
- used in finishing and polishing of restorations.

High speed handpiece: - have a free running speed above 160,000 rpm and some have speed up to 500,000 rpm.

- Preferred for cutting enamel and dentin.
- Penetration through enamel and extension of the cavities outline are more efficient at high speed.
- Small diameter burs should be used in the high speed handpiece. High speed generates considerable heat during cutting, even with small diameter burs and should be used with water coolant and high efficiency evacuation.

Burs:-

A group of instruments that can turn on an axis with different speed of rotation to perform different types of work.

- Its work are either cutting , abrasive, finishing or polishing.

-Burs used for cutting are manufactured from different materials, which may be stainless steel, carbide or diamond.

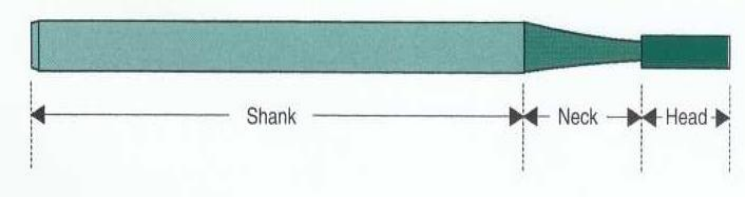
- The burs have hundreds of shapes and sizes.

Parts of bur:

Shank is the part that fit into the handpiece, accepts the rotation motion from handpiece, and which the bur is locked inside the handpiece head.

Neck is the part of the bur that connects the head to the shank.

Head is the working part of the bur which contains the cutting edges or points.



Burs are classified according to the shapes of their heads.

The basic ***bur shapes*** are:

Round bur: the head is spherical so it is used for initial entry into the tooth, preparation of retentive holes or for removal of carious dentin.

Inverted cone bur: the head is a cone – shape with the apex of cone directed toward the bur shank. This bur is used for flatting the floor of the cavity, increasing the depth of cavity or for providing undercuts in cavities preparation.

Fissure bur: is an elongated cylindrical head bur used for obtaining the outline form of the cavity and to cut walls, floor, or margins of the cavity, its either straight or tapered.

Sterilization in Operative Dentistry

د.العلاء

Is a term referring to any process that eliminates (removes) or kills all forms of microbial life, including the resistant bacterial spores using physical or chemical means. Sterilization in dentistry is a very important and crucial aspect of providing successful dental treatments. Since most instruments contact mucosa and/or penetrate oral tissues, it is essential that reused instruments be thoroughly cleaned and sterilized by accepted methods that can be routinely tested and monitored.

DISINFECTION:

A much lesser term of sterilization and indicate procedure offering variable measures of control of infection, in this way we not going to kill all living microorganism may viruses kept survive.

Classification of sterilization

♦ PHYSICAL METHODS
♦ CHEMICAL METHODS
♦ COMBINATION OF BOTH

Physical methods	*Chemical methods*
Moist heat	Alcohols
Dry heat	Aldehydes
Filtration	Halogens
Radiation	Phenols

Methods of sterilization

There are four accepted methods of sterilization:

1. Steam pressure sterilization (autoclave)
2. Chemical vapor pressure sterilization (chemi-clave)
3. Dry heat sterilization (dryclave)
4. Ethylene oxide sterilization

1. STEAM PRESSURE STERILIZATION (AUTOCLAVING)

Sterilization with steam under pressure is performed in a steam autoclave. For a light load of instruments, the time required at 250° F (121° C) is a minimum of 15 minutes at 15 psi pressure.

Time for wrapped instruments can be reduced to 3 minutes if the temperature is raised to approximately 273° F (134° C) to give 20 psi of pressure. Time required for the sterilizer to reach the correct temperature is not included.

Instruments which are sterilized by using autoclave is

Handpieces, orthodontic pliers, impression trays, and surgical instruments.

Advantages of autoclaves

1- Autoclaving is the most rapid and effective method for sterilizing cloth surgical packs and towel packs.

2- Economical

3- Good penetration on all surfaces.

4- Short procedure time

5- Easily monitored

Disadvantages of autoclaves

1- Items sensitive to the elevated temperature cannot be autoclaved.

2- Autoclaving tends to rust carbon steel instruments and burs.

3- Steam appears to corrode the steel neck and shank portions of some diamond instruments and carbide burs.

4- Dulling of unprotected cutting edges.

2. CHEMICAL VAPOR PRESSURE STERILIZATION (CHEMICLAVING)

- Sterilization by chemical vapor under pressure is performed in a Chemiclave.
- Chemical vapor pressure sterilizers operate at 270° F (131° C) and 20 lbs pressure.
- They are similar to steam sterilizers and have a cycle time of about half an hour.
- Like ethylene oxide sterilizers, they must be used with a prescribed chemical by

the manufacture.

- **Instruments which are sterilized by using chemiclave is:**
  - ❑Periodontal, restorative and endodontic instruments
  - ❑ Carbon steel and other corrosion sensitive burs and pliers

Advantages of Chemiclaves

Carbon steel and other corrosion-sensitive burs, instruments, and pliers are said to be sterilized without rust or corrosion.

Disadvantages of Chemiclaves

1- Items sensitive to the elevated temperature will be damaged.
2- Instruments must be lightly packaged in bags obtained from the sterilizer manufacturer.
3- Towels and heavy cloth wrappings of surgical instruments may not be penetrated to provide sterilization.

3-DRY HEAT STERILIZATION (hot air ovens)

It is the most widely used method of sterilization by dry heat. Dry heat sterilization is readily achieved at temperatures above 320° F (160° C) for 1-2 hours. The oven is electrically heated and is fitted with a fan to ensure adequate and even distribution of hat air in the chamber. It is also fitted with a thermostat that maintains the chamber air at a chosen temperature.

Instruments which are sterilized by using hot air oven are :

❑ Endodontic instruments
❑ Condensers
❑ Hand instruments
❑ Orthodontic pliers
❑ Surgical instruments
❑ Burs

Advantages of dry heat

1- Carbon steel instruments and burs do not rust, corrode, or lose their temper or cutting edges if they are well dried before processing.
2- Economical.
3- Easily monitored.

Disadvantages of dry heat

1- High temperatures may damage more heat-sensitive items, such as rubber or plastic goods.

2- Sterilization cycles are prolonged at the lower temperatures.

3- Heavy loads of instruments, crowding of packs, and heavy wrapping easily defeat sterilization.

4-Hot air is bad conductor of heat hence it has less penetrating power.

4 - Ethylene Oxide sterilization

Ethylene oxide sterilization is the best method for sterilizing complex, heat sensitive instruments and delicate materials like rotary handpiece. Ethylene oxide is a gas at a temperature below 100°C. It is highly explosive and inflammable. It is highly penetrative, non-corrosive agent with a bactericidal action. It is used for the sterilization of towels, metal and plastic instruments.

LIQUID STERILANTS/HIGH-LEVEL DISINFECTANTS

. Sterilants used for high-level disinfection of items for reuse are glutaraldehydes at 2% to 3% concentrations; it kills bactereial spores in 6-10 hours.

· Greater dilutions are not encouraged for repeated use.

· Placing wet items into disinfectant trays dilutes the solution.

· Glutaraldehydes are irritating, sensitizing to skin and respiratory passages, and can be toxic as indicated in manufacturers' safety data sheets.Keep trays tightly covered in a well-vented area.

· *Do not use 2% glutaraldehyde solutions to wipe counters or equipment* (e.g., dental unit and chair).

Infection control program in minimum dental office

1.Sterilization of instruments

2.Comprehensive medical history

3.Hepatitis B vaccine to prevent any cross infection

4.Antiseptic and mouthwash

5.Disposal mask and gloves

6.Protective eye glass

7.Rubber dam

8.Surface cleaning and cover tray

9.Needle and sharp instrument safety

DENTAL INSTRUMENTS CLASSIFICATION

based on risk of transmission and need of sterilization
-CRITICAL
-SEMI-CRITICAL
-NON-CRITICAL

Category	Definitions	Dental instrument or item	Type of sterilization
Critical	Penetrate soft tissue, contact bone, enters into or contacts the blood stream	Surgical instruments, periodontal scalers, scalpel blades, surgical dental burs.	HEAT STERILIZE between uses or use sterile single-use, DISPOSABLE devices
Semicritical	Contact mucous membranes or non intact skin, will not penetrate tissue, contact bone, enter into or contact blood stream.	Dental mouth mirror, amalgam condenser, reusable dental impression trays, dental handpieces	HEAT STERILIZE or HIGH-LEVEL DISINFECT
Noncritical	Contact intact skin	Radiograph head\cone, blood pressure cuff, facebow	Clean and disinfect using a LOW TO INTERMEDIATE LEVEL DISINFECTANT

Stages for instrument sterilization

►Presoaking - Placing the instrument in a presoak solution until time is available for full cleaning prevents drying and begins to dissolve or soften the debris. Presoak solutions used are detergents

►Cleaning - Clean instruments in an ultrasonic cleaner (preferred), instrument washer, or by hand while wearing proper protection. Ultrasonic cleaners are safest and most efficient ways to clean instruments, ultrasonic cleaning is 9 times more effective than hand cleaning ,it provides fast and thorough cleaning without damage to instruments.

►Packaging - Place instruments in a sealed package or pouch, unless you're going to use them immediately after sterilization.

►Sterilization- Sterilize instruments using steam autoclaving, dry-heat, or chemical vapor machines.

►Drying or cooling- Store Instruments in a Dry, Protected Area

CLEANING AND DISINFECTION OF DENTAL UNIT AND ENVIRONMENTAL SURFACES

- Countertops and dental unit surfaces that may have become contaminated with patient material should be cleaned with disposable toweling, using an appropriate cleaning agent and water as necessary.

-Surfaces then should be disinfected with a suitable chemical germicide. Including: phenolics, iodophors, and chlorine-containing compounds.

-A fresh solution of sodium hypochlorite (household bleach) prepared daily is an inexpensive and effective intermediate-level germicide. Concentration (1/4 cup of bleach to 1 gallon of water) is effective on environmental surfaces that have been cleaned of visible contamination. Caution should be exercised, since chlorine solutions are corrosive to metals, especially aluminum.

DISINFECTION OF THE DENTAL LABORATORY

Laboratory materials and other items that have been used in the mouth (e.g., impressions, bite registrations, fixed and removable prostheses, orthodontic appliances) should be cleaned and disinfected before and after being manipulated in the laboratory, whether an on-site or remote location and before placement in the patient's mouth.

STERILISATION OF HANDPIECES

After each patient use,

► run any handpiece that is connected to the dental air/water system, to discharge water and/or air for at least 30 seconds

► Leave the bur in place while you clean the outside of the handpiece with detergent and warm water.

►Sterilize in an autoclave.

►If recommended by the manufacturer, lubricate the handpiece with pressurized oil until clean oil appears from handpiece.

Some dental instruments have components that are heat sensitive or are permanently attached to dental unit water lines. Some items may not enter the patient's oral cavity, but are likely to become contaminated with oral fluids during treatment procedures, including, for example, handles or dental unit attachments of saliva

ejectors, high-speed air evacuators, and air/water syringes. These components should be covered with disposable covers that are changed after each use or, if the surface permits, carefully cleaned and then treated with a chemical germicide having at least an intermediate level of activity.

DISPOSAL OF WASTE MATERIALS

►Blood, suctioned fluids, or other liquid waste may be poured carefully into a drain connected to a sanitary sewer system.

►Disposable needles, scalpels, or other sharp items should be placed intact into puncture-resistant containers before disposal.

►Solid waste contaminated with blood or other body fluids should be placed in sealed, sturdy impervious bags to prevent leakage of the contained

Conservative dentistry

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Lec: 4

Classification of Cavity

1. **According to tooth surface involvement**:

   Simple cavity: cavity involve only one surface of the tooth Ex: occlusal cavity (O) CL I.

   Compound cavity: cavity that involved two surfaces Ex: mesio-occlusal (MO) CLII.

   Complex cavity: cavity involves three or more surfaces.

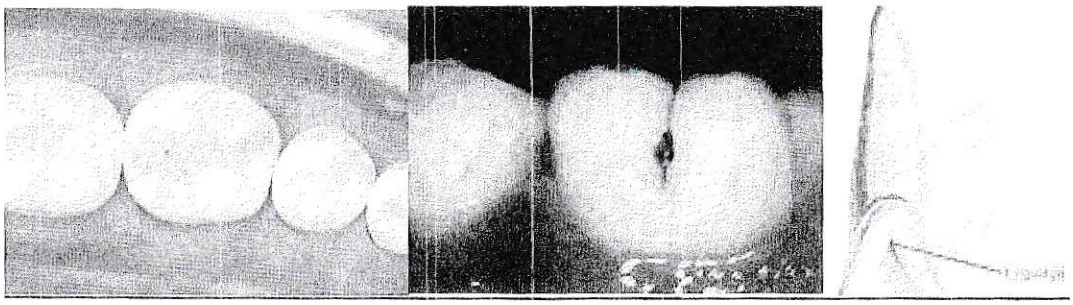
2. **According to site involved:**

   Site 1: pits, fissure and enamel defects on occlusal surfaces of posterior or other smooth surfaces.
   Site 2: proximal enamel in relation to areas in contact with adjacent teeth.
   Site 3: the cervical one third of the crown or following gingival recession and the exposed root surface.

3. **According to G.V. Black:**

   CLI restorations: these restorations are used in CL I lesions the following surfaces are involved:

   - Occlusal pits and fissures of premolars and molars fig 1a.
   - Facial & lingual pits and fissures of mandibular molars fig 1b.
   - Palatal pits of maxillary incisors, most frequently in the pit near the cingulum.

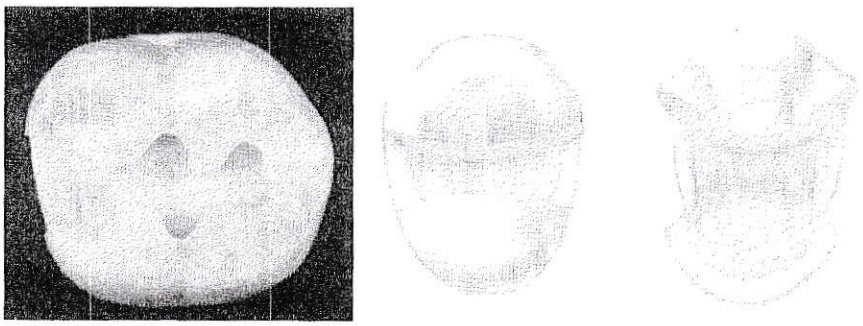


A b c

Fig 1: Cl I

CL II restorations: is the extension of CLI restoration into the proximal surfaces of premolars and molars, the following surfaces are involved:

- Two surface restoration of posterior teeth fig 2a.
- Three surface restoration of posterior teeth fig 2b.
- Four surface (or more) restoration of posterior teeth fig 2c.



a b c

Fig 2. Cl II

CLIII: affects the interproximal surface of incisors and canines fig 3.

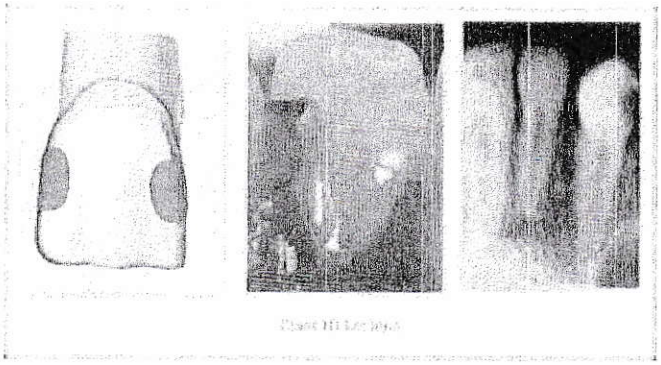


Fig 3: CL III

CLIV: involves a larger surface area, including the incisal edges and interproximal surface of incisors and canine fig 4.

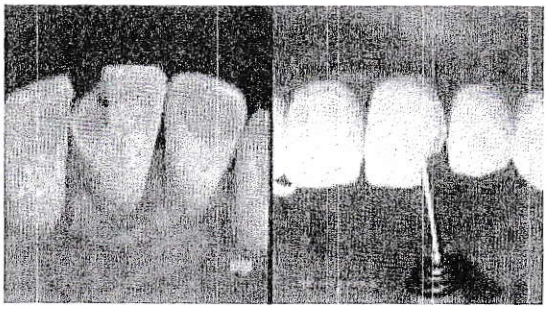


Fig 4: CL IV

CL V: - gingival third of the facial or lingual surfaces of any tooth.

Root of a tooth near the cemento-enamel junction fig 5.

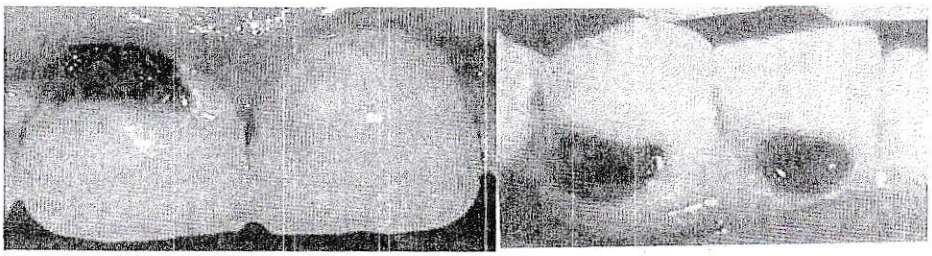


Fig 5: CL V

Cl IV: incisal edge of anterior teeth or on cusp tip of posterior teeth

Objectives of cavity preparation

1- To remove diseased tissue as necessary and at the same time provides the protection to the pulp.
2- To locate the margins of the restoration as conservative as possible.
3- To ensure the cavity form, it should not be under the force of mastication of the tooth.
4- To allow the functional placement of the restorative material.

Steps in the cavity preparation (Given by G. V. Black)

Obtain outline form.

Obtain resistance form

Obtain retention form.

Obtain convenience form.

Removal of remaining carious dentin.

Finishing of enamel walls & margins

Performing the toilet of the cavity

Class I cavity

1. **Establishing the outline form** means placing the preparation margins in the positions they will occupy in the final preparation, the typical features of establishing proper outline form and initial depth are:

- Width of the facio-lingual walls of the cavity should be ¼ I.C.D (inter-cuspal distance).
- Preserving marginal ridge strength (2mm thickness marginal ridge).
- The depth of the preparation into dentin should be 1.5-2mm.
- The extent of the caries lesion affects the outline form of the proposed tooth preparation because the **objective is to extend to sound tooth structure also** Ideal outline includes all pits & fissures even if its sound to prevent them from caries in the future **(extension for prevention).**

2. Resistance form

Is the shape of the cavity that enables both the tooth and restoration to withstand occlusal forces without fracture.

And this includes:

- Factors prevent fracture of the tooth
- The facio-lingual width of the preparation should not exceed 1\4 I.C.D fig 6.

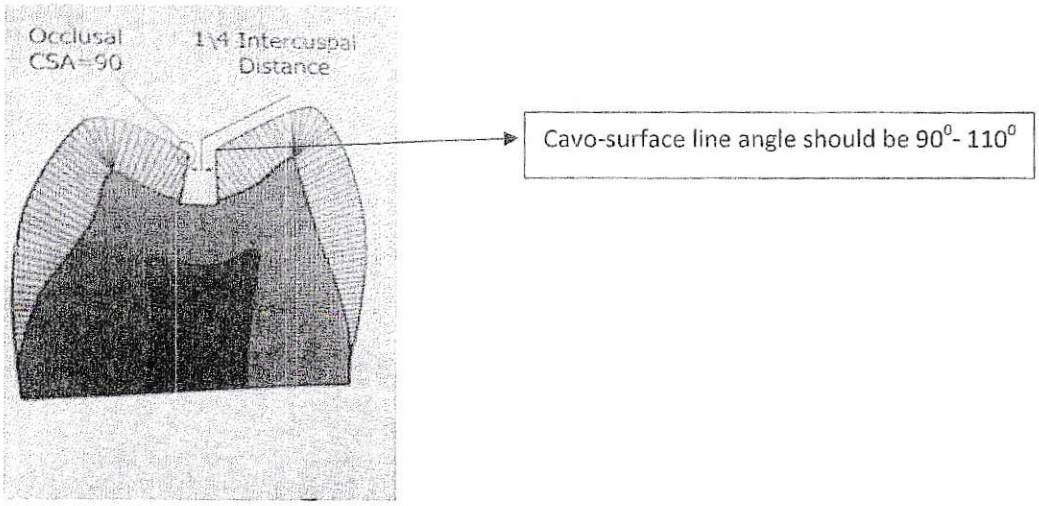


Fig 6: resistance means of CL I.

- Mesial & distal walls of the cavity should be parallel and slightly *diverge occlusally* to be within the enamel rod direction and prevent any unsupported enamel at the marginal ridge.
- All internal line angle should be rounded to prevent stress concentration area.

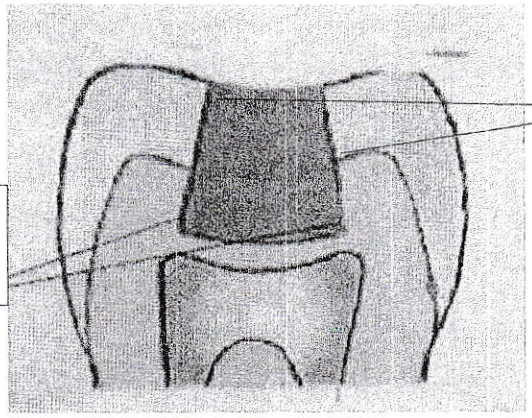


Fig 7

- Factors prevent fracture of restoration

- Facio-lingual width should be 1\4 I.C.D because large surface area exposed to more force and fracture occurs.
- Occlusal amalgam should have thickness of (1.5-2.0 mm) to resist fracture during function.

- Factors prevent fracture for both tooth and restoration:

- Removal of unsupported enamel by making the margin (90^0-110^0) because less than 90^0 the tooth is more subjected to fracture if more than 110^0 lead to fracture of restoration .
- Smooth pulpal floor to prevent stress concentration area.

3. **Retention form:** is the shape of the cavity that permits the restoration to resist displacement through the tipping or lifting force.

To provide retention the cavity has the following:

- Opposing wall of should be parallel to each other or *converge occlusally* (5^0) this convergence done on buccal and lingual wall fig 7.
- The floor of the cavity should be *flat* to prevent restoration movement.
- Outline form should be small as possible to prevent displacing force on it.
- Dove-tail preparation to increase retention.

4. Convenience form:

Is the shape of the cavity that allows an adequate observation, accessibility this achieved by giving good depth (1.5-2mm) and width (1\4) I.C.D

5. Removal of remaining caries

Deep dentinal caries can be removed by using spoon excavator or large round bur with slow speed hand piece.

6. Finish enamel walls

Involve making the wall smooth and removing of unsupported enamel.

7. Clean the preparation:

Removal of all debris by washing the cavity and drying it.

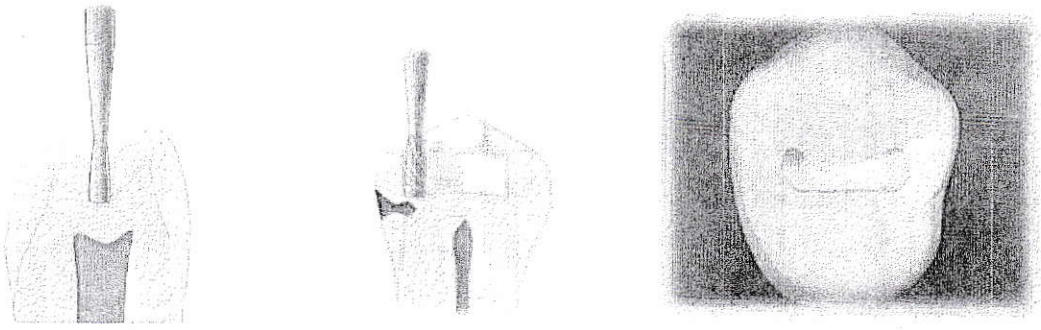
Clinically:

Occlusal outline form:

Enter the pit with a punch cut using no.245 bur fig 8 A, the long axis of the bur & the long axis of tooth crown should remain parallel during cutting procedures, the bur should be rotating when applied to the tooth and should not stop rotating until removed.

Proper depth of the initial entry cut is 1.5-2 mm.

While maintaining the same depth & bur orientation move the bur to extend the outline to include the central groove & the opposite pit fig 8 B which provided by dovetail retention form the isthmus width should be as narrow as possible & no wider than ¼ I.C.D, it may be necessary to tilt the bur to create facial, lingual slight occlusal convergence & mesial and distal walls to diverge occlusally.



A B C

Fig8: A. initial depth, B. bur position to begin the proximal ditch cut. C, Cl I cavity preparation

Buccal Pit Cavities:

The outline of these cavities usually describes a triangle with its base forming the gingival wall and its sides forming the mesial and distal walls, the gingival wall is placed at or slightly occlusal to the height of contour of the tooth.

- All walls are extended just enough to eliminate defective enamel and dentin.
- The enamel walls are planned in the direction of enamel rods and perpendicular to the axial wall.
- Hoe excavators are used to smooth the axial wall and make it parallel with the external surface of the tooth.
- It should be re-emphasizing that the shape of the cavity will be governed by the extension of caries, accordingly the outline of these cavities may be a rounded or oval in shape.

OUTLINE FORM FOR PIT RESTORATIONS

Occlusal pits of mandibular first premolars

Mandibular 1st. premolars have 2 exceptions:

1- We can made 2 separated cavity one on mesial occlusal pit &one on distal without including central fissure if this fissure not involved by caries because of the presence of well-developed transverse ridge &in order not to weakening the tooth unless the fissure is involved by caries so we have to include all pits &fissure in one class I preparation.

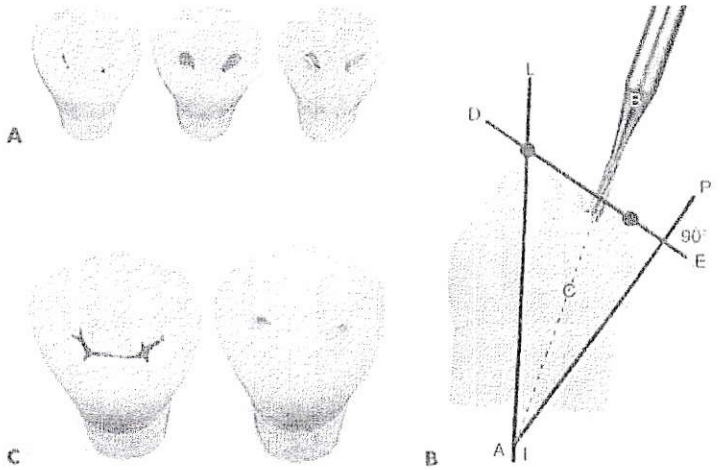
2- The buccal horn of pulp is higher than the lingual one .So according to this

when we prepare the cavity floor it should be inclined lingual (not flatted) in order not to harm the pulp.

To achieve this cutting instrument is held so that its long axis is parallel with bisector of angle formed by long axis of tooth and the line perpendicular to plane drawn through facial & lingual cusp point (see lower Fig)

All the principles of cavity preparation for class I as discussed previously

were applied here except *flattening of pulpal floor.*



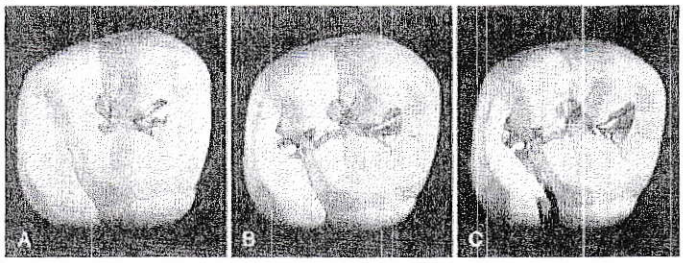
17-17 **A,** Preparation design and restoration of carious (or at risk for caries) occlusal pits on mandibular first premolar. **B,** Bur tilt for entry. Cutting instrument is held so that its long axis *(broken line, CI)* is parallel with bisector *(B)* of angle formed by long axis of tooth *(LA)* and line *(P)* that is perpendicular to plane *(DE)* drawn through facial and lingual cusp points. This dotted line *(CI)* is bur position for entry. **C,** Conventional outline, including occlusal pits and central fissure.

Cavity preparations for maxillary first molars

Upper 6 also had exceptions because of the anatomy of the tooth. The presence of oblique ridge in between distobuccal & mesiopalatal cusps gives the possibility to do 2 separated cavities one mesial &one distal without the need to include oblique ridge within the preparation unless it is involved by caries or weakened duo to cavity preparation in this case one outline cavity design extended from mesial pit through oblique ridge to distal pit were performed.

Buccal and Lingual Extensions:

- In case of occluso-buccal and occluso-lingual cavities extensions are made through the fissures and towards the respective surfaces.
- The cutting is done in dentin at the amelo-dntinal junction using a #56 fissure bur until the occdusal ridge is undermined and removed.
- If the caries is still gingival to the level of the pulpal seat, a step is indicated: a #330 or 56 but is used to cut the dentin at the amelo-dentinal junction, applying pressure in a gingival direction and at the same time moving the bur mesio-distally.
- The enamel thus undermined, is broken down with chisels.
- Retention grooves are then cut in dentin along the axio-mesial and axiodistal line angles. The cavity walls and margins are finished as previously described.



Class I with Palatal extention of upper 1st molar

The same principles and procedures for Cl I cavity preparation were applied occlusaly. For the extension: The tooth preparation for the extention should be no wider than necessary; ideally the mesiodistal width of the palatal extension should not exceed 1 mm, except for extension necessary to remove carious or undermined enamel or to

include unusual fissuring. The tooth preparation should be cut more at the expense of the oblique ridge rather than centering over the fissure (weakening the small disto-lingual cusp). Especially on smaller teeth, the margins on the occlusal portion should extend as little as possible on to the oblique ridge and disto-lingual cusp.

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Cl II amalgam restoration

Preparations involving the proximal surfaces of posterior teeth are termed *Class II*., the following surfaces are involved:

- Two surface cavity for posterior teeth fig 1A
- Three surface cavity for posterior teeth fig 1B
- Four surface (or more) cavity for posterior teeth fig 1C.

A. B. C.

Fig 1: A: two surface cavity, B: three surface cavity, C: four surface cavity

Step 1: Outline Form and Initial Depth:

Establishing the outline form means placing the preparation margins in the positions they will occupy in the final preparation, the typical features of establishing proper outline form and initial depth are:

- Width of the facio-lingual walls of the cavity should be ¼ I.C.D.
- Preserving marginal ridge strength (2mm thickness marginal ridge).
- The depth of the preparation into dentin should be 1.5-2mm.

- The extent of the caries lesion affects the outline form of the proposed tooth preparation because the **objective is to extend to sound tooth structure also** Ideal outline includes all pits & fissures even if its sound to prevent them from caries in the future **(extension for prevention).**

Step 2: resistance form:

May be defined as the shape of the cavity that prevent fracture of the remaining tooth structure and the restoration this includes:

Factors prevent fracture of the tooth

- The facio-lingual width of the preparation should not exceed ¼ I.C.D (intercuspal distance).

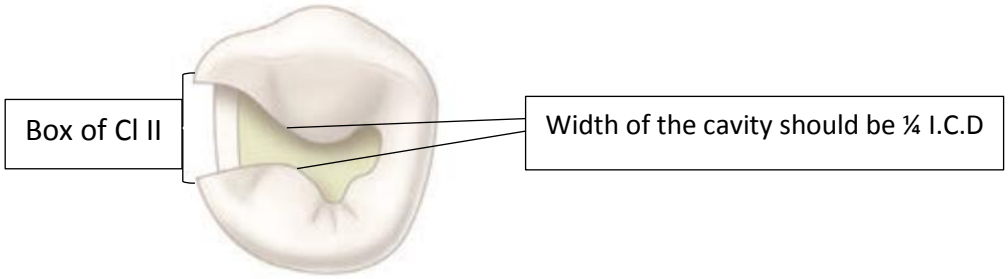


Fig2: Cl II cavity preparation occlusal view

- Removal of unsupported enamel by making the margin (90^0-110^0) because less than 90^0 the tooth is more subjected to fracture fig 3.
- Smooth pulpal floor & gingival seat to prevent stress concentration area.

- Mesial & distal walls of the cavity should be parallel and slightly diverge occlusally to be within the enamel rod direction and prevent any unsupported enamel at the marginal ridge.
- All internal line angle should be rounded to prevent stress concentration area fig3.
- Box shape of Cl II fig 2.
- Rounded gingival cavo-surface line angle

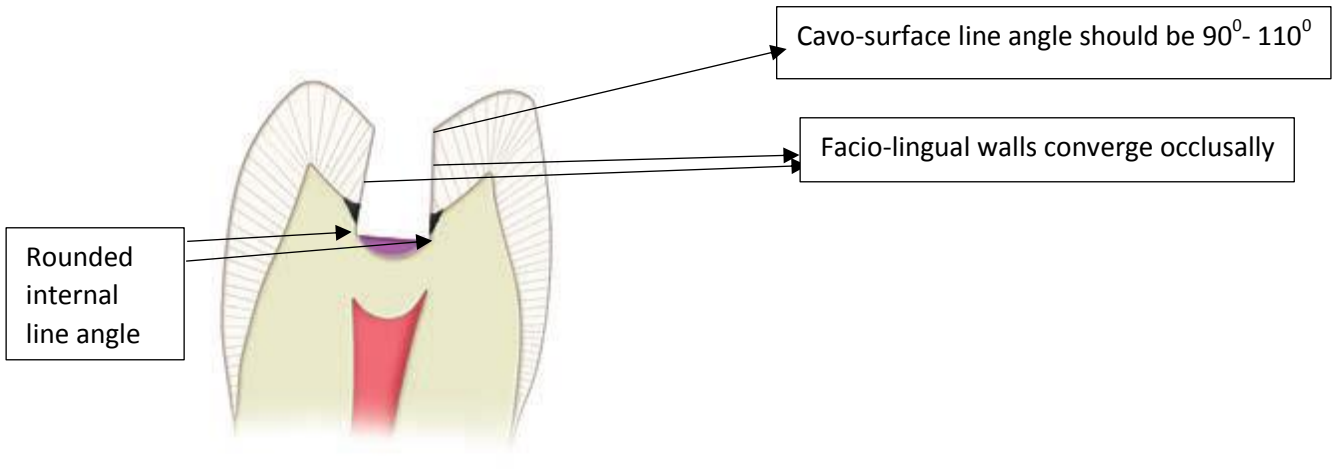


Fig 3: resistance factors which prevent fracture of the tooth

Preventing fracture of restoration

- The margins or Cavosurface line angle should be (90^0-110^0) if more than this lead to fracture of restoration.
- Facio-lingual width should be ¼ I.C.D because large surface area exposed to more force and fracture occur.
- Occlusal amalgam should have thickness of (1.5-2.0 mm) to resist fracture during function.

- The pulpal floor & gingival seat should be smooth to prevent concentration area on restoration.
- Rounded axio-pulpal line angle.

<u>Step3. Retention form</u>: is the shape of the cavity that permits the restoration to resist displacement through the tipping or lifting force.

To provide retention the cavity have the following:

- Facial & lingual walls should be parallel to each other or converge occlusally (5^0) fig3.
- Pulpal floor & gingival seat of the cavity should be flat.
- Dove-tail preparation to increase retention fig4.
- Width of the cavity.
- The occlusal convergence of the box (from proximal view) fig5.
- Retentive grooves or locks in the axiofacial and axiolingual line angle fig5.

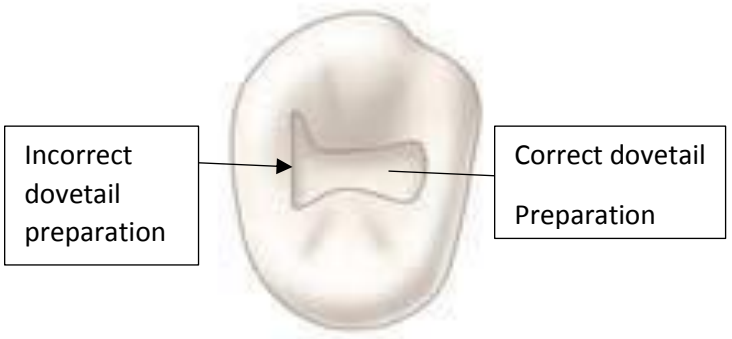


Fig: 4 dovetail

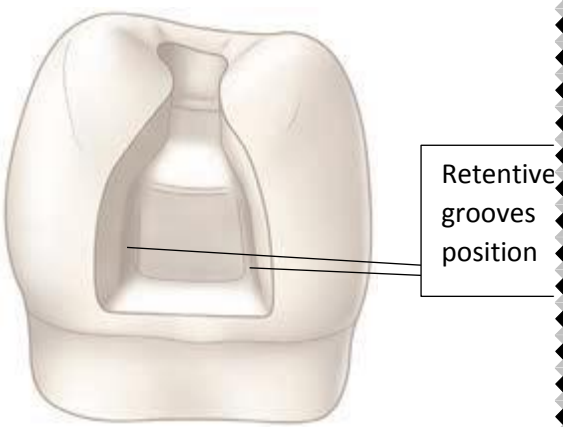


fig 5: proximal view of ClII box

Step 4: Convenience Form:

Convenience form is the shape or form of the preparation that provides for adequate observation, accessibility, and ease of operation in preparing and restoring the tooth.

Step5: Removal of remaining caries

Deep dentinal caries can be removed by using spoon excavator or large round bur with slow speed hand piece.

Step6: Finishing enamel walls

Involve making the wall smooth and removing of unsupported enamel.

Step7: Clean the preparation:

Removal of all debris by washing the cavity and drying it.

Clinically:

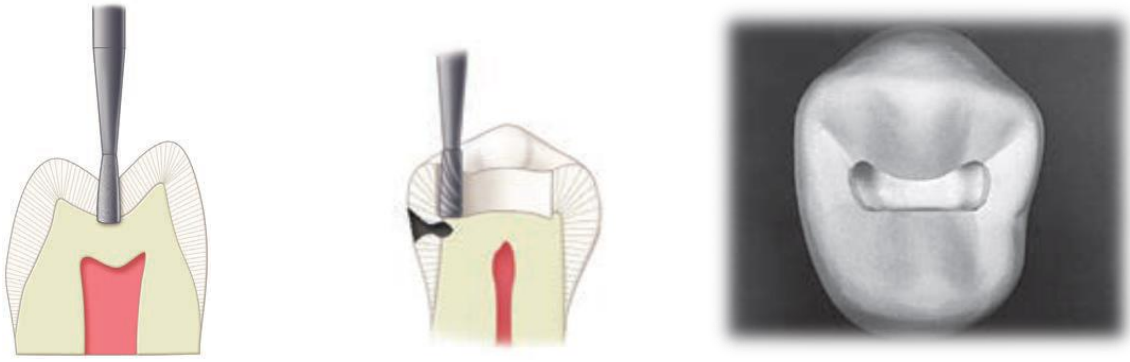
Occlusal outline form (occlusal step):

The occlusal outline form of Cl II tooth preparation for amalgam is similar to that for Cl I tooth preparation, enter the pit nearest the involved proximal surface with a punch cut using no.245 bur fig 6 A, the long axis of the bur & the long axis of tooth crown should remain parallel during cutting procedures, the bur should be rotating when applied to the tooth and should not stop rotating until removed.

Proper depth of the initial entry cut is 1.5-2 mm.

While maintaining the same depth & bur orientation move the bur to extend the outline to include the central groove & the opposite pit fig

6 B which provided by dovetail retention form the isthmus width should be as narrow as possible & no wider than ¼ I.C.D, it may be necessary to tilt the bur to create facial, lingual slight occlusal convergence & mesial and distal walls to diverge occlusally.



A B C

Fig6: A. initial depth, B. bur position to begin the proximal ditch cut. C, Cl I cavity preparation

Proximal outline form (proximal box) preparation:

The objectives for extension of proximal margins are to:

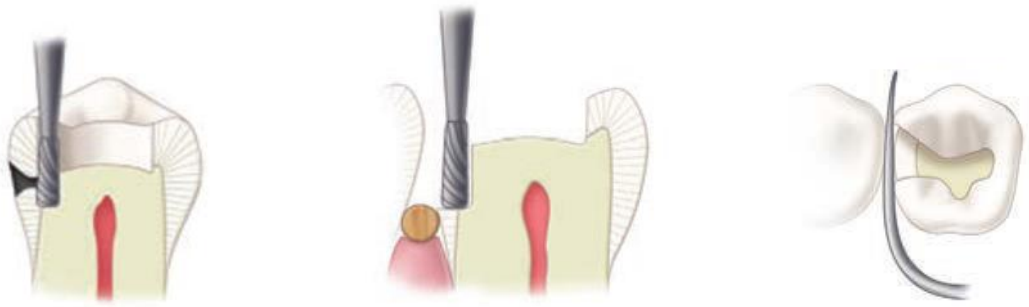
- Include all caries, faults or existing restorative material.
- Remove unsupported enamel.
- Establish not more than 0.5 mm clearance with the adjacent proximal surface facially, lingually & gingivally.

The initial procedure in preparing the outline form of the proximal box is the isolation of the proximal enamel by the proximal **ditch cut** fig 7A this is a very important procedure in conservative tooth preparation.

Place the bur over the DEJ in the pulpal floor near the remaining marginal ridge, allow the end of the bur to cut the ditch gingivally then move the bur facially & lingually along the DEJ this lead to create **axial wall** fig 7 B, the ditch should extended gingivally just beyond the caries or

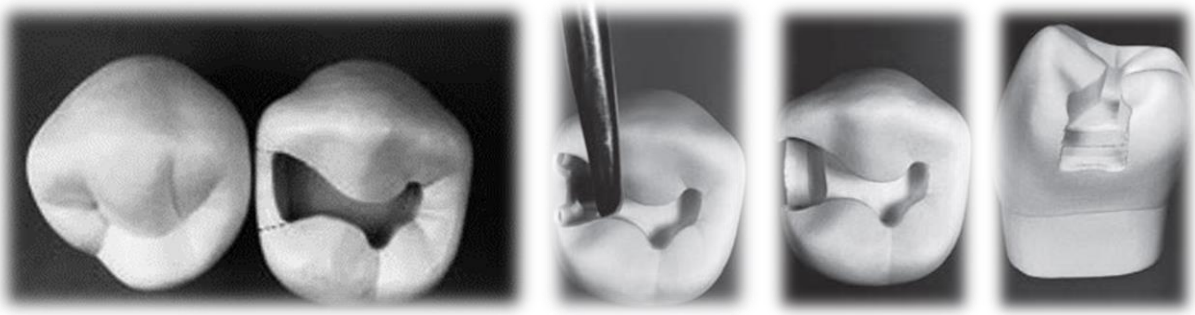
the proximal contact area, the location of final proximal margins (facial, lingual, gingival) should be established with hand instruments (chisel, hatchets, gingival margin trimmers) then remove the weakened enamel along the gingival wall by using the gingival margin trimmer in scraping motion.

Ideally the minimal clearance of the completed gingival margin with the adjacent tooth is 0.5 mm fig 7C.



A B C

Fig 7: A. The proximal ditch is extended gingivally to the desired level of the gingival wall (i.e., floor). B, box formation. C, clearance of the gingival wall with the adjacent teeth.



A B C D

Fig 8: A. The proximal ditch is extended gingivally to the desired level of the gingival wall (i.e., floor). B, box formation. C, clearance of the gingival wall with the adjacent teeth D, proximal view of the tooth.

FINISHED

Conservative dentistry

LEC: 6 ***Dr. Alalaa***

CL III amalgam restoration

CLIII restoration indicated for defects in the proximal surface of incisors and canines without Incisal edge involvement fig1.

a b

Fig1: a. Cl III caries, b. Cl III cavity

Indications:

Few indications exist for a Class III amalgam restoration. It is generally reserved for **the distal surface of maxillary and mandibular canines** if

(1) The preparation is extensive with only minimal facial involvement.

(2) The gingival margin primarily involves cementum.

(3) Moisture control is difficult.

For esthetic reasons, amalgam rarely is indicated for the proximal surfaces of incisors and the mesial surface of canines.

Contraindications:

Class III amalgam restorations usually are contraindicated in **esthetically** important areas because many patients object to metal restorations that are visible

Advantages:

1. Amalgam restorations are stronger than other Class III direct restorations.

2. They are generally easier to place.

3. Less expensive to the patient.

4. Amalgam restorations are usually easier to finish and polish without damage to the adjacent surfaces.

Disadvantage:

1. Metallic color.

2. Less conservative cavity preparation when compared to that of esthetic restorative materials.

Outline form:

The outline form of the Class III amalgam preparation may include only the proximal surface fig2a. A lingual dovetail may be indicated if one existed previously or if additional retention is needed for a larger restoration fig 2b.

Fig2: a. Cl III preparation from proximal view, b. Cl III with dovetail.

Resistance form:

Resistance form against post-restorative fracture is provided by

(1) Cavosurface and amalgam margins of 90 degrees.

(2) Removal of unsupported enamel.

(3) Sufficient bulk of amalgam (minimal 1-mm thickness).

(4) Rounded internal angles.

(5) Conserve the disto-incisal tooth structures as possible to reduce the risk for fracture

Retention form:

Retention form for Cl III preparation is provided by:

(1) The box-like preparation form.

(2) Gingival groove, incisal cove, and sometimes a lingual dovetail.

Tooth Preparation

A lingual access preparation on the distal surface of the maxillary canine is described here for esthetic reasons, use of facial approach for a mandibular canine may be indicated if the lesion is more facial than lingual fig3.

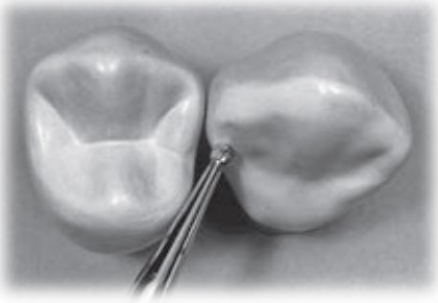


Fig3: initial entry for Cl III which conserve the marginal ridge.

Bur size selection depends on the size of the lesion, bur options may include a no. 2 (or smaller) round bur, the bur is positioned so that the entry cut penetrates into the caries lesion, Ideally, the bur is positioned so that its long axis is perpendicular to the lingual surface of the tooth, but directed at a mesial angle as close to the adjacent tooth as possible, this position conserves the marginal ridge enamel fig3.

Initial axial depth (0.5 mm) inside the DEJ or 0.75 mm axial depth when the gingival margin is on the root surface (in cementum)

(Infected dentin that is deeper than this limited initial axial depth is removed later during final tooth preparation) the cavity of Cl III is made in a box-like preparation.

The **gingival retention groove** is prepared by placing a no.14 round bur (rotating at low speed) in the axio-facio-gingival point angle, It is positioned in the dentin to maintain 0.2 mm of dentin between the groove and the DEJ, the rotating bur is moved lingually along the axio-gingival line angle fig4.

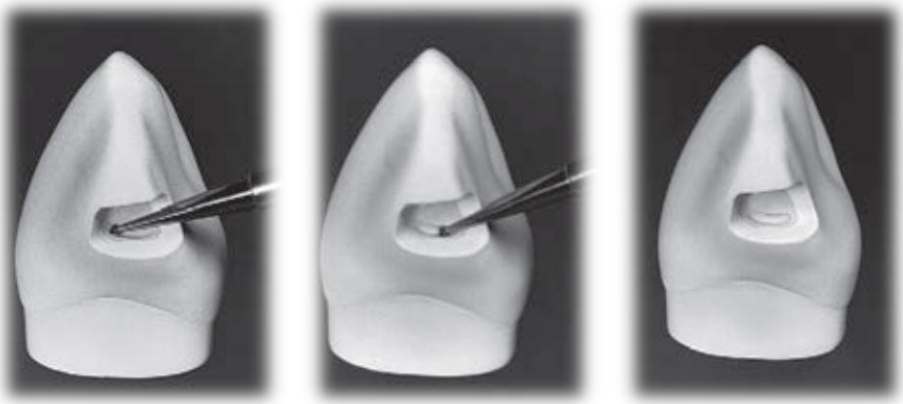


Fig4: Preparing the gingival retention form. A, Position of No. 14 round bur in axio-facio-gingival point angle. B, advancing the bur lingually to prepare the groove along the axio-gingival line angle. C, Completed gingival retention groove.

If less retention form is needed, two gingival **coves** may be used, as opposed to a continuous groove placed in the axio-gingivo-facial and axio-gingivo-lingual point angles, the diameter of the 14 round bur is 0.5 mm, and the depth of the groove should be half this diameter (0.25 mm).

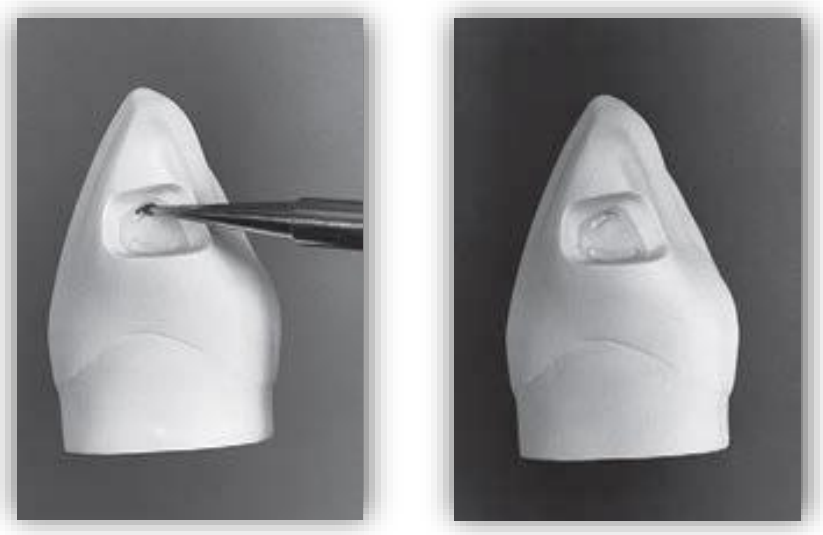


Fig5: Preparing the incisal retention cove. A, Position of No. 14 round bur in the axio-incisal point angle. B, Completed incisal cove.

If a lingual **dovetail** is needed fig6:

- It is prepared only after initial preparation of the proximal portion has been completed. Otherwise, the tooth structure needed for the isthmus between the proximal portion and the dovetail may be removed when the proximal outline form is prepared.
- The lingual dovetail should be conservative, generally not extending beyond the mesio-distal midpoint of the lingual surface; this varies according to the extent of the proximal caries.
- The axial depth of the dovetail should approximate 1 mm.

fig 6: lingual dovetail in Cl III

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Class V amalgam cavity preparation

Lec 7: **م.م العلاء جمال**

Definition

Class V Caries: Smooth surface carious lesions located on the gingival/cervical third of labial/buccal and more rarely the lingual surfaces of all teeth.

Simple lesion as it mostly involves one surface of a tooth as shown in fig1.

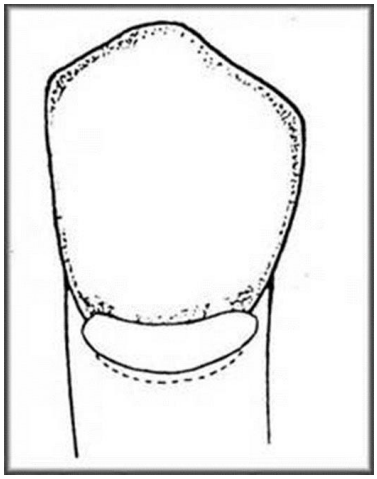


Fig1: CL V

Caries is not only the reason of cavitation, abrasion and erosion may also responsible

- **Erosion:** tooth loss at the cervical area due to nonbacterial acid attack.

- **Abrasion:** tooth loss at the cervical area of the tooth due to abrasive slurry between two surfaces (mechanical action) e.g: tooth brush – dentifrice abrasion.

In both cases there is no caries if we prepare a class V cavity it is better to be filled by amalgam, because of high abrasive resistance of amalgam.

Restorative materials for Class V cavity

- ✓ Amalgam
- ✓ Composite
- ✓ Resin modified GIC
- ✓ Compomers

Indications for amalgam as restorative material

- ✓ Non-esthetic areas
- ✓ Areas where access and visibility are limited
- ✓ Areas where moisture control is difficult
- ✓ Areas those are significantly deep gingivally.

Contraindications for amalgam as restorative material

- ✓ Esthetically important areas

Advantages of amalgam as restorative material

- ✓ Amalgam restorations are stronger than other direct restorations
- ✓ Easier to place
- ✓ less expensive to the patient
- ✓ Usually easier to finish and polish

Disadvantages of amalgam as restorative material

- ✓ The primary disadvantage amalgam restorations are that they are metallic and non-esthetic.
- ✓ The preparation for an amalgam restoration typically requires 90-degree cavo-surface margins specific and uniform axial depths, and incorporation of secondary retentive features, all of which results in a less conservative preparation than that for other esthetic restorative materials.

Clinical technique for class V amalgam preparation

Initial Clinical Procedures

 Local Anaesthesia

 Isolation (rubber dam recommended)

Tooth preparation

I. OUTLINE FORM

 Rounded trapezoid in gingival 1/3.

 Conforms to the tooth shape, typical caries location, and site of plaque accumulation.

 Primarily determined by the location and size of the caries/defect or old restorative material

 Cavosurface margins should be extended to sound tooth structure while maintaining a limited axial depth of 0.5 mm inside the DEJ and 0.75 mm inside the cementum (when on the root surface)

 Using round bur to start entry to the cavity, the direction of the bur should be perpendicular to the buccal (or palatal) surface of the tooth , then using a tapered fissure bur of suitable size, enter the carious lesion to a limited initial axial depth of 0.5 mm inside the DEJ.

 This depth is usually 1 to 1.25 mm total axial depth, depending on the incisogingival/occlusogingival location (The enamel is considerably thicker occlusally and incisally than cervically)

 However, if the preparation is on the root surface, the axial depth is approximately 0.75 mm.

 Extend the preparation incisally, gingivally, mesially, and distally until the cavosurface margins are positioned in sound tooth structure providing the desired outline form

 Preparation of the axial wall depth 0.5 mm inside the DEJ results in a uniform depth for the entire preparation.

 Because the axial wall follows the mesiodistal and incisogingival/occlusogingival contours of the facial surface of the tooth, it will usually be convex in both directions as shown fig 2.

 The mesial, distal, gingival, and incisal walls of the tooth preparation are perpendicular to the external tooth surface to keep the cavosurface angle 90 degree and to follow the direction of enamel rods, they usually diverge facially.

 Consequently, this form provides no inherent retention, and retention form must be provided.

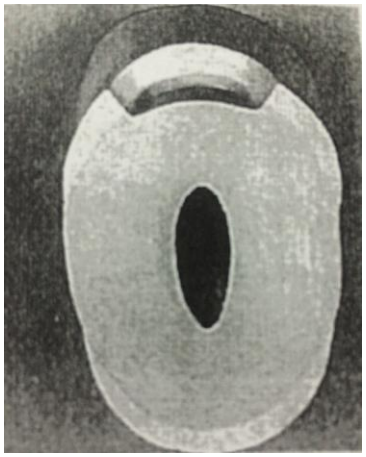


Fig 2: convex axial wall

II. Resistance form

 Depth of the cavity is 1.5 mm: the axial wall of the cavity should not be flat, if we do so will not have even depth of the cavity because of convexity of tooth structure, so the axial wall should be slightly convex.

 cavosurface line angle (90-110).

Rounded internal line angles

Removal of unsupported enamel

 Occlusal and gingival walls should be perpendicular to the long axis of the tooth and parallel to each other, any convergence of these walls will create unsupported enamel.

III. Retention form:

 Use a No. 1/4 bur to prepare two retention grooves, one along the incisoaxial line angle and the other along the gingivoaxial line angle (figure 3) 0.2-0.3mm inside the DEJ

 The handpiece is positioned so that the No. 1/4 bur is directed generally to bisect the angle formed at the junction of the axial wall and the incisal/occlusal or gingival wall

 Ideally the direction of the incisal (i.e., occlusal) groove is slightly more incisal (i.e., occlusal) than axial, and the direction of the gingival groove is slightly more gingival than axial.

 Mesial and distal walls should be slightly diverge.

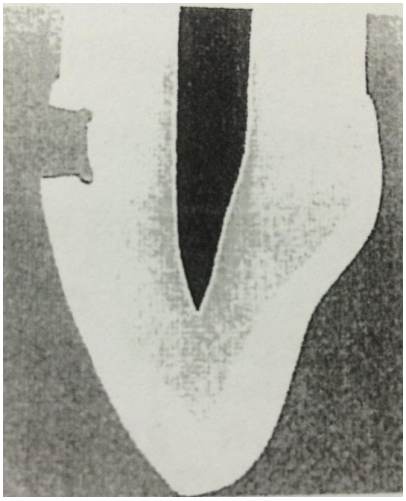


Fig 3: retentive grooves of CLV

III. Final preparation:

 Removal of any remaining infected dentin

 Pulp protection

 Finishing external walls

 Cleaning & inspecting

Summary

 Outline form – Rounded Trapezoid

 Axial Depth- 1- 1.25 mm (when margins in enamel), 0.75 mm when margins are in cementum (Root surface)

 Axial wall- 0.5 mm inside DEJ, Convex in all directions to conform the external tooth contour

 Divergent Incisal, Gingival, Mesial & Distal walls- follow the direction of enamel rods

 Retention features- Grooves & Coves- 0.2- 0.3 mm inside DEJ using ¼ round bur

Lec 8 Cavity Liner and Cement Base 1

د. العلاء

Liners and bases material act as pulp protection agents require consideration of: chemical protection, electrical protection, thermal protection, pulpal medication, and mechanical protection (as in figure 1).

Reasons for use of base and lining materials:

1. Insulation against temperature changes and electrical stimuli under metallic restorations such as amalgam.
2. Mechanical protection provides by distributing local stresses from restoration across the underlying dentin surface.
3. To reduce the risk of microleakage.
4. Cementation of cast or ceramic restorations.
5. As a pulp capping.
6. Some have bactericidal or bacteriostatic properties.
7. Prevention of the risk of along-term damage to the pulp-dentin organ from operative treatment.
8. Cementation of orthodontic bands.

The ideal lining material should have these properties:

1. Be compatible with the restorative materials.
2. It should not irritant to the pulp.
3. Prevent injuries of the pulp-dentin from restorative materials.
4. Be insoluble in the oral fluids.
5. Possess sufficient physical strength during insertion of the restoration.
6. Prevent heat/cold conduction from metallic restorations.
7. It should have a bacteriostatic effect eg: zinc oxide eugenol.
8. It should improve the marginal seal and have sealing ability eg: zinc oxide eugenol, so we use it as a temporary restorative material.

9. It should be easy to manipulation and apply.
10. It should be radiopaque in the X-ray.

Two groups of pulp protection materials are available:

- Varnishes and liners
- Cement bases.

The materials may be used alone or in combination, depend on:

- The extent and location of the preparation.
- The restoration material to be used.

Liners: are materials that are placed as thin coating or layer.

Function:-

1. To provide a barrier against chemical irritation. (They do not function as thermal isolators).
2. Reduce marginal leakage around most filling materials (amalgam) so reduce the inflammatory reaction and post-operative sensitivity caused by marginal leakage.
3. Electrical insulation (treatment of galvanic shock).

   The need for liners is greatest with metallic restorations that are not well bonded to tooth structure. eg: Varnish, Ca $(OH)_2$,and resin bond.

Bases:

(Cement bases, typically 1 to 2 mm). Deep parts in the dentin should be covered by a base or a subbase/base combination. The thickness of the base depends on its physical properties, but always allowing adequate thickness for the final restorative material.

Function:

1. Provide thermal insulation.
2. Mechanical protection by resist forces applied during condensation of the restorative materials.
3. A barrier against chemical irritation

The cement materials include:

1- Zinc phosphate cement:

It is hard and strong but irritating to the pulp, it is a powder-liquid system. The powder consists mainly of zinc oxide with the addition of magnesium oxide and silicon dioxide.

The liquid consist of ortho-phosphoric acid (40%) with metallic salts that serve to slow down the setting reaction, and water.

Setting reaction:

When the powder is brought into contact with the liquid to begin the cement mix, wetting occurs and chemical reaction is initiated. The surface of the powder is dissolved by the liquid resulting in an exothermic reaction. The initial mixture is highly acidic.

$$ZnO + 2H_3pO_4 \xrightarrow[\text{reaction}]{\text{exothermic}} Zn(H_2PO_4)_2 + H_2O + \text{heat} + ZnO$$

Zinc oxide + Phosphoric acid + heat → Amorphous zinc phosphate + Zinc oxide (unreacted)

Advantages:

1. Easy to manipulate.
2. High strength necessary for a base.
3. Withstand mechanical trauma.
4. Provide good protection against thermal shock.

Uses:

1. As a base material when high compressive strength is required.
2. To lute cast restorations to the teeth.
3. Cementation of orthodontic bands.
4. Rarely may be used as a temporary cement dressing.

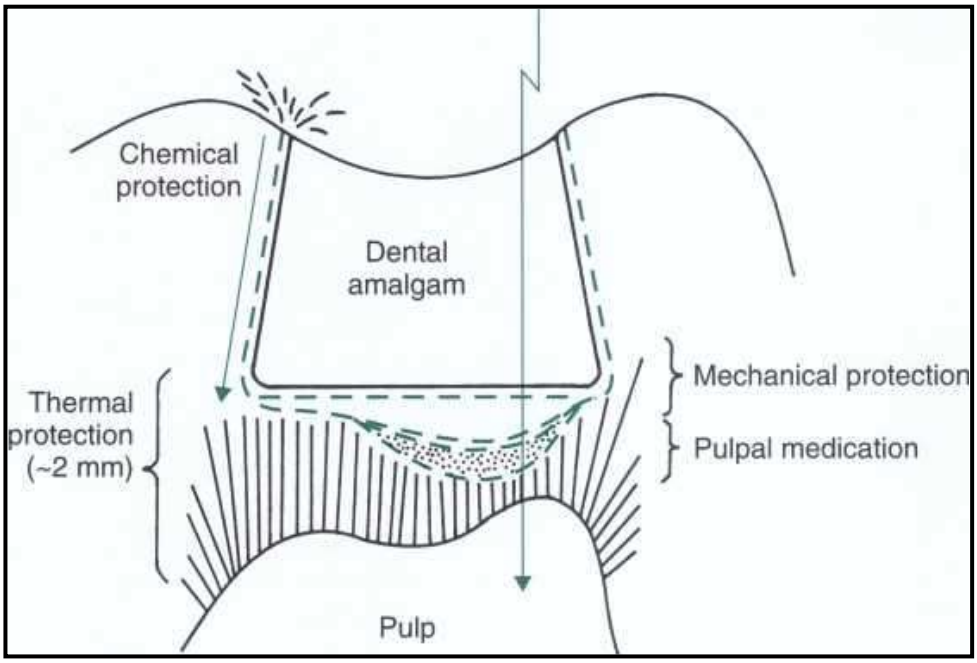


FIG . 1 Schematic view of needs for pulpal protection below metallic restoration. Varnishes, liners, and/or bases may be added to tooth preparation under amalgam for purposes of chemical, electrical, thermal, or mechanical protection, and/or pulpal medication.

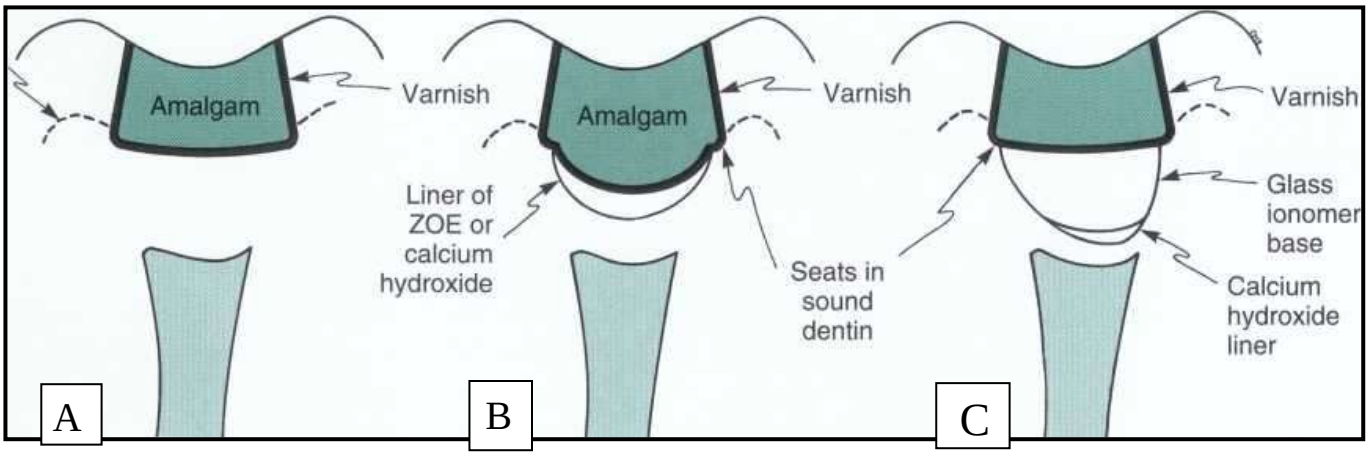


Fig. 2 Schematic examples of use of liners and bases for amalgam restorations. A, For shallow amalgam tooth preparations, varnish or sealer is applied to walls of preparation before insertion of restoration. B, For moderate depth tooth preparations, liners may be placed for thermal protection and pulpal medication. (Note seats in sound dentin for amalgam restoration.) C, In very deep preparation, calcium hydroxide is placed in deepest region in which infected dentin was excavated, and then base of glass ionomer is inserted. Amalgam bonding systems are being advocated as a substitute for liner and varnish, except for calcium hydroxide liner in the deepest region (judged to be within 0.5 mm of pulp).

Characteristic properties of zinc phosphate:

1. **Consistency:** Two arbitrary consistencies: either luting consistency, or cement base consistency. In luting consistency less powder/liquid ratio is used in order to have creamy mix which is used for cementation of crown and inlays. While in cement base consistency more powder/liquid ratio is used to have putty mix of zinc phosphate cement which may be used as thermal insulator over a thin dentin and as high strength base.
2. **Viscosity:** It depends on time and temperature of mixing. So mixing should be made on a cool glass slab to reduce the viscosity of mixing.
3. **Setting time:** It is time elapsed between the end of mixing and the beginning of setting. Setting time of zinc phosphate range from 2 to 8 minutes at 37^{o} C (depending on the product and the mixing consistency).
4. **Strength:** Influenced by the initial powder and liquid composition, powder/liquid ratio and the manner of mixing, and the handling of the cement during its placement.
5. **Solubility:** Greater resistance to solubility is obtained by increasing the powder/liquid ratio.
6. **Dimensional stability:** Zinc phosphate exhibits shrinkage on hardening. This shrinkage can be reduced by increasing powder/liquid ratio and with proper incorporating of powder with liquid during mixing.
7. **Acidity:** In early manipulation stage the cement is highly acidic, and this acidity reduced with time and become nearly neutral at 48 hours.
8. **Thermal and electrical conductivity:** Zinc phosphate is desirable to protect against thermal and electrical trauma to the pulp.

Manipulation of zinc phosphate:

The proper amount of powder should be slowly incorporated into the liquid on a cool slab (approximately 21°C) to attain the desired consistency of cement.

1) **Mixing slab:** Because the reaction between zinc oxide and phosphoric acid is exothermic reaction, the glass slab should be thick cool and clean.
2) **Powder/liquid ratio:** Because an increase in the ratio of powder to liquid generally provide more desirable properties, incorporation as much powder as possible to obtain a particular consistency.
3) **Care of the liquid:** When zinc phosphate cement liquid is exposed to a humid atmosphere, it will absorb water, whereas exposed to dry air will lose water. Addition of water cause more rapid reaction result in shorting setting time. While loss of water from liquid will lengthened the setting time. So the cement liquid bottle should be kept tightly closed when not dispensing the material.
4) **Mixing procedure:**

a) The powder should be divided into several small amounts as in figure (1), so that each may be separately drawn into the liquid and spatulated. The liquid is dispensed to another area on the slab.

b) Mixing over a large area: The heat of the reaction is most effectively dissipated when the cement is mixed over a large area of the cooled slab. A long, narrow-bladed stainless steel spatula may be used to spread the cement across this large area (as in figure 2).

c) The zinc phosphate should be mixed to a thinner consistency for setting inlays or cementation of crowns. A thick mix or thick consistency (a putty-like mixture) is used when basing material is

required. This will cause lowered initial acidity of the base material, less post operative pain, and ease of placement.

d) Mixing time not more than 60-90 Sec. 15 for each increment.

5. Frozen slab method: In this method a glass slab is cooled in a refrigerator at (6 °C) or a freeze at (-10 °C). A mix of cement is made on the cold slab by adding the powder until the correct consistency is reached. The advantages of the frozen slab method are an increase in the working time and shorter the setting time. This method has been advocated for cementation of bridges with multiple retainers, also for preparing base material for multiple cavities at the same visit, or for cementation of orthodontic bands.

6. Insertion:

a) The tooth structure should be dry; this will insures better adhesion and a harder set.

b) Small quantity of cement is rolled lightly into a ball between the thumb and the forth finger then picked up on the point of a probe and carried into the cavity (as in figure 3).

c) Then the cement shaped with appropriate instrument, either (Ash 49) on the pulpal floor of the cavity, or (Ash 6) to adapt the cement on the axial wall in class II cavity. The instrument coated with the powder of the cement to prevent the cement from sticking to the instrument. The axiopulpal line angle is molded to around angle with the same instrument.

d) Small excavator is used to remove any excess from the retention grooves or pits and from the cavity walls. Any trimming by burs should be delayed for at least 10 minute after insertion to avoid dislodgment. If need to do that (do it with sharp burs operated at low speed and minimum pressure). Adequate space should be left for the restoration, otherwise it becomes weak and fracture will occur

due to thin restoration. No cement should be extending over any margins of the cavity and in the undercuts.

* When there are one or two spots of caries on the pulpal floor they should be removed by round bur, but without removing the sound dentin around these spots to gain flat pulpal floor, because this may cause pulp exposure. In this case a base material is used in these deep parts to have flat pulpal floor.

Figure (1). Cement powder divided into small increments on a thick glass slab.

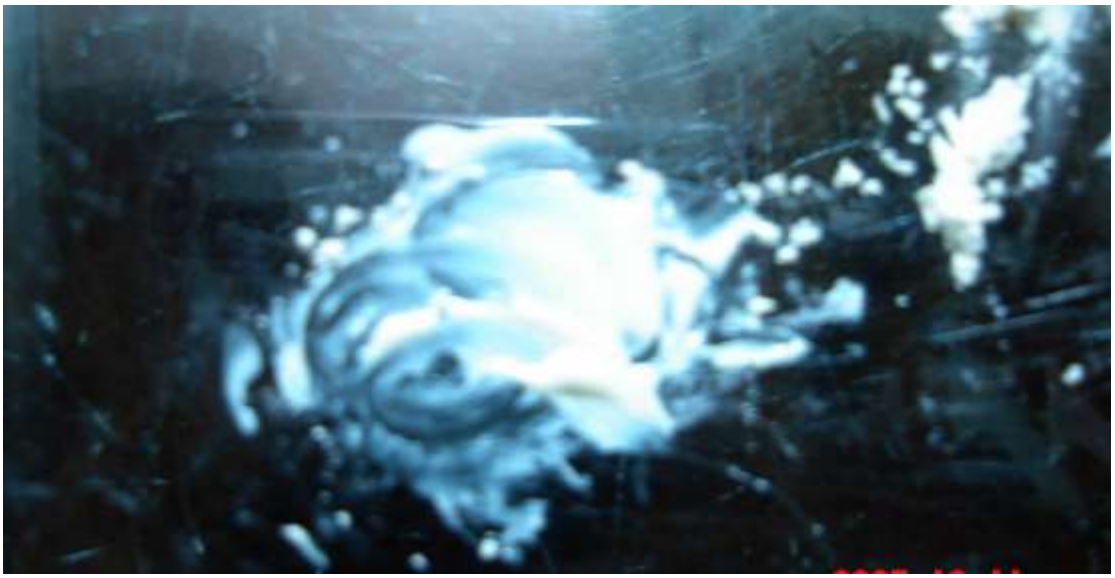


Figure (2). Mixing of zinc phosphate is done on a wide area on a glass slab.

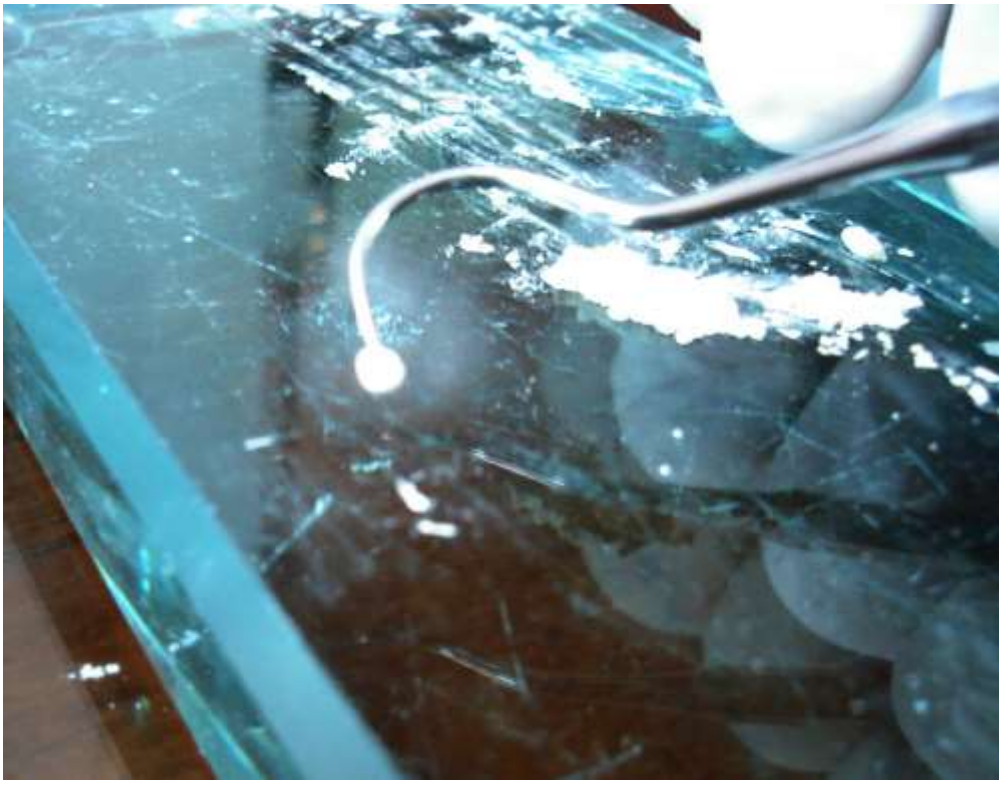


Figure (3). A mixed Cement ball is carried by the tip of the probe into the cavity

2- Zinc oxide-eugenol cements (ZOE):

Powder: Zinc oxide with the addition of white rosin to reduce the brittleness of the set cement, and zinc acetate to improve the strength of the cement.

Liquid: eugenol with olive oil as a plasticizer.

Two compositional changes have been used to increase the strength of the cement for luting purposes:

1- Methyle methacrylate polymer is added to the powder.

2- Alumina (AL_2O_3) is added to the powder and ethoxy benzoic acid to the liquid.

Setting reaction:

Zinc oxide + eugenol $\xrightarrow{\text{water}}$ Zinc eugenolate + Zinc oxide

(powder) (liquid) (unreacted)

1- The reaction is not exothermic a cooled mixing slab is not required and the presence of moisture is essential for setting to occur.

2- There is no need to incorporate the powder in small increments. The bulk of powder is incorporated in the initial step, and then a series of smaller amounts is added until the mix is complete.

3- The average setting time is around 8 minutes.

Properties:

1. Neutral in PH (7) can be safely used in moderately deep cavities without danger to pulp.
2. Has a sedative effect on the pulp so that we use it without any varnish or liner.
3. Radio-opaque.
4. Excellent seal against leakage, so used as temporary restoration.

Uses:

1. As temporary restorations.
2. The modified type used as a crown and bridge cementation and as a cement base.
3. As an endodontic sealer.

***** Zinc oxide eugenol Cement is unaccepted as base material under composite restorations because it impaired the setting reaction (polymerization) of composite resin.

3- Zinc polycarboxylate cement:

Zinc polyacrylate cements (or zinc polycarboxylate) are supplied as a powder and a liquid or as a powder that is mixed with water. The liquid is a water solution of polyacrylic acid (32% to 42%). The cement powder is essentially zinc oxide and magnesium oxide. The cement powder that is mixed with water contains the zinc oxide particles coated by 15% to 18% polyacrylic acid.

Properties

1- Poly carboxylate cement is one of the dental cement systems which have chemical adhesion to enamel and dentin, by the ability of the carboxylate groups in the cement molecule to chelate to calcium in enamel and dentin.

2- The large sizes of the polyacrylic acid molecule, which can't penetrate through dentinal tubules, make this cement low irritant to the pulp, so this cement is used as a base or for cementation with sensitive teeth.

3- Short setting time (2-6 minutes).

4- This cement is sensitive to disintegration and solubility more than zinc phosphate cement.

Uses:-

1- As a luting agent. 2- As a base material.

3- In orthodontics for cementation of bands.

Manipulation:-

1. Powder/liquid ratio for the base consistency is 2-3 parts of powder to 1 part of liquid by weight. The powder/liquid ratio

becomes (1.5/1) when using poly carboxylate cement as a luting agent.

2. Dry and cool glass slab are used for mixing, the cooling slows the chemical reaction and thus provide longer working time.
3. The liquid should not be dispensed until just prior to the time of mixing, to avoid evaporation of water which cause increase in the viscosity and this will cause decrease in strength and higher solubility.
4. The mix should be completed within 30-40 second.

4- Glass ionomer cement :-

Glass ionomer cements are supplied as a powder and a liquid or may come as capsules. The powder is fluoro-alumino-silicate glass.The liquid typically is a 47.5% solution of 2: l polyacrylic acid and itaconic acid copolymer.

Uses:-

1- As a base material.
2- Luting agent.
3- Also can be used as filling material specially of the modified types of glass ionomer cements (Cl I, Cl III, Cl V).
4- Fissure sealants.

Properties:

1. The compressive strength is greater than zinc phosphate cement.
2. Glass ionomer cements are very sensitive to contact with water during setting. The field must be isolated completely. If glass ionomer is used as filling material, once the cement has achieved its initial set (about 7 minutes), coat the cement

surface with a coating agent such as a varnish, because the complete setting reaction takes place in 24 hours.

3. Glass ionomer cement bond to tooth structure chemically by ionic interaction with calcium and/or phosphate ions from the surface of the enamel or dentin. In addition, when the enamel surface is conditioned (etched with 37% phosphoric acid), the bond strength of glass ionomer cement become greater, because acid etching of enamel surface will produce micro porosities on the etched surface that will improve the mechanical retention.
4. Glass ionomer cement release fluoride, so it has anti cariogenic effect (bacteriostatic or bactericidal), thus this cement can be used in patient with a high caries index.

Classification of glass ionomer cement:

The most practical classification of the Glass ionomer cements is on their clinical usage into:

Type I Glass ionomer cements are the **luting cements**, characterized by low film thickness and rapid set.

Type II Glass ionomer cements are **restorative cements**, with sub-types into two types. **Type II-1** Glass ionomer cements are **aesthetic cements** (available in both conventional and resin-modified presentations) and **Type II-2** Glass ionomer cements are '**reinforced**' cement which are more wear-resistant.

Type III Glass ionomer cements are the **lining cements** and **fissure sealants**, characterized by low viscosity and rapid set.

5- Resin cements:-

Are thin versions of restorative resins (e.g. calibra and panavia resin cements), consist of a resin matrix with inorganic fillers that are bonded to the matrix with monomers. The fillers are silica or glass particles, and the fillers level vary from 40%-80% by weights. The bonding of the cement to enamel be attained by the acid-etch technique. Then bonding agent is used to provide mechanical adhesion of the cement to etched surface of the tooth.

Polymerization of resin cement is achieved either by chemical reaction (self cure), light activation (light cure), or both (dual cure). The self cured composite cement are typically two pastes system (base and catalyst), while the light cure cement is a single component system.

Properties:

1- Resin cements are insoluble in oral fluids.

2- Higher filler particles loading result in higher mechanical properties (strength and stiffness) and reduce polymerization shrinkage, and a lower coefficient of thermal expansion.

3- In some products fluoride is added to act as anticariogenic factor, and reduce the resin cement sensitivities.

Uses:

1. As a luting material either for cast or for tooth colored restorations such as esthetic ceramic and laboratory processed composite restoration.
2. Also resin cement with high filler range can be used as a base material.

Cavity liners:

1- Cavity varnishes:-

They are solutions of natural resins or synthetic resins dissolved in a solvent such as alcohol, chloroform, or acetone. The solvent evaporates, leaving a thin film on the cavity preparation.

Functions:-

1- It is placed on enamel and dentin walls to reduce the penetration of oral fluids around amalgam restoration. The cavity varnish inhibited microleakage during the first few weeks. After that the varnish will dissolved by oral fluids and replaced by the corrosion products of the amalgam which form at the amalgam tooth interface.

2- Varnish is applied on dentin surfaces to minimize penetration of the acid from zinc phosphate cements by occluding the orifices of the dentinal tubules.

3- Reduce post operative sensitivity.

Properties:

1- Varnishes, neither posses mechanical strength, nor provides thermal insulation because of thin film thickness.

2- When glass ionomer cement is used as abase material, varnish should not be used as subbase, because glass ionomer cement contains fluoride, and varnish prevents fluoride release and reaction with the tooth, also varnish prevents the chemical bonds between tooth and glass ionomer cement.

3- Varnish should not be used when the restoration is composite resin. Because varnish inhibits polymerization reaction of

composite resin material. So calcium hydroxide can be used under composite resin.

Manipulation: - Varnish solutions are usually applied by a mean of a small round piece of cotton. A thin layer is applied on the preparation then gently dried with steam of air. A minimum of 2 thin layers should be applied, as the initial layer dries it leaves small voids, so the second layer fills in the voids and produce a more continuous coating. Varnish solutions should be tightly capped immediately after use to minimize loss of solvent. Most varnishes are supplied with a separate bottle of a pure solvent this solvent used to keep the varnish from becoming too thick, also used for removing varnish from external tooth surface.

2- Bonding agent:

Generally bonding agents are unfilled resins which are used for mechanical adhesion of the composite restoration to the conditioned enamel and dentin. The conditioning is achieved by using of 37% phosphoric acid for 15-60 seconds then washing and dryness of the tooth. These bonding agents act as liner for the composite restorations especially for shallow cavities, because they occlude the orifices of dentinal tubules and reduce post operative sensitivities.

Also special bonding agents are introduced as amalgam bond which can act as a liner for amalgam restorations by sealing the cavity against fluid flow and microleakage.

3- Calcium hydroxide: $Ca(OH)_2$

Usually referred as liner, intermediate base, or pulp capping agent; examples: calcipulp, dycal, hydrex. Calcium hydroxide

supplied as a two paste system one is a base and the other is a catalyst.

Properties:

1- The set material has an alkaline PH (9.2-11.7), which reduces the acidity of zinc phosphate when used as a sub base material in deep cavities.

2- The antimicrobial action of calcium hydroxide makes this material useful in **indirect pulp capping** procedures.

3- Calcium hydroxide stimulate the odontoblast cells for the formation of secondary dentin (stimulate the formation of dentinal bridge) when it is put directly over exposed pulp tissue, so calcium hydroxide is used for **direct pulp capping**.

4- Water is important component for the setting reaction of calcium hydroxide based liner.

Manipulation:-

Equal lengths of the different colored pastes are dispensed on a paper pad and then mixed into a uniform color (homogenous) and then applied by using of dycal applicator. The setting time is short (about 1-2 minutes); therefore, the mix should be done quickly and then applied on a dry dentin so flow freely and easily. Proper setting requires humidity; place a moist cotton pellet at the opening of the cavity, on top of the newly placed cement for 30 seconds. Be sure that the cotton does not contact the cement. After 30 seconds, check the cement gently with the explorer to ensure that it cannot be penetrated.

* A resin has been added to calcium hydroxide to improve its properties (improve thermal and mechanical properties, reduce solubility) and the setting is performed by light curing.

General Clinical Consideration: -

After cavity preparation, certain factors should be taken in consideration during lining placement in the cavity:

1- The prepared cavity should be clean and dry before application of lining material. The quadrant of the prepared tooth should be isolated completely form saliva, because the entire lining and base material are sensitive to water during their application and setting.

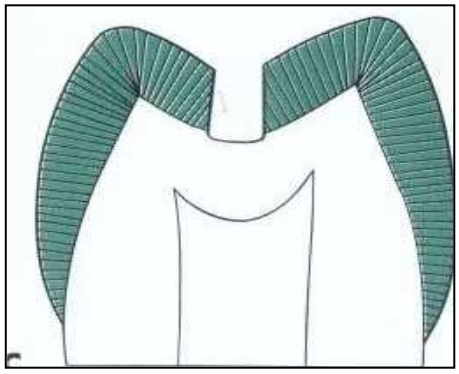
2- All liners and base materials undergo dissolution and disintegration in saliva with time; therefore, they should not reach to the margins of the cavity (except varnishes and bonding agent). So lining is placed on: pulpal floor in Cl I, pulpal floor and axial wall in Cl II, axial wall in Cl III, IV, and V.

3- In cavities prepared for amalgam restorations, the base material should not be extended on the walls of the cavity because this material will block the undercuts (convergence of the buccal and lingual walls) which are important for the amalgam retention. Also all the retentive holes, grooves, and pins should be free from lining before amalgam placement.

Cavities can be classified according to their proximity from the pulp into:

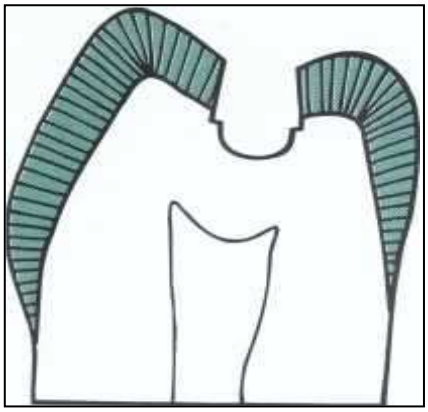
1- **Shallow cavity preparation: -** (as in fig bellow) there is no need for pulpal protection, there is a sufficient thickness of

dentin so that no protective base required. For dental amalgam the cavity is coated with two thin coats of a varnish or amalgam bond and restored. For a composite the cavity is etched, coated with a single coat of a bonding agent and restored. Both varnish and the bonding system provide chemical protection.



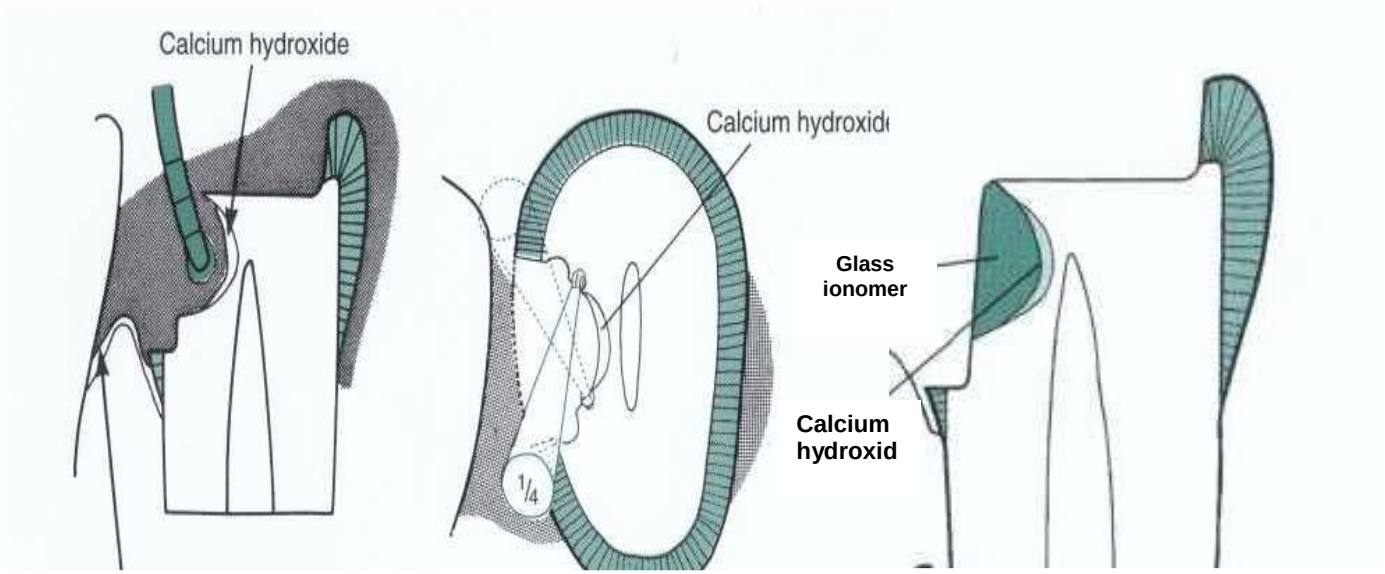
2- **Moderately deep cavity:** - (as in fig bellow) a prepared cavity that extends into dentin beyond the minimal depth necessary to attain retention and strength for the restorative material.

Varnish is used to coat the floor and walls, then a cement base such as zinc phosphate cement, or modified ZOE cement may be contoured to replace the missing dentine.



3- **Deep cavity:** - (as in fig bellow) that includes some extension toward the pulp, a liner such as Ca (OH) 2 should be applied on the pulpal and axial walls. On top a cement base is placed

such as zinc phosphate cement, or modified zinc oxide euogenol cement or poly carboxylate cement then a varnish is used to coat the walls. Recently, new protocol prefers the use of dycal with glass ionomer base, because of the present of chemical bonding between the tooth and the glass ionomer cement that will reduce microleakage and the sensitivity postoperatively.



4- Deep cavity with exposure of the pulp: - exposure of a small area of the pulp with no sign or symptoms of degenerating pulp, the choice of conservation pulp capping is recommended. In an isolated clean field, calcium hydroxide is carefully placed over the pulp and the border of dentin which surround the exposure site. A base material is placed on top (such as zinc phosphate or reinforced zinc oxide eugenol), and also glass ionomer cement base is preferred. The restoration of the tooth should be completed as soon as possible. Secondary dentin barrier is likely to be formed within a few weeks.

Conservative dentistry

LEC: 10 ***Dr. Alalaa***

Dental Amalgam

Is an alloy made by mixing liquid mercury (Hg) with the solid particles of the silver-tin dental amalgam alloy (Ag-Sn). The powder silver-tin alloy may contain varying amounts of copper and small amounts of other elements such as zinc. Dental amalgam is the most widely used direct filling material for the posterior teeth since its introduction in the mid of 1800s.

Advantages

1- Can be easily contoured to resemble the anatomy of the lost part of the tooth.
2- It has a reasonable force resistance.
3- Least technique sensitive of all restorative materials.
4- Applicable to a broad range of clinical situations.
5- Newer formulations have greater long-term resistance to surface corrosion.
6- Ease of manipulation by dentist. Can be easily inserted in the cavity.
7- Minimal placement time compared to other materials.
8- Initially, corrosion products seal the tooth-restoration interface and prevent bacterial leakage.
9- One appointment placement (direct material)
10- Long lasting if placed under ideal conditions (long service life).
11- Economical (Low cost filling).
12- No sensitivity to the mouth tissue and, it is not irritant.

Disadvantages

1- Some destruction of sound tooth tissue.

2- Poor esthetic qualities.

3- Long-term corrosion at tooth-restoration interface may result in "ditching" leading to replacement.

4- Galvanic response potential exists.

5- Concern about possible mercury toxicity.

6- Marginal breakdown.

Composition of dental amalgam:

Powder: The alloy powder composed of:

1- Silver; it is about 40-70% w.

- ✓ Gives strength.
- ✓ Produce high expansion of the restoration.

2- Tin; it is about 20-30%w.

- ✓ Gives contraction.
- ✓ Increase affinity for mercury.
- ✓ Speed the amalgamation.
- ✓ reduce compressive strength
- ✓ Increase the flow of the amalgam.

3- Copper; if its concentration is between 15-30% called high copper alloys, and if the concentration is less than 5% called low copper alloys, Copper lead to:

- ✓ Reduce corrosion of the restoration.
- ✓ Minimize the flow.
- ✓ Increasing setting expansion.

4- Zinc; if its concentration more than 0.01% the alloy classified as zinc containing alloys, and if it is less classified as zinc free alloys. Zinc:

- ✓ Acts as a scavenger for oxides formed during manufacturing.
- ✓ Help the process of amalgamation.

The alloy particles have different sizes and with different shapes according to the manufacture. If the shapes of the particles are irregular so the alloy is called **lath-cut** alloy, and if they have spherical shape called

spherical alloy, or it may be a mixture of both (lath-cut and spherical particles) so called **admixed** alloy.

Liquid: is pure mercury which is highly dense liquid, very toxic if it's improperly handed. It can be absorbed by skin and it may inhale of its vapor during placing or removal of amalgam restoration. The mercury must be very pure because its impurities may reduce its combination with the alloy.

Amalgam alloys can be classified basically according to:

1- Alloy particle geometries, into lathe cut, spherical (these alloys called uni compositional alloys), and admixed alloys.

2- Zinc content, into zinc containing, and zinc free alloys.

3- Copper content, into high copper and low copper alloys.

Amalgamation:

It is the process of reaction between the mercury and the amalgam alloy. The amalgamation reaction consists of two phenomena which include **solution** and **crystallization**. The amalgam alloy is intimately mixed with liquid Hg to wet the surface of the particles and leads to form at the surface a silver-mercury and tin mercury phases and this crystallization growth leading to cause a hard amalgam. The amalgamation of conventional or low copper amalgam can be described by this equation:

$Ag_3Sn + Hg \longrightarrow Ag_2Hg_3 + Sn_{7-8}Hg + Ag_3Sn$

Unreacted

Ag**3** Sn is the silver tin alloy which is called (γ) phase. Ag**2**Hg**3** is silver mercury or called (γ1) phase which is the predominant product of the reaction. Sn**7-8** Hg is tin mercury or called (γ2) phase which is the weakest and the more corrodible phase of the reaction. Also unreacted silver-tin (γ) phase is remaining in the mixture which is the strongest phase. So mixed amalgam can be described as particles of (γ) phase surrounded or bonded by continuous matrix of (γ1) and (γ2) phases. While in the high copper alloys the amalgamation process differs in that these alloys contain proper amount of copper causes most, if not all, of the (γ2)

phase to be eliminated within a few hours after its formation or prevents its formation entirely, therefore, high copper amalgams tend to have superior physical and mechanical properties.

Properties of dental amalgam:

1- Compressive strength: amalgam has high compressive strength for high copper alloy and less for low copper alloy**.** Because amalgam is brittle material therefore a sudden application of excessive forces to amalgam tend to fracture of amalgam restoration.

2- Tensile strength: Because amalgam is strongest in compression and much weaker in tension and shear, the prepared cavity design should maximize the compression forces in service and minimize tensile and shear stresses resulted from bite forces.

3- Creep: Is permanent deformation under static loads. Under a continued application of force in compression, an amalgam shows a continued deformation, even after the mass has completely set. The maximum allowable creep value for dental amalgam should not exceed 3%. After aging of the amalgam restoration at oral temperature for 6 months the creep value will be reduced. High copper alloys have lower creep values in compared with low copper alloys. So low copper alloys may have high incidence of marginal fracture (ditching of the margin as in figure 1) in compared with high copper alloys**.**

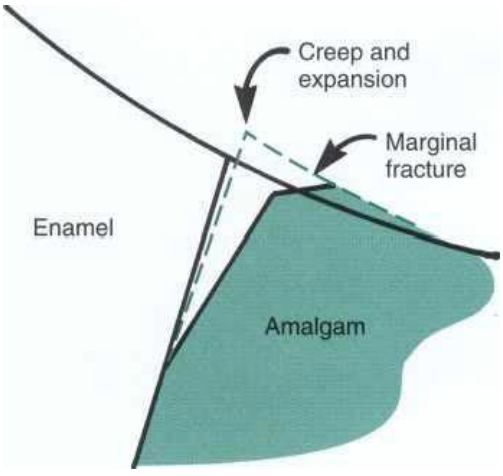


Figure (1) Schematic view of Class I amalgam restoration with expanded margin due to creep that lead to marginal fracture and ditching

4- Dimensional changes: The amalgam undergo shrinkage at the first time after setting (first 20 min.) and after this period the expansion will occur, although, the total change remain negative, and the dimension become constant within 24 hours.
If a contamination of the amalgam with moisture will occur during mixing or condensation, the zinc in the amalgam will decompose water into H2 and O2 gases which will lead to excessive delay expansion of the amalgam restoration and this may cause; marginal discrepancy, pitting of the surface of the restoration, compression on the surrounding tooth surface, post- operative pain, fracture of the
restoration, and recurrent caries.

5- Corrosion: It is a progressive destruction of the metal by chemical or electrochemical reaction with its environment. The early corrosion products are important to reduce the marginal leakage of the freshly placed restoration. Excessive corrosion can lead to increase porosity, reduce marginal integrity (ditching of the restoration margins), loss of strength, and release of metallic products into the oral environment.
Tarnish of the amalgam is black discoloration of the surface due to chemical corrosion with the sulfide.

Packing of the amalgam alloy:
The amalgam alloys are packed either as powder alone or as a pre weighted capsules containing both the alloy and mercury. The alloy is separated from mercury by membrane which is ruptured during mixing. Manufactures commonly supply capsules containing 400, 600, or 800 mg of alloy with appropriate amount of mercury. The alloy/mercury ratio is determined by the manufacture according to the
type of alloy and the size and shape of its particles.

Amalgam mixing (triturating):
In the past the alloy and mercury are mixing manually with mortar and pestle. But now mechanical amalgamator machines give standard produces and can save time. Two types of amalgamator are present; one

type used for mixing of the powder and liquid in different containers, and the other for mixing of pre weighted capsules, or both types are present in one machine. The speed (if possible) and time of mixing should be adjusted according to the manufacture before starting of mixing.

Three types of mixing may be resulted with different appearance and properties:

1- Undermixed (undertriturated) *amalgam:* which appear dull and crumbly. The mercury does not completely wet the outer surfaces of the particles, so the mass remains soft for a longer period of time, producing an amalgam with a longer working time. Such an amalgam mass contains excessive amounts of porosity, has lower strength, and possesses poorer corrosion resistance.

2- Normal mix: which appear shiny and separated in one mass from the capsule.

3- Overmixed (overtriturated) amalgam: which appear soupy and tend to stick to the inside of the capsule. Over-trituration reduces working time, causing the reaction rate to increase because the amalgamated mass becomes hot. The resulted amalgam has low compressive strength and high creep.

Amalgam condensation:

Condensation of the amalgam inside the cavity is important for:

1- Good adaptation of amalgam to cavity walls and margins.

2- To get compact and homogeneity amalgam restoration and minimal voids, this can effect on the strength of filling.

3- To remove excess of mercury and this reduce the dimensional changes, creep and increase compressive strength of filling.

 After mixing, the amalgam must be used immediately without prolonging the time between mixing and condensation because this will lead to condensation of partially set amalgam and that may lead to break and fractures in the matrix that has been formed in the mixed amalgam.

 Cavity to be filled should be kept completely dry during amalgam condensation.

A-Hand condensation:

1- There are many hand instruments with many tip shapes and with different sizes.

2- Lateral and vertical direction of the condensation provides better adaptation of the amalgam to the cavity walls and floor.

3- Amalgam should never be touched with hands to eliminate contaminations.

4- The amalgam carried to the cavity in small amount by using of amalgam carrier and condensation should be done immediately to each small increment, because if large amount of the amalgam is putted in the cavity, the condensation will be ineffective to have a properly condensed restoration with low amount of mercury.

5- After condensation of each amount, the surface of the amalgam will appear shiny because there is excess of mercury present at the surface. This excess mercury should be removed from the surface of each amount of amalgam before applying the next increment.

6- Condensation is continued till we have over-filled cavity, this mean put amount of amalgam above the occlusal surface and this overfilling is important for:

a- To ensure that the cavo-surface margins are completely covered to avoid exposure of that margins.

b- To be able to do good carving.

c- Get rid of excess mercury.

B- Mechanical condensation:

Many mechanical devices are available for condensing amalgam. These devices are more popular and more useful for condensing irregularly shaped alloys when high condensation forces are required.

Amalgam carving:

The main aim of carving the amalgam is for removal of the excess material and maintains the structure of the tooth. There are many instruments that can be used for carving such as carver and spoon excavator.

 after ending of the condensation, the surface of the overfilled amalgam should be burnished by using of a large burnisher with high force moving from the center of the restoration to the margins, this will produce denser amalgam at the margins of the cavity.
 Carving should begin immediately after condensation with suitable size carver. All carving should be done with the edge of the blade perpendicular to the margins as the instrument is moved parallel to the margins. Part of the edge of the carving blade should rest on the unprepared tooth surface adjacent to the preparation margin. Using this surface as a guide helps to produce a continuity of surface contour across the margins.
 Over-carving or deep occlusal grooves carving should not be done on the restoration, because these may thin the amalgam at the margins, invite chipping, and weaken the restoration.
 Under-carving leaves thin portions of amalgam (subject to fracture) on the unprepared tooth surface. Such margins give the appearance that the amalgam has expanded beyond the preparation.
 The mesial and distal fossae should be carved slightly deeper than the proximal marginal ridges.
 After end of carving, post carving burnishing is done by lightly rubbing the carved surface with a burnisher of suitable size and shape to improve smoothness and produce a satin (not shiny) appearance. Post carve burnishing may improve the marginal integrity of high-copper amalgams; it may also improve the smoothness of the restoration.
 After that the occlusion of the restoration must be evaluated, it's done by telling the patient to do light closing to check if there is any high spots in the restoration and this spot look more shiny ;also can be checked by articulating paper, any high spot should be removed before beginning of the initial setting of amalgam.
 Finally; the grooves are enhanced with conical amalgam burnisher and the restoration smoothed by small damp ball of cotton.
 In cervical cavity; the edge of carving instruments must rested on the external tooth surface to prevent over carving; under carving should be avoided as well.

Filling cavities using matrix band:
The matrix-bands are used in compound or complex cavities:
1- To have the desired contour of the restoration**.**
2- To substitute the lost wall of tooth cavity especially in class II (mesial or distal or both) also in complex cavities; and also keeps the amalgam in the needed place and contour during condensation.

Matrix bands: They are used for class II cavity fillings; its position must be 2 mm above the marginal ridge. They are available in many thickness; thin bands are widely used. The thicker bands leading to difficulty in establishing good contact point .The band are either precut or been cut from a ribbon or as a copper ring or band fig 3.

Matrix retainer: It's a mechanical device retained the band in its selected position. Retainers classified into:
1- Ivory No.l.: Used to surround tooth from one surface MESIAL or DISTAL, and with this retainer perforated bands are used fig 2.

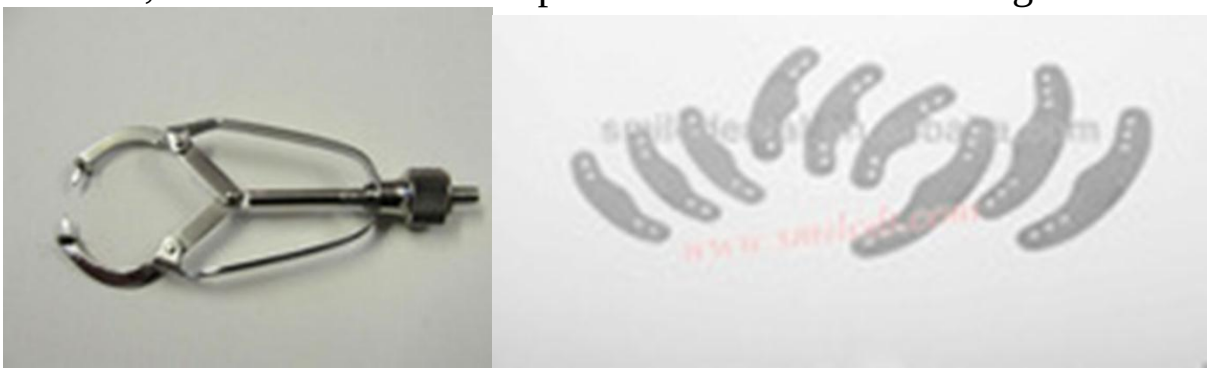


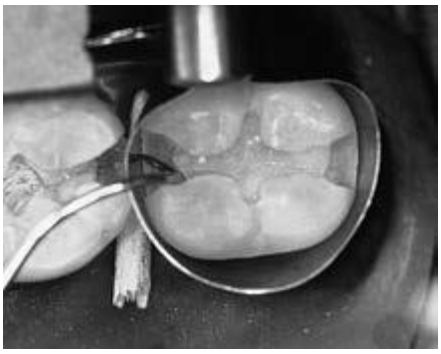
Fig 2: Ivory No.1 and its perforated bands

2- Ivory No.8 and ivory No.9 (tofflemire retainer): these retainers can be used in MOD cavities. The band surrounds the tooth and the retainer lie in muco-buccal fold. The contrangle-tofflemire can be placed at the lingual side .When there is one missing wall of the tooth circumferential retainer can be used. Attention must be given to have the proper contour of matrix band bucco-lingual and occluso-gingival direction, otherwise the restoration will has defects in its contour. Contouring occur by burnishing the band in the areas corresponding to the proximal surface or surfaces to be restored once the band is positioned around the tooth.

Burnishing means that the metal band has been deformed occluso-gingivally with a suitable burnisher to produce a rounded or convex surface that (when in place around the tooth) will produce a restoration that is symmetric in contour with the adjacent proximal surface. See fig (3).

Figure (3): Straight and contra-angled Universal (Tofflemire) retainers. Bands with varying occlusogingival measurements are available.

The band may be trimmed for the shallower gingival margin, permitting the matrix to extend farther gingivally for the deeper gingival margin on the other proximal surface.



Use of the explorer tip (with pressure) to ensure proper adaptation of the band to the gingival margin. In addition, the tip is pressed and dragged along the gingival margin in both directions to ensure removal of any friable enamel.

Wedge: It's a triangular or circular cross section wooden or plastic piece located interproximaly to:

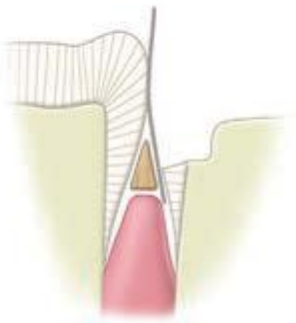
1- Hold the band tightly against the gingival margin of the cavity.

2- Prevent an over hanged filling.

3- Provide sufficient separation of teeth to compensate the thickness of band.

The wedge is placed in the gingival embrasure, from the lingual or facial embrasure (whichever is larger), slightly gingival to the gingival margin of the cavity, however the lingual embrasures are larger than the buccal in the posterior teeth. Wedge the band tightly against the tooth and margin, if the wedge is placed occlusal to the gingival margin, the band will be pressed into the preparation, creating an abnormal concavity in the proximal surface of the restoration. See fig 4

Figure (4) A- wedge B- correct wedge position.



Filling done without wedge cause:

1- No contact point with the adjacent tooth, and that leads to food impaction causing gingivitis and caries

2- Overhanging restoration.

 A contoured matrix putted in place with wedge and with a probe check the adaptation of the band to the cavity gingival margin. After that relaxation of the band quarter or half turn to be sure that a good contact point is obtained. Condensation of amalgam must start at the box of the cavity until the cavity is over filled .At each stage of condensation excess mercury must be removed from the surface because if this excess left it may cause weakness of the restoration.

 Carving of the filling: Means bringing the filling as near as could to the tooth shape; and that done by removing the excess material then the outer inclination of the marginal ridge is established by carver or probe while the matrix band is still in place.

 We must not try to remove the band before the reduction of the marginal ridge to its approximate height, else fracture of that margin may occur, as well gross contouring of occlusal surface with large excavator must be done. And then the wedge and retainer removed, after that the band removed bucco-occlusally or lingo-occlusally. Checking of the gingival margin should begin immediately after removal of the band and that done by using a probe; then the carving of the restoration is completed.

Finishing and polishing: This can be done at least 24 hours later; and it is done for:

1- Well finished and polished restoration this will keep the surface smooth and clean so less tarnish and corrosion occur**.**

2- Rough surface may cause accumulation of food particles leading to secondary caries**.**

3- Polished surface gives better response to the surrounding soft tissues**.**

4- We can have more ideal carving and contouring**.**

5- A small feather edges of amalgam excess left beyond the margins may fractured under stress leaving rough surface and that can be removed during polishing**.**

For finishing and polishing we use the following:

1- Tapered stone bur.

2- Round or flamed finishing bur with deferent sizes.

3- Rubber cup and pumice with water.

4- Thin zinc-oxide with soft cup brush for final shine.

Conservative dentistry

LEC: 11 ***Dr. Alalaa***

Complex Amalgam Restorations

Complex posterior amalgam restorations should be considered when large amounts of tooth structure are missing, when one or more cusps need capping, and when increased resistance and retention forms are needed fig 1.

Fig1: Mesio-occluso-disto-facial-lingual (MODFL) complex amalgam

Indications:

1- Control restorations in teeth that have a questionable pulpal and/or periodontal prognosis.
2- Control restorations in teeth with acute and severe caries.
3- Foundations (abutment teeth for fixed prostheses).

Contraindications:

1- If the area to be restored is esthetically important for the patient.
2- If the tooth cannot be properly restored with a direct restoration because of anatomic and/or functional considerations.

Resistance and Retention Form:

1- In a tooth severely involved with caries or, any undermined enamel or weak tooth structure subject to fracture must be removed and restored.

2- When conventional retention features are not adequate because of insufficient remaining tooth structure, pins, slots, and amalgam bonding techniques may be used to enhance retention

3- The retention features needed depend on the amount of tooth structure remaining and the tooth being restored. As more tooth structure is lost, more auxiliary retention is required.

4- Pins, slots, and bonding also provide additional resistance form to the restoration.

5- Capping cusps: (fig 2)

a) When caries is extensive, reduction of one or more of the cusps for capping may be indicated (capping cusps).

b) When the facial-lingual extension of the occlusal preparation exceeds two third the distance between the facial and lingual cusp tips (inter-cuspal-distance), reduction of the cusp(s) for amalgam is usually required for the development of adequate resistance form.

c) The reduction should be 2mm as minimum depth on the occlusal surface of each cusp to be capped using the side of carbide fissure bur, to ensure that the final restoration has restored cusps with a minimal thickness of 2 mm of amalgam

d) The occlusal contour of the reduced cusp should be similar to the normal contour of the unreduced cusp. Any sharp internal corners of the tooth preparation formed should be rounded to reduce stress concentration in the amalgam and thus improve its resistance to fracture from occlusal forces.

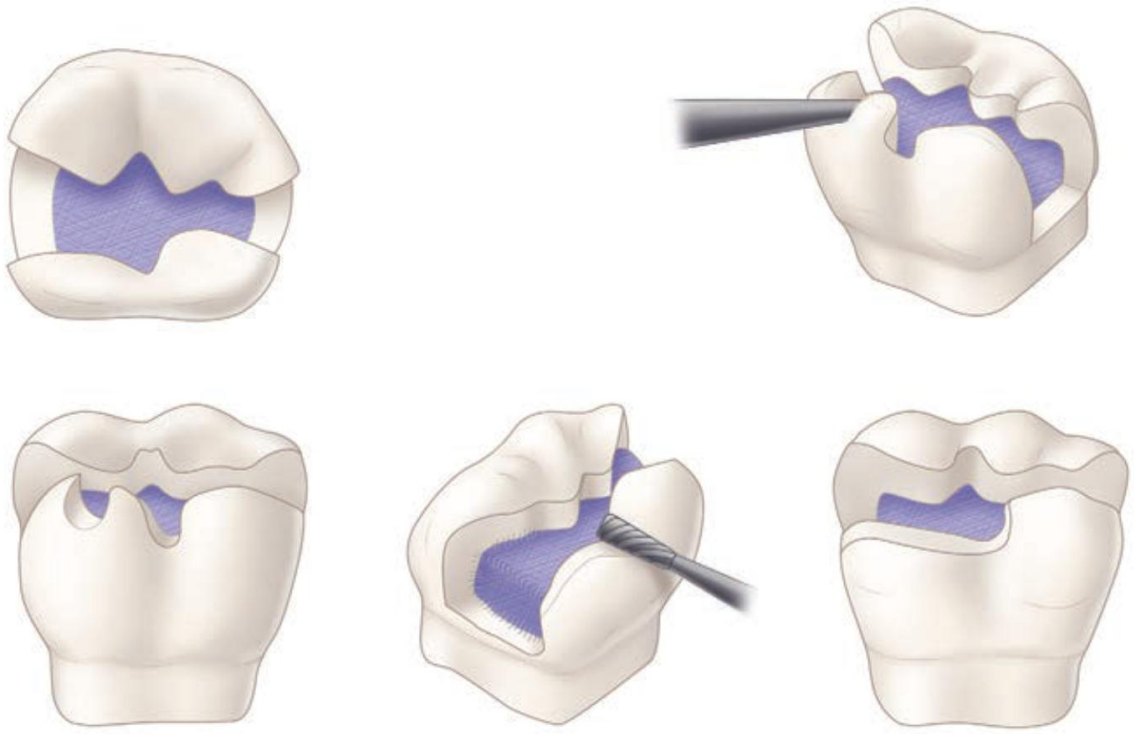


FIG. (2) Capping cusp with amalgam

* When possible, opposing vertical walls should be prepared to be converge occlusally, to enhance primary retention form. The pulpal and gingival walls should be relatively flat and perpendicular to the long axis of the tooth.

Secondary retention means:

Cusp reduction significantly diminishes retention form by decreasing the height of the vertical walls, so secondary retention means are required which may include:

1- Coves and locks: Coves are prepared in a horizontal plane and locks are prepared in a vertical plane. These locks and coves should be prepared before preparing pinholes and inserting pins. (see fig.3 A&C)

2- Slots: which may be prepared along the gingival floor, or in addition to, pinholes (as appear in fig.3 B). The slot should be prepared 0.5 mm pulpal to the dentino-enamel junction and at least 0.5 mm in depth.

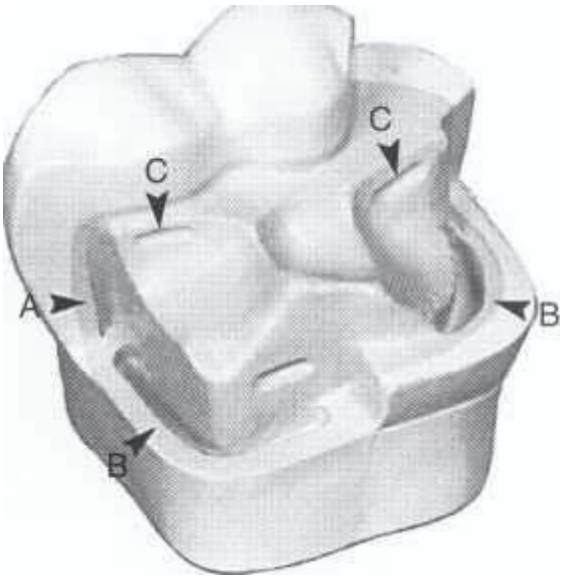


Fig. 3 Locks (A), slots (B), and coves (C).

3- Pins: Pins placed into prepared pinholes provide auxiliary resistance and retention forms.

PIN RETAINED AMALGAM RESTORATION:

It's any filling may needs one or more pins to provide adequate resistance and retention forms.

Fig 4: pin retained amalgam restoration

Advantages:

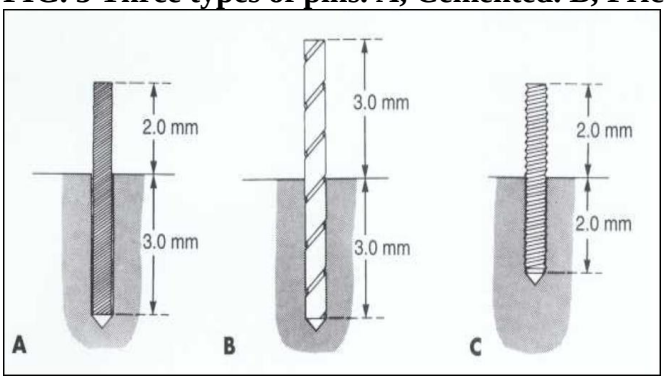
1- Conservative; means the pin is more conservative in tooth cutting than slot and crown preparation.

2- Time value: Pined amalgam needs only one visit; the cast may needs two visits.
3- Resistance and retention are better by using pins.
4- More economic than cast.

Disadvantages:
1- It's difficult to penetrate when there is little dentin left.
2- Stress induced into tooth structure.
3- Perforation may occur to the pulp or to the external tooth surface.
4- Requires at least 4 mm's of occlusal clearance.

Types of pins:
1. Self -threading pins: The pin is retained by threads on pin surface through engaging the dentin when it's inserted. It is the most retentive type of pins and also it is the most widely used than the other types. However, vertical and horizontal stresses can be generated in the dentin when a self-threading pin is inserted causing craze lines in the dentin which are related to the size of the pin. The diameter of pin hole is 0.1 mm smaller than pin diameter .The elasticity of dentin allows the insertion of pin into a hole of smaller diameter. The depth of pin hole is about 1.5-2mm. (Fig 5, C)
2. Cemented pins: Its threaded or serrated stainless steel pins cemented into pin holes 0.05mm larger than the diameter of the pin .The cement used may be any standard dental luting agent such as Zinc phosphate or polycarboxylate cement. The cemented pins produce less stresses in the dentin. The depth of pin hole should be 3 mm. (Fig 5, A)
3. Friction-locked pin: The diameter of the prepared pin hole is 0.025 mm less than diameter of the pin ; the pin is tapped in place retained by resiliency of dentin; Its 2-3 time more retentive than cemented pins; its inserted by specially designed instrument. (Fig5, B)

FIG. 5 Three types of pins. A, Cemented. B, Friction-locked. C, Self-threading.



Factors Affecting the Retention of Pin in Dentin and Amalgam:

1- Type of pin: The self-threading pin is the most retentive, the friction locked pin is intermediate, and the cemented pin is the least retentive.

2- Surface characteristics: The number and depth of the elevations (serrations or threads) on the pin influence retention of the pin in the amalgam restoration. The shape of the self-threading pin gives it the greatest retention value.

3- Orientation, number, and diameter: Retention provided by placing the pins in a non parallel manner; also excessive bending of pins to improve retention in amalgam is not desirable, because bending interfere with the adequate condensation of amalgam around the pin, also bending may weakens the pins. Pins should be bent only to provide an adequate amount of amalgam (approximately 1 mm) between the pin and the external surface of the finished restoration**.**

4- Extension of pin into amalgam and dentin:

The extension of pin into dentin and amalgam greater than 2 mm is unnecessary for pin retention and is contraindicated to preserve the strength of the dentin and the amalgam. (Fig.5)

Pin Placement Factors and Techniques:

1- Pin size: Two determining factors for selecting the appropriate pin size are the amount of dentin available to safely receive the pin, and the amount of retention desired. In the Thread Mate System (TMS) four sizes of pins are available (from the largest size to smaller size: Regular,

Minim, Minikin and Minuta)**.**The Minikin pins usually the pins of choice for severely involved posterior teeth to reduce the risk of dentin crazing, pulpal penetration, and potential perforation. The Minim pins usually are used as a backup in cases where the pinhole for the Minikin was over prepared. The Regular or largest diameter pin is rarely used because a significant amount of stress in the tooth (dentin and enamel) may be created during its insertion. The Minuta pin is usually too small to provide adequate retention in posterior teeth so this pin can be benefit for providing retention for anterior teeth restorations.

2- Number of pins:

a- As a rule one pin per cusp or marginal ridge.

b- The fewest pins possible should be used to achieve the desired retention for a given restoration.

c- If more than one pin is used, 3-5 mm space between pins is required.

d- As the number of pins increases the retention of the restoration increases, while an excessive number of pins can fracture the tooth and significantly weaken the amalgam restoration.

3- Location:

a- Occlusal clearance should be sufficient to provide 2 mm of amalgam over the pin.

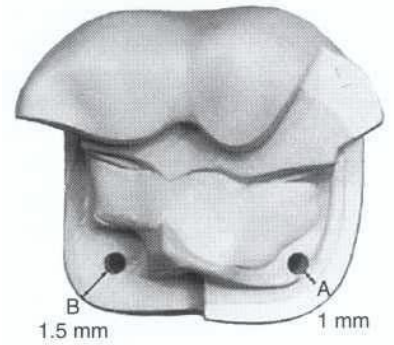
b- Pinholes should be located halfway between the pulp and the DEJ or external surface of the tooth root. The pinhole should be positioned no closer than 0.5 to 1 mm to the DEJ or no closer than 1 to 1.5 mm to the external surface of the tooth. (See Fig. 6)

c- The pinhole should be parallel to the adjacent external surface of the tooth.

d- A minimum space of 0.5 mm is required around the circumference of the pin for adequate condensation of amalgam.

e- Pinholes should be prepared on a flat surface that is perpendicular to the proposed direction of the pinhole.

Fig. 6 Pinhole position. A, Position relative to DEJ. B, Position relative to external tooth surface.



f- Several posterior teeth have anatomic features that may preclude safe pinhole placement. External perforation may result from pinhole placement on these areas:

i- Over the prominent mesial concavity of the maxillary first premolar.

ii- Over bifurcation areas of the lower molars and trifurcation areas of the upper molars.

iii- The distal aspect of mandibular molars and the lingual aspect of maxillary molars because of root angulations of these teeth just apical to CEJ.

iv- Teeth that are rotated in the arch.

v- Abnormal tilted teeth. (See Fig 8)

Pinhole preparation:

1- The drill is a twist drill made of aluminum shank, which acts as a heat absorber, and is color coded so that it can be easily matched with the appropriate pin size. A drill with limited depth of 2mm should be used to prepare the hole.

2- When the pinhole locations have been determined, a No. ¼ round bur is first used to prepare a hole. The purpose of this hole is to permit more accurate placement of the twist drill and to prevent the drill from "crawling" once it has begun to rotate.

3- Put the hand-piece on clockwise rotation at very low speed (300 to 500 rpm).

4- Prepare the hole parallel to nearest external tooth surface. Align twist drill with external tooth surface. Drill the hole in one continuous motion

until the depth is reached then pulls the drill without stopping the rotation to prevent breaking of the drill while it's in the hole. (See fig. 7)

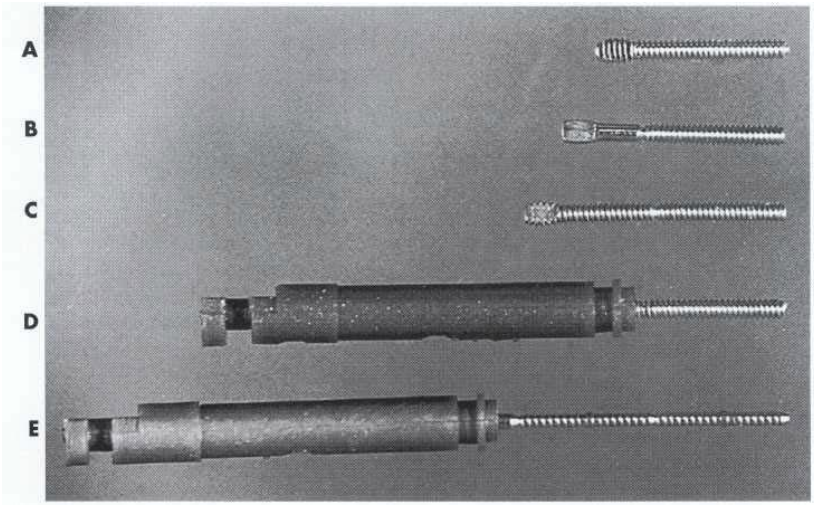
FIG (7): A and B, with twist drill at correct angulation, prepare pinhole in one thrust until depth-limiting portion of drill is reached.

Fig. (8) Care must be exercised when preparing pinholes in mesially tilted molars to prevent external perforation on mesial surface (A) and pulpal penetration on the distal surface (B). Broken line is incorrect angulation of twist drill.

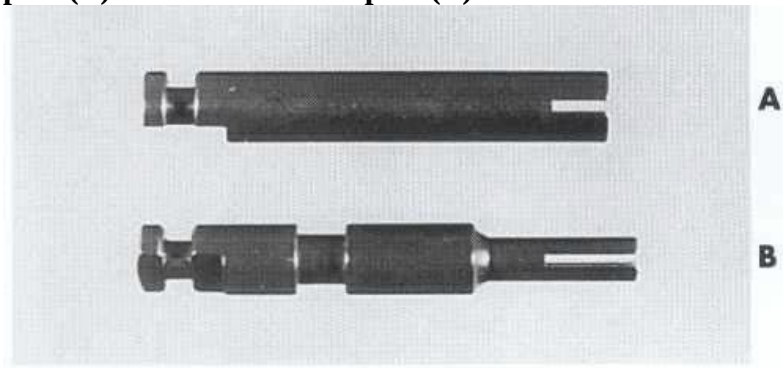
Pin design:

For each of the four sizes of pins, several designs are available: standard, self-shearing, two-in one, Link Series, and Link Plus (Fig. 9). The Link Series and Link Plus pins are recommended. TMS pins are available in titanium or stainless steel plated with gold. When the pin reaches the bottom of the hole, the top portion of the pin shears off, leaving a length of pin extending from the dentin.

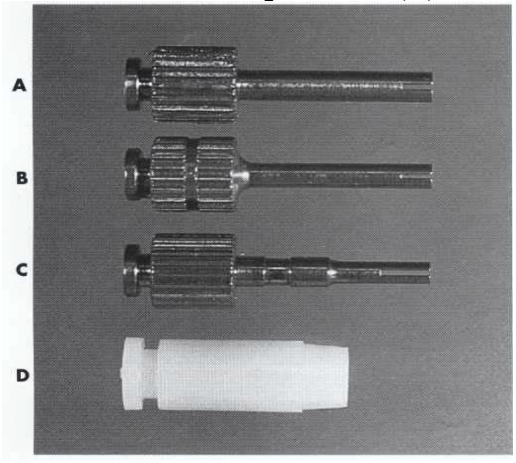
FIG (9) Five designs of TMS pins. A, Standard. B, Self-shearing. C, Two-in-one. D, Link Series. E, Link Plus.



Hand-piece chucks for the Thread Mate System (TMS) regular self-shearing and Minikin pins (*A*) and TMS Minuta pins (*B*).



Hand wrenches for TMS pins. (A) TMS regular self-shearing and A, Regular and Minikin. B, Minim. Minikin pins, and (B) TMS Minuta pins C, Minuta. D, Link Series and Link Plus.



Notes:
When pin is placed in the pin hole, the pin should not exceed 2 mm in length in the amalgam, if the length is more than that, the excess should be cut. It is desired to have at least 2 mm of thickness of the amalgam occlusal to the end of the pin to prevent weakening of the restoration.

Possible Problems with Pins:
1- Failure of pin-retained restorations: The failure of pin retained restorations might occur at any of five different locations (Fig. 10). Failure can occur:
a- Within the restoration (restoration fracture).
b- At the interface between the pin and the restorative material (pin-restoration separation).
c- Within the pin (pin fracture).
d- At the interface between the pin and the dentin (pin-dentin separation).
e- Within the dentin (dentin fracture).

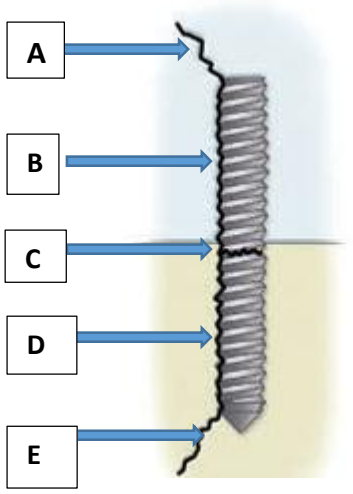


Fig (10) Five possible locations of failure of pin-retained restorations.
a, Fracture of restorative material;
b, Separation of pin from restorative material;
c, Fracture of pin;
d, Separation of pin from dentin;
e, Fracture of dentin.

2- Broken drills and broken pins: A twist drill will break if it is stressed laterally or allowed to stop rotating before being removed from the pinhole. Pins also may break during bending, if care is not exercised. The treatment for both broken drills and broken pins is to choose an alternate location, at least 1.5 mm away from the broken item, and prepare another pinhole.

3- Loose pins: The pin should be removed from the tooth and the pinhole re-prepared with the next largest size drill, and the appropriate pin inserted. Preparing another pinhole of the same size 1.5 mm from the original pinhole also is acceptable.

4- Penetration into the pulp and perforation of the external tooth surface:

It is obvious if there is hemorrhage in the pinhole following removal of the drill, also the operator can feel when a penetration or perforation has occurred by an abrupt loss of resistance of the drill to hand pressure. In an asymptomatic tooth, a pulpal penetration is treated as any other small mechanical exposure by control the hemorrhage, then place a calcium hydroxide liner over the opening of the pinhole, and prepare another hole 1.5 to 2 mm away.

Perforation of the external surface of the tooth can occur occlusal or apical to the gingival attachment. When the perforations occur occlusal to the gingival attachment, the pin can be cut off flush with the tooth surface and no further treatment. Or the pin can be removed, if still present, and the external aspect of the pinhole enlarged slightly and restored with amalgam. If the perforations occur apical to the attachment, reflect the tissue surgically, remove the necessary bone, enlarge the pinhole slightly, and restore with amalgam.

FAILURE OF AMALGAM RESTORATION:

The failure of amalgam restoration may include:

1- Secondary caries: Class I and Class II amalgam restorations, caries around margins was the predominant cause of restoration failure. Also

amalgam restoration in high caries incidence individuals may fail as a result of secondary caries.

2- Isthmus fractures or marginal ridge fracture of restoration: the marginal ridge fracture in Cl II restoration may be caused by:

a- Axio-pulpal line angle not rounded in class II cavity.

b- Marginal ridge left too high.

c- Improper removal of the matrix.

3- Tooth fractures: Excessive tooth cutting or excessive caries, may resulted in large cavity with thin walls that cannot withstand occlusal forces, and will cause tooth fracture. Also sharp internal line angles may cause stress concentration of the restoration on the tooth walls and lead to fracture.

4- Improper marginal adaptation and marginal fractures:

Marginal deterioration of amalgam restorations are mainly caused by the following factors:

a- Improper marginal preparation.

b- Improper carving and finishing.

c- Excess mercury.

d- Use of low copper amalgam.

e- Amalgam expansion.

5- Other reasons: these includes faults in the clinical procedures during amalgam placement such as: gingival overhang of the restoration (due to not or improper using of the wedge), improper contact area with the adjacent tooth which will lead to periodontal problems.

Lec 12 **Resin-based Composites** **Dr. Alalaa**

It is introduced commercially in 1962 by Bowen of the National Bureau of Standards most popular tooth colour material consist of a continuous polymeric or resin matrix in which an inorganic fillers is dispersed.

Indications:

1. Classes I, II, III, IV, V and VI restorations
2. Foundations or core buildups
3. Fissure sealants and conservative composite restorations (preventive resin restorations)
4. Esthetic enhancement procedures

• Partial veneers
• Full veneers
• Tooth contour modifications
• Diasthema closures

5. Cements (for indirect restorations)
6. Temporary restorations

Contraindications:

1. An operating area that cannot be adequately isolated.
2. Class V restorations that are not aesthetically critical.
3. Restorations that extend into the root surface (may exhibit gap formation).

Advantages:

1. Aesthetics
2. conservative of tooth structure removal (less extension; uniform depth not necessary; mechanical retention usually not necessary)
3. less complex when preparing the tooth

4. low thermal conductivity
5. bonded to tooth structure resulting in good retention, low micro leakage, minimal interfacial staining, and increased strength of remaining tooth structure
6. Repairable

Disadvantages

1. may result to gap formation, usually occurring on root surfaces as a result of the forces of polymerization shrinkage of the composite material
2. restoration is more difficult, time-consuming, costly (compared to amalgam restorations)
3. Are more technique sensitive because the operating site must be appropriately isolated and the placement of etchant, primer, and adhesive on the tooth structure (enamel and dentin) is very demanding of proper technique
4. May exhibit greater occlusal wear in areas of high occlusal stress or when all of the tooth's occlusal contacts are on the composite material
5. Have a higher linear coefficient of thermal expansion, resulting in potential marginal percolation if an inadequate bonding technique is utilized

Composition

A. Organic Resin – forms the matrix

-dimethacrylate monomer (BIS-GMA)

B. Inorganic filler

- inhibits deformation of the matrix
- reduce the coefficient of thermal expansion of the resin matrix

e.g. fused silica, crystalline quartz, lithium aluminum silicate, borosilicate glass

- better mechanical properties, such as compressive strength;
- greater aesthetics;

- confers radio-opacity

C. Coupling Agent

- unite the resin with the filler
- stress absorber of the filler and resin

D. Initiator System – activate the setting mechanism

E. Stabilizers

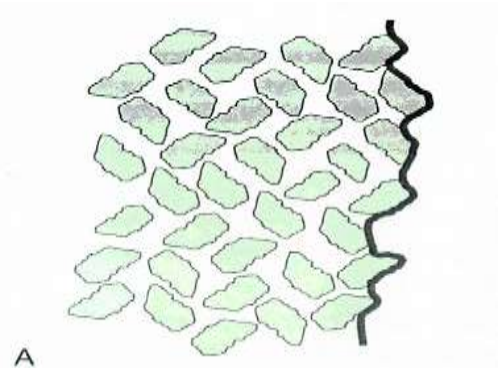
F. Pigments

Classification

1. Conventional
2. Microfilled
3. Hybrid -Flowable - Packable
4. Nano-composite (nanofilled) - Completely nanofilled - Nanohybrids
5. Reinforced

Conventional Composites

1. contains 75-80% inorganic filler by weight
2. average particle size 8µm
3. large size particle and extremely hard filler
4. rough surface structure, strontium and barium glass (radiopaque)



Microfilled Composites

1. introduced in the late 1970
2. polishable
3. smooth lustrous surface similar to tooth enamel

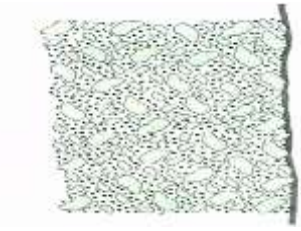
4. particle size is 0.01 – 0.04µm
5. contains 35-60% inorganic filler by weight
6. some of physical and mechanical properties are inferior; wear resistant
7. low modulus of elasticity (allow restoration to flex)
8. high resin content results in an increased coefficient of thermal expansion and lower strength

Use of Microfilled Composites

- used for low stress restorations, buccal and lingual surfaces of class III and class V

Hybrid Composites

1. combines the properties of conventional and microfilled
2. contains 75-85% inorganic filler by weight
3. particle size is 0.4 – 1µm
4. physical properties is superior to conventional
5. predominant direct aesthetic resin
6. have universal clinical applicability



Use of Hybrid Composites

- used in moderate stress restorations where strength and wear resistance are more important than surface luster; Class I, class II, class IV

Flowable composites

1. flows into cavity due to lower viscosity
2. have lower filler content

3. inferior physical properties (lower wear resistance, lower strength)
4. used in small class I, pit and fissure sealant, marginal repair materials, as the first increment placed as a liner under hybrid or packable composites
5. easy to use
6. good wet ability
7. favourable handling properties are popular features
8. clinical indications for their use are limited.

Packable (Condensable) composites

1. more viscous, "thicker, stiffer feel"
2. have filler particle feature that prevents sliding of the filler particle by one another
3. easier restoration of proximal contact
4. similar to the handling of amalgam

Nanofill composites

1. Contain filler particles that are extremely small (0.005-001 microm.)
2. Because of these small particles a high filler levels can be generated in the restorative material, resulting in good physical properties and esthetics
3. Nanofills highly polishable
4. These materials are likely to become a popular composite restorative material choice

Completely nanofilled resins

Contain nano-meter sized particles throughout the resin particles

Nanohybrids resins

Consist of large partials surrounded by nano-meter sized particles

Reinforced composites

It consists of a combination of a resin matrex, randomly orientated E-glass fiber and inorganic particulate fillers.

Used as base filling material in high stress bearing areas especially in large cavities of vital and non- vital posterior teeth

Classification according to the method of activation:

1. Chemically-activated composites:

Also they are called self -curing composite resins. Most commonly available as two-paste system composed of a catalyst and base materials. When these two components are property mixed, the polymerization process is chemically activated. The rate of set is uniform through the bulk of the material causing a gradual increase in viscosity at room temperature. Hence the material have a limited working time, making the technique time sensitive with the increased possibility of air bubble incorporation during mixing of the two pastes and thus affecting the composite physical and mechanical properties .

2. Light-activated: composites:

Light activated materials afford a number of advantages over chemically activated ones. The light curable materials are single components, and require no mixing, and so have reduced porosity, and better resistance to wear and abrasion. The working time is virtually that chosen by the clinicians, and the material hardens rapidly when exposed to light. The components of light -activated composites are contained in single paste system. The mixture is supplied in various shades in disposable syringes. These syringes are made of opaque plastic to protect the material from exposure to light.

3. Dual cured composites:

Combine self curing and light curing materials .The self curing rate is slow and is designed to cure only those portions that are not adequately light cured Specially in the interproximal areas where the access is limited and require special approaches to guarantee adequate light curing energy

Lec 13 Light -activation sources: Dr. Alalaa

1. Ultraviolet light source:

The introduction of photopolymerization to dentistry began in the late 1960s. Initially, ultraviolet cured pit and fissure sealant were put into clinical practice, UV radiation cause possible eye problems that might develop in office personnel and the possibility of selectively altering the oral flora of the patient's mouth through exposure to ionizing radiation.

2. Visible light sources:

A- Quartz-Tungsten-halogen (QTH) light source:

A modified light source delivery was introduced in the form of the handheld dental curing light.

Visible radiation passed through the infrared filter, is then further filtered by a band pass filter, providing energy restricted to a narrow visible light region where the absorbance of the photoinitiator is maximum, so that, only blue light is emitted. However, only the wavelengths around 470 nm are strongly absorbed by the Composite.

B- Argon laser lights

When laser technology provided sources that emitted high-intensity light within the energy band required by the photoinitiator in light-activated dental materials, the dental industry developed this type of curing source for the practitioner. The argon-ion laser provides high output energy at 488 nm for rapid polymerization of commercially available dental restorative

C. Short-Arc Xenon Sources (Plasma-Arc Curing lights (PAC)):

In the mid 1990s, Xenon arc light units were introduced in restorative dentistry as alternative for rapid light curing. Manufacturers claimed that these sources can effectively reduce clinical exposure

duration to only 1 to 10-seconds or some manufacturers claimed that composites could be adequately polymerized in less than 1 second.

D. Blue light- emitting diode curing units (LED) s

The blue LED has become available in output wavelengths that fell within the spectral absorbance of a common dental photoinitiator (CQ). The intensity of these devices has increased at a rapid rate, and now commercial devices are available for the photopolymerization of dental composites. Instead of the hot filaments used in halogen bulbs, LED, use junction of doped semiconductors for generation light.

Polymerization:

Resin composite restoratives solidify by means of the chemical process termed polymerization. The polymerization of the resin matrix produces a gelation in which the restorative material is transformed from a viscous-plastic into a rigid-elastic phase. During the early stages of polymerization, monomers are mainly converted into polymeric chains.

After a certain degree of conversion has been attained, the predominant reaction is the cross-linking of the polymeric chains, resulting in a strong polymeric network.

Factors affecting polymerization shrinkage stress:

1-Factors related to the cavity design:

Stress developed during curing can be minimized by consideration of the ratio between the bonded and unbonded surface area (c- factor). When this ratio increases, as in Class I and Class V situations, increase the shrinkage stress loading on the tooth- resin interface leading to de bonding.

2-Factors related to the placement technique:

The second factor that might reduce polymerization shrinkage is to insert resin composites in increments to reduce the volume of the resin that is shrinking during polymerization.

3-Factors related to the composite formulation:

Nonbonded microfiller particles have been found to produce significant decreases in polymerization stress by acting as stress-relieving sites within the composite.

Acid Etching:

- A physical process that creates a microscopically rough enamel surface (enamel tags)
- first successful technique developed to bond dental materials to tooth structure
- acid used is 37% ortho-phosphoric acid
- sometimes referred to as conditioner

Smear Layer: When a rotary or handheld instrument is used on dentin it creates a special surface texture called a smear or smear layer that closes off the dentinal tubules. This layer is lightly adhered to the dentin surface and contains tooth cuttings, saliva, bacteria, and other surface debris

Enamel Etching

Enamel consists of organic and inorganic components. Application of 37% phosphoric acid removes about 10 microns of enamel to expose prisms of enamel rods and create the classic honeycomb effect. Acid also increases surface energy for better wetting of the enamel. Resins flow into micromechanical retentive areas. Resin tags fill microscopic holes to provide retention. Retention is about 30 MPa.

Acid etching is done for a minimum of 15 to 30 seconds. Thorough rinsing for 10 seconds removes acid and dissolved calcium phosphates.

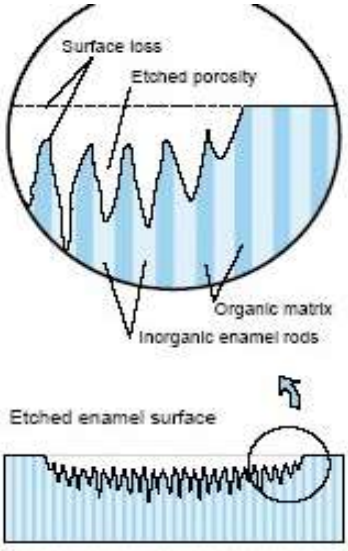


Figure 8–3. Schematic diagram depicting how acid etching produces microporosities in enamel.

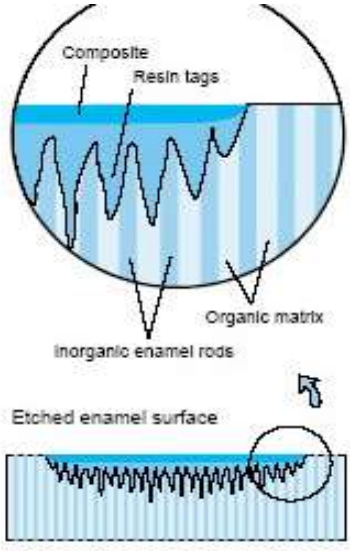


Figure 8–4. Schematic diagram depicting how resin tags penetrate the microporosities produced by acid etching of enamel.

- Over-etching results to formation of crystals (precipitates) that inhibits bonding
- Built-in quality control check – if properly etched it appears frosty or chalky white.

Dentin Etching

- 37% ortho-phosphoric acid
- removes the smear layer from the surface of the of the dentin as well as the plugs of material forces into dentinal tubules during cavity preparation.
- decalcifies a layer of dentin several microns thick.Time:10-15 seconds

If the etched tooth surfaces are contaminated with saliva or blood, they need to be reetched. Such a reetching procedure requires only 5 seconds.

Adhesion to Dentin

Conditioning or Etchant (E):-dentin etching time 15 sec only

-Removes the smear layer.

- Exposes the intertubuler and peritubular collagen.

- Opens the tubules.

-Decreases the surface free energy.

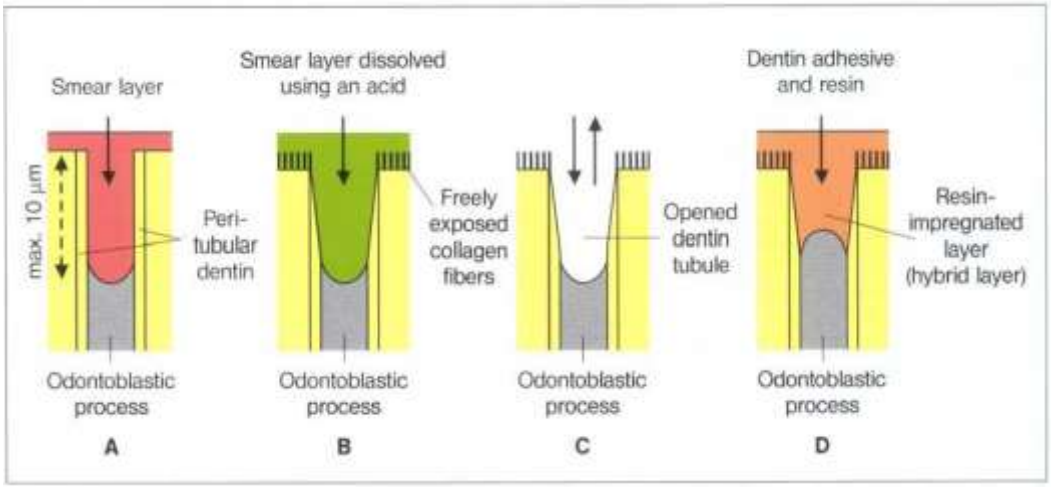
Primer (P):-

- Includes bifunctional molecules hydrophilic and hydrophobic).
- Envelops the external surface of collagen fibrils.
- Re-establishes surface free energy to levels compatible with more hydrophobic restorative materials

Bonding Agent (B): (Adhesive resin)

- Includes monomers that are mostly hydrophobic such as Bis-GMA
- Copolymerize with the primer molecules penetrates and polymerizes into interfibriller spaces to serve as a structural backbone to hybrid layer.

Adhesion to Dentin protects the pulp, because after removal of the smear layer with a mild acid (conditioner) the opened dentin wound was sealed with a hydrophilic resin, for example, HEMA (primer) and a bonding agent (adhesive). During this treatment a dentin surface impregnated with resin (hybrid layer) is formed that guarantees an optimal dentin wound closure which is acid resistant and prevents bacteria penetrating.



Effect of the total etch technique on the opening of the dentin canals

A- Prepared cavity
B -The smear layer is dissolved through treatment with phosphoric acid
C- The acid and the dissolved smear layer are washed away using a water-air spray
D- Forming the hybrid layer with a dentin adhesive

Current strategies for Adhesion of Resin to Dentin:

I-Total etch adhesive

A- Three step total etch adhesive:

Etchant (E) + Primer (P) + Bonding Agent (B)

B- One-bottle total –etch (two step total-etch adhesive):

Etchant (E) +Primer and Bonding agent (PB)

II-Self-etch adhesive:

A- Two –bottle self-etch:

Etchant and Primer (EP) + Bonding (B)

B- All-in-one self-etch (EPB) we call it single application:

-it demineralises and penetrates dentin simultaneously leaving a precipitate on the hybrid layer.

- Forms a thin layer of adhesive.
- a multi-coat approach is recommended.

Adhesive strategies – principles:

1- Acid etch will remove smear layer with collagen fibers upright, tubules open, primer and adhesive penetrate.

2- Leave smear intact, tubules plugged, partially demineralize smear layer with self- etching primer and replaced with resin filler in to tubuler dentin.

Since their introduction in 1955, dental bonding agents have evolved from no-etch to total-etch (fourth- and fifth-generation) to the more recent, self-etch systems (sixth- and seventh-generation). The newest adhesive system, seventh-generation, combines the acid, primer, and bond in one bottle, which requires a single step with no mixing or etching.

Thirty-six primary anterior teeth were randomly divided into 3 groups of 5th generation (Single Bond 2), 6th generation (Clearfil SE) and 7th generation (Single Bond Universal) bonding agents.

Seventh-generation bonding agents have water as a solvent

Seventh-generation bonding agents offer good bond strengths to tooth structure and less technique sensitivity than etch-and-rinse (total-etch) and sixth-generation bonding agents. They may be excellent choices for bonding direct and indirect resin and all-ceramic posterior restorations.

6th-**generation bonding agents** are self-etching, which means that they do not need phosphoric acid to demineralize tooth structure. They contain a self-etching primer that demineralizes and primes the tooth structure simultaneously. They also utilize a hydophobic adhesive that bonds more readily to composites.

fifth generation bonding agents primer and adhesives are in same bottle.

4th generation 3-step system

5th generation 2-step system

Third generation attempted to deal with smear layer and dentinal fluid

The **third generation** bonding systems introduced a very important change: the acid etching of the dentin in an effort to modify or partially remove the smear layer

Lec 14 CLASS V RESTORATIONS CLINICAL TECHNIQUE FOR DIRECT CLASS III, CLASS IV AND

Dr. Alalaa

CAVITY PREPARATION FOR COMPOSITE RESTORATIONS

Three designs of tooth preparations for composite restorations, and sometimes they are used in combination. The designs include:

(1) Conventional (2) Beveled conventional (3) Modified

Class III Tooth Preparation:

There is a choice between facial or lingual entry into the tooth

Indications for Lingual Approach

1- To conserve facial enamel for enhanced esthetics.

2- Carious lesion is positioned lingually.

3- Lesion is accessible from the lingual. Advantages:-

1-Color matching of the composite is not as critical.

2- Discoloration or deterioration of the restoration is less visible.

Indications for Facial Approach

1- The carious lesion is positioned facially

2-Teeth are irregularly aligned, making lingual access undesirable.

3- Extensive caries extent into the facial surface.

4- Faulty restoration that was originally placed at the facial.

Conventional Class III

Indicated for restorations involving the root surface

1. Using a No. ½, 1, 2 round bur prepare the outline form on the root surface

2. Extend the preparation into sound walls

3. Extend pulpally 0.75mm in depth

4. The gingival/cervical and incisal wall is perpendicular to the root surface (box like design)

5. A continuous groove retention can be prepared 0.25 mm (½ of diameter of bur) into dentin of the gingival and incisal walls with a ¼ round bur.

6. The groove is placed at the junction of the axial and the external walls.

7. Clean preparation and inspect the final preparation.

Bevelled Conventional Class III

- Indicated for replacing an existing defective restoration in the crown portion of the tooth
- When restoring a large carious lesion for which the need for increased retention and/or resistance form is anticipated.

Lingual Access

1. Use a round bur No. 1/2, 1. 2 depending on the size of the caries to enlarge the opening sufficiently to allow for caries removal.

2. Extend external walls to sound tooth structure using a straight bur

3. Extend the gingival and incisal walls up to extent of caries or location of old restoration.

Unless necessary, DO NOT:

- include the proximal contact.
- extend into the facial surface.
- extend subgingivally

4. Create an initial axial wall depth of 0.2mm into the dentin/DEJ (approximately 0.75 – 1.25mm in depth)

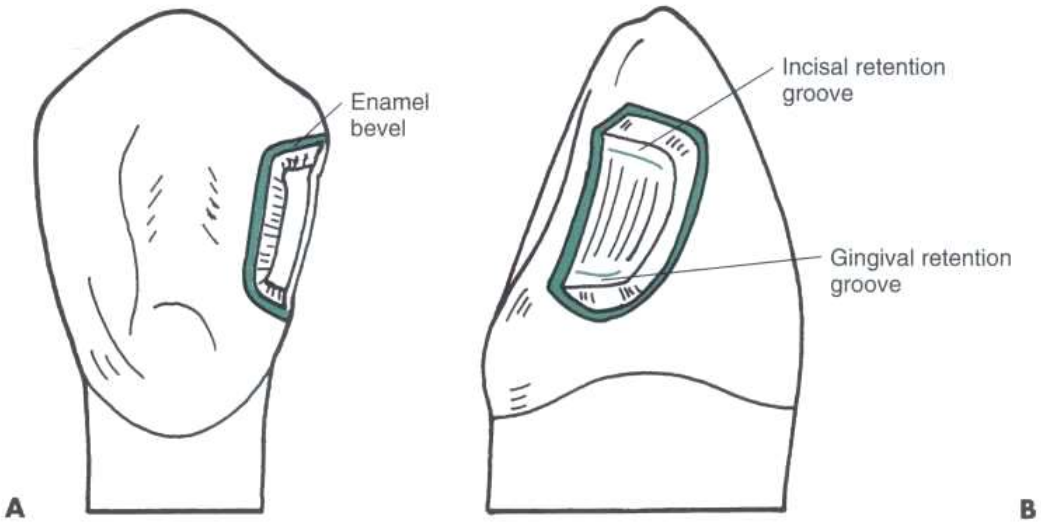
5. Axial wall is convex, following the external contour of the tooth.

6. Remove all remaining infected dentin, using a round bur or small spoon excavator.

7. Remove friable enamel at the margins.

8. If necessary, prepare retention (grooves or coves)

- prepare it along the gingivoxial line angle, and sometimes at the incisoaxial line angle 0.25 mm with a ¼ round bur.

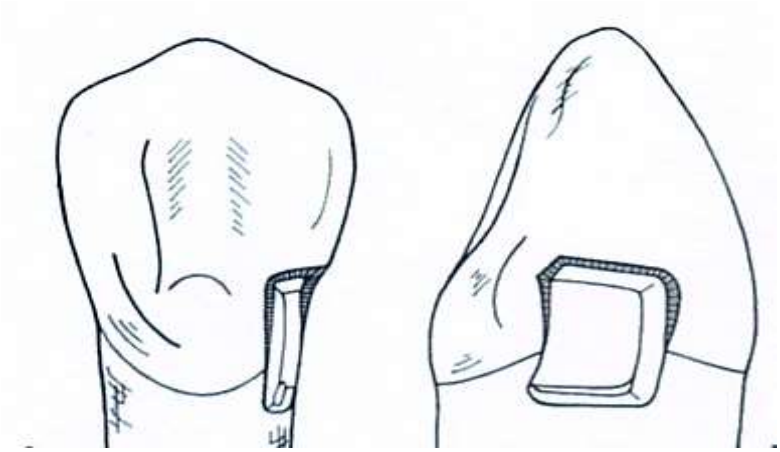


9. Place cavosurface bevel or flare at the enamel except at the gingival margin area.

10. Use a flame shape or round bur resulting in a 45 degrees angle to the external tooth surface.

11. Bevel width should be 0.25 to 0.5mm.

12. Clean the preparation of any debris and inspect final preparation.



Facial Access

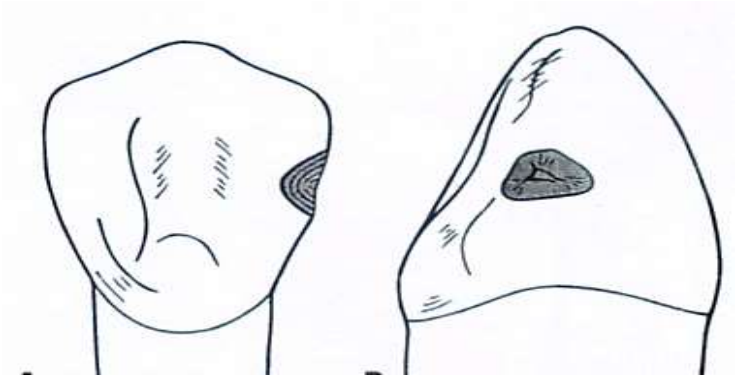
- same stages and steps are followed
- procedure is simplified because of easy access

Modified Class III

- most used type of cavity preparation.
- indicated for small and moderate lesions or faults.
- designed to be as conservative as possible.
- preparation walls have no specific shapes or forms.
- preparation design appears to be scooped or concave

1. Use a 1/2, 1, 2 round bur, point of entry is within the incisogingival dimension of the lesion, perpendicular to the enamel surface.

2. Remove all remaining caries or defect.



3. No attempt is made to create a uniform axial wall.

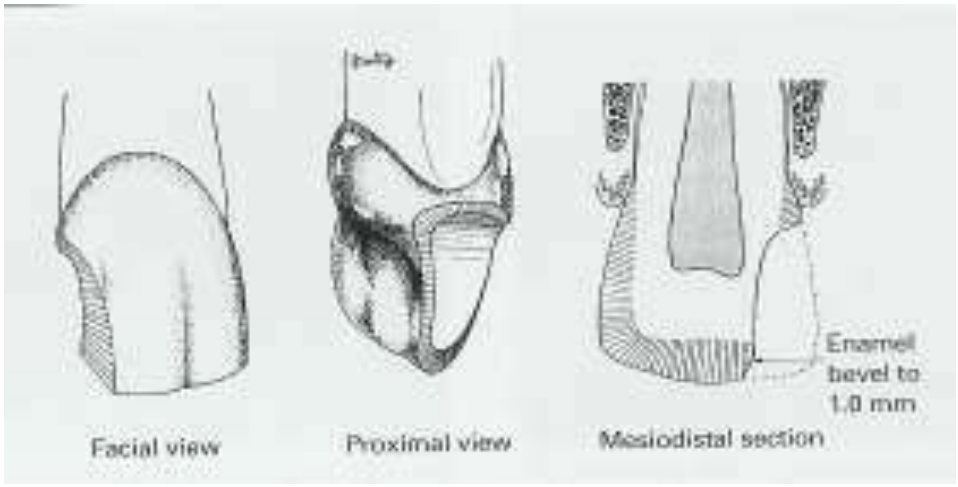
4. Place cavosurface bevel or flare at the enamel except at the gingival margin area.

5. Use a flame shape or round bur resulting in a 45 degrees angle to the external tooth surface.

6. Bevel width should be 0.25 to 0.5mm.

7. Clean the preparation of any debris and inspect final preparation.

Class IV Tooth Preparation



- preoperative assessment of occlusion is very important (placement of margin in noncontact areas)

- shade selection is more difficult
- preparation is similar to Class III except that the preparation for class IV is extended to the incisal angles

For fracture: If no caries or pulpal involvement a bevel is the only preparation necessary 1.0-2 mm enamel bevel should be placed around the periphery of the cavity

Use of Pins:

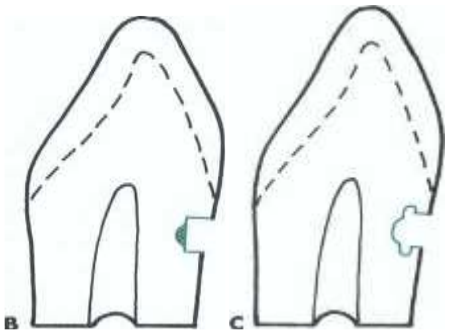
* Retentive pins are not needed because the adhesive technique provides sufficient retention for the restoration

Class V Tooth Preparation

Conventional

- the feature of the preparation include a 90 degree cavosurface angle, uniform depth of the axial line angle, and sometimes, groove retention form.
- conventional design is indicated only for portion of the lesion extended onto the root surface

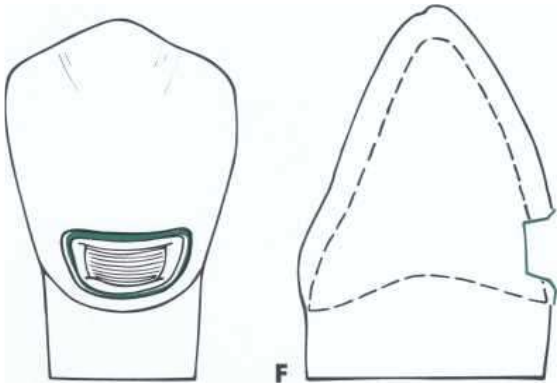
1. Use a tapered fissure (No. 700, 701, or 271) or No.1 or 2 round bur.
2. Make entry at 45 degrees angle to tooth surface, this should result to a 90 degree cavosurface.
3. Axial depth is 0.75 mm to strength of preparation wall, strength of composite and placement of retention groove
4. Axial should follow contour of the tooth.
5. Extent of outline form is dictated by the carious lesion extent.
6. Remove remaining carious lesion
7. Prepare retention groove (similar to Class III preparation)
8. Clean preparation



Bevelled Conventional Class V

- Indications

1. replacement of defective class V restorations
2. large carious lesion
   - exhibits 90 degrees of cavosurface
   - axial wall depth is uniform (0.2mm or 0.5 when retention groove is to placed)

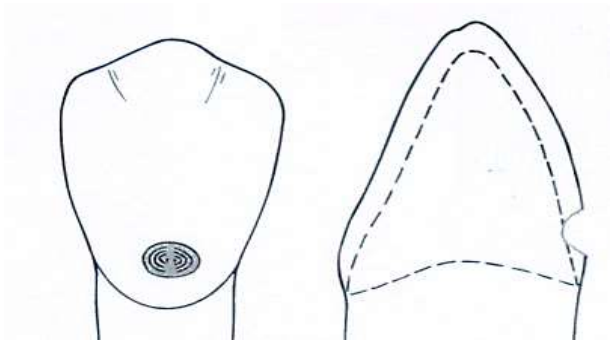


- groove is not indicated when periphery of tooth preparation is located in enamel.
- remove all infected dentin
- clean preparation

Modified Class V

- indicated for small and moderate lesion and lesion entirely in the enamel
- no effort to prepare a butt-joint

- no retention groove
- lesion is scooped out
- preparation has divergent wall
- axial wall does not have uniform depth
- prepare tooth with round or elliptical instrument
- preparation is extended initially no deeper than 0.2 mm
- no effort is made to prepare a 90 degree cavosurface margins.
- infected enamel is removed with a round bur or excavator.



Restorative Technique

1. Determine shade of tooth

Shade Selection:

After caries removal and cavity preparation shade selection was done using shade guide

Restorative Technique

1. Determine shade of tooth
2. Clean the tooth preparation using slurry of pumice, polishing cup.

3. Isolate the tooth, preferably with a rubber dam or cotton rolls, to keep the prepared teeth from saliva, blood, debris and other fluids..

4. Protect adjacent unprepared tooth from the acid etchant with a polyester strip apply the wedge.

5. Apply the gel etchant 0.5 beyond the prepared margins onto the adjacent unprepared tooth.

6. Etchant is left undisturbed for 15 seconds.

7. The area is washed to remove the etchant.

8. Dry the tooth structure

9. Bonding system is applied on all tooth structure that has been etched with a microbrush or other suitable applicators

10-Application of Bonding Agent: Application of the bonding agent and then cured for 10 seconds.

11. Incrementally place composite material and cure.

12. **Curing of the Composite:** The material is cured using the light curing machine for 20 seconds for every increment of composite that was placed.

13. **Finishing and Polishing:** The use of polishers with enhancers and polishing paste were done after the trimming of the excess composites.

Lec. 13

د.العلاء

Fluoride – Releasing Materials

Fluoride exists only in combination with other elements as a fluoride compound.It is present in the body in bone and teeth.The fluoride's effect is to serve as an aid for both the mineralization of developing tooth enamel prior to tooth eruption and for remineralization of surface enamel. The combination of these fluoride effects greatly reduce occurrence of dental caries. Fluoride is incorporated in tooth structure when small amounts are swallowed daily while the teeth are forming. Fluoride becomes concentrated in the outer enamel surfaces when applied after teeth erupt into the mouth.Dental plaque and saliva act as fluoride reservoirs to enhance the remineralization process.

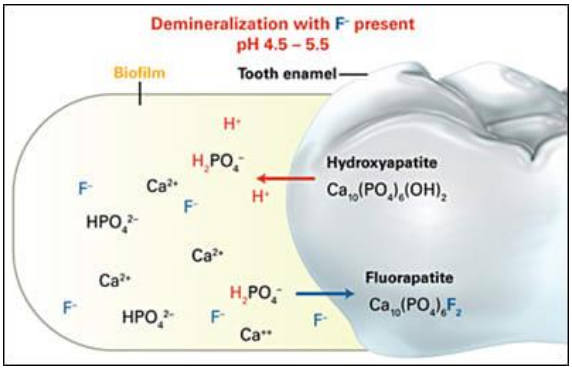
Mechanism of Action of Fluoride:

1- Inhibition of demineralization:

The mechanism is that it binds calcium and phosphate dissolving as a result of the acid penetration in to the dental tissue.

2- Enhancing remineralization:

The fluoride from topical sources enhances remineralization by speeding up the growth of a new surface on the partially demineralized subsurface crystals in the caries lesion, fluoride adsorb to the crystal surface and attract calcium ions followed by phosphate ions leading to new mineral formation.



3- Antimicrobial action:

Fluorides interfere with the decay-causing bacteria colonizing on teeth and reduce their acid production by reduce carbohydrate metabolism, thus slowing demineralization.

Fluoride Varnish:

Fluoride varnish has been found to be effective in preventing caries on permanent teeth. Fluoride varnish also has recently been shown to prevent or reduce caries in the primary teeth of young children.

How is the varnish applied?

Application is quick and easy: small droplets of varnish are applied directly to the tooth surface.

Glass ionomer cements:

Glass ionomer cements release fluoride by two mechanisms, which are the dissolution and diffusion. The large release of fluoride ion during the first few days after replacement declines rapidly during the first week and stabilizes after 2-3 month. Fluoride release normally takes place from the matrix into the adjacent environment but, in the presence of a high fluoride concentration in the month, fluoride ion can be taken up into the cement again. Glass ionomer materials, can therefore be regarded as a fluoride reservoir.

Their main characteristics are:

1. An ability to chemically bond to enamel and dentine with insignificant heat formation or shrinkage.

2. Biocompatibility with the pulp and periodontal tissues.
3. Fluoride release producing a cariostatic and antimicrobial action.
4. Less volumetric setting contraction; and a similar coefficient of thermal expansion to tooth structure.

These advantages have made them successful as luting cements and lining materials. However, as a restorative material, their sensitivity to moisture and low mechanical strength and wear resistance make them the least durable. This may be adequate for primary teeth because they will exofoliate in a number of years.

Resin-modified glass ionomer cements:

The fluoride release of the RMGICs would be affected by methacrylate-components and the polymerization systems. The contribution from the dissolution mechanism is, however very little because of the presence of the hydrophobic resin which will repel the water.

Their main characteristics are:

1. Resin-modified glass ionomer cements bond chemically to enamel and dentine with insignificant heat formation or shrinkage of material during the hardening reaction. So that the cement can firmly adhere to both enamel and dentine without signs of marginal leakage.

2. Shear bond strength of the resin-modified cement to dentine is significantly higher than that of conventional glass ionomer cement and the bond is a stable one.

3. Resin-modified glass ionomers have the advantage of being able to directly bond to resin composite, making them useful in glass ionomer/composite laminate restorations.

4. The resin modified glass ionomers are also highly biocompatible to the pulp and it has better adaptation and seal to the cavity preparation than conventional glass ionomer materials.

5. The final set structure shows a dramatic increase in compressive strength but is rather brittle and comparatively low in tensile strength and has low abrasion resistance making it unsuitable for high stress - bearing areas such as posterior teeth.

6. The fluoride release from and uptake by the resin-modified products was higher than or the same as that of conventional glass ionomers and has no adverse effect on the bond strength.

7. resin-modified glass ionomers have greater curing shrinkage than the conventional chemically-cured cements. Incremental placement techniques should always be used to ensure complete curing at depth and to minimize polymerization shrinkage.

Clinical use

Usually came as two-paste system . It has a longer working time. It sets sharply once the polymerization reaction is initiated by light. Most manufacturers state that immediate polishing can be carried out after light-curing. However, the setting reaction will continue slowly for at least 24 hours and the best result can be obtained if finishing is delayed. When immediate polishing is required, care must be taken not to overheat the restoration as this may cause excessive drying and cracking and may prevent setting of the ionomeric component. Highly desirable, alternative to amalgam for restoring primary teeth, and as a liner/base material.

Composite

In recent years, resin composite has been formulated to release fluoride. A slow release of small amount of fluoride from composite resin would be advantageous even more than periodic high concentration of fluoride applications.

Resin cements

It consists of a resin matrix with inorganic fillers that are bonded to the matrix with monomers. Polymerization of resin cement is achieved either by chemical reaction (self cure), light activation (light cure), or both (dual cure). The self cured composite cement are typically two pastes system (base and catalyst), while the light cure cement is a single component system. In some products fluoride is added to act as anti cariogenic factor, and reduce the resin cement sensitivities.

Polyacid-modified resin composites (compomers)

Recently, other resin-ionomer hybrid restoratives have been marketed as multipurpose materials or are resins that may release fluoride but have only limited glass ionomer properties. One such new material is the 'compomer' which contains the major ingredients of both composites (resin component) and glass ionomer cements (polyalkenoate acid and glass fillers component) except for water. The fluoride release from compomers has been demonstrate, more than composite but at lower level from that of GICs. Although low, the level of fluoride release has been reported to last at least 300 days.

Their main characteristics are:

1. It have two different mechanisms are responsible for the formation of adhesive bonds to the cavity wall. One of these is the self-adhesive property of the restorative itself, it can bond to both enamel and dentine without acid etching by carboxyl (-COOH) groups, the functional carboxyl groups can form ionic bonds with the calcium ions of the tooth surface. The second mechanism is adhesion to the tooth surface through the primer/adhesive system.
2. Can only be hardened through light-curing.
3. It has a significantly less bond strength to dentine than other resin-modified glass ionomer cements and chemically cured glass ionomer.

4. Often one component with an adhesive system.
5. Little is known about the clinical wear performance on the recently marketed compomer restorative materials.
6. Recently, studies have found that the release of fluoride by compomers was significantly less than resin modified glass ionomer cement more than other fluoride releasing resin composite. However, the antibacterial action decreased significantly over time. In addition, the caries inhibition effect of compomer restorative material was higher than the conventional type of resin composite.
7. Radiopacity of compomers is differing from that of dentine and it slightly higher than that of enamel. This value is considered to be desirable for radiographic detection of recurrent caries and offers an easy method for documentation of dental work.

Clinical use:

Ease of manipulation is another advantage of the compomer restoratives. Similar to resin composites, since the adhesive can provide sufficient bond strength for retention, no acid etching procedure is required prior to placement of the restorative. The consistency makes it easy to apply and contour without stickiness and, therefore, less time will be required for final finishing. These properties are especially beneficial in treating children because restorations usually can be completed much faster and within the tolerance of the child patient. A recent study has shown that curing shrinkage is similar to that of the conventional hybrid resin composites. Therefore, placement in increments of 3 mm or less is recommended for Dyract AP, 2 mm or less for other newer compomers, and then each to be cured for at least 40 seconds. Finishing can be undertaken immediately after curing using fluted tungsten carbide finishing burs or polishing discs.

They may or may not have the typical features of true glass ionomers such as chemical adhesion to tooth structures and long-term fluoride release.

Therefore, they should be used carefully, closely following the instructions of the manufacturers because different handling methods may influence their clinical behavior. It is used as liner/base, restoration, fissure sealant.

Amalgam

Fluoride containing amalgams have been shown to have anticaries properties that is sufficient to inhibit the development of caries in cavity walls. Studies have shown that the concentration of fluoride in the saliva by fluoriden releasing amalgams is sufficient to enhance remineralization. Therefore, fluoride releasing amalgam restorations may have a favourable effect on initial demineralization in the mouth. Restorative materials show an initial release that is significant. However, this release of fluoride decreases to minor amounts after 1 week.