ENDODONTICS

Lecture 6 Ass. Lec. Othman H. Alani

Rubber Dam

The rubber dam is a disposable aid in endodontic treatment for the following reasons:

1-It prevent accidental swallowing or aspiration of the small, easily dropped endodontic instruments.
2-It prevents intra canal irrigants from entering to the mouth because most of them are of unpleasant taste.
3-It helps to maintain a dry field of operation by eliminating salivary contamination.
4-It eliminates soft tissue interference by retracting the check & tongue.
5-It enhances better concentration of the dentist by showing only the tooth to be treated.

Rubber Dam Materials

It comes in a variety of thickness, colors & sizes.

A) Thickness :

(i) Medium weight: It is indicated in general all around in the mouth.
(ii) Thin weight: This thickness is indicated in lower anterior teeth & partially erupted posterior teeth.
(iii) Heavy weight: It has the advantage of providing great adaptation around the teeth & does not tear easily but it exerts much force on the lips & cheek.

B)color

(i) Light: It provides better illumination of the field

(ii) Dark: It provides a sharp contrast between the tooth & the dark background.

C) Size The rubber dam comes in precut sheets of different dimensions.

Rubber Dam Frame

The Purpose of rubber dam frame is to hold the rubber dam in a manner to:

1) Provide lip & cheek retraction.
2) Provide unobstructed access to the tooth to be treated.

Types

1-type A. This is called Young's frame. It is U-shaped, and made of metal. It might interfere with the X-ray causing obscuring of important structure in the radiograph.

2-Type B. This is called Starvisi frame. It is a U-shaped frame, and made from radiolucent plastic & nylon materials. It is regarded as a suitable substitute for Young's frame.

3-Type C. This is called Nygard Ostby frame. It is made from radiolucent plastic & nylon materials & can be left inside the patient's mouth while taking a radiograph without obstruction in the radiograph.

Rubber Dam Clamps

The RD. clamp is used to grasp the tooth needed to be endodontically treated and secure the rubber dam material and frame in place. There are many types of RB. clamps, and each one of them is placed in a different tooth or region.

Rubber Dam Puncture

It is an instrument used to create a hole in rubber dam. The hole should be clear without any tags or tears. The size of the hole punched or created depends on the tooth to be isolated. The puncture provides this hole to give maximum adaptation of the rubber dam around the tooth.

Clamp Holder

Sometimes it is called a forceps. This holder or forceps is used to place the clamp on the tooth by grasping the RD. clamp from 2 lateral holes and widening the clamp to fit on the tooth.

Methods of Applying The Rubber Dam

- **Method 1:** Application of the clam & rubber dam together

-Select the suitable clamp to be used.
-Insert the wing in the hole after stretching the rubber dam on the frame with the forceps. Apply the clamp on the tooth.
-Release the wing from the dam.
-Re-stretch the rubber dam on the frame tightly to provide a good retraction to lips & cheek.
-Swab the isolated tooth & the adjacent dam with a suitable disinfectant.

Advantages

1-Easy & fast.
2-It doesn't require the aid of assistance.
3-If the clamp snaps during placement, it's held by the dam.

Disadvantage

1-It doesn't permit direct visualization of the tooth & soft tissues during placement.

❖ **Method 2** : Application of clam& then dam.

-Select the suitable clamp to be used.
-Place the clamp on the tooth.
-Stretch the dam on the frame.
-Draw the dam over the clamp.

Advantages

1-t allows unobstructed visualization of the tooth & surrounding tissues during clamp placement.

2-Its most efficient method of dam placement if there's difficulty in securing the clamp.

Disadvantages

1- Tearing of the dam.

2-Dislodgment of clamp during rubber dam drawing.

❖ **Method 3** : Application of dam & then the clam

-Select the suitable clamp to be used.
-Stretch the dam on frame.
-Apply the dam on the tooth.
-While retracting the dam to expose the tooth & the adjacent gingiva, place the clamp on the tooth.

Advantages

- There is little tendency to dislodgement of the clamp during placement.
-It provides direct visualization of the tooth & adjacent gingiva.

Disadvantage

-It needs help of assistance especially in post. teeth as the mandibular molars.

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ENDODONTICS

Lecture 7 Ass. Lec. Othman H. Alani

Radiography in Endodontics

There are many applications of radiographs in endodontics including:

1) Aid in the diagnosis and localization of hard tissue alteration of the tooth (sclerosis and resorption) and periradicular structures.

2) Determine the number, location, size, shape and direction of roots and root canals.

3) Estimate and confirm the length of root canals prior to instrumentation.

4) Determine the relative position of structures in facial or lingual dimensions.

5) Confirm the position and adaptation of the filling points.

6) Assess the outcome of root canal treatment

Working Length determination of teeth:

Determination of an accurate working length is one of the most critical steps of endodontic therapy. The cleaning, shaping and obturation of the root canal system cannot be accomplished accurately unless working length is determined precisely. According to endodontic glossary, working length is defined as "the distance from a coronal reference point to a point at which canal preparation and obturation should terminate".

Objective of the working length

To establish the length of the tooth at which the canal preparation and subsequent obturation are to be completed. The apical end of the root canal is the CDJ, which is usually 0.5-1mm short of the radiographic apex. Sometimes the apical foramen is laterally positioned so it would be more than 1 mm from the radiographic apex.

Reference point: It is the site on the incisal edge or occlusal surface from which measurements are made. Usually it's the highest point on the incisal edge in anterior teeth & the tip of the cusp in posterior teeth.

It should be:

1) Stable

2) Easily visualized during preparation

3) not changing during or between appointment

Before we discuss various methods of detennination of working length, we need to understand the anatomic consideration regarding it.

1. Anatomic apex: is "tip or end of root determined morphologically".

2. Radiographic apex: is "tip or end of root determined radiographically".

3. Apical foramen: is main apical opening of the root canal which may be located away Eom anatomic or radiographic apex.

4. Apical constriction (minor apical diameter): is apical portion of root canal having narrowest diameter. It is usually 0.5 -1 mm short of apical foramen. The minor diameter widens apically to foramen, i.e. major diameter.

5. Cementodentinal junction: is the region where cementum and dentin are united, the point at which cemental surface terminates at or near the apex of tooth. It is not always necessal, that CDJ always coincide with apical constriction. Location of CDJ ranges from 0.5-3 mm short of anatomic apex

Consequences of over-extended working length

- Perforation through apical construction
- Over instrumentation
- Overfilling of root canal
- Increased incidence of postoperative pain
- Prolonged healing period
- Lower success rate due to incomplete regeneration of cementum, periodontal ligament and alveolar bone.

Consequences of working short of actual working length

- Incomplete cleaning and instrumentation of the canal
- Persistent discomfort due to presence of pulpal remnants
- Underfllling of the root canal
- Incomplete apical seal
- Apical leakage which supports existence of viable bacteria, this further leads to poor healing and periradicular lesion.

DIFFERENT METHODS OF WORKING LENGTH DETERMINATION

Various methods for determining working length include using average root lengths from anatomic studies, preoperative radiographs, tactile sensation, etc. Other common methods include use of paper point, working length radiograph, electronic apex locators or any combination of the above.

1. RADIOGRAPHIC METHOD OF WORKING LENGTH DETERMINATION

Procedure of Working Length determination

1-Examine preoperative radiograph & estimate the length of the tooth.

2-Know the average length of each tooth.

3-Place the file selected to be the correct initial width into the canal with it's rubber stopper set at the estimated working length.

4-Radiograph the tooth to verify the position of the instrument.

5-Readjust the file length according to the radiograph result.

Results are either fit, too long, or too short.

Notes: * Bisecting technique in x-ray can't measure the exact length of the tooth. The parallel technique is more accurate

*The radiographs should be repeated in the following stages of treatment to check the working length.

* Initial size: It is the first instrument used to fit the working length & has slight resistance.

* If the radiograph results are too long e.g. 3mm. long, here we have to subtract 4 mm. & take another radiograph.

''' If the radiograph results are too short e.g. 3mm. short, here we have to add 2mm. & then take another radiograph.

When two superimposed canals are present (for example buccal and palatal canals of maxillary premolar, mesial canals of mandibular molar)

One should take following steps:

a. Take two individual radiographs with instrument placed in each canal.

b. Take radiograph at different angulations, usually 20° to 40° at horizontal angulation.

c. Insert two different instrument, e.g. K file in one canal, H file/ reamer in other canal and take radiograph at different angulations.

d. Apply SLOB rule, that is expose tooth from mesial or distal horizontal angle, canal which moves to Same direction, is Lingual whereas canal which moves to Opposite direction is Buccal.

2. ELECTRONIC APEX LOCATORS

Radiographs are often misinterpreted because of difficulty in distinguishing the radicular anatomy and pathosis from normal structures. Electronic apex locators (EAL) are used for determining working length as an adjunct to radiography. They are basically used to locate the apical constriction or cementodentinal junction or the apical foramen, and not the radiographic apex.

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ENDODONTICS

Lect :10 Ass. Lec. Othman H. Alani

Obturation of root canal system

After chemo-mechanical debridement of root canal system by instrumentation and irrigation, the next step is complete (3 dimensional) obturation of root canal space to maintain the tooth functional within the dental arch.

The remaining non-vital pulp within incompletely debrided root canal will undergo autolysis and the disintegrated by products will diffuse into the surrounding tissue.

The fundamental aim of obturation is to provide 3 dimensional hermetic seal of root canal space to prevent the leakage from or into root canal system. The obturation method include the use of a solid or semisolid core material (gutta percha) surrounding by a sealer type of material to produce the fluid tight seat, by filling the main root canal(s), the accessory canals, voids, spaces and irregularities.

Aims of root canal obturation:

1-The achievement of 3 dimensional obturation of the root canal space to prevent ingress of bacteria and body fluids into root canal space, as well as egress of bacteria or their toxins out of the root canal.

2-To provide fluid tight seal within all regions of root canal space to prevent microleakage.

3-The replacement of the root canal space filled with necrotic tissue by an inert filling material to create a favorable healing environment and avoid recurrent infection.

4-To provide adequate coronal seal with proper coronal restoration to obtain long term success of root canal therapy.

- **Timing of obturation:** Several factors should be checked before doing obturation:

1- The sensitivity to percussion indicative that the inflammation of the periaplcal periodontal ligament is present. Therefore, the obturation has to be postponed until the inflammation subside. In cases of irreversible pulpitis with no tenderness to percussion present. The root canal treatment can be completed in a single visit as soon as the cause of the pain and inflammation has been removed.

2-Canal wettability :

Presence of wet canal with purulent exudate, blood or pus is a strong evidence that the periradicular inflammation is still present. Obturation of the root canal at this stage increase the pressure within periradicular region and subsequent tissue destruction may proceed rapidly. Therefore, in cases of active periradicuiar infection, delaying obturation until all signs and symptoms of inflammation have to be subside is extremely recommended.

3-**Negative culture:** most of the endodontist do not relay on this test because researches have approved that the false negative results inaccurately assess the intra-canal microbial flora. Furthermore, the positive results is not an indicative for the potential bacterial pathogenicity.

Features of an ideal root canal obturation:

1-Complete 3 dimensional obturation from the coronal orifice of the root canal until CDJ.

2-Radiographicaity, the root filling should be within 0.5-0.75 mm from radiographical apex.

3-The root canal should be completely filled, mainly with root filling material with a minimum amount of sealer.

Under filling: occur when the root canal filling is shorter that total root canal space. This definiteiy provide an environment for initiation, persistence or recurrence of periradicuiar infection.

Overfilling: occur when the root filling material extended beyond the CDJ. According to N9 et al. 2007 the extrusion of root canal filling is considered to be acceptable within 2mm beyond (longer than) the radiographical apex, if it is associated with 3 dimensional sealing of root canal system.

❖Characteristics of an ideal root filling material:

1-Easy introduced in the root canal.

2-Provide an apical and lateral sealing of the root canal.

3-Dimensionally stable after usage.

4-lmpervious to moisture.

5-Bacteriostatic or at least should not encourage bacterial growth

6-Radiopaque.

7-Non staining to tooth structure.

8-Non irritating

9-Sterile or easily sterilized.

10-Removed easily from canal if required.

Materials used for obturation

- Plastics: Gutta-percha.
- Solids or metal cores Silver points ,gold, stainless steel titanium
- Cements and pastes:

-MTA

-Gutta flow

Gutta percha

Gutta percha :Is a natural material extracted as a dried coagulated from a Brazilian trees(PaIaqu1um) Its molecular structure is close to natural rubber. Chemically gutta percha is available into two crystalline forms: alpha and beta.

The most commercially available product is in B-form with composion following:

- Organic content: gutta percha 20% + waxes and resins 3%
- Inorganic: zinc oxide filler 66% + heavy metal sulfates as radiopacifiers 11%

Forms of Gutta percha:

Gutta percha available in different forms. The B-form is produced as gutta percha points (cones) which is available in different sizes and tapering as follow:

1-Standard cones of the same size and shape of the ISO endodontic instruments.

2-Greater taper gutta percha points: available with taper 4%, 6%, 8% and 10%.

3-Auxiliary points: non-standard cones.

Properties of gutta percha:

The Gutta percha expand on heating and increase volume which could be advantageous to compact into root canal spaces. However, Gutta percha shrink on cooling. Therefore, vertical pressure should be applied on warm gutta percha to compensate for volume loss after cooling.

- Heat sterilization is inapplicable with gutta percha. For disinfection, gutta percha points can be immersed in ethanol alcohol (96%) for one minute prior to its use.
- Because gutta percha has no adherence property, it should always be used with sealers to seal the root canal space.
- Gutta percha can be dissolved in certain chemical solvent such as chlorofom eucalyptus oil, etc. The chemically plasticized property of gutta percha is important in soften gutta percha points for better filling or in easily removal of gutta percha from the canal during re-endodontic treatment.

Advantages of gutta percha:

1-Compatibility: adaptation to the canal wall.

2-Inertness: do not interact with the tissue

3-Tissue tolerance.

4-Dimensionally stable.

5-Radiopacity.

6-Plasticity: can be soften either with heat or using chemical solvent

Disedvantages:

1-Lack of rigidity: can be bend easily with pressure which make its application difficult especially in narrow canals.

2-Lack of adhesiveness so it should be used with sealers and cements.

3-Easily displaced by pressure.

Silver points:

Old endodontic filling points which were made from silver. They are stiff points with rounded cross section, which can be easily used in rounded and narrow canals. However, because of their sliver corrosive products, which are toxic in nature, their use have been declined nowadays. In addition, silver points are not compatibles, lacking plasticity, and cannot adhere to the canal wall.

Root canal sealers:

Seaiers can serve several functions:

1-Lubricate and aid the seating of gutta percha cones.

2-Facilitate the bonding between gutta percha and root canal walls.

3-Filling the gaps and anatomical spaces where the primary filling cannot reach.

4-The combination between sealer and primary filling effectively increase the fluid tight seal and prognosis of endodontic treatment. However, there are some sealers (cements) that can be used as obturating material without gutta percha.

5-Antimicrobial agent: the germicidal property is exerted immediately after placement.

6-Radiopacity: this property helps to identify the presence of auxiliary canals, resorption regions, root fracture, and the shape of apical foramen.

Different types of sealers are available in the market such as: zinc oxide-eugenol formulations, calcium hydroxide sealers, glass ionomers, epoxy resin sealers, silicon sealers, bioceramics and medicated sealers. These types have different physical and biological properties. Therefore, a care should be taken to evaluate all characteristics of a sealer before selection.

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ENDODONTICS

Lect:11 Ass. Lec. Othman H. Alani

Obturation Techniques

Different methods are available for obturating root canal system. This lecture: will focused on the following

1. Lateral compactioh technique.

2. Vertical compaction technique.

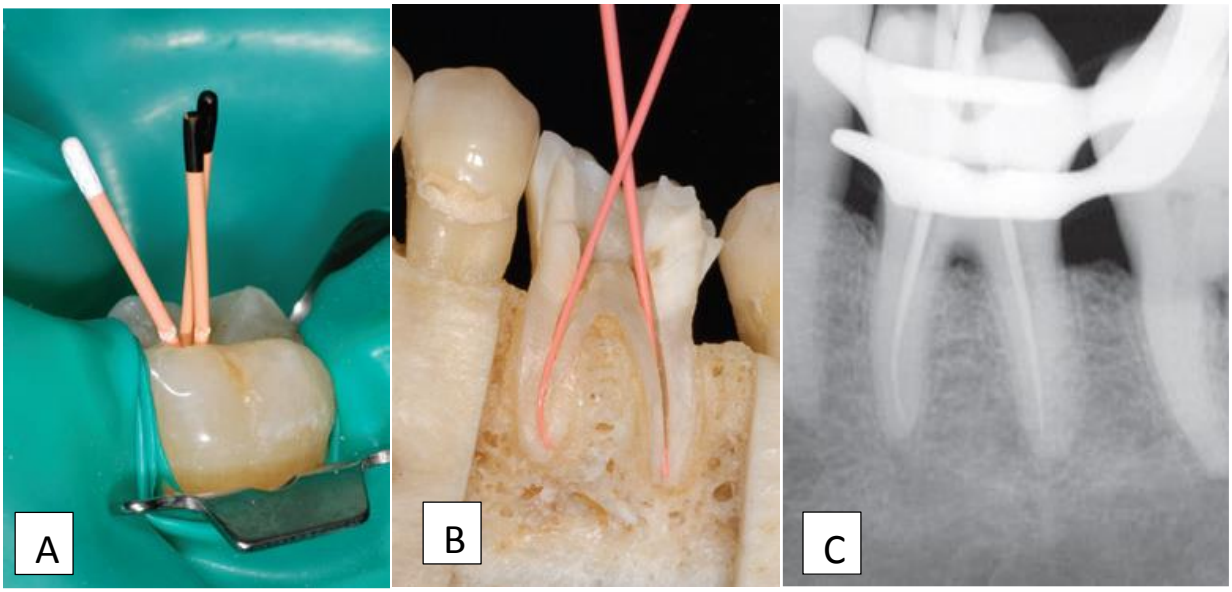
Armamentarium for obturation:

- Primary and auxiliary (accessory) cones of gutta percha.
- Absorbent paper point for dryness of the root canal after irrigation complete. These point are available with different sizes and tapering matching that of gutta percha cones.
- Spreaders and pluggers for compaction of gutta percha. These instrument also available in different sizes to tit the size of the prepared canal. The spreaders are either hand or finger spreaders with pointed tips and sizes starting from ISO size 20 to 45 or 50. The pluggers are mainly available with handles and flat tips to vertically compact the soften gutta percha. The tip sizes are available from 0.4 to 1.2mm.
- Endodontic ruler for measuring the length of gutta percha point.
- Scissor for cutting gutta percha points during fitting inside the canal.
- Heating device such as spirit lamp or gas torch.
- Heating instrument such as spoon excavator.

Lateral compaction technique:

The most common obturation compaction technique involves the placement of the master gutta percha point and accessories under lateral pressure against the canal walls by using a spreader. The canal should be continuously tapered shape with definitive apical stop. The procedure is as follow:

1-After canal preparation, select the master gutta-percha cone, whose size is consistent to the size of the largest file used in instrumentation up to the full working length. This gutta-percha cone is called **master apical cone (MAC)**. This cone have to fit to the full WL of the canal (Fig-1: A).



(Fig -1: A, B&C)

a-Should feel resistance when you pull the cone out of the canal. This resistance comes from the engagement of MAC between walls of the apical region of the prepared canal (3-5mm of the apical canal region). This feeling of resistance is called **tug back** (Fig-1: B). If the MAC fit the entire WL but no tug back, you can either choose larger cone size or cut 0.5 - 1mm from the cone tip until a tug back has to be fit. After that mark

the WL on the MAC at the level of incisal or occlusal reference point. This can be done by making a notch on the MAC at this level (Fig-1: A).

b- Check the fit of MAF radiographically (Fig-1: C).

- If the master cone fit within canal WL, remove the cone from the canal and place it over a piece of cotton socked in either sodium hypochlorite or 96% ethanol.
- If the MAC fits shorter of the WL, check for any canal blocking by dentin chips, ledge or canal curvature and treat them accordingly.
- If the MAC going beyond the apical foramen, either select larger cone size or cut the cone to the WL.
- If the tip of MAC shows "8" shape in radiograph this means that the cone is too small for the canal. A larger size can be selected to fit the canal.

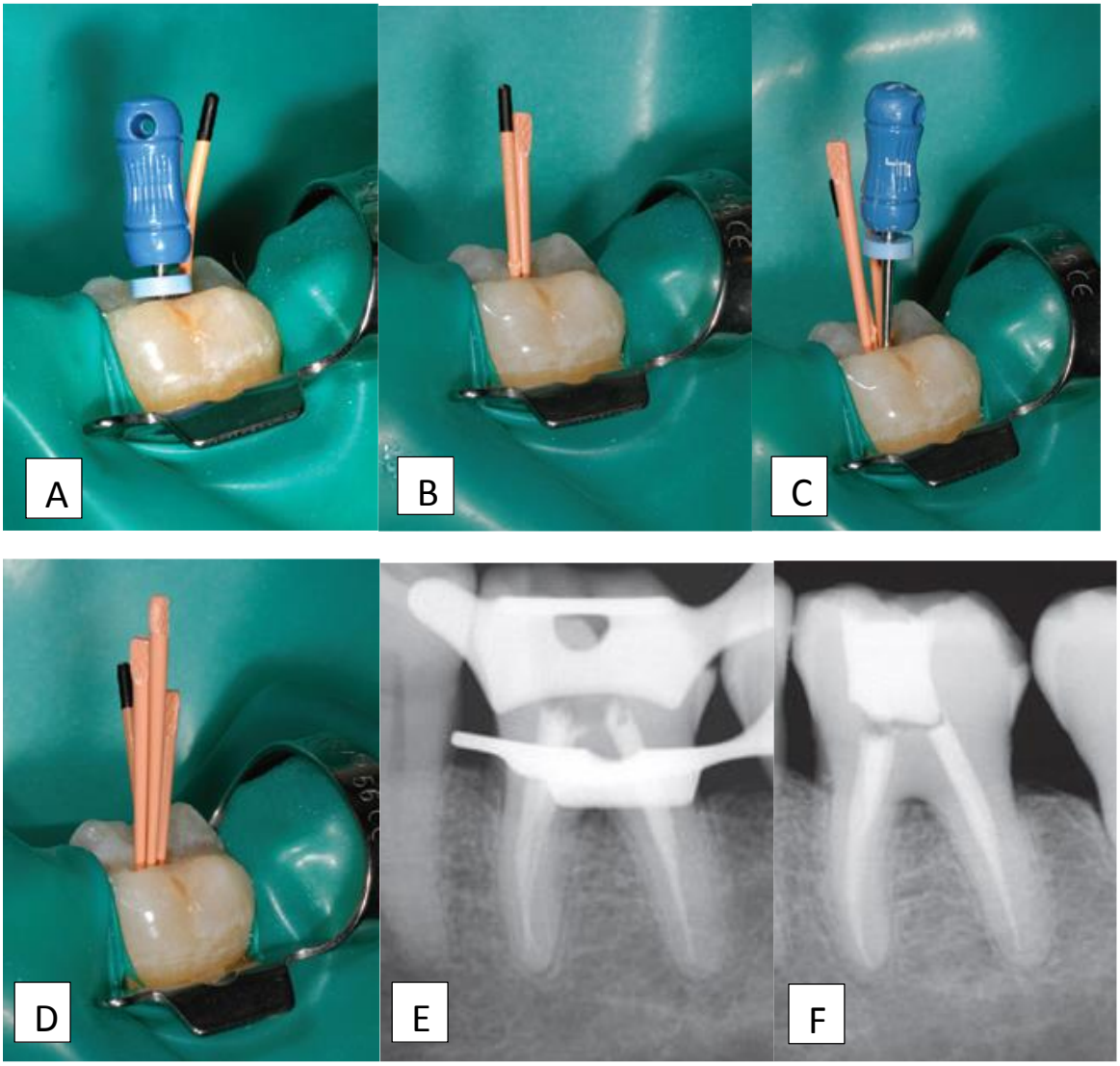
2-Select suitable size of a spreader to be used for lateral compaction, which should reach 1-2mm shorter of the canal WL.

3-Dry the canal completely with paper point.

4-Mix the sealer according to the manufacturer instruction and apply it within the canal either by a paper point or a clean file with counter clockwise rotation inside the canal .

5-Coat the measured MAF with small amount of sealer and place it inside the canal. The spreader then placed into the canal alongside the MAF with vertical gentle pressure. The spreader will act as a wedge to compact gutta percha laterally under vertical pressure on the wall of the canal (Fig 2: A)

After that the spreader can be removed from the canal by rotating it back. This will leave a space alongside the MAF for the accessory gutta percha.



(Fig .2: A, B,C,D,E&F)

An accessory cone can then be placed into the left space (Fig 2 :B) and the above procedure is repeated until the spreader can no longer penetrate beyond the cervical line (Fig 2: C&D).

Finally the cut the protruded parts of gutta percha points with hot instrument such as spoon excavator of the endo plugger (Fig 2 :E). A gentle vertical compaction can also be done by the plugger to seal the coronal orifice of the canal with the melted gutta percha (Fig 2: F).

Advantages of lateral compaction:

1-It can be used with the most routine clinical situations.

2-During lateral compaction, it provides length control with less chance of overfilling and post-operative pain.

Disadvantages:

1-May not sufficiently fill the irregularities within the canal.

2-Does not produce homogenous mass.

3-Voids and spaces may exist between accessory and master cones.

Vertical compaction technique:

This technique was introduced to overcome the drawbacks of lateral compaction technique. It uses hot plugger with vertical pressure to compact the heat soften gutta percha to flow into canal irregularities. The prepared canal that can be filled by this technique should have:

- A funnel shape with continuous tapering to the apex.
- Good apical stop region (apical constriction is as small as possible).

The procedure is as follow:

- ❖ Select the master cone gutta percha which should fit the canal size and taper, and check its fitness by radiograph.
- ❖ Dry the canal completely with paper point.
- ❖ Select the sizes of pluggers according to the size and taper of the canal. Pluggers should be pre-fitted at 5 mm intervals in order to capture maximum cross section area of the softened gutta percha.
- ❖ Coat the canal lightly with sealer by a paper point.
- ❖ Cut the coronal end of the gutta percha cone at the incisal or occlusal reference point.

- ❖ Use the heated plugger to vertically force the master cone into the canal. Fold the soften gutta-percha inward to fit apically and laterally. If the soften gutta percha stuck into the plugger tip, just slight rotate the plugger to loosen it. This vertical compaction will free 2-3 mm of space coronally to allow adding more gutta-percha.
- ❖ After finish the apical filling, complete obturation by doing backfilling. This can be done by heating small segment of gutta perch and carrying them into the canal using heated larger pluggers.
  - ✓ Be careful not to overheat the gutta-percha to facilitate its handling.
  - ✓ Don't apply more sealer into the soften gutta-percha because this will prevent the adhesion between the soften layers of gutta-percha.

- ❖ After completion, clean the pulp chamber from the excess of sealer and gutta-percha by a piece of cotton socked in alcohol then put the temporary or final restoration.

Advantages of the vertical compaction technique:

Provide excellent sealing of the canal apically and laterally with filling of the lateral and accessory canals.

Disadvantages

1- Increase the risk of vertical root fracture.
2- 2-Overfllling and apical extrusion of the gutta-percha and sealer periapically.
3- Time consuming procedure.

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Endodontic 2019/2020

lec.3+4 **L. ayad mahmood**

Endodontic instruments, equipment, and material

a- Extracanal instruments.[1]
b- Intracanal instruments.

Extracanal instruments

A- Endodontic explorer: This is subdivided into:
i- Straight: To locate the root canal orifice
ii- L-shaped: To detect the unremoved parts of the pulp chamber roof.

B-Plastic instruments: They are used to manipulate a plastic material and it has two types
i- One with a blade: This is used to carry temporary filling.
ii- Plugger: This is used to condense cement and base in the root canal.

C- Endo excavator: It is larger than spoon excavator which is used to excavate pulp chamber and curettage of periapical lesions during apicectomy.

D- Endodontic locking pliers (Tweezers): it has a lock that allows the material to be hold the material without continuous pressure; also it has a groove to facilitate holding gutta percha and absorbing points.

E- Endodontic ruler: A metal ruler of 0.5 mm division.

F- Endodontic syringe: This is subdivided into:
i- One with a flat tip to prevent penetration into small canals.
ii- groove to permit the irrigant to flow coronally rather than apically, thus reducing post-operative pain.

G- Instrument organizer (endo. Kit): Used to arrange intra-canal instruments.

H- Transfer sponge: saturated with a disinfectant solution and also used to arrange intra-canal instruments after being used.

I- Instrument stopper: these indicate the working length and some have a notch to indicate the direction of curvature.

Intracanal instruments

ISO Grouping of Instruments

In due time, the ISO committee grouped intracanal root canal instruments according to their method of use:

Group I: Hand use only—files, both **K** type (Kerr) and **H** type (Hedstroem); **reamers, K** type and **U** type; and broaches, pluggers, and spreaders.

• **Group II: Engine-driven** latch type—same design as Group I but made to be attached to a handpiece. Also included are paste fillers.

• **Group III: Engine-driven** latch type—**drills** or reamers such as Gates-Glidden (**G** type). Peeso (**P** type), and a host of others.

• **Group IV: Root canal points—**gutta-percha, silver, paper.

Group I

I- Broaches: These are either smooth for exploring or barbed for extirpation and to remove cotton and paper point from the canal, it is used in the coronal 2/3 of the root using the suitable size and should be inserted freely.

II- Reamers: They are manufactured by twisting triangular stainless-steel bar to produce 0.5-1 flute/mm and they are more flexible than file but used mainly with reaming action.

III- Files: The main types of files are:

a- K-type files: They are manufactured by twisting a square stainless-steel bar to produce 1.5-2.25 flute/mm. either a reaming or a filing action may be used. Although most K-type files were originally used with a in-out. circumferential filing technique, the balanced-force technique.

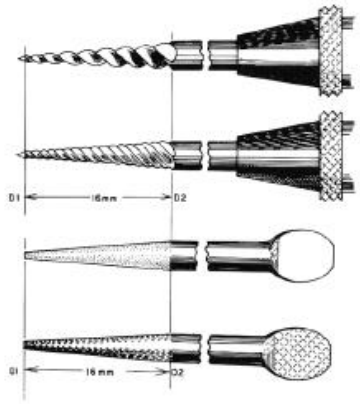
Reamer	
1. More flexible	**Less flexible.**
2. Less no. of cutting	**More no. of cutting flutes**
3. Used mainly in reaming action	**Used mainly in filing action.**
4. Less effective in filing action	**Rotation Can be used in reaming action. less no. of flutes. less no. of flutes.**
5. cutting motion is rotation and retraction	**Push Pull**
6. Cross section is Triangular	**Square**
7. Round preparation shape	**Ovoid**

b- K-flex files: They are manufactured by twisting a rhomboid (diamond) shape stainless steel bar so alternating blades with an acute and obtuse angle that will cause an increase in its sharpness and cutting efficiency, the alternating low flutes formed by obtuse angles of rhombus provide more area for debris removal. it is more flexible than K-files but it becomes blunt more quickly.

c- Hedstroem files (H-type): They are made by machining a continuous groove in a triangular metal bar and it is more aggressive than K-files and they are more effective in pulling action but must not be used with rotary action because they are liable to fracture. It is impossible to ream or drill with this instrument. To do so locks the flutes into the dentin much as a screw is locked in wood. The file is impossible to withdraw once it is locked in the dentin and can be withdrawn only by backing off until the flutes are free.

d- NiTi files: It is much more flexible but fracture without a warning sign and it is difficult to be used in the circumferential filling.

Each instrument has a number which refers to the size of its tip D_0 and D_{16}= D_0 =0.32mm, the distant between D_0 to D_{16}=16mm, but the total length vary (length=31 mm for anterior, medium=25mm, or short=21mm for posterior)
E.g. Reamer size 30 ------ D_0 =0.3mm
70 ------ D_0 =0.7mm



Original recommendation for standardized instruments.Cutting blades 16 mm in length are the same size and numbers as standardized filling points. The number of the instrument is determined by diameter size at D1 in hundredths of millimeters.Diameter 2 (D2) is uniformly 0.32 mm greater than D1.

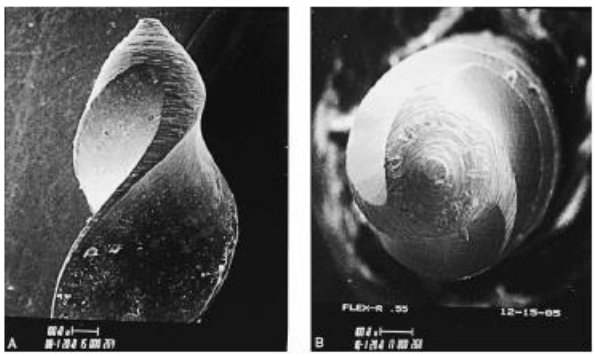
All intracanal instruments are color coded and each color represents a size

Table 10-1 Dimensions in Millimeters. Revision of ADA Specification No. 28 Added Instrument Sizes 08 and 110 to 150 to the Original Specification

Size	Diameter (Tolerance ± 0.02 mm)			Handle Color Code
	D_1 mm	D_2 mm	D_3 mm	
08	0.08	0.40	0.14	Gray
10	0.10	0.42	0.16	Purple
15	0.15	0.47	0.21	White
20	0.20	0.52	0.26	Yellow
25	0.25	0.57	0.31	Red
30	0.30	0.62	0.36	Blue
35	0.35	0.67	0.41	Green
40	0.40	0.72	0.46	Black
45	0.45	0.77	0.51	White
50	0.50	0.82	0.56	Yellow
55	0.55	0.87	0.61	Red
60	0.60	0.92	0.66	Blue
70	0.70	1.02	0.76	Green
80	0.80	1.12	0.86	Black
90	0.90	1.22	0.96	White
100	1.00	1.32	1.06	Yellow
110	1.10	1.42	1.16	Red
120	1.20	1.52	1.26	Blue
130	1.30	1.62	1.36	Green
140	1.40	1.72	1.46	Black
150	1.50	1.82	1.56	White

*New diameter measurement point (D_3) was added 3 mm from the tip of the cutting end of the instrument. Handle color coding is official.

Tip Modification. Modification of the sharpness of the instrument tip by grinding to remove the transition angle between the tip and first blade (blunt tip).This modification will make less ledging and/or transportation (machining the preparation away from the natural canal anatomy) and the file remains centered within the original canal.



Flex-R-file with noncutting tip. A, Note rounded tip. B, "Nose" view of a noncutting tip ensures less gouging of the external wall and reduced cavity transport.

IV-Spiral root fillers: May be used for posting paste within the canal but are liable to fracture, the alternative is to coat a file with paste and spin it in an anticlockwise direction.

V- Spreader: Long tapered and pointed end instrument to compress gutta-percha laterally and apically and leaving space for auxiliary cones. There is also a finger type which smaller and shorter, so can be used in posterior teeth.

VI-Plugger: Similar to spreader but with blunt flat tip used for vertical condensation and in the termination of all obturation condensation.

The mode of action of intra-canal instruments
I- Reaming action (used with a reamer): It is a repeated clockwise rotation which gives round preparation in cross section.
II- Filling action (used with the file): A push-pull action which gives irregular general oval cross section.
III- Quarter-turn filing (used with file and reamer): A push and 1/4 clockwise and pull action that gives oval cross section.
IV- Circumferential filing: A push and 1/4 clockwise and pull action each time from a different site from the coronal cavity to give an oval cross section which is highly flared cervically.

Nickel – Titanium endodontic Instrumen[2-4]

A new generation of an endodontic instrument made from remarkable alloy, Nickel – titanium has added a striking new dimension to the practice of endodontic. The super elasticity of Ni-Ti differentiates it from other metals such as stainless steel that sustain deformation and retain permanent change shape. These properties make nickel-titanium endodontic files more flexible and better able to conform to canal curvature, resist fracture, and wear less than stainless steel files.
Advantages1- NiTi files are more flexible than the stainless-steel files (low modulus of elasticity).
2- Superior resistance to fracture in a clockwise or counter-clockwise reaming motion.
3- They are biocompatible and appear to have excellent anticorrosive properties.
4- These instruments maintain the original shape of the curved canal and remain centered in the canal and cause the least amount of apical transportation, zipping, elbow, and ledging.
5- They have good resistance to untwisting, rounding of edges and tip alternation.
6- They are significantly faster than other instruments.
7- Concerning cutting efficiency as well as instrumentation of curved canals Ni-Ti instrument were clearly superior to all another instrument.

Disadvantages
1- Their high expense.
2- The penetration ability of Ni-Ti instruments seems to be less than that of stainless steel instruments.
3- Ni-Ti instruments have an inability to bypass or remove ledge.
4- These instruments break without any previous sign of their fracture such as untwisting of the file, unlike stainless steel instruments which allow discarding the instrument before fracture.

ISO Group II and III: Engine – driven instruments can be used in three types of contra angle handpieces:
1- Rotary contra angle handpiece: The instrumentation with a full rotary handpiece is by straight line drilling full rotary contra angles are used primarily to develop coronal access to the canal orifices. In addition, special drills or reamers, listed under ISO Group II, may be used to funnel out orifices for easier access, to widen as much 2/3 of the canal, or to prepare post canals for final restriction of the tooth.

Since most of these instruments do not bend, they should primarily be used in straight canals because they are often misdirected or forced beyond their limits. They will cause perforations or break in the hands of the instruments. Lack of tactile sense is a real problem, and the slower handpiece improves this.

An entirely new 'wrinkle' in rotary handpieces is the **Morita Tri Auto – ZX**, a cordless, battery – powered, endodontic slow speed (280 rpm) handpiece with a built – in apex locator.

It uses rotary nickel-titanium instruments held by a push button chuck. The Tri **Auto – ZX** has three automatic functions. The handpiece automatically starts when the file enters the canal and stops when the file is removed, if too much pressure is applied, the handpiece automatically stops and reverse rotation. It also automatically stops and reverses rotation when the file tip reaches the apical stop, as determined by the build in apex locator. The Tri Auto ZX will work in a moist canal.
2- Reciprocating Handpiece: To overcome the inflexibility of conventional endodontic hand instrument, the Giromatic (quart turn endodontic handpiece) was introduced in 1964. This handpiece operates by rotary-reciprocal action through a 90 – degree are, which delivered 3000 times per minutes.

Rotary instruments:
1-Gates-Glidden drills.
2-Pesso reamers.

- Ultrasonic Handpieces.
- Sonic handpieces.

1- Gates – Glidden drills: These are an integral part of new instrument techniques which have many uses:

1. To open the canal orifice.
2. To achieve straight line access by removing the dentin shelf.
3. To flare the coronal and middle third of the canal rapidly

The Gates-Glidden drills are steel instruments for the contra-angled handpiece characterized by a long shank and an elliptical extremity which is flame shaped with a "guiding" non-cutting tip The Gates-Glidden drills are available in six sizes and marked with circular notches on the part that attaches to the contra-angled handpiece; The Gates-Glidden drills are designed with the weakest point at the start of the shank, so that they are easier to remove in case they fracture inside the root canal The Gates drills must be used passively on withdrawal from the canal with a brush like circumferential movement and their use must always be preceded by preflaring of the canal using hand instruments. An active use of the Gates Glidden drills is not recommended because they can lead to the formation of ledges and dangerous structural weakening that in the curved and thin canals can cause stripping. The blades of the Gates-Glidden drills do not have angles but flat cutting planes to reduce the aggressiveness and the tendency to screw in; they could be considered as the first example of the "radial lands" type of blades.

Used at slow speed for preparing the coronal 2/3 of the canal. It is used in withdraw the motion to remove tooth structure. They come in the following sizes:

Number 1 equal to ISO 50
Number 2 equal to ISO 70
Number 3 equal to ISO 90
Number 4 equal to ISO 110
Number 5 equal to ISO 130
Number 6 equal to ISO 150

2- Pesso reamers:

Peeso Reamers are steel instruments for the contra-angled handpiece similar to the Gates-Glidden drills, from which they differ in that the blades are spread over a wider surface and the shape that is cylindrical. The design of the blade (radial lands type) and the non-cutting tip is, in fact, identical to that of the Gates drills. On the contrary, the Peeso drills are very useful in the preparation of the dowel space (post space) in canals already enlarged or in retreatments to speed up the removal of the obturation material.

These instruments are available with or without safe tips. Gutta-percha should have previously been removed to post depth with a hot plugger. Pesso resembles The Gates-Glidden drills in sizes.

ProTapers

The ProTaper System is made up of 6 instruments that are divided into 2 groups of 3 instruments each: Shapers with the marking SX, S1 and S2 and Finishers with the marking F1, F2, and F3. The Shapers are instruments for eliminating coronal interferences and to create a smooth pathway for the Finishing instruments while the Finishers are meant for the finalizing of the shape created by the Shapers and for giving a definitive taper and diameter to the canal. The S-X Shaper is an auxiliary instrument used in canals of teeth with shorter roots or to extend and expand the coronal aspects of the preparation, similar to the use of Gates-Glidden drills or orifice openers. Sx has a much quicker rate of taper between D1 and D9 as compared with the other ProTaper Shaping files. Shaping File S-1 is designed to prepare the coronal 1/3 of the canal, whereas Shaping File S-2 enlarges and prepares the middle third in addition to the critical coronal region of the apical third. The important structural characteristics of the ProTapers are

– Robust triangular cross-section with convex sides to increase the metal mass of the central core resistance of the instruments;
– cutting blades with cutting angles (there are no radial lands);
– Variable helical angle to reduce screw in risk;
– Variable pitch (distance between spirals) to reduce the risk of screw in and aid the removal of debris;
– Multiple increases in tapers towards the handle of the shapers (so as to increase the flexibility in the apical third) and decrease towards the handle in the Finishers (so as to enlarge the apical preparation without making the coronal third of the instrument too rigid).

Path Files

Mechanical glide path and Preflaring.

Available in 3 ISO sizes (013, 016 and 019) and 3 lengths (21, 25 and 31mm). Flexible and resistant to cyclic fatigue, they offer many advantages compared to manual solutions

Pathfinder: These are used for negotiation of irregular calcified canal when it is difficult to use 06, 08 and 10 files which may prove to tip fracture, so that to avoid this problem pathfinder files can be used, these files are available in two

sizes K1 (between 06 and 08) and K2 (between 08 and 10). They are made of stainless steel or carbon steel (become more rigid).
The taper of their instruments reduced to give the tip a greater rigidity so that more apical pressure can be applied without the risk of tip bending damage to the tip of the small instrument may be due to a relatively abrupt change in the direction of the canal.

- **Ultrasonic Handpieces:** Instruments used in the hand pieces that move near or faster than the speed of sound range from standard K – type files to special broach like instruments.

Ultrasonic endodontic is based on a system in which sound as an energy source activates an endodontic file resulting in three-dimensional activation of the file in the surrounding medium.

The main debriding action of ultrasonic was initially thought to be by cavitation, a process by which bubbles formed from the action of the file, become unstable, collapse and cause a vacuum like ‘explosion’. A combined shock, shear and vacuum action results. Since an irrigation and aspiration system is employed in the endodontic equipment for ultrasonic, the broken cell parts are washed out and then removed from the canal system.

The cleaning efficacy can be enhanced by placing an ultrasonic tip into the irrigated space of the canal. Ultrasonic creates both cavitation and acoustic streaming. The cavitation created is minimal and is restricted to the tip. However, the acoustic streaming effect is significant. These motions allow cleaning and flushing out of areas that files may not be able to negotiate.

- **Sonic handpieces:** The endo MM 1500 (Endo Micro – Mega 1500) was developed as sonic vibratory handpiece (special handpiece) to be attached to the turbine line of a dental unit. The handpiece operates at a frequency of 1500 HZ at a pressure 0.4 Mpa tap water irrigant and coolant is delivered into the preparation from the handpiece.

These instruments have safe ended non cutting tips. 1.5 – 2 mm in length. Those files were particularly ineffective in widening the canal as the previous two instruments. The root canal instrument vibrates in the simpler pattern than ultrasonic files. A continuous flow of water is delivered through the handpiece to the instrument.

The WaveOneTM single file reciprocating system

The new WaveOneTM NiTi file from DENTSPLY Maillefer is a single use, a single file system designed to completely shape the root canal from start to finish.

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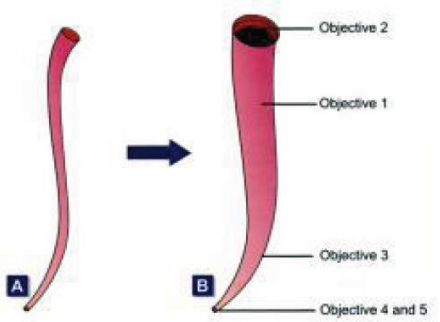
TECHNIQUES OF RADICULAR CAVITY PREPARATION

Over the years, there has been a gradual change in the ideal configuration of a prepared root canal. At one time, the suggested shape was round and tapered, almost parallel, the more accepted shape of the finished canal has become a **gradually increasing taper**, with the smallest diameter at the apical constrictor, terminating larger at the coronal orifice.



Mechanical Objectives of Root Canal Preparation (given by Schilder)

- The root canal preparation should develop a continuously tapering cone.
- Making the preparation in multiple plane which introduces the concept of "Flow".
- Making the canal narrower apically and widest coronally.
- Avoid transportation of foramen.
- Keep the apical opening as small as possible.

Two approaches to debriding and shaping the canal have finally emerged: either starting at the apex with fine instruments and working one's way back up (or down) the canal with progressively larger instruments—the **"step-back"** or serial technique—or the opposite, starting at the cervical orifice with larger instruments and gradually progressing toward the apex with smaller and smaller instruments—the **"step-down"** technique, also called **"crown-down"** filing.

A- Step-back preparation: It is divided into two phases. **Phase I** is the apical preparation starting at the apical constriction. **Phase II** is the preparation of the remainder of the canal, gradually stepping back while increasing in size. The completion of the preparation is the Refining **Phase IIA and IIB** to produce the continuing taper from apex to cervical. Although the step-back technique was designed to avoid zipping the apical area in curved canals, it applies as well to straight canal preparation.

Step-Back, Step-by-Step—Hand Instrumentation:

Phase I. To start Phase I instrumentation, it must be assumed that the canal has been explored with a fine pathfinder or instrument and that the working length has been established. The first active instrument to be inserted should be fine (No. 08, 10, or 15) 0.02, tapered, stainless steel file, curved and coated with a lubricant, such as Gly-Oxide, R.C. Prep, File-Eze, Glyde, K-Y Jelly, or liquid soap. The motion of the instrument is **"watch winding,"** two or three quarter-

turns clockwise and then retraction. On removal, the instrument is wiped clean, **recurved,** relubricated, and repositioned.

"Watch winding" is then repeated. Remember that the instrument must be to full depth when the cutting action is made. This procedure is repeated until the instrument is loose in position. Then the next size K file is used. Very short (1.0 mm) filing strokes can also be used at the apex. Nickel-titanium files do not need precurving and maintain the canal shape better than stainless steel.

By the time a size 25 K file has been used to full working length, Phase I is complete and size 25 K file is considered as the master apical file (MAF). Then, of course, larger instruments are used to start with.

Using a number 25 file here as an example is not to imply that all canals should be shaped at the apical restriction only to size 25. In fact most, canals should be enlarged beyond size 25 at the apical constriction in order to round out the preparation at this point and remove as much of the extraneous tissue, debris, and lateral canals as possible. It must be emphasized here that irrigation between each instrument use is now in order, as well as **recapitulation** with the previous smaller instrument carried to full depth and watch wound. This breaks up the apical debris so that it may be washed away by the sodium hypochlorite.

Phase II. The process begins with a No. 30 K-style file. It's **working length is set 1 mm short** of the full working length. It is precurved, lubricated, carried down the canal to the new shortened depth, watch wound, and retracted. The same process is repeated until the No. 30 is loose at this adjusted length. Recapitulation to **full length** with a No. 25 file follows to ensure patency to the construction. This is followed by copious irrigation before the next curved instrument is introduced. In this case, it is a No. 35, again shortened by 1.0 mm from the No. 30 (2.0 mm from the apical No.25). It is curved, lubricated, inserted, watch wound, and retracted followed by recapitulation and irrigation.

Thus, the preparation steps back up the canal **1 mm** and **one larger** instrument at a time. When the middle portion of the canal is reached, it is at this point that Hedstroem files are most effective. They are much more aggressive rasps than the K files. This midcanal area is the region where reshaping can also be done with power-driven instruments: Gates-Glidden drills, starting with the smaller drills (Nos. 1 and 2) and gradually increasing in size to No. 4, 5, or 6. Gates-Glidden drills must be used with great care because they tend to "screw" themselves into the canal, binding and then breaking.

The next 5 mm are prepared with successively larger instruments. Recapitulation with No. 25 to full length between each step. The coronal part of the canal is enlarged with circumferential filing or Gates-Glidden drills.

This completes the chemomechanical step-back preparation of the continuing taper canal. It is now ready to be filled or medicated and sealed at the coronal cavity until the next appointment.

B- Step-down or **crown-down technique:** Gates-Glidden drills and larger files are first used in the coronal two-thirds of the canals and then progressively

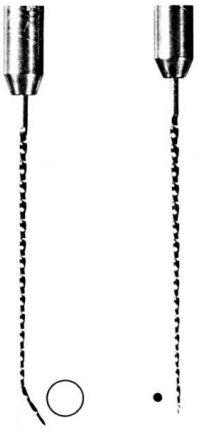
smaller files are used until the desired length is reached. It has risen in popularity, especially among those using nickel-titanium instruments with varying tapers.

Clinical benefits of Crown-Down technique

1. Ease of removal of obstacles that prevent access to the root apex.
2. Enhanced tactile feedback with all instruments by removal of coronal interferences.
3. Increased space for Irrigant penetration and debridement
4. Rapid removal of dental pulpal tissue that is located in the coronal 1/3rd. is to minimize or eliminate the amount of necrotic debris that could be extruded through the apical foramen during instrumentation. This would help prevent post-treatment discomfort, incomplete cleansing.
5. Straight line access to root curves and canal junctions.
6. Decrease in canal blockages

K-File Series Step-Down Technique. As stated above, the initial penetrating instrument is a small, curved, stainless steel K-file, exploring to the apical constriction and **establishing working length (negotiation)**. To ensure this penetration, one may have to enlarge the coronal third of the canal with progressively smaller Gates- Glidden drills or with instruments of larger taper such as the .04 or the .06 instruments**.** At this point, and in the presence of sodium hypochlorite and/or a lubricant such as Glyde, step-down cleaning and shaping begin with **K-Flex, Triple-Flex, or Safety Hedstrom** instruments in the 0.02, 0.04, or 0.06 taper configurations depending on the canal size, to begin with. Starting with a No. 50 instrument (for example) and working down the canal to say, a size No. 15, and the instruments are used in a watch-winding motion until the apical constriction (or working length) is reached. When resistance is met to further penetration, the next smallest size is used. Irrigation should follow the use of each instrument and recapitulation after every other instrument. To properly enlarge the apical third, and to round out the ovoid shape and lateral canal orifices, a reverse order of instruments may be used starting with a No. 20 (for example) and enlarging this region to a No. 40 or 50 (for example). The tapered shape can be improved by stepping back up the canal with ever larger instruments, bearing in mind all the time the importance of lubrication, irrigation, and recapitulation. At this point, the canal should be ready for smear layer removal, drying, and either medication or obturation.

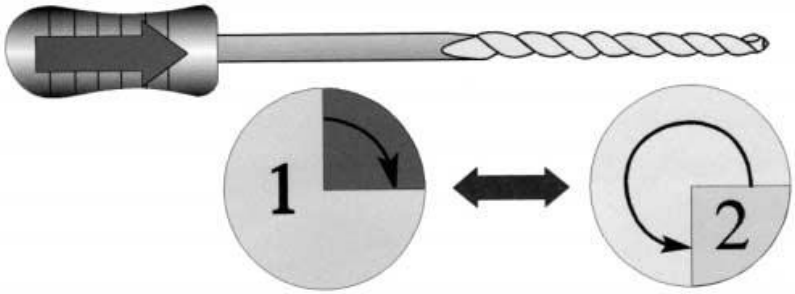
A curved pathfinding instrument can be rotated away from a catch or curve on the wall and advanced down the canal to the apical region. From the initial pathfinding instrument, the length of the tooth may be established. With control of probing, poking, twisting, and turning, the fine pathfinder can almost always be penetrated to working length. The action can best be described as a “watch-winding” type of finger action.



When turned on its axis, the tip of a curved instrument **(left)** scribes a circle. The tip of a straight instrument **(right)** turns on its own axis, which reduces control of the tip of the instrument.

Balanced Force Concept

Insertion is done with a quarter-turn clockwise rotation while slight apical pressure is applied. Cutting is accomplished by making a **counterclockwise rotation;** Pressure should maintain the instrument at or near its clockwise insertion depth. Then counterclockwise rotation and apical pressure act together to enlarge and shape the canal to the diameter of the instrument. The counterclockwise motion must be 120 degrees or greater.

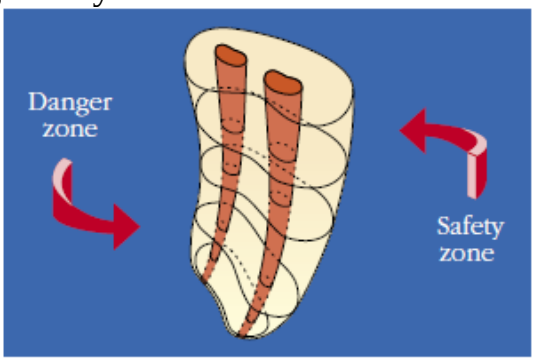


1. For a **balanced force** motion, the file is pushed inwardly and rotated one quarter-turn clockwise. **2**. It is then rotated more than one half-turn counterclockwise. The inward pressure must be enough to cause the instrument to maintain depth and strip away dentin as it rotates counterclockwise. These alternate motions are repeated until the file reaches working length. (Courtesy of Dr. James B. Roane.)

ANTICURVATURE FILING METHOD

For the preparation of curved canals, but in practice, the technique should always be performed in preparing the canals of the molars, either upper or lower, particularly in the mesial canals of the lower molars and the mesiobuccal canals of the upper molars, whose roots always present a buccolingual concavity on their distal surface. This means that these canals are closer to the distal surface of the respective root than they appear to be radiographically in practice, the anti-curvature filing method consists of working the endodontic instruments constantly against the external wall of the curve. The goal of the anti-curvature filing method is to prepare the canal, especially at the expense of the thickest portion of the root, staying far away from the area of the curve and from the

bifurcation; in other words, from that area in which the root is dangerously thinner.



Schematic representation of the mesial root of a lower molar. The "safety zone" is the mesial portion, while the "danger zone" is the distal portion of the root (Adapted from Abou-Rass, Frank, and Glick).

The mesiobuccal root is often curved distally. The degree of curvature varies from case to case. One must keep this in mind during cleaning and shaping since it will be necessary to modify the working length of the instruments and always use the "anticurvature" filing method.

ProTaper System

The distinguishing feature of the **ProTaper System** (Dentsply/Tulsa Dental) is the **progressively variable tapers** of each instrument that develop a "progressive preparation" in both vertical and horizontal directions. Underuse, the file blades engage a smaller area of dentin, thus reducing the torsional load that leads to instrument fatigue and file separation.

ProTaper rotary System: Directions for Use

1. Establish proper access and a glide path with No. 10 and No. 15 stainless steel files to the working length or the apical constriction exit.
2. Flood the canal and chamber with sodium hypochlorite and begin shaping with the **Shaper S-1** using multiple, passive-pressure passes. Go no deeper than three-quarters of the estimated canal length. Irrigate and recapitulate with a No. 10 hand file, establishing patency to full working length. Now, with **S-1**, extend the preparation to full working length. Again irrigate and recapitulate.
3. "Brush" with the **Shaper S-X** to improve the straight-line access in short teeth or to relocate canal access away from furcations in posterior teeth.
4. **Shaping file S-2** is now used to full working length. Irrigate, recapitulate, and reirrigate.
5. Confirm and maintain working length with a hand file. (Remember, as curves are straightened, canals are shortened.)

6. With **Finisher F-1,** passively extend the preparation to within 0.5 mm of the working length. **Withdraw after one second! And only one second!** The **F-1** has a tip size of 0.20 mm, and if a No. 20 hand instrument is found to be snug, the preparation is finished.

With the instrument in place, radiographically verify the exact length before final irrigation.

7. If the **F-1** and the No. 20 hand file are **loose**, continue the preparation with the **Finisher F-2,** which is 0.25 mm diameter at the tip. Confirm with a No. 25

hand instrument and, if snug, confirm the length radiographically, irrigate, and complete.

8. If the **F-2** instrument and the No. 25 hand file are **loose**, continue the preparation to just short of the working length with the **Finisher F-3 file**, which has a 0.30 mm tip diameter, and follows with the confirming No. 30 instrument. If the No. 30 is found to be snug, the preparation is finished. If this is loose, there are a number of techniques to enlarge the apical third to larger sizes.

9. Frequent irrigation and file cleansing are imperative. Now that the perfectly tapered preparation is complete, smear layer removal with EDTA and sodium hypochlorite is in order, followed by either medication and/or obturation.

Errors in instrumentation:

1- Over instrumentation: Passage of the file beyond the apical foramen, i.e. the apical constriction here has been violated and injury to the periapical areas will occur.

2- Under instrumentation: Files don't reach the correct working length like leaving 2-3 mm of the canal unprepared and full bacteria and debris which lead to infection and inflammation.

3- Ledge formation: Is artificially created irregularity on the surface of the root canal wall which prevents the placement of instrument to the apex.

Ledgeing is caused by the use of uncurved instruments, short of the working length with an excessive amount of apical pressure.

The newer instruments with non-cutting tip have reduced this problem by allowing the instruments to truck the lumen of the canal as have nickel-titanium files.

4- Perforation and ledge perforation:

a-Cervical canal perforation: Is the most often perforation during the process of locating and widening the canal orifice or inappropriate use of Gates-Glidden burs.

b- Mid root perforations: Lateral perforations at mid-root level tend to occur mostly in curved canal, either as a result of perforating when ledge has

formed during initial instrumentation or along the root as the canal is straightened out, and this referred to as canal " stripping " and results in fairly long perforation that seriously compromises the outcome of treatment.

c--apical perforation: Maybe the result of not establishing accurate working length and instrumentation beyond the apical confines, perforation of the curved root is the result of "ledging, apical transportation or apical zipping"

The transportation defined as removal of canal wall structure on the outside curves in the apical half of the canal due to the tendency of files to restore themselves to their original linear shape during canal preparation.

The apical zipping defined as an elliptical shape that may be formed in the apical foramen during the preparation of curved canal when a file extends through the apical foramen and subsequent transports that outer wall.

d- Lateral perforation: caused by over instrumentation through thin wall in the root and most likely to happen on the distal wall of curved canal such as the distal wall of the mesial roots in a mandibular first molar.

5- Failure to debride all canals: Due to incomplete knowledge of root canal anatomy, so that some canals will not be located and left without obturation leading to re-infection.

6- Broken instrument: We try to remove the broken instrument and if we can’t, we bypass the fractured piece.

Causes of instrument breakage:

a- Small access opening.

b- Using non-flexible instrument with extreme pressure.

c- Skipping instrument sizes. (The instruments should be used according to their sequence, example: use file size 35 after file size 3o etc.

7- **Crown fracture:** The tooth may have a preexistent crack that becomes a true fracture when the patient chews on the tooth weakened additionally by an access preparation. Crowns with infraction should be supported with circumferential bands or temporary crowns during endodontic treatment.

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ENDODONTIC

lec.7 **L. ayad mahmood**
2019/2020

Root canal irrigation[1]

Success in all parts of treatment will be needed for elimination of infection and healing of periapical pathosis. The sequence of events and procedures in the control of endodontic infections are host defense system, systemic antibiotic therapy (rarely used with specific indications only), instrumentation and irrigation ("cleaning and shaping"), intracanal medicaments used between appointments, permanent root filling, and coronal restoration.

Irrigation of the root canal

Chemomechanical preparation of the root canal involves both mechanical instrumentation and antibacterial irrigation and is the single most important stage in disinfection of the pulp space. Despite technological advances in the ability to shape root canals, at least 35 percent of root canal surfaces still remain uninstrumented, and cleaning of the canal in terms of soft tissue removal and elimination of bacteria relies heavily on the adjunctive action of chemically active irrigating solutions due to the anatomic complexity of the pulp space.

Objectives and requirements of irrigants

The aims of root canal irrigation are:

• Root canal irrigants should possess a broad antimicrobial spectrum with potent activity against endodontic pathogen biofilms.

There is clear evidence that apical periodontitis is a biofilm-induced disease A biofilm is an aggregate of microorganisms in which cells adhere to each other and/or to a surface.

• Dissolution of vital or necrotic pulp tissue.

• Lubrication of canal walls and instruments.

• Removal of dentine particles, remove the smear layer

The following are requirements of a root canal irrigant:

• A broad antimicrobial spectrum.

• Biocompatibility.

• Tissue-dissolution capability.

The smear layer is comprised of an inorganic and organic material such as dentine filings and pulp tissue remnants, and may also contain bacteria. This layer blocks the entrance to dentinal tubules and may, therefore, protect bacteria in root dentine from antimicrobial agents. [2]

The removal of the smear layer is a crucial step to facilitate disinfection of the root canal system.

- **Firstly, microorganisms embedded in the smear layer are eliminated and canal cleanliness is improved.**
- **Secondly, it has been shown that the removal of the smear layer improves the antimicrobial effect of intraradicular medicaments in the deeper layer of dentine.**
- **Smear layer removal facilitates penetration of sealers into the dentinal tubules. It also enhances disinfection of the root canal wall and deeper layers of dentin.**
- **Furthermore, it interferes with a tight adaptation of root canal sealers to dentine walls and may, therefore, promote bacterial ingress.**

Sodium hypochlorite

Sodium hypochlorite (NaOCl) is the most widely used irrigation solution in endodontics. Sodium hypochlorite (NaOCl) is considered the most ideal irrigant for use throughout instrumentation because

1. **It possesses both strong antimicrobial and proteolytic activity.**
2. **Unlike other irrigants, NaOCl has the unique ability to dissolve necrotic tissue, as well as the organic components of the smear layer.**

Currently, available evidence strongly indicates that NaOCl is the irrigant of choice. In endodontic therapy, NaOCl solutions are used in concentrations varying from 0.5% to 5.25%.

3. **Sodium hypochlorite is characterized by having strong antibacterial activity with comparably short contact times, both 6% and 1% NaOCl killed more than 99.7% of bacteria after contact times of 1 or 5 minutes, while 2% chlorhexidine and MTAD killed only 60.5% and 16% of the biofilm bacteria respectively**

Disadvantage of NaOCl

1. **NaOCl is caustic if accidentally extruded into periapical tissues or adjacent anatomical structures such as the maxillary sinus. In the case of accidental injection of NaOCl into periapical tissues, emphysema may develop within 10–20 minutes.**
2. **Oedema and paraesthesia may result due to the tissue- dissolving capability of NaOCl. An even more serious development is ecchymosis, which is associated with severe pain, profuse interstitial bleeding, and hemorrhage under the skin. Fortunately, most of these symptoms will regress within 2 weeks.**
3. **Although allergic reactions to NaOCl are rare, there have been several case studies on the potential risk of hypersensitivity reactions.**
4. **have bad smell**
5. **Cause dramatic spot bleaching of the patient's clothes.**

Chlorhexidine

It is generally accepted that as an irrigant chlorhexidine gluconate (CHX) should be used in a concentration of 2%. CHX has a wide antimicrobial spectrum and is effective against Gram-positive and Gram-negative bacteria as well as yeasts. CHX is able to permeate the cell wall or outer membrane and attacks the bacterial cytoplasmic or inner membrane or the yeast plasma membrane. CHX solutions in concentrations of 0.2–2% are considered toxicologically safe. For instance, a 2% solution has been used as a subgingival irrigant without any adverse effects.

Unlike NaOCl, CHX does not possess any tissue dissolving ability and is unable to remove the smear layer or neutralize lipopoly-saccharides, which are obvious benefits of NaOCl. It is only because of these differences that CHX cannot be a substitute for NaOCl as the gold standard of root canal irrigants.

Direct contact between NaOCl and CHX should be avoided, otherwise, red CHX crystals will precipitate immediately

EDTA

Ethylenediaminetetraacetic acid (EDTA) as a 17% solution (pH 7) effectively removes the smear layer by chelating the inorganic components of the dentine.

Advantage

- **Highly biocompatible.**
- **Chelating agents like EDTA can disrupt the biofilm adhering to the root canal wall.**

Disadvantage

- **EDTA has almost no antibacterial activity,**
- **Can dematerialize intertubular dentine and reduces the surface hardness of root canal wall dentine.**
- **Some caution should be exercised when using EDTA inside the root canals because prolonged exposure to EDTA may weaken root dentine and thereby increase the risk of creating a perforation during mechanical root canal instrumentation.**
- **EDTA retains its calcium's complexing ability when mixed with NaOCl, but EDTA causes NaOCl to lose its tissue-dissolving capacity**
- **According to the results of preliminary studies, irrigation of the root canal using alternate NaOCl and EDTA appears to be very promising. This combination seems to enhance the tissue dissolution capability of NaOCl and is more efficient in reducing intraradicular**

microbes than NaOCl alone. Therefore EDTA and NaOCl should be used separately and EDTA should never be mixed with NaOCl. Furthermore, After irrigation of the canals with EDTA, 2 ml of NaOCl should be finally used to neutralize the acidic effects of EDTA and to allow NaOCl to penetrate into the dentinal tubules, which are opened after the use of EDTA.

Citric acid

Concentrations ranging from 1–40% have been used in Endodontics to remove the smear layer after root canal preparation. Comparable with EDTA (proper conc. 10%).

Irrigation protocol

• Size of apical preparation: at least size 35.
• After access cavity: flush the canals with NaOCl.
• Between instruments: 2–5 ml of NaOCl per canal.
• After shaping: 5–10 ml of NaOCl per canal, irrigation with 5 ml of EDTA per canal for 1 minute (or with citric acid) then Final rinse with 2 ml NaOCl per canal
• Optional: final irrigation with chlorhexidine
• Optional: rinse with alcohol before obturation[3]

MTAD

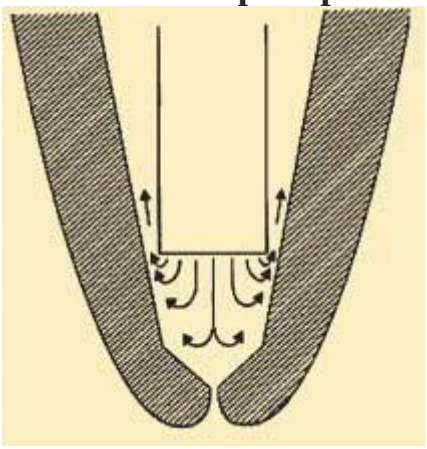
MTAD is a mixture of tetracycline (doxycycline, 3%), citric acid (4.25%), and detergent (Tween 80, 0.5%), with a pH of 2.15; the commercial product is Biopure. MTAD was reported to be effective in removing the smear layer due to its low pH and showed tissue-dissolving action as long as the canal was rinsed with NaOCl during mechanical preparation. A preliminary report found the alternating use of NaOCl and MTAD might potentially cause iatrogenic tetracycline staining of teeth. Another concern is the high concentration of tetracycline in MTAD; resistance to tetracycline is not uncommon among bacteria isolated from root canals.

Clinical and technical aspects of Irrigation

The aim is to introduce the needle as near as possible to working length to improve the irrigation efficiency. Since the smallest needle recommended for root canal irrigation is a 30-gauge needle.

Flexible irrigation needles with a safety tip are recommended so that the needle can be pre-bent according to the canal curvature to allow proper cleaning of the apical part of curved root canals.

When trying to insert the needle tip as close as possible to the working length, the needle might become jammed in the root canal and the pressure exerted can easily result in extrusion of NaOCl or H2O2 into the periapical tissue. Hence, when resistance to the needle



is felt, it should be pulled back approximately 2 mm to ensure space between the canal wall and needle to allow the irrigant to flow out of the canal. This will minimize the risk of injecting irrigation solutions beyond the apex and into the periapical tissue.
When introducing the irrigation needle there must be enough space between the canal wall and the needle to allow the irrigant to flow out of the root canal.

Use of ultrasonics to enhance root canal cleaning

The use of ultrasonically activated instruments may contribute to the cleaning of the root canal system through agitation of the irrigant solution. Ultrasonic energizing of an endodontic instrument results in oscillation (25–40 kHz) which initiates fluid movement along the sides of the instrument known as acoustic streaming.
This may help to dislodge debris from root canal surfaces and to more efficiently direct irrigant into areas of complex root canal anatomy. Under certain circumstances ultrasonics may instigate the formation and collapse of vacuum bubbles in a liquid; a process is known as cavitation; however, acoustic streaming appears to be the main mode of action.
In addition, ultrasonic energy may produce heat, rendering the sodium hypochlorite solution more effective.
Ultrasonic activation of irrigant should only be used passively after the canal preparation has been completed, employing a narrow non-cutting instrument. A freely oscillating instrument will cause more ultrasound effects in the irrigating solution than a file that binds in the root canal. Furthermore, use of ultrasonic files during canal preparation may lead to gouging of the root canal walls and severe transportation of the canal with zipping and strip perforations.

The EndoActivator System

The EndoActivator System is a more recently introduced sonically driven canal irrigation system by Dentsply. It consists of a portable handpiece and 3 types of disposable polymer tips of different sizes. These tips are claimed to be strong and flexible and do not break easily. Because they are smooth, they do not cut dentin. Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon. This might be operated 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear layer and biofilm.13 The EndoActivator System was reported to be able to effectively clean debris from lateral canals, remove the smear layer, and dislodge clumps of simulated biofilm within the curved canals of molar teeth.

The EndoVac System

The EndoVac apical negative pressure irrigation system has been introduced by Discus Dental Company. It has three components: The Master Delivery Tip, MacroCannula and MicroCannula. The Master Delivery Tip simultaneously delivers and evacuates the irrigant. The MacroCannula is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The MacroCannula or MicroCannula is connected via tubing to the high-speed suction of a dental unit. The Master Delivery Tip is connected to a syringe of irrigant and the evacuation hood is connected via tubing to the high-speed suction of a dental unit.[4]

Medicaments

Medicaments are used as an aid to improve the predictability and prognosis of endodontic treatment. They are used in endodontic therapy in order to:

1. **eliminate or destroy any remaining viable bacteria in the root canal system that have not been destroyed by the chemomechanical preparation**
2. **After processes (i.e., instrumentation and irrigation), it reduce periradicular inflammation and hence reduce pain,**
3. **help eliminate apical exudate if it is present,**
4. **prevent or arrest inflammatory root resorption if it is present,**
5. **Prevent re-infection of the root canal system by acting as both a chemical and a physical barrier if the temporary or interim restoration breaks down.**

Phenol-based agents

Chemicals of the phenol group such as phenol, formocreosol, cresatin, parachlorophenol (monoparachlorophenol), camphorated phenol, and camphorated parachlorophenol have a long history in endodontics as locally used root canal disinfecting agents. They have been applied into the pulp chamber in a moist cotton pellet (vapor effect), or the whole canal has been filled with liquid with various concentrations of the phenol compound.200-208 The rationale of using phenol compounds for root canal disinfection has its roots in their role as general disinfecting agents in the past. However, emphasis of safety in addition to effectiveness has resulted in dramatic decline in their use generally. Also in endodontics, concerns have been raised regarding the toxicity and possible mutagenicity of the disinfecting agents of the phenol group.

Antibiotics

Various combinations of antibiotics have been put forward and were tried so that it would provide a broad spectrum antibacterial action. These combinations of drugs were relatively successful for the production of negative root canal cultures; however, mutations occasionally have produced resistant microorganisms.

Calcium Hydroxide

It is normally a thick suspension of the Ca (OH)2 powder in sterile water or saline. In such water suspension, less than 0.2% of the powder is dissolved into calcium and hydroxyl ions. It is a powerful alkaline paste with a PH of (12.3-12.5). The high PH of calcium hydroxide paste is responsible for the destructive effect on the bacterial cell membrane protein structure. Few bacteria can survive at this high PH. Another mode of action is by its ability to absorb CO2 rapidly and deny the microorganism from it.

Chlorhexidine

Chlorhexidine has recently been advocated as an intracanal medicament. A 2% gel is recommended, which can be used alone or mixed with calcium hydroxide. The combination of chlorhexidine and calcium hydroxide has greater antimicrobial activity than calcium hydroxide mixed with saline,and periradicular healing in animal models appears to be enhanced.

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OPERATIVE DENTISTRY

lec.2 **2019/2020** *L.ayad mahmood*

Biological Consideration of Enamel and its clinical significance in practice of restorative dentistry[1]

Enamel provides a hard, durable shape for the function of teeth and a protective cap for the vital tissues of dentine and pulp.

E. is the hardest substance of the human body, E. is very brittle, so it requires a base of dentin to withstand the masticatory force or it fractures easily.

Permeability: Enamel is composed of 90% inorganic hydroxyapatite mineral by volume and 4-12 % water which is contained in the intercrystalline spaces and in a network of micropores opening to the external surface.

Various fluids, ions, and low molecular weight substance can diffuse through the semipermeable enamel. So that the acid demineralization and fluoride uptake are not limited to the surface but are active in three dimensions.

Crystal structure and enamel rods

Enamel is composed of millions of E. rods or prisms. These rods are in the form of small elongated appetite crystal which is densely packed and have a wavy course of orientation that gives strength and durability to the enamel. An organic matrix or sheath surrounds individual crystal. The spacing and orientation of the crystals and the amount of organic matrix make the enamel rod boundary and the center core differentially soluble when exposed for a short time to weak acids.

The acid-treated (etching) E. surface has irregular and pitted surface with numerous microscopic undercut, the etched enamel has a higher surface energy, so resin monomer flows into & adheres to the etched depressions to polymerize & form retentive resin tags. Because there are (30,000) to (40,000) E. rod/mm^2 & acid etch penetration increases the bondable surface area to (10) to (20) folds, micromechanical bonding of resin restorative materials to E. is significant.

Acid-etching modification of E for restoration retention provides a conservative, reliable, alternative to traditional surgical methods of tooth preparation &restoration. (retentive groove, pins, an extension for prevention.)

Starting at 1mm from the CEJ, the rods on the vertical surfaces run occlusaly or incisally at proximately 60-degree inclination and progressively incline to approach the marginal ridge and cusp tips, where the rods are parallel to the long axis of the crown. The rods beneath the occlusal fissures are also parallel to the long axis, but rods on each side of the fissure vary up to 20 degree from the long axis.

Loss of enamel rods that form the cavity wall of cavomargin of dental restorations creates a gap defect, leakage of bacteria and their products that may lead to secondary caries. Therefore, a basic principle of cavity wall preparation is to bevel or parallel the direction of E. rods and avoid undercutting them.

In the cervical region of permanent teeth, enamel rods are oriented outward in a slightly apical direction, therefore a perpendicular cut to the external surface of occlusal walls of preparation on axial surfaces compromised enamel, so an obtuse enamel cavosurface angle is recommended to closely parallel the rod direction and preserve the integrity of enamel margin.

Clinical appearance and diagnosis of pathological conditions

1- Color changes associated with demineralization:

E. is relatively translucent; its color is primarily a function of its thickness and the color of underlying dentin. The thickness is more at the cusp tips and incisal edges and decrease below deep fissures and become thin cervically at the junction with cementum.

Color changes related to E. demineralization and caries are critical diagnostic observation. Subsurface E. porosity from carious demineralization is manifested clinically by a milky white opacity called (white spot lesion) when located on smooth surfaces. In later stages of caries, internal demineralization of E. at the DEJ, subsurface cavitation gives a blue or gray color to the overlying enamel.

2- Cavitation: The dentin is not affected until enamel breaks away to create a cavity, a restoration must then be placed. If untreated the cavitations expand to compromise the structural strength of the crown and microorganisms infiltrate into deep dentin to affect the vitality of the tooth.

3-Wear: E. is hard as steel; however, the enamel will wear because of attrition or frictional contact against opposing enamel or harder restorative materials such as porcelain. Heavy occlusal wear is demonstrated when rounded cuspal contacts are ground to flat facets.

4- Faults and fissures: A deep fissure is formed by the incomplete fusion of lobes of cuspal enamel in the developing tooth. The resulting narrow clefts provide a protected area for acidogenic bacteria. Pits and fissures defects are eight times more vulnerable to caries than are smooth surfaces.

Biological Consideration of Dentin and its clinical significance in practice of restorative dentistry

The function of dentin: The coronal dentin provides both color and elastic foundation for enamel. Together with radicular dentin, dentin forms the bulk of the tooth and protective encasement for the pulp. As a vital tissue without vascular supply or innervations, it is nevertheless able to respond to thermal, chemical or tactile external stimuli.

Morphology: Dentin is composed of small apatite crystals embedded in a cross-linked organic matrix of collagen fibrils. The extended cytoplasmic processes of the formative cells (the odontoblasts) form channels or tubules transferring the full thickness of the tissue. Dentin contains 45% to 50% inorganic apatite crystals, about 30% organic matrix, and about 25% water. Dentin is pale yellow.

Support: Tooth strength and rigidity are provided by the intact dentinal substrate. The resistance of tooth to fracture is significantly lowered with increasing depth and width of cavity preparation. Therefore a conservative initial approach that combines localized removal of carious tooth structure, placement of a bonded restoration, and the placement of sealant is recommended.

The permeability of dentin: It is directly proportional to the dentin depth. When the external cap of enamel and cementum is lost from the periphery of the dentinal tubules by caries, preparation with burs, abrasion or erosion, the exposed tubules become a communicative pathway between the pulp and the external oral environment.

The sensitivity of dentin: Although dentin is sensitive to thermal, tactile and osmotic stimuli across its (3-3.5mm) thickness. Dentin is neither vascularized nor innervated.

Theories of thermal sensitivity

1- **Theory of thermal shock:** This states that sensitivity is the result of a direct thermal shock to the pulp via temperature changes transferred from the oral cavity through the restorative material, especially when the remaining dentin is thin. Protection from the insult would then be provided by an adequate thickness of an insulating material.

2- **Hydrodynamic theory:** It is based on the capillary flow of the fluid-filled dentinal tubule. In a vital tooth with exposed dentin, there is a constant slow movement of fluid outward through the dentinal tubules. This theory proposes that when a stimulus such as air evaporation, cold or heat stimuli causes slow fluid movement to become more rapid causing displacement of odontoblast bodies and the nerve endings in the pulp are deformed, a response that is interpreted as pain.

As dentin near the pulp, tubule density and diameter increase also the permeability increase, thus increasing both the volume and flow of fluid. This explains why deeper restorations are associated with more problems of sensitivity.

According to the theory, if the tubules can be occluded, fluid flow is prevented and temperature does not induce pain.

Two main types of dentin according to its morphology which are:

1- **Intertubular dentin:** The primary structural component of the hydroxyapatite embedded collagen matrix between tubules.

2- **Peritubular dentin:** The hypermineralized tubular walls.

These components ratio vary according to a depth of dentin, age and traumatic history of the tooth.

Depth of dentin: dentin is classified according to the depth from pulp

1- Outer dentin: It is the dentin near the DEJ, the tubules of the outer dentin are relatively far apart and the intertubular dentin makes up 96% of the surface area.

2- Inner dentin: The dentin near the pulp differs from that near DEJ; these differences affect the permeability and bonding characteristics of inner dentin. In the inner dentin, the tubules diameters are larger and the distance between tubule centers is half that of tubules at DEJ. Thus, the intertubular matrix is only 12% of the surface area, and the permeability of inner dentin is about eight times more permeable than the dentin near the DEJ.

Physiology of dentin: dentin is classified according to the physiological need into:

1- **Primary dentin:** Which is formed relatively quickly until root formation is completed by odontoblast.

2- **Secondary dentin:** A slowly formed dentin that continues to constrict the dimension of the pulp chamber in response to a mild occlusal stimulus, secondary dentin is mainly deposited in the pulp horns and on the roof and floor of the pulp chamber so after many decades the chamber becomes quite narrow occluso-gingivally. The dentist must pay attention for the size and location of the pulp chamber to decide the design of the preparation and placement of retentive features such as pins.

3- **Sclerotic dentin (transparent or peritubular dentin):** Results from aging or mild irritants such as slow caries and causes changes in the composition of the primary dentin. The tubular content appears to be replaced by calcified material that obliterates the tubules, progressing from the DEJ pulpally. These areas are harder, denser, less sensitive and more protective of the pulp against subsequent irritation.

Sclerosis resulting from aging is called **(physiological dentin sclerosis)** and that resulting from mild irritant called **(reactive dentin sclerosis)**

4- **Reparative dentine (tertiary dentin):** An Intense traumatic insult to the tooth, whether caused by bacterial penetration associated with caries, heat or trauma from bur that may be severe enough to destroy the supporting odontoblasts in the affected location. Within 3 weeks, fibroblasts or mesenchymal cells of the pulp are converted or differentiated to stimulate the activities of original odontoblasts and form irregularly organized tubules. The tooth will be able to compensate for the traumatic or carious loss of peripheral dentin with deposition of new dentin substrate and reduction of pulpal irritation from tubule permeability. Unless the lesion is either arrested or removed and a restoration placed, the diffusion of bacterial toxins will reach the pulp and initiate strong inflammatory response and result in pulpal necrosis.

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OPERATIVE (2019-2020)

lec.4 **L. ayad mahmood**

Treatment of deep-seated caries and pulp exposure[1]

Deep-seated caries: When the dentist is faced with the deep carious lesion and the tooth has normal pulp, all the caries is removed and a protective base such as calcium hydroxide or glass-ionomer cement is placed between the permanent restoration and the dentin to minimize postoperative sensitivity and promote pulp tissue healing.

Pulp exposure: Pulp exposure may occur:

1- Accidently during cavity preparation (mechanical or traumatic exposure).
2- As a consequence of deep carious dentin (pathological exposure).

Pulp capping

Indications: A small mechanical pulp exposure and the surrounding dentin is clean and no history of spontaneous pain or inflammation.

Pulp capping agents

1- Calcium hydroxide (dycal): It is an acceptable medicament in dentistry used for pulp protection. It has an antibacterial action because of its high pH (9.2) which causes sterilization of carious dentin also; it stimulates the formation of reparative dentin and pulp coverage.

The use of any calcium hydroxide should be kept to a minimum because it dissolves over time, resulting in an unsupported restoration.

After any pulpal exposure, the preparation should be disinfected with Concepsis (Ultradent) and then dried. Alternatively, 2.625% sodium hypochlorite can be applied and then rinsed off with water. (Sodium hypochlorite also helps create hemostasis.) An adequate amount of calcium hydroxide to cover the exposure should be applied, and then a small amount of light-polymerized resin-modified glass ionomer should be used to cover the calcium hydroxide, creating a bacterial barrier.

2- Mineral trioxide aggregate (MTA)[2]: A recent material that is used for many applications like the treatment of root perforation, apexification, pulp capping and root end filling. It has the following properties:

a- Biocompatibility and no mutagenic potential.
b- Great sealing ability.
c- Antibacterial activity.
d- Low cytotoxicity.
e- Stimulation of mineralized tissue formation.

-However, MTA is expensive

3-Theracal LC pulp capping material and liner:[3]

Theracal LC is dentistry's first light-cured flowable resin containing the "apatite stimulating" calcium silicates. It is the first of a new proactive class of internal flowable to serve in protecting and revitalizing pulp tissue and will be described by the profession as a RMCS, or Resin Modified Calcium Silicate.

The significant calcium release:

- provides reparative ions,
- creates a sustaining alkaline environment required to promote wound healing,
- provides immediate bond and sealing properties, and
- stimulates hydroxyl-apatite and secondary dentin formation within affected tissues.

I- Direct pulp capping: It is one appointment procedure which includes the following steps:

1- The field must be isolated with a rubber dam to minimize bacterial contamination of the treatment site.

2- Soft carious dentin is excavated by sharp explorer.

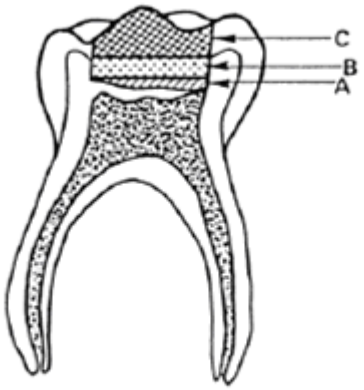
3- We should be careful not to force carious dentin into the pulp chamber.

4- A cleansing agent is used as sterile water or saline solution and no air should be used.

5- After cleansing the area, the cavity is dried by a cotton pellet and calcium hydroxide is placed.

6- If bleeding at the exposure site is arrested and the area is dry, calcium hydroxide is used. If bleeding continues, calcium hydroxide powder is used instead and a sharp excavator is used to remove the excess material from the periphery.

7- Glass-ionomer cement is placed over calcium hydroxide to protect the base and to enhance seal, and then ZOE cement is placed.



Direct pulp-capping technique. A, Capping material covers pulp exposure and the floor of the cavity. B, Protective base of zinc oxide–eugenol cement. C, Amalgam restoration.

- For a direct pulp cap to be successful a number of factors have to be met and these are

History	Preoperative assessment	Clinical findings.
No recurring or spontaneous pain. No swelling.	Normal vitality tests. Not tender to percussion. No radiographic evidence of periradicular pathology. Young patient. Radiographically obvious pulp chamber and root canal.	Pink pulp Bleed if touched but not excessively.

II- Indirect pulp capping: It is a two-appointment procedure which is preferred by many clinicians and it is more conservative and more likely to yield favorable results than direct pulp capping.

The following procedures are applied:

1- The field must be isolated with a rubber dam to minimize bacterial contamination of the treatment site.

2- All peripheral carious dentin is removed with large round bur or spoon excavator.

3- The deep soft carious dentin adjacent to the pulp is left without removal.

8- Calcium hydroxide is placed over the area and Glass-ionomer cement is placed over calcium hydroxide to protect the base and to enhance seal, and then ZOE cement is placed.

Signs of clinical success of direct or indirect pulp capping

After 4-6 weeks or more the cement is removed and the internal surface of the cavity inspected for remineralization and hard dentin formation. Dentin at the suspected site should be hard with no bleeding. Also, the tooth should be asymptomatic and no history of spontaneous pain.

III-Pulpotomy: It is a conservative therapy performed to remove the inflamed coronal portion of the pulp and preserve the vitality of the remaining radicular pulp.

Indications: a Permanent tooth with incomplete root formation and no history of pain and clinically no abscess, extreme mobility, large carious lesion or mechanical/traumatic exposure. Radiographically, a normal bone structure with no internal or external root resorption and it is a short-term preservation f permanent teeth.

Agents used in Pulpotomy:

1- Calcium hydroxide is most widely used.

2- Formocresl.

3- Glutaraldehyde.

The following procedures are applied:

1- The field must be isolated with a rubber dam to minimize bacterial contamination of the treatment site.
2- Amputation of the pulp and surrounding dentin at a depth of 2mm beyond the exposure and the cutting intermittently and with light pressure.
3- Establish hemostasis and cover the pulp with calcium hydroxide and restore the tooth.

Signs of clinical success of Pulpotomy:

1- No clinical signs and symptoms
2- No radiographic pathology.
3- Continued development of immature roots.
4- Sensitivity to electrical stimulation.

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OPERATIVE 2019/2020

lec.5 **L. ayad mahmood**

Histology of dental pulp [1]

Dental pulp occupies the pulp cavity and it is a viscous connective tissue of collagen fibers and ground substance supporting the vital cellular, vascular and nerve structure of the tooth.

The pulp organ is divided into:

1- Coronal pulp: it is located in the pulp chamber in the crown portion of the tooth, including the pulp horns.

2- Radicular pulp: It is located in the pulp canals in the root portion of the tooth; the radicular pulp is continuous with the periapical tissue by connecting through the apical foramen.

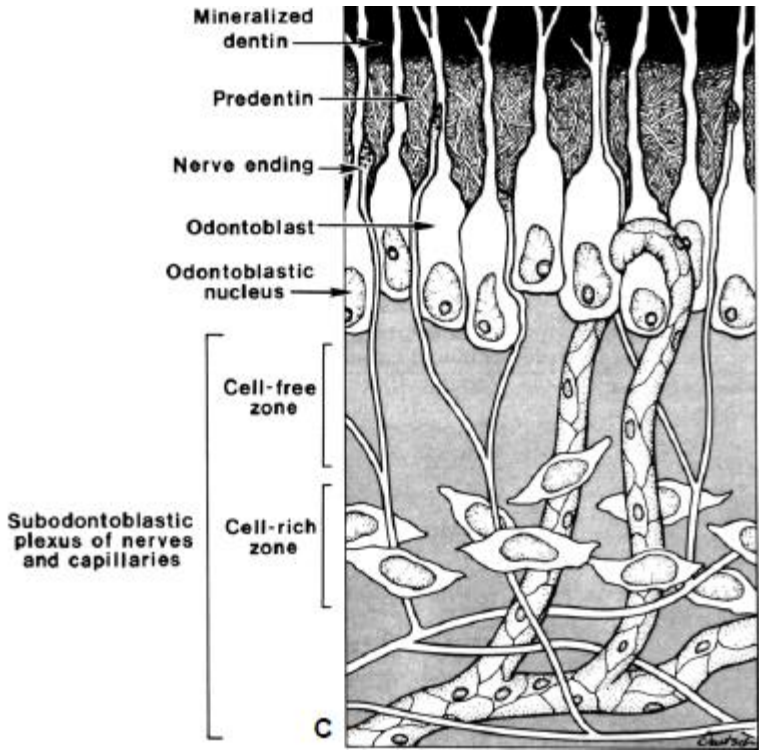
Pulp histology:

1- Odontoblastic zone: odontoblastic cells lie at the periphery of the pulp.

2- Cell-free zone: It is a space which was previously occupied by odontoblasts which have moved during tooth development.

3- Cell-rich zone: They are mainly fibroblast cells and undifferentiated mesenchymal cells.

4- Pulp core: It is the central region of the pulp, contains the large nerves and blood vessels.



Structure of the pulp

I- Cells

1- Undifferentiated mesenchymal cells: They have the capability of differentiation upon demand into most of the mature cell types.

2- Fibroblasts: Most of the cells of the pulp are fibroblast, derived from mesenchymal cells and responsible for the production of collagen fibers and pulp matrix.

3- Defense cells: that include

a- Histiocytes and Macrophages: Undifferentiated mesenchymal cells around blood vessels can differentiate into fixed or wandering histiocytes (macrophages), these cells are highly phagocytic and can remove bacteria, foreign bodies, dead cells or their debris.

b- Polymorphonuclear leukocytes: They are major cell type in microabscess formation and are very effective at destroying and phagocytizing bacteria or dead cells.

c- Lymphocytes and plasma cells: These inflammatory cell types. These cells are not normally present in the healthy pulp. Their presence would indicate the presence of a persistent irritant.

d- Mast cells: They are seldom found in normal pulp, these cells are near blood vessels releases histamine which increases vessel permeability, allowing fluid and leukocytes to escape.

4-Odontoblasts: The principal cell of the dentin-forming layer, arise from mesenchymal cells. It lines the predentin border. The layer is about 6-8 cells in depth. Each odontoblastic process occupies canaliculi in the dentinal matrix. The odontoblastic processes are called Toms fiber. When dentin is injured, the arrangement and continuity of the odontoblast cells are altered and initiate a reaction within the pulp.

In the mature tooth, the odontoblasts form dentin in response to injury, particularly when the original dentin thickness has been reduced by caries, attrition, trauma, or restorative procedures. Dentin can also be formed at sites where its continuity has been lost, such as at a site of pulp exposure. Dentin formation occurs in this situation through the induction, differentiation, and migration of new odontoblasts or odontoblast-like cells to the exposure site

II- Intercellular matrix (fibrous matrix)

a- Fibers: mainly collagen fibers and there are no elastic fibers except in the walls of blood vessels.

The greatest concentration of collagen generally occurs in the most apical portion of the pulp. ¬Significance: ¬ During pulpectomy; engaging the pulp with a barbed broach in the region of apex affords a better opportunity to remove the tissue intact.

b- Ground substance: It is dense and gel like which acts as a medium to transport nutrients to cells and metabolites of cells to the blood vessels and composed of acid mucopolysaccharides, protein polysaccharides, and water.

III- Blood vessels: The communication between the pulp and the periodontium is through the apical foramen and the accessory canals. Blood flow is more rapid in the pulp than in the most area of the body and the blood pressure is quite high. The walls of pulpal vessels become very thin as they enter the pulp.

IV- Lymph vessels: The anterior teeth drainage passes to the submental lymph nodes. The posterior teeth drainage passes to the submandibular and deep cervical lymph nodes.

Nerves: They follow the distribution of blood vessels and most of the nerves are myelinated, but there are also unmyelinated. The Unmyelinated C fibers are True nociceptive fibers that Pain-conducting fibers that respond to stimuli capable of injuring tissue Remain excitable even in necrotic tissue (last tissue to die). The peripheral axons form a network of nerves located adjacent to the cell rich zone and this is termed parietal layer of nerves and also known as plexus of raschkow.

A small number of axons pass between the odontoblast cell bodies to enter the dentinal tubules in proximity to the odontoblast process

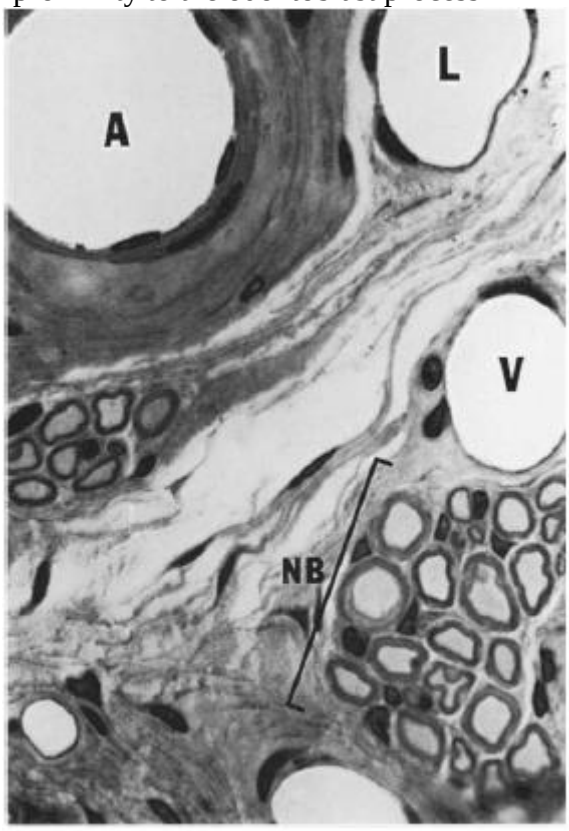


Figure 2-11 Cross-section from the central pulp showing major support systems, including arterioles (A) with a muscular wall, thin-walled lymphatics (L), venules (V), and nerve bundles (NB) containing myelinated and unmyelinated nerves. Reproduced with

The sensory response in the pup cannot differentiate between heat, touch, pressure or chemicals; this is because the pulp organ lacks those types of receptors that distinguish these other stimuli.

Age changes of pulp[2]:

1- Continuous formation of secondary dentin through life, thus gradually reducing the size of the pulp chamber and root canals that make the location of root canal orifice difficult to obtain.

2- There is a gradual decrease in the cellularity and increase in number and thickness of collagen fibers, particularly in the radicular pulp.

3- There is a progressive reduction in the number of nerves and blood vessels.

4- The odontoblasts decrease in number and size and may disappear in a certain area of the pulp particularly on the pulp floor over the bifurcation areas of multirooted teeth.

5- The appearance of calcium deposit known as pulp stone.

The function of pulp[2]:

1-The induction of dental lamina and enamel organ formation.

2- The formation of dentin through odontoblast cells.

The primary function of the pulp is formative; it gives rise to odontoblasts that not only form dentin but also interact with dental epithelium early in tooth development to initiate the formation of enamel

3-Nutrition of dentin due to the presence of blood vessels.

4-Protection of dentin due to the presence of sensory nerves fibers that respond to pain with all stimuli.

5-Defensive or reparative by the production of reparative dentin.

***Pulp stones (denticles):** They are calcified structures which are found frequently within the pulp of healthy, diseased, unerupted or impacted teeth, although their incidence increase with age.

Pulp irritation: Pulp irritation is classified according to the type of irritant into:

1- Bacterial irritants: Bacteria can reach the pulp and cause irritation through dental caries, through periodontal disease by lateral canals or by an infection which could occur by systemic disease as tuberculosis, leprosy, actinomycosis…..

2- Physical irritants: Which may include

A- Thermal insult: Heat generated by grinding procedures of tooth structure as the greatest single cause of pulp damage during cavity preparation or polishing. The inevitable inflammation following cavity preparation ranges

from reversible to irreversible pulpitis. The rise in temperature of pulp depends on several factors:

i- The depth of preparation: The deeper the cavity, the more damage to the pulp will occur. Occasionally during cavity preparation (full crown), the dentin is seen to suddenly blush due to increase in pulpal pressure that caused rupture of pulp vessels and the erythrocytes reach to dentinal tubules, but this condition may disappear with time.

ii- The speed of the bur: The more the speed of rotation, the more damage especially if there is no water coolant.

iii- The size, shape and the composition of bur: Thermal damage with steel bur is greater than carbide bur; also the larger burs give more damage than smaller burs.

iv- The amount of pressure applied: It is inversely proportional to pulp damage.

v- Type of tissue being cut whether it is enamel or dentin.

B- Dehydration: Constant drying with warm air during cavity preparation under rubber dam may contribute to pulp inflammation and possible necrosis.

C- Orthodontic tooth movement: Pulp can be devitalized during orthodontic tooth movement. Also, hemorrhage can occur and the blood vessels in periodontal ligaments may rupture and lead to loss of nutritional supply to a pulp.

D- Tooth fracture: This may occur by direct trauma to the tooth causing fracture of cusps or incisal edge, or indirectly by abrasion, attrition, abrasion…

E- Pin insertion: The insertion of pins introducing the hazards of tooth fracture, pulp exposure or perforation through the periodontal ligament.

F-Laser Burn: Laser beams are sometimes used to weld dental materials intraorally, particularly gold and nickel-chromium alloys. Ruby laser radiation has been shown to be most damaging to the pulp.

3- Irradiation effect: It occurs in patients who are exposed to radiation of oral cavity and neck for treatment of malignant disease. In time the odontoblasts and the cells undergo death and pulp become necrotic. The salivary glands are affected leading to decrease in salivary flow. The teeth with necrotic pulp should be treated endodontically, because extracting teeth may lead to necrosis of the involved bone.

4- Chemical irritation: The pulp is subjected to chemical irritation from:

i- Various filling materials that produce some chemical toxicity, acidity and absorption of water during setting. For example, in deep cavities, no irritating material should be placed like zinc oxide eugenol.

* **Zinc oxide eugenol ZOE:** In order to determine the toxic effect of eugenol, scientists have found that eugenol could pass the dentin barrier and the thicker the remaining dentin, the less is the toxic effect of eugenol.

***Cavit (**Premier Dental; Norristown, Pa.), the resin-reinforced, ZOE temporary cement used extensively in pulpless teeth, enjoys less favor in temporizing vital teeth because of the pulpal discomfort that ensues. When Cavit is placed against dentin covering a vital pulp, it causes desiccation. Although Cavit, like ZOE, is hygroscopic, it has a six-fold greater water absorption value than ZOE. The pain on insertion undoubtedly arises from fluid displacement in the dentin tubule. Therefore, Cavit should always be placed in a moist cavity.

ii-Local anesthesia contains vasoconstrictor that may cause a reduction in blood flow and could lead to concentration of irritants accumulating within the pulp.
iii-Various medicaments used for desensitization or dehydration of dentin-like Alcohol, Ether.

iv- Low pH drinks.

v- Fumes of acids which are deleterious to the teeth.

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OPERATIVE 2019/2020

Lec.6. *L. ayad mahmood*

LUORIDE RELEASING MATERIAL

The value of topical fluoride in preventative care is well-established. **Fluoride offers protection by replacing the ions lost during demineralization with fluoride, thereby forming fluorapatite, which is a larger and stronger crystal than hydroxyapatite. Prolonged fluoride exposure increases the amount of fluoride acquired**

FLUORIDE VARNISHES

Fluoride varnishes and gels are available and are successful in preventing caries. Varnishes provide a high uptake of the fluoride ion into the enamel, yet provide a lower dosage of fluoride than gels or rinses. These are professionally applied, yet may provide the most cost-effective means of delivery of fluoride to the teeth. They are effective bacteriocidal and caries prevention agents.

GLASS IONOMERS [1]

Glass ionomers are materials consisting of ion-cross-linked polymer matrices surrounding glass-reinforcing filler particles. The earliest glass-ionomer materials for restorations were based on a solution of polyacrylic acid liquid that was mixed with a complex alumino-silicate powder containing calcium and fluoride. The acidic liquid solution (pH = 1.0) dissolves portions of the periphery of the silicate glass particle, releasing calcium, aluminum, fluoride, silicon, and other ions. Divalent calcium ions are quickly chelated by ionized carboxyl side groups on polyacrylic acid polymer chains, cross-linking the chains and producing an amorphous polymer gel. During the next 24 to 72 hours, the calcium ions are replaced by more slowly reacting aluminum ions to produce a more highly cross-linked matrix that is now mechanically stronger.

The same carboxylic acid side groups also are capable of chelating surface ions on the glass particles, or calcium ions from the tooth

structure. This process generates true chemical bonds at all internal and external interfaces when the reaction conditions are correct. Set materials have modest properties compared with composites, but have relatively good adhesion and the ability to release fluoride ions from the matrix for incorporation into the neighboring tooth structure to suppress caries.

The following list summarizes the characteristics of traditional glass-ionomer materials:

Advantages

- **Form a rigid substance on setting**
- **Good fluoride release (bacteriostatic, inhibit caries)**
- **Low exothermic reaction on setting**
- **Less shrinkage than polymerizing resins**
- **Coefficient of thermal expansion similar to dentin**
- **No free monomers**
- **Dimensional stability at high humidity**
- **Filler–matrix chemical bonding**
- **Resistant to microleakage**
- **Non-irritating to pulp**
- **Good marginal integrity**
- **Adhere chemically to enamel and dentin in the presence of moisture**
- **Rechargeable fluoride component**
- **Good bonding to enamel and dentin**
- **High compressive strength**

Disadvantages

- **Susceptible to dehydration over lifetime**
- **Sensitivity to moisture at placement**
- **Poor abrasion resistance**
- **Average esthetics**
- **Less tensile strength than composites**
- **Technique sensitive powder-to-liquid ratio and mixing**
- **Less color-stable than resins**
- **Contraindicated for Class IV or other stress-bearing restorations**
- **Poor acid resistance**

Resin-modified glass-ionomer cement[2]

This is achieved by adding a water-soluble monomer, such as hydroxyethyl methacrylate (HEMA), to the liquid of a water-soluble polyacrylic acid.

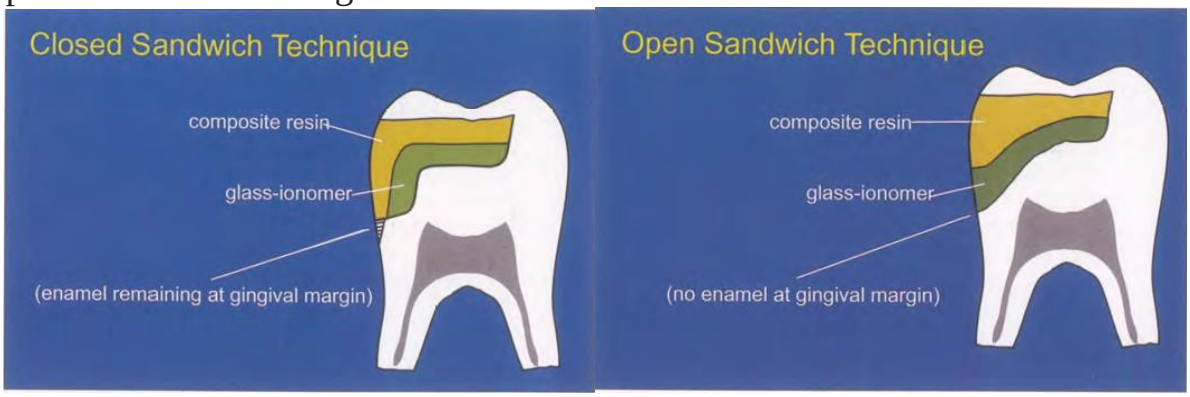
Two separate setting reactions occur one common to conventional glass ionomers and the other common to photoinitiated resin composites. The photoactivation may affect the material's final properties, depending on the strength of the glass-ionomer cure.

In general, the RMGICs appear to perform well in terms of retention. Secondary caries, as well as postoperative sensitivity, are not a problem. However;

- RMGICs found that the marginal adaptation was poor at 18 months and likely to deteriorate over time.
- From the limited data that the RMGICs exhibit some loss of anatomic form and surface wear, particularly in the mid to long term.
- While the initial color match may have been favorable relative to tooth structure, it appears that these materials change over time. This may be related to the surface changes within the materials as manifested in the form of loss of anatomic contour and wear
- The RMGICs cannot be considered biocompatible to the same extent as conventional glass-ionomers.

When restoring Class V non-carious cervical lesions with RMGI, it was found that the dentin should be lightly roughened and prepared with a rotary instrument to create a uniform dentin smear layer and clean dentin surface. It is also important to use a cervical matrix to provide for 100% leak-free restorations. Clinically the cervical matrix allows the material to be adapted to the margins of the preparation under pressure as compared to adapting the restorative with a hand instrument, which can have the tendency to pull the restorative away from the margin. Another study investigated marginal adaptation of RMGI and recommended that restorations be finished in a separate appointment to allow for water sorption to improve marginal adaptation. Whenever placing Class V restorations, potential contamination with sulcular fluid or moisture is a risk factor. It has been reported that when bonding RMGI to slightly moist dentin the restorative material exhibits moisture tolerance with no reduction in shear bond strength.[3]

Glass ionomer and resin modified glass ionomer restorative materials have the highest levels of fluoride release and good recharge, which increases long-term fluoride release. These are useful for the high caries risk patient, but their poor wear resistance and low fracture toughness limits their usefulness as a posterior restorative. However, glass ionomers are useful as a liner or extended base and should be used in deep cavity preparations, especially when the proximal margin is subgingival (sandwich technique). A conditioner or primer is provided with glass ionomer restorative materials. These conditioners are weak inorganic acids and clean rather than etch the tooth surface prior to bonding. They effectively improve the bond of the glass ionomer to the tooth structure.



Recently, nanofillers have been added to a resin modified glass ionomer (RMGI) (Ketac Nano) to reduce the filler particle size, producing a smoother, more esthetic restoration. All glass ionomers should be bonded to moist tooth structure, after the conditioner is applied and rinsed off or light-cured, depending upon the brand used, and the mixed resin modified glass ionomer applied to the moist tooth and light-cured. After curing, the resin modified glass ionomer is wet-finished.

Polyacid-modified resin composites

Polyacid-modified resin composites, which are more widely known by the name “compomers,” attempt to combine the best properties of glass ionomers and composite resins. A major reason for their success is that they are user-friendly: they are soft, nonstick, do not need to be mixed, and are easy to place. They are easy to inject into a cavity, simple to shape, quick to cure, and readily polished after curing. They are used in anterior proximal restorations and in cervical restorations. In almost all other areas, composites and glass ionomers are preferred.

Compomers have nominal adhesion to tooth structure and, therefore, are always attached with resin-dentin bonding agents. Compomers provide less fluoride release than glass ionomers, and the small amount they do release may be of limited value since the resin bonded interface prevents the fluoride from entering the tooth. Nevertheless, the surface fluoride release from compomers can affect the surrounding tooth structure.

The advantages of compomers include the following characteristics:

- No mixing required
- Easy to place
- Easy to polish
- Good esthetics
- Excellent handling
- Less susceptible to dehydration
- Radiopaque
- Higher bond strengths than resin-modified glass ionomers
- Stronger than glass ionomers

The disadvantages of compomers include the following characteristics:

- Bonding agent required
- More leakage than resin-modified glass ionomers
- Expand from water sorption over time
- Wear more easily than composites
- Longevity difficult to predict because of an enormous variety of products
- Physical properties weaker than those of composites, and they decrease over time
- Limited fluoride uptake

Ionomer-modified resins

Ionomer-modified resins, or fluoride-containing composite resins, are materials that contain glassionomer fillers but no polyacids. They have been in the dental market for a long time and represent they suspend ionomer-glass or reacted glass-ionomer components in a resin system, and hence are also known as suspension systems

Unfortunately, whereas compomers absorb water, which gives them the potential for acid-base reactions and significant fluoride release, suspension

systems have no such potential. The only avenue for fluoride release from an ionomer suspension system is the diffusion of ionomer particles entrapped in voids that fill with water after placement.

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Operative Dentistry

Ass. Lec. Othman H. Alani

Lecture (1)

Patient Evaluation, Diagnosis and Treatment Planning

Pretreatment considerations consisting of patient assessment, examination and diagnosis, and treatment planning are the foundation of sound dental care.

Excellence in dental care is achieved through the dentist's ability to assess the patient, determine his needs, and design an appropriate plan of treatment.

Infection Control

Before the examination and diagnosis, attention is given to infection control. Before, during and after any patient visit, appropriate infection control measures must be instituted. Barrier protection of personnel using masks, protective eyewear, gloves and gowns is now a standard requirement for dental procedures.

Patient Assessment

Medical History

The medical systemic care phase includes aspects of treatment that affect the patient systemic health. Comprehensive medical history that helps to identify conditions that could alter, complicate or contraindicate dental procedures. For example, the dentist may identify

1. Contagious diseases that require special precautions, procedures, or referral
2. Allergies or medications that may contraindicate the use of certain drugs;
3. Systemic diseases and cardiac abnormalities that demand less strenuous procedures or prophylactic antibiotic coverage; and
4. Physiologic changes associated with aging that may alter clinical presentation and influence treatment.

Chief Complaint

It is generally the first information obtained. Chief complaints are symptoms or problems expressed by the patient in his own words relating to the condition that prompted the patient to seek treatment. The patient should be encouraged and guided to discuss all aspects of the current problem, including onset, duration, symptoms, and related factors.

Dental History

A brief history of past dental treatment can provide useful information about patient's tolerance for dental treatment. Questions about previous episodes of fractured or lost restorations, trauma, infection, sensitivity and pain can give information that will alter the dentist to possible problems and guide him to clinical and radiographic examination. Patients may not volunteer this information; hence specific questions regarding thermal sensitivity, discomfort during chewing, gingival bleeding and pain are warranted. When there is a history of symptoms indicative of pulpal damage or incomplete tooth fracture, specific diagnosis tests should be performed during the examination.

Clinical Examination

Clinical examination is the "hands-on" process of observing both normal and abnormal conditions. Diagnosis is a determination and judgment of variations from normal.

The intraoral assessments involve an examination of the periodontium, dentition and occlusion.

The clinical examination is performed systematically in a clean, dry, well-illuminated mouth. Proper instruments including a mirror, explorer, and periodontal probe are required.

An accurate examination can occur only when the teeth are clean and dry. This may require initial scaling, flossing, and a tooth brushing prophylaxis before clinical examination of the teeth.

Elements of the clinical examination include:

1. EVALUATION OF THE DENTITION

A. <u>Assessment of caries risk and plaque:</u> the determination of baseline caries risk and plaque levels at the time of initial examination provides a basis for communication with the patient and the dentist, and it is important information in establishing a prognosis for restorative care. The patient can be given instructions for good oral hygiene. Once plaque assessment completed an examination of other areas can be accomplished.

B. <u>Detection of caries lesions:</u>

- <u>Pit and fissure caries lesions</u>: it may begin in small enamel defects that lie near DEJ, so it is difficult to detect early on radiograph (it must be extensive to be detected radiographically).

Tactile examination with firm application of sharp explorer into fissure and a sticky sensation felt on removal of the explorer has been the classic sign of pit and fissure caries. Clinical studies have shown this method to be unreliable, producing many false-positive and false-negative diagnosis, in addition an explorer can cause cavitation in a demineralized pit and fissure, preventing the possibility of remineralization.

Visual observation with magnification of a clean dry tooth has been found to be reliable non-destructive method. Pit and fissure lesions appear as a gray or gray-yellow opaque area that show through the enamel.
Fiberoptic transillumination may be helpful in visualizing pit and fissure lesion.
A variety of new technologies are being evaluated for detection of caries lesions like air abrasion and laser.

- Smooth-surface caries lesions: proximal caries are the most difficult to detect clinically, it is inaccessible to both visual and tactile examination, proximal lesions usually detected by radiograph in posterior teeth wile in anterior teeth may be diagnosed radiographically or with visual examination; using transillumination. Smooth caries on buccal and lingual surface can be easily detected by visual and tactile examination.

C. Assessment of the pulp: each tooth that has extensive restoration and teeth with pulps of questionable vitality; should be tested.

1. **The application of cold and hot** is a valuable method of vitality testing. A cotton pellet saturated with an aerosol refrigerant spray such as (tetrafluoroethane), is placed on the tooth to determine vitality or a pencil of ice made by freezing water inside a sterilized anaesthetic cartridge. Hot application is also helpful by applying a heated piece of gutta-percha on the tooth surface.
2. **Electric pulp tester** another method of vitality test. However this test has limitations, it cannot be used in a wet field or on teeth with metallic restorations unless measures are taken to insulate adjacent teeth. Also the method does not reflect the health of the pulp or its prognosis.
3. **A test cavity**: used when previous thermal and electric pulp tester failed to provide a clear picture of pulp vitality and a restoration is indicated. So the preparation initiated without using anesthetic. If pain or sensitivity is elicited when dentin is cut with a bur, pulpal vitality is confirmed.

Other tests that should be conducted during examination are

Percussion test: This test is performed by gently tapping the occlusal **or** incisal surfaces of the suspected tooth and adjacent teeth with the end of the handle of a mouth mirror to determine the presence of tenderness. Pain on percussion suggests possible injury to the periodontal membrane from pulpal or periodontal inflammation. Care must be taken when interpreting a positive response on maxillary teeth because teeth in close proximity to maxillary sinuses also may exhibit pain on percussion when the patient has maxillary sinusitis.

Palpation: This test is performed by rubbing the index finger along the facial and lingual mucosa overlying the apical region of the tooth, an alveolar abscess in an advanced stage or other periapical pathosis may cause tenderness to palpation.

D. Evaluation of existing restorations

The following criteria are used to evaluate existing restoration:

1. **Structural integrity**: this evaluation involves determining whether it is intact or whether portions of the restoration are partially or completely fractured or missing. The presence of fracture line indicates replacement of the restoration.
2. **Marginal opening:** For amalgam restorations, the existence of marginal ditching does not indicate the replacement of the restoration; because the margins of amalgam restorations become relatively well sealed from the accumulation of corrosion products, unless signs of recurrent caries are present.

For composite restoration, the marginal gap should be considered for repair or replacement of the restoration. The presence of marginal gap is less critical for restorations with anticariogenic properties, e.g. glass ionomer cement. As studies have shown that tooth structure adjacent to GI cement restorations is less susceptible to caries; replacement of the restoration indicated when tooth structure adjacent to the marginal gap becomes carious or by marginal staining, that is esthetically unacceptable especially in anterior teeth.

3. **Caries:** the dentist must use a combination of visual, tactile and radiographic examinations to detect the presence of caries lesion. A radiolucent area surrounding a radiopaque restoration or the presence of soft tooth structure generally indicates caries and must be repaired or replaced.

4. **Restoration-related periodontal health**: examination of restorations must include an assessment of the effect that existing restoration have on the health of the adjacent periodontuim. Problems commonly encountered in this area are:

a. Surface roughness.
b. Interproximal overhangs.
c. Impingement on the zone of attachment (called the biologic width) [the area approximately 2mm in the apicocoronal dimension, occupied by the junctional epithelium and the connective tissue attachment].

All three of these phenomena can cause inflammation within the periodontium even in the absence of impingement on biologic width. Open or rough subgingival margins can harbor bacterial plaque to generate an inflammatory response. Gingival inflammation around crown may also due to an allergic reaction to material in the crown.

5. **Occlusal and interproximal contacts**: the dentist should assess all interproximal contact with thin dental floss. Contacts should allow the smooth passage of floss. Contacts that are open or excessively light should be evaluated to determine whether pathosis, food impaction or annoyance to the patient has resulted.

In occlusal contacts of all restorations should be evaluated to determine whether they are serving their masticatory function without creating a symptomatic or pathogenic occlusion. Restorations whose occlusal contacts are creating primary occlusal trauma should be altered or replaced to resolve the problem. Restorations that are in significant infra-occlusal may permit the super eruption of opposing teeth and should be considered for replacement.

6. **Esthetics:** some of the more common esthetic problems found in the existing restoration are:
   a. Display of metal.
   b. Discoloration or poor shade match in tooth colored restoration.
   c. Poor contour in tooth-colored restoration.
   d. Poor periodontal tissue response in anterior restoration.

E. Evaluation of tooth integrity and fractures

Cracked-tooth syndrome: is a common result of incomplete tooth fracture. Patients suffering cracked tooth syndrome often experience cold sensitivity and sharp pains of short duration while chewing. The cusps most commonly fractured are the nonfunctional cusps. Often patients with multiple cracked teeth have parafunctional habits or malocclusions. Cracked-tooth syndrome is an age-related phenomenon, the greatest occurrence is found among patients between 33-50 years of age.

This syndrome is often difficult to diagnose. The patient is unable to identify the offending tooth and evaluation tools such as radiograph, visual examination, percussion and pulp tests are typically non diagnostic.

The two most useful tests are:

- **Transillumination:** when a tooth with a crack is transilluminated from either the facial or lingual direction, light transmission is interrupted at the point of the crack. This results in the portion of the tooth on the side away from the light appearing quite dark.
- **Biting test**: it is the most definitive means of localizing the crack, by having the patient bite a wooden stick, rubber wheel; the dentist will be able to reproduce the patient's symptom and identify the fractured tooth.

In treatment of incomplete tooth fracture, the tooth sections are splinted together with a cuspal coverage restoration. This may include the use of an amalgam restoration, a crown or indirectly fabricated onlay or resin composite.

F. Esthetic Evaluation

In addition to an esthetic evaluation of existing restorations, an assessment of the esthetics of the entire dentition should be completed. Commonly encountered esthetic problems that are related to restorative dentistry include:

1. Stained or discolored anterior teeth.
2. Unaesthetic contours in anterior teeth (length, width, incisal edge shape or axial contour).
3. Unaesthetic position or spacing of anterior teeth.
4. Carious lesions and unaesthetic restoration.
5. Unaesthetic color and/or contour of tissue adjacent to anterior restorations, this includes: excessive gingival display occasionally referred to as the (gummy smile).

The restorative treatment of esthetic problems may range from conservative therapy such as micro abrasion or bleaching to more invasive care such as the placement of resin veneers, ceramic veneers, or complete coverage crowns.

Additionally periodontal, endodontic or orthodontic procedures may be helpful depending on the nature of the problem.

2. EVALUATION OF THE PERIODONTIUM

Evaluation of periodontium consists of a clinical assessment of attachment levels, bony support, tooth mobility, qualitative assessment of tissue health, and radiographic evaluation of supporting bone.

The qualitative assessment of periodontal tissue health includes tissue color, texture, contours, edema and sulcular exudates are noted. The presence of specific local factors such as plaque, calculus and their relationship to tissue inflammation should be noted.

During examination of periodontium, the dentist must estimate the location of margins for future restorations and their potential to impinging on the biologic width.

2. EVALUATION OF OCCLUSION AND OCCLUSAL WEAR

The occlusion can have significant effects on the restorative treatment plan. The following factors should be evaluated during occlusal examination:

1. Occlusal interferences between the occlusion of centric relation and that of maximum intercuspation.
2. The number and position of occlusal contacts as well as the stress placed on the occlusal contacts.
3. The amount and pattern of attrition of teeth and restorations resulting from occlusal function.
4. The interarch space available for placement of needed restoration.

The number and position of occlusal contacts strongly influence the selection of restorative materials as well as the design of the preparation and restoration.

Attrition: excessive occlusal wear caused by occlusal parafunction (bruxism). In these instances, facets on opposing teeth match well. Prevention is accomplished with use an occlusal resin appliance (night guard, bite plane), and education of the patients.

4. EVALUATION OF RADIOGRAPH

The radiographic examination is an essential component of the comprehensive evaluation. Clinical situations for which radiograph may be indicated includes:

-Pervious periodontal or root canal therapy.
-History of pain or trauma.
-Large or deep restorations.
-Deep carious cavity.
-Swelling and mobility of teeth, fistula or sinus tract infection.
-Abutment teeth for fixed or removable partial prosthesis.
-Unusual tooth morphology or color.
-Missing teeth with unknown reason.

In evaluating radiographic findings for restorative purposes, the dentist should note open interproximal contacts, marginal openings, overhanging restoration, periapical radiolucencies within the bone of the tooth.

The dentist must interpret abnormal radiographic finding with caution. For example when the clinician evaluates radiolucencies that appear to represent carious tooth structure but may in fact represent nonpathologic processes as in a radiographic phenomenon known as (burnout) which is a radiolucency not cause by caries, it occurs when x-ray beam traverses a portion of the tooth with less thickness than surrounding areas most commonly seen in cervical area of the tooth. So the dentist must be careful not to mistakenly diagnose as demineralized tooth structure. Also the dentist must be cautious in diagnosing caries beneath existing restorations because certain radiolucent dental materials have a radiographic appearance similar to that of carious tooth structure.

Treatment Plan

Having completed a comprehensive examination, the dentist lists the problem related to restorative dentistry. Planning the restoration of individual teeth requires the consideration of four factors:

1. The amount and form of remaining tooth structure.
2. The functional need of each tooth.
3. The esthetic needs of each tooth.
4. The final objective of the overall treatment plan.

Operative Dentistry

Ass. Lec. Othman H. Alani

Lecture (3)

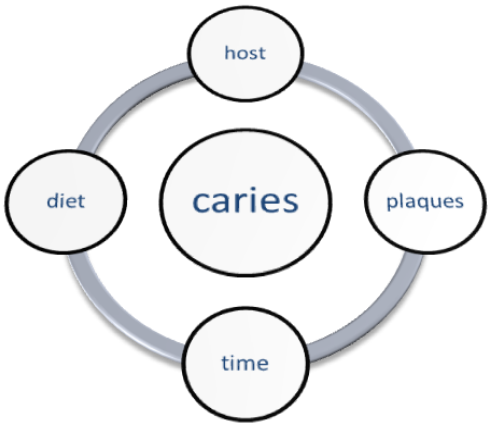
Management of dental caries in enamel and dentin (Classification, diagnosis, prevention, and treatment)

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

It is essential to understand that cavitations in teeth are signs of bacterial infection (mostly *Mutans Streptococci* and *Lactobacilli*). Carious lesions only occur under a mass of bacteria (dental plaque) capable of producing a sufficiently acidic environment to dissolve tooth structure. The plaque bacteria metabolize refined carbohydrates for energy and produce organic acids as bi-products. The acids produced may then cause a carious lesion by dissolution of the tooth's crystalline structure.

Dental caries is a multi factorial disease; it is the result of complex interaction between ***Host, Plaque, Diet,*** and ***Time***.

The initiation and progression of caries is affected by other factors such as saliva, fluoride, preventive measures, etc..



1-Host Factors

A-Teeth

The teeth vary in their susceptibility to dental caries from one surface to another and from one subject to another. There are several factors affecting tooth susceptibility as:

Morphology of teeth:

Susceptible sites on the tooth, which favour plaque retention and stagnation, are prone to decay.

These include:

1- Enamel pits and fissures.

2- Approximal enamel smooth surfaces.

3- Cervical margin of teeth.

4- Exposed root surfaces because of gingival recession.

5- Deficient or over hang restoration (recurrent caries).

6- Tooth surfaces adjacent to denture and bridges.

Composition of teeth:

Teeth are composed of inorganic elements (96% in enamel, 70% in dentin), organic elements and water. Composition of teeth is effected by environmental factors (water, diet, and nutrition).

Inorganic components: involve *major elements* as calcium, phosphate, hydroxyl group these are the constituents of hydroxyapatite crystals.

As the pH decreased, calcium phosphate minerals become susceptible to demineralization. As the environmental pH recovers, dissolved calcium & phosphate can re-precipitate and the process called (remineralization).

B-Saliva: Saliva can affect caries etiology and progression through the *rate of secretion* and *composition*.

- Saliva affects the integrity of teeth by the composition of buffer system (calcium and phosphate).
- By the cleansing action of saliva (oral clearance), it can reduce the number of oral micro organisms and food debris from the mouth.
- Saliva can provide antibacterial agents through *oral immune system* (specific and non specific) that can minimize the number of cariogenic bacteria.

C-Subject*:* The behaviour, attitude and dental knowledge can affect the caries initiation and progression. These can influence the oral hygiene of the person as well as his dietary habits.

D-Social & demographic factors: many studies have shown that dental caries is more prevalent in the lower socioeconomic categories.

F-Fluoride: it reduces tooth demineralization through the formation of fluorhydroxyapatite and fluorapatite crystals, and through accelerating and promoting reminerlization of a previously demineralized tooth structure.

2-Dental plaque: A gelatinous mass of bacteria adhering to the tooth surface.

Carious lesion only occurs under a mass of bacteria capable of producing a sufficiently acidic environment to demineralize tooth structure.

Plaque quantity and quality greatly influence caries etiology. Bacteria adhere to tooth surface and ferment carbohydrate causing release of acid that demineralizes the tooth surfaces. Cariogenic bacteria include *mutans streptococci, Lactobacilli* and others.

Mutans Streptococci → early carious lesions of enamel.

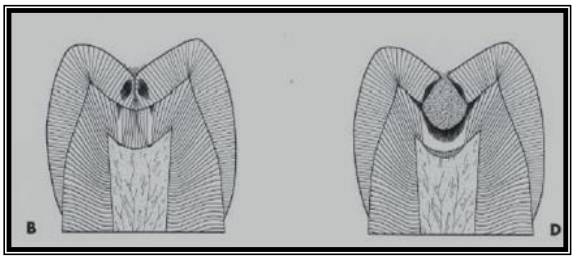
Lactobacilli → dentinal caries.

3- Diet: dietary carbohydrates are necessary for the bacteria to produce the acids that initiate demineralization.

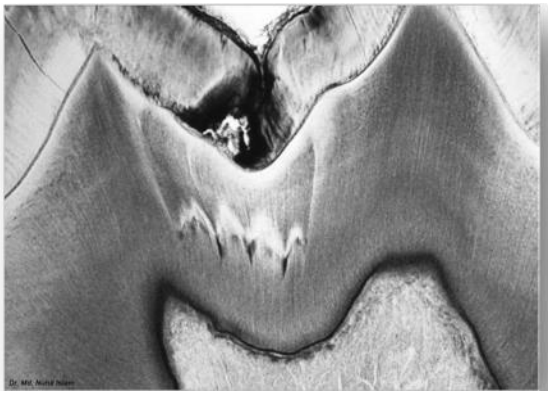
CLASSIFICATION OF DENTAL CARIES

The characteristics of the carious lesion vary with the nature of the surface on which the lesion develops.

1. The first and most susceptible site is in the *developmental pits and fissure* of the enamel.

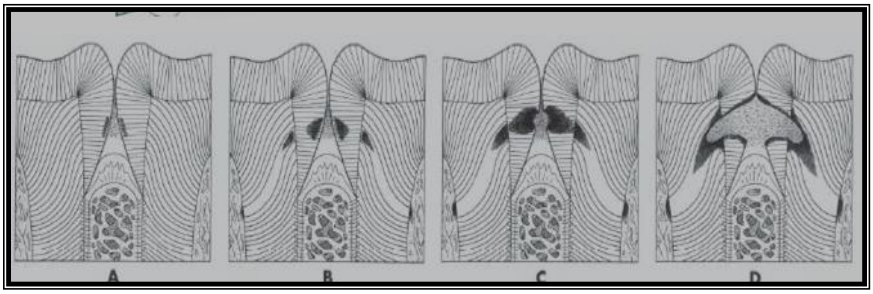


The shape of pits and fissures contributes to their high susceptibility to caries. Pit and fissure caries expand as it penetrates into the enamel affects a greater area of DEJ. Thus the entry site may appear much smaller than the actual lesion. In cross section, the gross appearance is an inverted V (or triangle) with a narrow entrance and a progressively wider area of an involvement closer to the DEJ.



2. The second site is on certain areas of the *smooth enamel surfaces* were contour or tooth position protects plaque against the rubbing action of some foods and often from being loosened by toothbrush, these include the areas of contacting proximal surfaces which are gingival to the contact area. Other susceptible smooth enamel surfaces are those areas gingival to the height of contour of the facial and lingual surfaces.

Lesions starting on smooth enamel surfaces have a broad area of origin and a conical, or pointed, extension toward the DEJ. A cross section of the enamel portion of a smooth surface lesion show a V shape (or triangle) with a wide area of origin and the apex of the V directed toward the DEJ. After caries penetrates the DEJ, softening of the dentin spread rapidly laterally and pulpally.



3. The third site where caries may attack is the *root surface*. The root surface is rougher than enamel and readily allows plaque formation in the absence of good oral hygiene. The cementum covering the root surface is extremely thin and provides little resistance to caries attack. Root caries lesions have well defined margins, tend to be U-shaped in cross section, and progress more rapidly due to the lack of protection from an enamel covering; in addition to the fact cementum begins to demineralize at pH 6.7, which is higher than the enamel's critical pH of 5.5. It has been notable increase in prevalence of root caries, probably due to the increasing number of older persons who experience gingival recession and usually have cariogenic plaque on exposed root surface.

In addition, caries could be classified according to the type and severity of the lesion into:

1. *Acute caries "rampant"*: is a rapid progressing involving a large numbers of teeth. The acute lesions are lighter colored than other lesion, being light

brown or gray and their carious consistency makes the excavation difficult. Pulp exposures are often observed in patient with rampant caries.

2. *Chronic caries*: these lesions are usually of long standing involvement affect of fewer numbers of the teeth and are smaller in size than acute caries.

3. *Primary caries "Initial":* is one in which the lesion constitutes an initial attack on the tooth surface. It designated as primary because of the initial location of the lesion on the surface rather than on the extended damage.

4. *Secondary caries "Recurrent"*: this type is observed around the edges of restoration. Surface overhanging margin and fracture on the surfaces in posterior teeth that are naturally prone to caries because of difficult in cleaning.

PROGRESSION OF CARIES

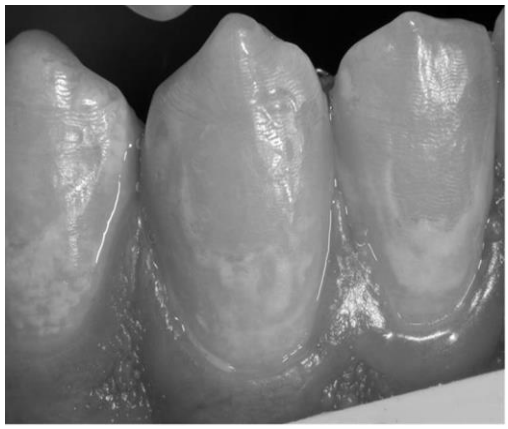
The progression and morphology of caries lesion is variable depending on the site of origin and the conditions in the mouth. The time for progression from incipient caries to clinical caries (cavitation) on smooth surface is estimated to be 18 ± 6 months. Peak rate for the incidence of new lesion occurs 3 years after the eruption of the tooth.

Occlusal pit and fissure lesions develop in less time than smooth surface caries. Both poor oral hygiene and frequent exposures to sucrose containing-food can produce *incipient* (white) lesions (first clinical evidence of demineralization) in as little as three weeks. The volume and buffering capacity of saliva available to tooth surfaces has a major role in caries protection. The buffering capacity of saliva is primarily determined by the concentration of bicarbonate ion. The benefit of the buffering is to reduce the potential for acid formations. Once the pH falls below 5.5, tooth minerals begins to dissolve and the calcium and phosphate ions leaves enamel surface towards the adjacent plaque. When the pH returns high (above 5.5), remineralization of damaged tooth structure can occur before the initiation of cavitation.

Radiation induced xerostomia (dry mouth) can lead to clinical caries development in as little as three months from the onset of radiation. Thus caries development in healthy person is slower in comparison to the rate in compromised persons.

CLINICAL CHARACTERISTIC OF ENAMEL CARIES

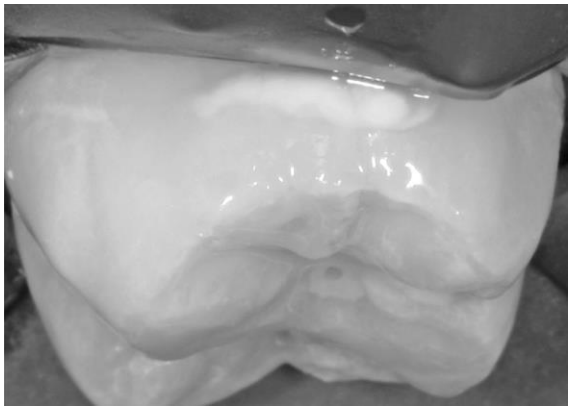
On clean, dry teeth, the earliest evidence of caries on smooth enamel surface of crown is a white spot. These lesions are usually observed on the facial and lingual surfaces of the teeth. White spot are chalky white, opaque areas that are revealed only when the tooth is dried, and termed ***incipient caries***. These areas of enamel lose their translucency because of the extensive subsurface porosity caused by demineralization.



Care must be exercised to distinguish white spots of incipient caries from ***developmental white spot hypocalcifications*** of enamel. Incipient caries partially or totally disappear visually when the enamel is hydrated (wet), while hypocalcified enamel is unaffected by drying and wetting. Hypocalcified enamel does not represent a clinical problem except when its appearance is objectionable esthetically.

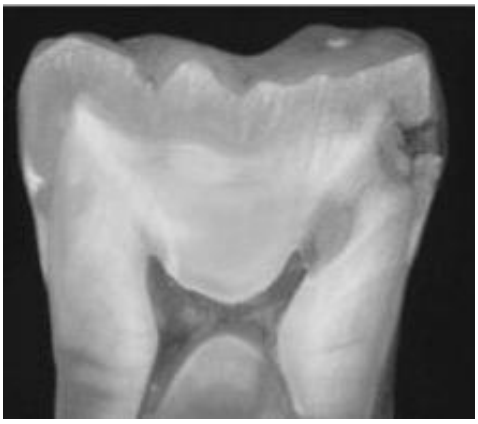
A more advanced lesion develops a rough surface that is softer than the unaffected, normal enamel, softened chalky enamel that can chipped a way with an explorer is a sign of ***active caries.***

Incipient caries can be remineralized. Non cavitated enamel lesion retain most of the original crystal framework of the enamel rods and the etched crystallites serves as nucleating agents for remineralization..



Calcium and phosphate ions from saliva can then penetrate the enamel surface and precipitate on the highly reactive crystalline surfaces on the enamel lesion. The change in color (to brown or black spots) is due to trapped organic debris and metallic ions within the enamel. These lesions which are termed ***"Arrested caries"*** are more resistance to subsequent caries attack than the adjacent unaffected enamel. They should not be restored unless they are esthetically objectionable.

CLINICAL CHARACTERISTIC OF DENTINAL CARIES



Dentinal caries is a V- shaped in cross section with a wide base at the DEJ, and the apex directed pulpally. Caries advance more rapidly in dentin than in enamel because dentin provides much less resistance to acid attack. Caries produces a variety of responses in dentin, including pain, demineralization, and remineralization.

Often, pain is not reported even when caries invades dentin, except when deep lesions bring the bacterial infection close to the pulp. Once bacterial invasion of the dentin is close to the pulp, toxins and even a few bacteria inter the pulp, resulting in inflammation of the pulpal tissues.

Initial pulpal inflammation is thought to be evident clinically by production of sharp pains for only a few seconds (10 or less) in response to a thermal stimulus. A short, painful response to cold suggests ***reversible pulpits*** or ***pulpal hyperemia***. Reversible pulpitis is a limited inflammation of the pulp from which the tooth can recover if the caries producing the irritation is eliminated timely by operative treatment.

When the pulp becomes more severely infected, a thermal stimulus will produce pain that continues after termination of the stimulus, typically longer than 10 seconds (partial or total pulp necrosis). This clinical pattern suggests ***irreversible pulpitis*** which need endodontic treatment.

Operative Dentistry

Lecture (4)

Ass. Lec. Othman H. Alani

CARIES DETECTION AND DIAGNOSIS

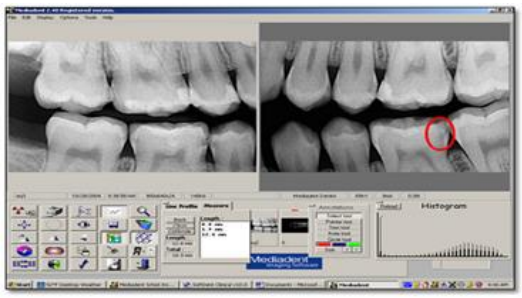
Detection of carious lesions must be done while the teeth are clean & dry:

1. Pit & fissure lesions: detection of these lesions most often done by visual inspection. Good lightening & dry clean teeth. It appears that any sign of visible cavitation in the occlusal surface corresponds to the progression of the lesion into the dentin. Bite-wing radiographs can detect only large occlusal lesions. Tactile examination of fissures with sharp probe is unreliable method because the explorer can damage a white spot lesion by breaking through intact surface zone & cause a cavity which will trap dental plaque & encourage lesion progression.
2. Lesions involving proximal surfaces:
   - visual or tactile examination.
   - Fiberoptic transillumination techniques have proven useful. In these techniques, a fine light is transmitted through the contact area. Lesions appear as a dark shadow.
   - Bitewing radiographs are the most effective method for evaluation of the proximal smooth surfaces for evidence of demineralization because these areas are not readily assessed visually or tactilely.
   - The use of orthodontic separator has been advocated in some cases to allow the dentist to see more clearly & gently feel for a break in the enamel surfaces.
3. Lesions in smooth free surfaces: lesions in smooth free surfaces whether in the enamel of the crown or the dentin of the root can be detected easily with visual examination.
4. Root surfaces: Root surfaces exposed to the oral environment, usually due to gingival recession, are at risk for caries and should be examined visually and tactilely. Discoloration of such areas is common and usually is associated with remineralization. Generally the darker the discoloration, the greater the remineralization. On the other hand, active, progressing caries shows little discoloration and is primarily detected by the presence of softness and cavitation.

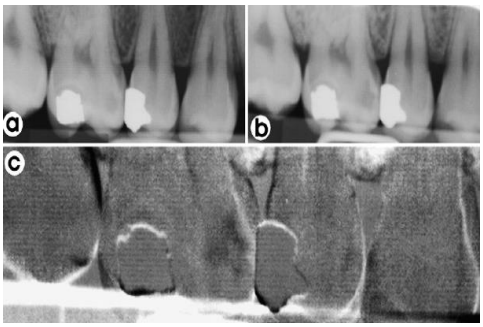
New Caries Detection Devices

The development of several new devices and detection methods is promising.

1. **<u>Electronic caries monitors</u>** are based on the principle that porous carious lesions have lower conductive values than intact tooth structure (for example: CarieScan system).



2. **<u>Direct digital radiographs</u>** for caries detection. This systems use a wire-based sensor that contains a computer chip inside a protective casing, the sensor is connected to a PC by wire. The sensor is placed in the patient's mouth, when this sensor hit by x-ray the information is transmitted directly to the computer and displayed as an x-ray image on the computer screen.

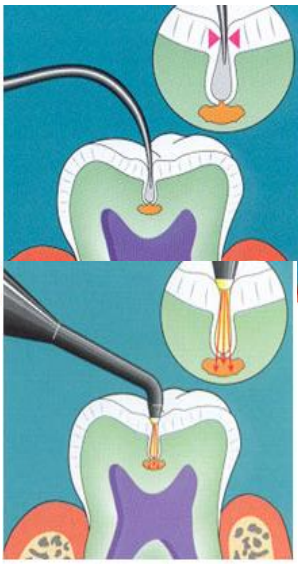


Substraction radiography

Used for detection of recurrent caries The basis of subtraction radiology is that two radiographs of the same object can be compared using their pixel values. any differences in the pixel values must be due to change in the object.

3. **<u>Intra-Oral camera</u> for caries detection and for patient motivation.**
4. **<u>Magnification using Loupes, and Dental Microscope.</u>**

5. Infrared Laser Fluorescence (DIAGNOdent)

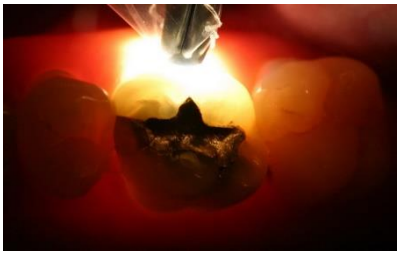


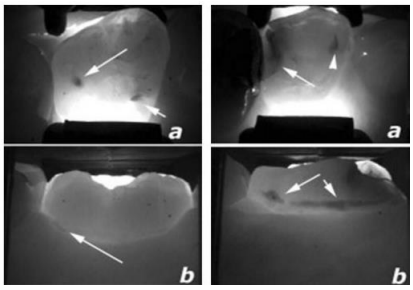
It can be used for detection of caries on occlusal and smooth surfaces.

The principle is that cariogenic bacterial metabolites exhibit increased fluorescence causing change in the fluorescence of the lesion.

The **higher** the number the more is the caries
Advantage: the most useful in confirming the presence of caries in suspicious fissure and detecting deep dentinal caries (hidden caries). However, it is not used for the detection reccurent caries or to detect proximal caries.

6. Fiber-optic transillumination

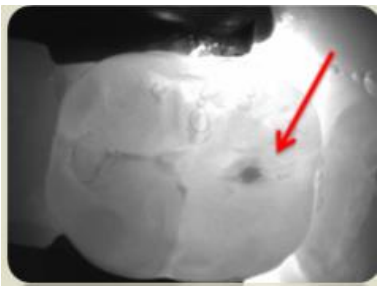




Fiber-optic transillumination (FOTI) as a caries detection technique is based on the fact that carious enamel has a lower index of light transmission than sound enamel.The intact tooth absorbs very little light allowing it free passage. In contrast areas of caries absorb and scatter light thus appear as dark shadow. This method is mainly used to determine proximal caries

Advantages: 1. Lesions which cannot be diagnosed radiographically can be diagnosed, 2. No radiation hazard, 3. Comfortable to the patient.
Disadvantages: 1. FOTI is not possible in all locations of carious lesions, 2.can not detect small lesions

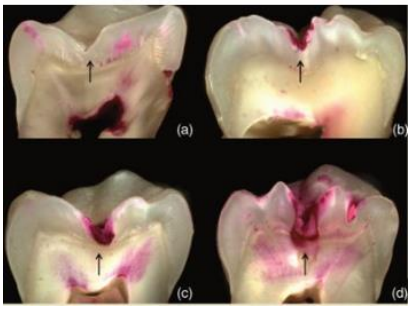
CariVu is a brilliant new approach to caries detection combining FOTI with a digital camera



7.Caries detector dyes

Various dyes such as silver nitrate, methyl red have been used to detect carious sites by change of color.

These dyes aid the dentist in differentiation of infected dentin. These dyes enhance the visual recognition of caries by selectively staining the infected demineralized dentin which should be removed during preparation leaving the inner affected dentine (demineralized but not infected) that should be kept and not removed because it could be remineralized.



Caries Prevention and Treatment

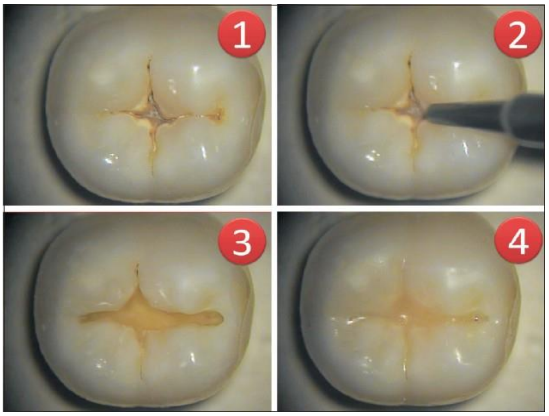
Caries preventive treatment is a complex process involving multiple interrelated factors. Maintaining of good oral hygiene "brushing and flossing", diet containing sucrose and carbohydrate control, and fluoride treatment; all these factor can affect carious lesion initiation and also remineralization of the incipient carious lesion specially in smooth surfaces to arrested carious lesions. Pit and fissure sealant is the most effective method in preventing pit and fissure caries.

Once caries has produced cavitation of the tooth surface, preventive measures are usually inadequate to prevent further progression of caries. So, cavity preparation and restoration are needed. Once the pulp is dead partially or completely; root canal filling become necessary to avoid tooth extraction.

	Active	Arrested
Occlusal lesion	-Frosted surface, plaque covered white spot lesion. -cavitated lesion; include micro cavities to cavities involving dentine which is visible on bitewing radiograph.	-shiny surface white or brown spot lesion
proximal	-appear on radiograph -appear on radiograph with persistent gingival inflammation despite pt. attempt to remove plaque by flossing. -lesion not present at previous examination.	-accurate bitewing radiograph shows no lesion progression.
Smooth surface	-white spot lesion close to gingival margin that may have frosted, plaque covered surface -cavitated, plaque covered lesion with or without exposed dentine, if dentine is exposed & soft dentine is heavily infected..	- shiny surface white or brown lesion & lesions are not plaque covered. - cavitated lesion; dark brown & hard dentine at their base, are not plaque covered & away from gingival margin.
Root surface lesion	- close to gingival margin, plaque covered. -soft or leathery consistency	- far from gingival margin, not plaque covered. -as hard as surrounding healthy root surface.

New Technologies for Caries Removal and Cavity Preparation (Minimal Invasive Dentistry)

1. **Air abrasion:** air abrasion removes tooth structure using a steam of aluminum oxide particles generated from compressed air. The abrasive particles strike the tooth with high-velocity and remove small amount of tooth structure.



Clinical application of air abrasion includes:

- Detection of pit and fissure caries.
- Removal of superficial enamel defects.
- Cleaning fissures and surface preparation for sealant preventive resin restoration.
- Small class I and V preparation.

2. **Chemo mechanical method:** this method involves the application of an isotonic solution on tooth tissue, softening the caries and facilitating its removal using specially design hand instrument. This reduces the removal of sound tooth structure, the cutting of open dentinal tubules, pulpal irritation and pain compared with conventional mechanical method. (Example is cariosolv).

3. **Laser devices:** laser devices that are capable of cutting dental hard tissues effectively and can be used for operative procedures, e.g. Er:YAG laser device, and laser-powered hydrokinetic system (LPHKS).

4. Smart bur (Smartprep):

The Smartprep bur is a polymer that safely and effectively remove decayed dentin, leaving healthy dentin intact.

The polymer instrument is self-limiting and will not cut sound dentin unless applied with great force, and then it will only wear away, rather than cut the healthy dentin. The self-limiting polymer is unlikely to mechanically expose dentinal tubules and unlikely to cause patient discomfort. In many cases, no local anesthesia is required for patient comfort.

5. Ozone treatment

The ozone delivery system is a device that takes in air and produces ozone gas. The ozone is then delivered via a hose into a disposable sterile cup. The ozone gas is refreshed in this disposable cup at a rate of 615 cc/minute changing the volume of gas inside the cup over 300 times every second. The cup forms a seal around the lesion being treated so that ozone cannot leak into the oral cavity.

Around 20-40 seconds of ozone application have been shown to penetrate through carious dentin to eliminate any live bacteria, fungi, and viral contamination. This treatment eliminates cariogenic organisms as well as priming the tissues for remineralization.

Operative Dentistry

Ass. Lec. Othman H. Alani

Lecture (6)

Dental adhesion (Enamel and Dentin Bonding)

(Agents and Techniques)

Definition

The bonding agents (dental adhesives) are resinous materials used to enable the restorative material to bond and adhere to dental tooth structures (enamel and dentin).

Requirements of Dentin Bonding Agents

1. Provide high bond strength to enamel.
2. Provide bond strength to dentin similar to that to enamel.
3. Show good biocompatibility to dental tissue, including the pulp.
4. Minimize microleakage at the margins of restorations.
5. Prevent recurrent caries and marginal staining.
6. Be easy to use.
7. Possess a good shelf life.
8. Be compatible with a wide range of resins.

Indications

1. To aids in bonding composite and even amalgam restorations to tooth structure.
2. To treat dentinal hypersensitivity.
3. For the repair of fractured porcelain, amalgam and resin restorations.
4. For pit and fissure sealants.
5. To lute crowns.
6. To bond orthodontic brackets.

Enamel Bonding

Bonding to enamel requires two clinical steps; 1) Acid etching, followed by 2) The application of the adhesive resin to the etched surface.

Usually 37% phosphoric acid is used for 15 to 30 seconds.

The goals of enamel etching are 1) to clean enamel surface from debris, 2) to increase the enamel surface area available for bonding, and 3) to partially dissolve the mineral crystallites to create retentive microporosities into which the resinous bonding agent can infiltrate and form retentive resin tags (micromechanical retention). 4) In addition, acid etching increases the surface energy and lowers the contact angle of resins to enamel.

It has been shown that optimal enamel–resin bonds could be achieved as long as the etched enamel surface was clean and free from any contamination.

• If phosphoric acid concentration is greater than 50%, then monocalcium phosphate monohydrate will get precipitated.

• If concentration is lower than 30%, dicalcium phosphate monohydrate is precipitated which interferes with adhesion.

• Deciduous teeth require longer time for etching than permanent teeth because of the presence of aprismatic enamel in deciduous teeth.

Procedure

Apply acid etchant in the form of liquid or gel for 15 to 30 seconds.

• Wash the etchant continuously with water for 10 to 15 seconds.

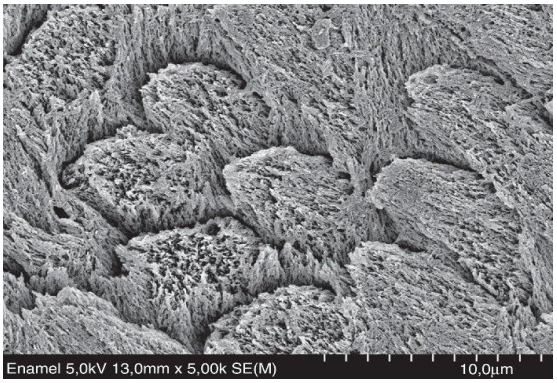
• Note the appearance of a properly etched surface. It should give a frosty white appearance on drying.

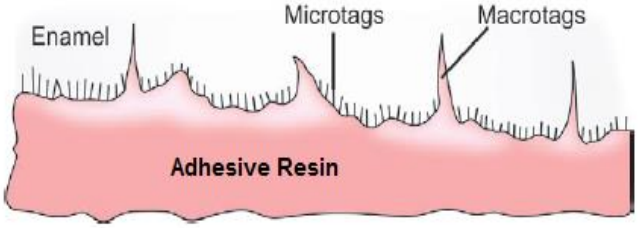
• If any sort of contamination occurs, repeat the procedure.

• Now apply bonding agent and low viscosity monomers over the etched enamel surface. Generally, enamel bonding agents contain Bis-GMA or UDMA with TEGDMA added to lower the viscosity of the bonding agent. The bonding agents due to their low viscosity, rapidly wet and penetrate the clean, dried, conditioned enamel into the microspaces forming resin tags. The resin tags which form between enamel prisms are known as Macrotags

• Finer network of numerous small tags is formed across the end of each rod where individual hydroxyapatite crystals were dissolved and are known as microtags. These microtags are more important due to their larger number and greater surface area of contact.

Micro and macrotags within the enamel surface constitute the fundamental mechanism of enamel-resin adhesion.





Enamel Etching and Bonding

Dentin Bonding

Bonding to dentin has been proven more difficult and less reliable and predictable than enamel. This is because of morphologic, histologic and compositional differences between them.

Problems Encountered During Dentin Bonding

1. Dentin contains more water than does enamel.
2. Hydroxyapatite crystals have a regular pattern in enamel whereas in dentin, hydroxyapatite crystals are randomly arranged in an organic matrix.
3. Presence of smear layer makes wetting of the dentin by the adhesive more difficult.
4. Dentin contains dentinal tubules which contain vital processes of the pulp, odontoblasts. This makes the dentin a sensitive structure.
5. Dentin is a dynamic tissue which shows changes due to aging, caries or operative procedures.
6. Fluid present in dentinal tubules constantly flows outwards which reduces the adhesion of the composite resin.

Ideally a dentin bonding agent should have both hydrophilic and hydrophobic ends. The hydrophilic end displaces the dentinal fluid to wet the surface. The hydrophobic end bonds to the composite resin.

Bonding to the inorganic part of dentin involves ionic interaction among the negatively charged group of the bonding agent (for example, phosphates, amino acids and amino alcohols, or dicarboxylates) and the positively charged calcium ions.

Commonly used bonding systems employ use of phosphates. Bonding to the organic part of dentin involves interaction with Amino (–NH), Hydroxyl (–OH), Carboxylate (–COOH), Amide (–CONH) groups present in dentinal collagen. Dentin bonding agents have isocyanates, aldehydes, carboxylic acid anhydrides and carboxylic acid chlorides which extract hydrogen from the above mentioned groups and bond chemically.

Classification of Dentin Bonding Agents

Historically, dentin bonding agents have been classified based on chemistry and the manner in which they treat the smear layer into 7 generations.

The first three generations failed to provide adequate bond strength to dentin.

Fourth Generation Dentin Bonding Agents

They were made available in the mid 1990s. Fourth generation bonding agents represented significant improvements in the field of adhesive dentistry. These agents are based on total etch technique (now it is called etch and rinse technique) and moist bonding concept.

Mechanism of Bonding

Fourth “generation” is characterized by the process of hybridization at the interface of the dentin and the composite resin. Hybridization is the phenomenon of replacement of the hydroxyapatite and water at the dentin surface by resin. This resin, in combination with the collagen fibers, forms a hybrid layer. In other words, hybridization is the process of resin interlocking in the demineralized dentin surface. This concept was given by Nakabayashi in 1982.

Components of Fourth Generation Adhesives

1. **Conditioner (Etchant):** Commonly used acids are 37% phosphoric acid, nitric acid, maleic acid, oxalic acid, pyruvic acid, hydrochloric acid, citric acid or a chelating agent, e.g. EDTA.

Use of conditioner/etchant causes removal or modification of the smear layer, demineralizes peritubular and intertubular dentin and exposes collagen fibrils.

2. **Primer:** Primers consist of monomers like HEMA (2-Hydroxyethyl methacrylate) and 4-META (4-Methacryloxyethyl trimellitate anhydride) dissolved in acetone or ethanol. Thus, they have both hydrophilic as well as hydrophobic ends which have affinity for the exposed collagen and resin respectively. Use of primer increases wettability of the dentin surface, bonding between the dentin and resin, and encourages monomer infiltration of demineralized peritubular and intertubular dentin.

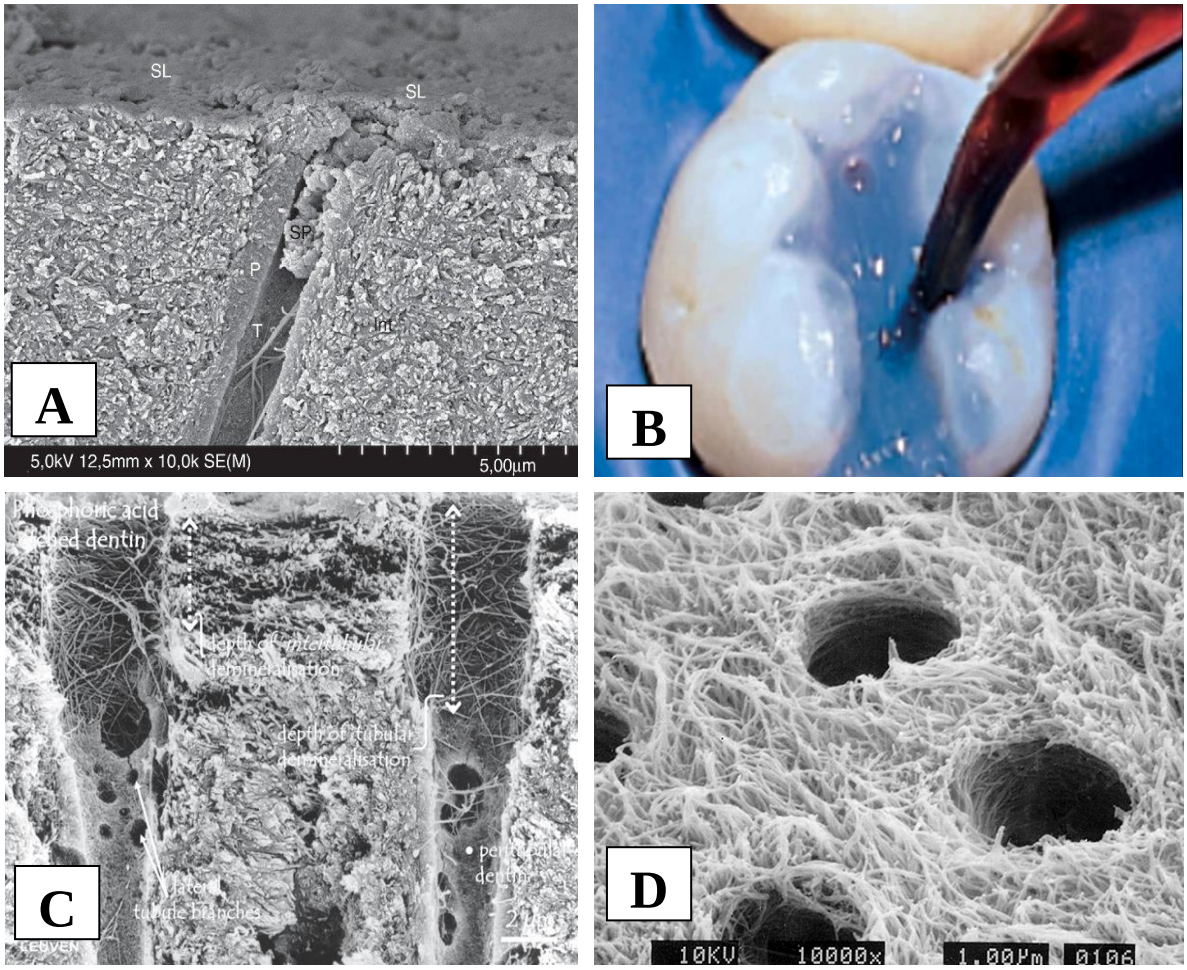
3. **Adhesive:** The adhesive resin is a low viscosity, filled or unfilled resin which flows easily and matches the composite resin. Adhesive combines with the monomers to form a resin reinforced hybrid layer and resin tags to seal the dentin tubules.

Etching of dentin results in removal of smear layer and minerals from dentin structure, exposing the collagen fibers. Areas from where minerals are removed are filled with water. This water acts as a plasticizer for collagen, keeping them in an expanded soft state. Thus, spaces for resin infiltration are also preserved.

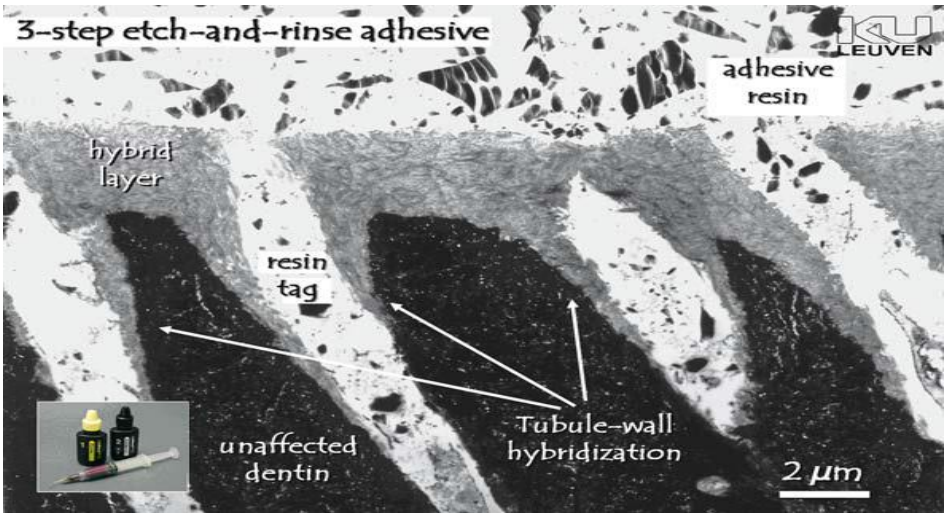
If the dentin surface is made too dry, there will be collapse of the collagen fibers of demineralized dentin. This results in low bond strength because of ineffective penetration of the adhesive into the dentin.

Primers are used to increase the diffusion of resin into moist and demineralized dentin and thus optimal micromechanical bonding. For optimal penetration of primer into demineralized dentin, it should be applied in multiple coats.

Total etch technique involves the complete removal of the smear layer by simultaneous acid etching of enamel and dentin. After total etching, primer and adhesive resin are applied separately or together.



Dentin Etching. A: prepared cavity showing smear layer SL, B: acid etching, C: demineralized dentin, D: exposed collagen fibrils.



Dentin bonding with 4th generation dentin bonding agents (etch and rinse technique)

Advantages

• Ability to form a strong bond to both enamel and dentin.
• High bond strength to dentin (17–25 MPa)
• Ability to bond strongly to moist dentin
• Can also be used for bonding to substrates such as porcelain and alloys (including amalgam).

Disadvantages

• Time consuming
• More number of steps
• Technique sensitive

Fifth Generation Dentin Bonding Agents

Fifth-generation DBAs were made available in the mid-1990s. Similar to the fourth generation, they are based on the total etch technique (a separate step of acid etching is needed). They are also known as "one-bottle" or "one-component" bonding agents. In these agents the primer and adhesive resin are in one bottle. Basic differences between fourth and fifth generation is the number of basic components of bottles.

Fourth generation bonding system is available in two bottles, one primer and other adhesive, fifth generation dentin bonding agents are available in one bottle only.

Sixth Generation Dentin Bonding Agents

These were made available in 2000. In fifth-generation, primer and adhesive are available in single bottle, and etchant in separate bottle. In sixth generation etching step is eliminated, because in sixth generation etchant and primer are available in single solution.

Most self-etching primers are moderately acidic with a pH that ranges between 1.8 and 2.5. Because of the presence of an acidic primer, sixth generation bonding agents do not have a long shelf-life and thus have to be refreshed frequently.

In these agents as soon as the decalcification process starts, infiltration of the empty spaces by the dentin bonding agent is initiated

Advantages

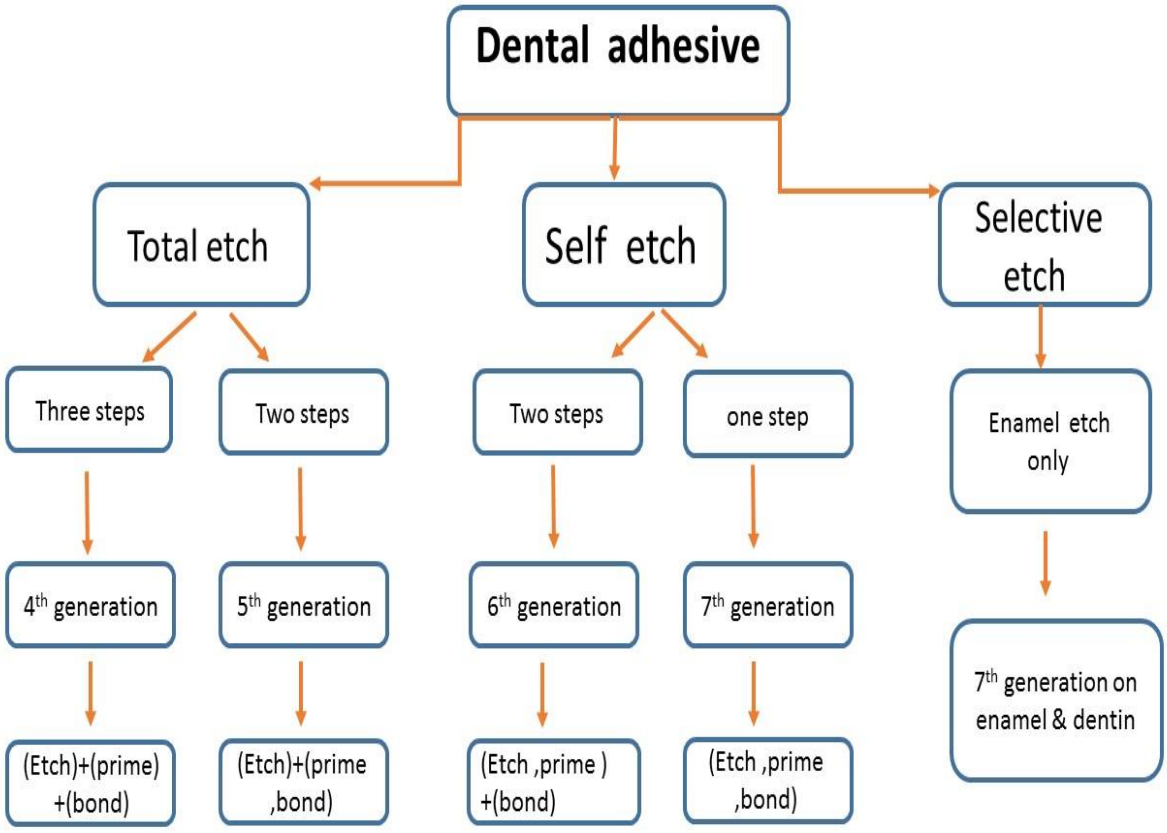
• Reduces postoperative sensitivity because they etch and prime simultaneously.
• It etches the dentin less aggressively than total etch products.
• Demineralized dentin is infiltrated by resin during the etching process.
• Since they do not remove the smear layer, the tubules remain sealed, resulting in less sensitivity.
• They form a relatively thinner hybrid layer than traditional product, which results in complete infiltration of the demineralized dentin by the resin monomers.
• Much faster and simpler technique.
• Less technique sensitive as fewe number of steps are involved for the self-etch system.

Seventh Generation Dentin Bonding Agents

They achieve the same objective as the sixth generation systems except that they simplified multiple sixth generation materials into a single component, single bottle one-step self-etch adhesive, thus minimizing the number of steps and avoiding any mistakes that could be encountered (the bottle contains all the components which are the weak acid, primer, and the adhesive).

8th generation

The term universal is being used in three main ways. One refers to the capability of these adhesives to adhere by different application methods, namely self-etch, total etch or selective enamel etch. Another is the capability to be used with all light, dual and self-cure materials. The last is the ability to adhere to all common dental substrates including direct and indirect restorations and repairs



Lecture (8)

Ass. Lec. Othman H. Alani

Posterior Composite Restoration

INTRODUCTION

Esthetic dentistry has shown much advancement in materials and technology since the last century.

The history of tooth colored restorative materials started with silicate cement in the year 1878 in England followed by self-curing acrylic resins which were developed in 1930 in Germany. Both of these materials showed poor physical properties like high polymerization shrinkage and coefficient of thermal expansion, lack of wear resistance, poor marginal seal, irritation to pulp and dimensional instability.

Bowen, in 1962 developed a polymeric dental restorative material reinforced with silica particles used as fillers. These materials were called 'composites'.

Composite is a compound composed of at least two different materials with properties that are superior or intermediate to those of an individual component.

Over the past two decades, there has been a substantial progress in the development and application of resin-based composites. Earlier composites were recommended only as a restorative material for anterior restorations, but now they have become one of the most commonly used direct restorative materials for both anterior and posterior teeth. Principal reasons for shifting from dental amalgam to composites are reduced need for preparation and strengthening effect on remaining tooth. Nowadays, composite resins are considered as an economical and esthetic alternative to other direct and indirect restorative materials.

COMPOSITION OF DENTAL COMPOSITES

1. Organic Matrix

Resin matrix represents the backbone of composite resin system. Most preferred monomers are Bis-GMA, Urethane dimethacrylate UDMA, or combination of them. Since these resins are very viscous, and in order to improve handling and to control viscosity, they are diluted with low viscosity monomers like triethylene glycol dimethacrylate (TEGDMA).

2. Fillers

Commonly used inorganic fillers are silicon dioxide, boron silicates and lithium aluminum silicates. In some composites, quartz is partly replaced with heavy metal particles like zinc, aluminum, barium, strontium or zirconium. Nowadays calcium metaphosphate is also used because it is softer than glass, so cause less wear of opposing tooth. Filler content ranges from 30% to 50% by volume and 50% to 85% by weight.

Advantages

1. Reduces the coefficient of thermal expansion
2. Reduces polymerization shrinkage
3. Increases abrasion resistance
4. Decreases water sorption
5. Increases tensile and compressive strengths
6. Increases fracture toughness
7. Increases flexure modulus
8. Provides radiopacity
9. Improves handling properties
10. Increases translucency

3. Coupling Agents: Coupling agent binds the hydrophilic filler particles to the hydrophobic organic resin. Interfacial bonding between the matrix phase and the filler phase is provided by coating the filler particles with silane coupling agents.

4. Initiator Agents: These agents activate the polymerization of composites. Most common photoinitiator used is camphorquinone. Currently most recent composites are polymerized by exposure to visible light in the range of 410 to 500 nm. Initiator varies with type of composites whether it is light cured or chemically cured.

5. Inhibitors:These agents inhibit the free radical generated by spontaneous polymerization of the monomers. For example, butylated hydroxyl toluene (0.01%).

6. Coloring Agents:Coloring agents are used in very small percentage to produce different shades of composites. Mostly metal oxides such as titanium oxide and aluminum oxides are added to improve opacity of composite resins.

TYPES OF COMPOSITES

1. Macrofilled Composite

These were developed during early 1970s. Average particle size of macrofill composite resins ranges from 8–12 μm. Filler content is approximately 60–65% by weight. It exhibits a rough surface texture because of the relatively large size and extreme hardness of the filler particles. Due to roughness, discoloration and wearing of occlusal contact areas and plaque accumulation take place quickly than other types of composites.

Advantage: Physical and mechanical performance is better than unfilled acrylic resins.

Disadvantages: Rough surface finish, Poor polishability,More wear.

2. Microfilled Composites Resins

These composites were introduced in the early 1980s. Average particle size ranges from 0.04 to 0.4 μm. Filler content is 30 to 40% by weight. Small particle size results in smooth polished surface which is resistant to plaque, debris and stains. But because of less filler content, physical properties are inferior. They are indicated for the restoration of anterior teeth and cervical lesions.

Advantages Highly polishable, Good esthetic.

Disadvantages

- Poor mechanical properties due to more matrix content
- Poor color stability
- Low wear resistance
- Less modulus of elasticity and tensile strength
- More water absorption
- High coefficient of thermal expansion.

3. Hybrid Composite Resins

Hybrid composites are composed of glasses of different compositions and sizes, with particle size diameter of less than 2 μm and containing 0.04 μm sized fumed silica. This mixture of fillers is responsible for their physical properties similar to those of conventional composites with the advantage of smooth surface texture.

Disadvantages: Not appropriate for heavy stress bearing areas , and loss of gloss occurs when exposed to toothbrushing with abrasive toothpaste.

4. Microhybrid, Nanohybrid, and Nanofill

Microhybrid composites have evolved from traditional hybrid composites. Filler content in microhybrids are 56 to 66% by volume with average particle size of 0.4 to 0.8 μm. Incorporation of smaller particles make them better to polish and handle than their hybrid counterparts.

Nanofill and nanohybrid composites have average particle size less than that of microfilled composites. Use of these extremely small fillers and their proper arrangement within the matrix results in physical properties equivalent to the original hybrid composite resins.

Advantages

Highly polishable

Tooth-like translucency with excellent esthetic

Optimal mechanical properties

Good handling characteristics.

Good color stability

Stain resistance

High wear resistance

Can be used for both anterior and posterior restorations and for splinting teeth with fiber ribbons.

Flowable Composite Resin

Flowable composites were introduced in dentistry in late 1996. Filler content is 60% by weight with particle size ranging from 0.02 to 0.05 μm. Low filler loading is responsible for decreased viscosity of composites, which allows them to be injected into small preparations.

Condensable (Packable) Composites

Condensable/packable composites have improved mechanical properties and handling characteristics. Main basis of packable composites is Polymer Rigid Inorganic Matrix Material (PRIMM). Here components are resin and ceramic inorganic fillers which are incorporated in silanated network of ceramic fibers. These fibers are composed of alumina and silicon dioxide which are fused to each other at specific sites to form a continuous network of small compartments.

Filler content in packable composites ranges from 48 to 65% by volume with average particle size ranging from 0.7 to 20 μm.

PROPERTIES OF COMPOSITE

Coefficient of Thermal Expansion

Coefficient of thermal expansion of composites is approximately three times higher than normal tooth structure. This results in more contraction and expansion than enamel and dentin when there are temperature changes resulting in loosening of the restoration. It can be reduced by adding more filler content.

Wear resistance

Composites are prone to wear under masticatory forces, toothbrushing and abrasive food. Site of restorations in dental arch and occlusal contact relationship, size, shape and content of filler particles affect the wear resistance of the composites.

Polymerization Shrinkage

Composite materials shrink while curing which can result in formation of a gap between resin-based composite and the preparation wall. It accounts for 1.67 to 5.68 percent of the total volume.

Configuration or C-factor

Cavity configuration or C-factor was introduced by Professer Carol Davidson and his colleagues in 1980s. C-factor is the ratio of bonded surface of restoration to unbonded surfaces. Higher the value of 'C'-factor, greater is the polymerization shrinkage. Three-dimensional tooth preparations (Class I and V) have the highest (most unfavorable) C-factor and thus are at more risk to the effects of polymerization shrinkage. C-factor plays a significant role when tooth preparation extends up to the root surface causing a 'V' shaped gap formation between the composite and root surface due to polymerization shrinkage.

Microleakage

It is passage of fluid and bacteria in micro-gaps (10–6 m) between restoration and tooth. It can result in damage to the pulp.

Microleakage can occur due to: 1) Polymerization shrinkage of composites, 2) Poor adhesion and wetting, and 3) Thermal stresses 4)Mechanical loading

Microleakage results in: 1) Bacterial leakage , 2) Recurrent caries, 3)Pulpal infection, and 4)Tooth discoloration.

ADVANTAGES

1. Conservation of tooth structure.
2. Esthetically acceptable
3. Low thermal conductivity: Composites have low thermal conductivity, thus no insulation base is required to protect underlying pulp.
4. Mechanical bonding to tooth structure: Restorations are bonded with enamel and dentin, hence show good retention.
5. Immediate finishing and polishing: Restoration with composite resins can be finished immediately after curing.
6. It can be repaired rather than replaced.
7. Restoration can be completed in one dental visit.
8. No galvanism because composite resins do not contain any metals.

DISADVANTAGES

1. Polymerization shrinkage.
2. Time consuming: Composites restorations require good isolation and number of steps for their placement.
3. Composites restorations are more difficult to place and are Time consuming.
4. Expensive: more expensive than amalgam.
5. Technique sensitive: It is more technique sensitive than amalgam because composite placement requires careful attention to all steps of placements.
6. Low wear resistance: Composites have low wear resistance than amalgam.

TOOTH PREPARATION

GENERAL CONCEPTS FOR TOOTH PREPARATION FOR COMPOSITE RESTORATIONS:

1. Conservation of tooth structure: Tooth preparation is limited to extent of the defect. For composite restorations, rule extension for prevention and proximal contact clearance, is not necessary unless it is required to facilitate proximal matrix placement.

2. Variable depth of pulpal and axial wall depth: Pulpal and axial walls need not to be flat.

3. Preparation of operating site: To facilitate bonding, tooth surface is made rough by using diamond abrasives.

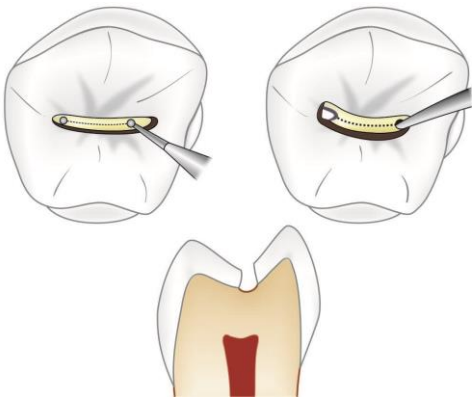
4. Enamel bevel: Enamel bevel is given in some cases to increase the surface area for etching and bonding.

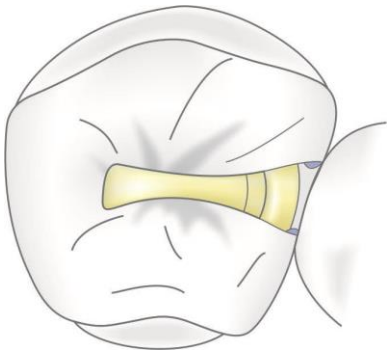
5. Butt joint on root surface: Cavosurface present on root surfaces has to be butt joint.

Designs of Tooth Preparation for Composites

1. Conventional preparation

Conventional design is similar to the tooth preparation for amalgam restoration, except that there is less outline extension and in tooth preparation, walls are made rough. Indicated in moderate to large class I or class II restorations and in preparations located on root surface.



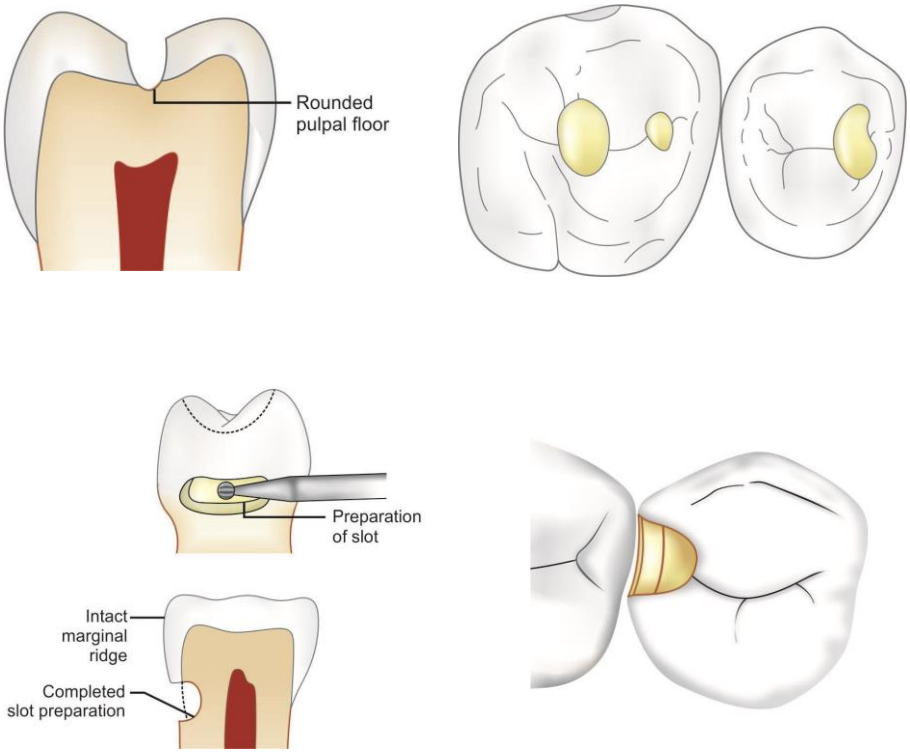


2. Beveled conventional tooth preparation

This design is almost similar to conventional design but some beveled enamel margins are incorporated. Specially indicated for classes III, IV, V and VI restorations.

3. Modified (conservative tooth preparation)

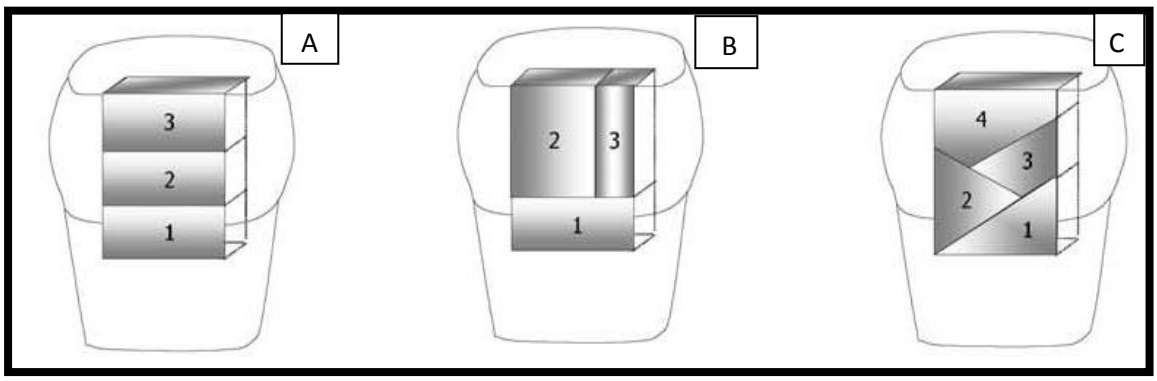
It is more conservative in nature since retention is achieved by micromechanical bonding to the tooth. It does not have specified wall configuration or pulpal and axial wall depth. Extent and depth of the preparation depends upon the extent and the depth of carious lesion. Indicated for initial or small carious lesions.



COMPOSITE PLACEMENT

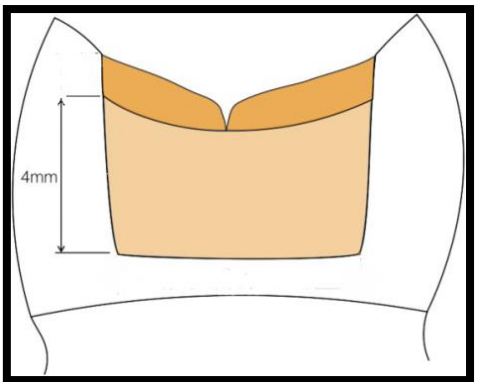
I. The Layering Technique

The incremental technique is based on polymerizing of less than 2mm thickness layers of resin based composites. This technique can help to improve marginal quality, prevent cavity wall distortion and ensure complete polymerization of composite restoration. Horizontal, vertical and oblique increments have been proposed, all have the same goal of increasing the unbonded area in each layer of composite resin, which maximizes the relaxation of polymerization stress through external flow.



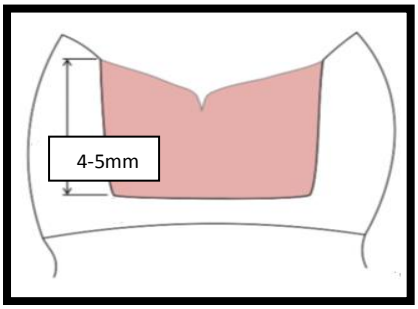
II. Two-steps amalgam-like sculpting technique (Bulk-fill flowable and regular composite)

This technique refers to the use of two types of composites with different viscosity by building the core with a flowable Bulk-fill composite in single layer up to 4 mm thickness, then the dentin core coated with a layer of the traditional composite.



III. Single-step amalgam-like sculpting technique (Bulk-fill regular composite)

This technique refers to the use of a regular consistency bulk-fill composite in one increment up to 4-5mm without addition capping layer as. Bulk-fill techniques have become broadly used as a direct posterior restoration after developing material that can be placed in single increment by improved curing efficiency and reduced polymerization shrinkage.



Final Contouring, Finishing and Polishing of Composite Restorations

For composite restorations, the amount of contouring required after final curing can be minimized by careful placement technique. Always take care to remove the some composite excess which is almost always present. Decreased need of contouring of the cured composite ensures that margins and surface of composite

restoration remain sealed and free of microcracks that can be formed while contouring.

Main objectives are to:

- Attain optimal contour
- Remove excess composite material
- Polish the surface and margins of the composite restoration.

For removal of composite excess, usually burs and diamonds are used. Surgical blade is used to remove proximal overhangs in the accessible area. For areas which have poor accessibility, composite strips can be used. Contact areas may be finished by using a series of abrasive finishing strips threaded below the contact point so as not to destroy the contact point.

Endodontics

Lecture 1 Ass. Lec. Othman H. Alani

Introduction and Scope of Endodontics

Endo is a Greek word for “Inside” and Odont is Greek word for “Tooth". Endodontic treatment treats inside of the tooth. Endodontics is the branch of clinical dentistry associated with the prevention, diagnosis and treatment of the pathosis of the dental pulp and peri-radicular tissue.

OBJECTIVE OF ENDODONTIC TREATMENT

The primary objective of endodontic therapy is to create a biologically acceptable environment within the root canal system which allows the healing and continued maintenance of the health of the peri-radicular tissue. This objective can be achieved by eliminating the bacteria (source of infection) from within the root canal system, and sealing the root canal and tooth to prevent re-infection. Since nothing is as good as the natural teeth, one should take care of them.

The endodontic therapy is a necessary treatment to cure a damaged or diseased tooth. Endodontics has been defined as art as well as science of clinical dentistry because in spite of all the factual scientific foundation on which the endodontics is based, to provide an ideal endodontic treatment is an art in itself.

Endodontic treatment encompasses procedures that are designed to maintain the health of all or part of the dental pulp. When the dental pulp is diseased or injured. treatment is aimed at preserving normal peri-radicular tissues. When apical periodontitis has occurred treatment is aimed at restoring the peri-radicular tissues to health: this is usually carried out by root canal treatment, occasionally in combination with surgical endodontics.

SCOPE OF ENDODONTICS

Scope of endodontics includes following:

a. vital pulp therapy (pulp capping, pulpotomy) .

b. Diagnosis and differential diagnosis of oro-facial pain.

c.Root canal treatment of teeth with or without periradicular pathology of pulpal origin.

d. Surgical management of pathology resulting from pulpal pathosis.

e.Management of avulsed teeth (replantation)

f.Root end resections, hemisections and root resections

g.Retreatment of teeth previously treated endodontically

h.Bleaching of discolored teeth.

i.Coronal restorations of teeth using post and cores

INDICATIONS FOR ROOT CANAL TREATMENT

Root canal treatment may be carried out on all patients where other dental procedures may be undertaken. Specific indications are

1. An irreversibly damaged or necrotic pulp with or without clinical and/or radiological findings of apical periodontitis.

2. Elective devitalization, e.g. to provide post space, prior to construction of an overdenture, doubtful pulp health prior to restorative procedures, likelihood of pulpal exposure when restoring a (misaligned) tooth and prior to root resection or hemisection.

CONTRAINDICATIONS FOR ROOT CANAL TREATMENT

1 . Teeth that cannot be made functional nor restored.

2. Teeth with insufficient periodontal support.

3. Teeth with poor prognosis, uncooperative patients or patients where dental treatment procedures cannot be undertaken.

4. Teeth of patients with poor oral condition that cannot be improved within a reasonable period.

ANATOMY OF DENTAL PULP

Pulp lies in the center of tooth and shapes itself to miniature form of tooth. This space is called pulp cavity which is divided into a pulp chamber and root canal/s starting from the orifice to the apical foramen. There are also accessory and lateral canals. The roof of pulp chamber consists of dentin covering the pulp chamber occlusally. Canal orifices are openings in the floor of pulp chamber leading into the root canals. The shape of root canal varies with size, shape, number of the roots in different teeth.

FUNCTIONS OF PULP

Pulp performs four basic functions:

. 1. Formation of dentine

2. Nutrition of dentine

3. Innervation of tooth

4. Defense of tooth

ROOT CANAL CONFIGURATION

The shape of root canals is divided into four types:

Type 1: A single canal leaving the pulp chamber and continuing as a single canal to the root apex and opens in a single apical foramen. It refers to 1-1-1

Type 2: Two canals leave the pulp chamber then join each other at the apical third to open in a single apical foramen. It refers to 2-1 -1

Type 3: Two canals leave the pulp chamber and continue as two canals to be opened in two separate apical foramina. It refers to 2-2-2

Type 4: A single canal leaving the pulp chamber, and bifurcating at the apical third into two canals and open in two apical foramina. it refers to 1-2-2 .

***Lateral canal:** Is a canal that is located approximately at right angle to the main root canal. Lateral canals are clinically significant; like the apical foramen, they represent pathways along which disease in the pulp may extend to periradicular tissues and occasionally allow disease in periodontium to extend to the pulp.

***Accessory canal:** Is one that branches off from the main root canal, usually located somewhere in the apical region of the root.

Accessory and lateral canals connect the pulp to the periodontal tissue, but many of these canals are sealed by cementum and/or dentin, however many remain viable which make them a source of spread of infection even after successful debridement of the main canal. Accessory canals can be exposed by removal of cementum during scaling and root planning, which establishes a communication between the oral cavity and the pulp, which can lead to necrosis

***Apical foramen:** It is a foramen at the apex of each root through which blood vessels, nerves and lymphatic that supply the pulp enter. The location and the shape of the apical foramen may undergo changes as a result of functional influence on the teeth.

BASIC PHASES OF TREATMENT

There are three basic phases of treatment:

1-The Diagnostic phase in which the disease to be treated is "determined "and the treatment plan developed.

2-The Preparatory phase in which the contents of the root canal are removed and the canal is prepared to receive a filling material.

3- The obliteration Phase in which the canal is filled or obliterated with an inert material to obtain an adequate seal as close as possible to C.D.J. (cementodentinal junction).

If there is a defect in any phase, the endodontic treatment will not be succeeded.

Who performs an endodontic therapy ?

Generally, all dentists receive basic education in endodontic treatment but an endodontist is preferred for endodontic therapy. General dentists often refer patients needing endodontic treatment to endodontists.

Why does patient Feel Pain?

When pulp becomes infected. it causes increased blood flow and cellular activity, and pressure cannot be relieved from inside the tooth. This causes pain. Pulp can even die without causing significant pain; it may depend on pain threshold and pain reaction of the patient.

How can You Tell if Pulp is infected?

when pulp gets inflamed, it may cause toothache on taking hot or cold, spontaneous pain, pain on biting or on lying down. On occasion a damaged pulp is noticed by drainage, swelling, and abscess at the root end (Fig. 2). Sometimes, however, there are no symptoms,

Why does patient Need Root Canal Therapy

Because tooth will not heal by itself, the infection may spread around the tissues causing destruction of bone and supporting tissue. This may cause tooth to fall out. Root canal treatment is done to save the damaged pulp by thorough cleaning and shaping of the root canal system and then filling it with gutta-percha (rubber like) material to prevent reoontamination of the tooth. Tooth is permanently restored with crown with or without post.

What are Alternatives to Root Canal Therapy ?

If tooth is seriously damaged and its support is compromised, then extraction is only alternative.

What is Root Canal Treatment Procedure?

Once the endodontic therapy is recommended, your endodontist will numb the area by injecting local anesthetic. After this a rubber sheet is placed around the tooth to isolate it. Then the opening is made in the crown of the tooth and very small sized instruments are used to clean the pulp from pulp chamber and root canals (Fig. 2). After thorough cleaning and shaping of root canals (Fig. 3), they are tilled with rubber like material

called guttapercha. which will prevent the bacteria from entering this space again (Figs 4 and 5). After completion of endodontic therapy, the endodontist places the crown or other restoration so as to restore the tooth to full function (Fig. 6).

Will the Tooth Need An Special Care or Additional Treatment after Endodontic

Treatment?

Patient should not chew or bite on the treated tooth until the patient has had a tooth restored

by the dentist. The non-restored tooth is susceptible to fracture. so patient should visit the

dentist for a full restoration as soon as possible not more than one month. Most endodontically treated teeth last as long as other natural teeth. In a few cases, a tooth that has undergone endodontic treatment does not heal or the pain continues. Occasionally, the

tooth may become painful or diseased months or even years after successful treatment. Often when this occurs. re-treating the endodontic procedure can save.

Can All Teeth be Treated Endodonticall ?

Most of the teeth can be treated endodontically. But sometimes when root canals are not accessible, root is severely fractured, tooth cannot be restored or tooth doesn’t have .sufficient bone support it becomes difficult to -.-treat the' tooth endodontlcally However; ‘. :I: advances In endodont‘cs ‘ar'e Fnaklng "tt possible sz" save the teeth that evena few years agowould have been lost. NeWer researches, techniques and materials have helped us to perform the endodontic therapy in better way with more efnciency Since Introduction of rotary instruments and other technologies reduce the treatment time the concept of single VISIt IS gaming popularity nowadays. It has been shown that success of endodontic therapy depends on the quality of root canal treatment and not the number of vusnts In the modem world, single visit endodontics is becoming quite popular.

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Endodontics

Lecture 2 Ass. Lec. Othman H. Alani

PULP AND PERI-RADICULAR PATHOLOGY

Etiology of pulpal diseases can be broadly classified into:

I. Bacterial irritant

Bacteria, usually from dental caries, are the main source of injury to the pulpal and periradicular tissues and they enter either directly or through dentine tubules.

Modes of entry for bacteria to the pulp are as follows:

1-Through the carious cavity.

2-Through the dentinal tubules as in contamination during cavity preparation, through exposed root surface, and surfaces with erosion, abrasion and attrition.

3-Through the apical foramen as in advanced periodontitis where microorganisms reach the apical foramen and then the pulp.

4-Through the blood stream (anachoresis: it is a process by which microorganisms get carried by the bloodstream from another source localize on inflamed tissue). Following trauma or inflammation to the pulp any bacteria in the blood might be attracted to the pulp causing pulpitis.

5-Through faulty tooth restoration.

6-Through extension of a periapical infection from adjacent infected tooth.

Bacteria most often recovered from infected vital pulps are:

.Streptococci

.Staphylococci

. Diphtheroids, etc.

II. Mechanical irritants

Examples of mechanical irritation include trauma. operative procedures, excessive orthodontic forces, subgingival scaling and overinstrumentation using root canal instruments.

Ill. Chemical irritants

Pulpal irritation may result from bacterial toxins or some restorative materials/conditioning agents.

Peri-radicular_ irritation may occur from irrigating solutions, phenol-based intra-canal medicaments orextrusion of root canal filling materials.

IV. Radiation iniury to pulp

Radiation therapy affect pulps of fully formed teeth in patients exposed to radiation therapy. The pulp cells exposed to ionizing radiation may become necrotic, there may occur vascular damage and the interference in mitosis of cells.

Classification of Pulp Disease

Diagnosis of pulp disease is usually based on patient symptoms and clinical findings. Pulpal disease may result in changes to both the soft and hard tissues.

❖ **Soft tissue changes**

- **Reversible pulpitis (Pulpal Hyperaemia):** It is a transient condition that may be precipitated by any insult (ex. caries) to the pulp and characterised by increase in vascular vasodilation.

The symptoms are usually:

- Pain needs an external stimulus and it subsides immediately after removal of stimulus.
- Pain is difficult to localise (as the pulp does not contain proprioceptive fibers).
- Normal periradicular radiographic appearance.
- Teeth are not tender to percussion but sensitive to cold stimulus.

Treatment involves covering up exposed dentine, removing the stimulus or dressing the tooth.

- **Irreversible pulpitis:** Irreversible pulpitis usually occurs as a result of more severe insults than in the reversible pulpitis. it may develop as a progression from a reversible state.

1) Acute pulpitis: The pulp experiences increased inflammatory process and intrapulpal pressure. The symptoms experienced are:

- Severe pain develops spontaneously or from stimuli which may last from minutes to hours.
- Heat stimulus increases pain due to expansion of blood vessels therefore increasing pressure in the pulp.
- Cold stimulus decreases pain due to contractile action on the blood vessels therefore lowering intrapulpal pressure.
- Not tender to percussion and normal radiographic apical region
- A widened periodontal ligament may be seen radiographically in the later stages.

Treatment involves either root canal therapy or extraction of the tooth.

2) Chronic pulpitis: After the acute phase the pulp might enter the chronic phase. The symptoms experienced are:

- Mild to moderate intermittent pain may be tolerated by the patient for long period of time.
- Thermal tests are of little value.
- Tenderness to percussion and radiographic changes are not seen until infection reaches the periapical region.

Treatment involves either root canal therapy or extraction of the tooth.

- **Hyperplastic pulpitis:** Hyperplastic pulpitis is a form of irreversible chronic pulpitis and is also known as a pulp polyp. It occurs as a result of proliferation of chronically inflamed young pulp tissue. Treatment involves root canal therapy or extraction.

Pulp necrosis: Pulp necrosis occurs as the end result of irreversible pulpitis; **treatment** involves root canal therapy or extraction.

❖ **Hard tissue changes**

Pulp calcification: Physiological secondary dentine is formed after tooth eruption and the completion of root development. It is a condition in which hardening. or calcification. of pulp tissue results in hypersensitivity and extreme pain because the dental nerves become compressed. A root canal is usually necessary to clear away hardened tissue. Pulp calcification is deposited on the floor and ceiling of the pulp chamber rather than the walls and with time can result in occlusion of the pulp chamber. Pulp calcification may be composed of irregular dentine (true denticle) or due to ectopic calcification of pulp tissue (false denticle). Tertiary dentine is laid down in response to environmental stimuli as reparative dentine where it is deposited directly beneath the path of injured dentinal tubules as a response to strong noxious stimuli. Treatment is dependent upon the pulpal symptomst

Internal resorption: Internal resorption is initiated within the pulp cavity and results in loss of substance from dentinal tissue. Occasionally, pulpal inflammation may cause changes that result in dentinoclastic activity. Such changes result in resorption of dentine; clinically, a pink spot may be seen in the later stages if the lesion is in the crown. Radiographic examination reveals a radiolucency that is seen to be continuous with the rest of the pulp cavity. Root canal therapy will result in arrest of the resorptive process; however, if destruction is very advanced extraction may be required.

External resorption: External root resorption is not a pulp dystrophy for its origin lies within the tissue of the periodontal membrane space. It is the removal of the mineralized and organic components of dental tissues by clastic cells. In the case of external root resorption, this may be a response that may occur following trauma or orthodontic tooth movement and is called **physiological root resorption**. All other forms of external root resorption are **progressive** and **are called Inflammatory (infective) root resorption** and usually results from luxation injury and is caused by the transmission of bacterial toxins from a devitalized and infected pulp via dentinal tubules to an external resorbed root surface.

Clastic cells are stimulated to the region by inflammatory mediators. A diagnosis of **inflammatory root resorption**, which is characterized radiographically by bowl-like radiolucencies in both the tooth and the adjacent bone, is also diagnostic of an infected and probably totally necrotic pulp.

Treatment: Early root-canal debridement and medication with calcium hydroxide paste is recommended.

Classification of periapical disease

Untreated pulpal infection leads to total pulp necrosis. If left untreated, irritants leak into periapical region forming periapex pathologies. Severity of periapical inflammation is related to microorganisms in root canals and the length of exposure to infecting microorganisms.

Acute apical periodontitis AAP

Acute apical periodontitis is defined as painful inflammation of the periodontium because of occlusal trauma, egress of bacteria from infected pulps, toxins from necrotic pulps, chemicals, irrigants or over instrumentation in root canal therapy. Clinically, the tooth is tender to biting. The distinctive features of AAP are dull throbbing constant pain, it occurs over a short period of time. Cold stuff may relieve pain, whereas heat may exacerbate pain. Widening of the periodontal ligament space may be seen on a radiograph.

Treatment depends on pulpal diagnosis it may range from occlusal adjustment to root canal therapy or extraction.

Chronic apical periodontitis

Chronic apical periodontitis occurs because of pulp necrosis. Affected teeth do not respond to pulp sensitivity tests. Tenderness to biting is usually mild however, some tenderness may be noted to palpation over the root apex, radiographic appearance is varied ranging from minimal widening of the

periodontal ligament space to a large area of destruction of periapical tissues. Treatment involves root canal therapy or extraction.

Condensing osteitis

Condensing osteitis is a variant of chronic apical periodontitis and represents a diffuse increase in trabecular bone in response to irritation. Radiographically, a concentric radio_ opaque area is seen around the offending root. Treatment is only required if symptoms/pulpal diagnosis indicate a need.

Acute apical abscess

It is a localized collection of pus in the alveolar bone at the root apex of the tooth, following the death of pulp with extension of the infection through the apical foramen into periradicular tissue. The most common cause of Acute Apical Abscess is invasion of bacteria from necrotic pulp tissue. Symptoms vary from moderate discomfort or swelling to systemic involvement, such as raised temperature and malaise. Teeth involved are usually tender to both palpation and percussion. The tooth is non vital and the pain is being of rapid onset with Readily localized as tooth becomes increasingly tender to percussion.

Radiographic changes are variable depending on the amount of periradicular destruction already present; however, usually there is a well-defined radiolucent area. As in many situations, an acute apical abscess is an acute exacerbation of a chronic situation. Initial treatment of an acute apical abscess involves removal of the cause as soon as possible. Drainage should be established either by opening the tooth or incision into a related swelling. An antibiotic may need to be prescribed, depending on the patient's condition. Once the acute symptoms have subsided, then root canal therapy or extraction may be performed. If the apical abscess is not treated, it will spread to surrounding tissues

Chronic apical abscess

Chronic periapical abscess is also known as suppurative apical periodontitis, which is associated with gradual egress of irritants from root canal system into periradicular area leading to formation of an exudate. In a chronic apical abscess, the abscess has formed a communication through which it discharges. Such communications may be through an intraoral sinus or, less commonly, extraorally. Alternatively the discharge may be along the periodontal ligament; such cases resemble a periodontal pocket. Usually these

communications or tracts heal spontaneously following root canal therapy or extraction.

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ENDODONTICS

Lecture: 3 Ass. Lec. Othman H. Alani

Access Opening

Access opening is the cavity that is prepared in the crown of a tooth to obtain adequate and direct access (straight line access) to the apical foramen to ensure free movement of the instruments during pulp extirpation. preparation and obturation of the root canal. Preparing the endodontic access cavity is a critical step in a series of procedures that potentially leads to the three-dimensional obturation of the root canal system. Access cavities should be cut so the pulpal roof, including all overlying dentin is removed.

Objectives of Access Opening

1) To facilitate visualization of all the root canal orifices by removing the pulp chamber and exposure of pulp horns.

2) To provide direct access (straight-line access) to the apical portion of the canal.

3) Conserve sound tooth structure as much as possible to avoid weakening of remaining tooth structure. The outline form of the access cavity must be correctly shaped and positioned according to:

l. The size of the pulp chamber.

II. The shape of the pulp chamber.

Ill. The number of individual root canals and their direction of curvature.

The outline form is affected by the size of the pulp chamber, so access opening for young patients is larger, because the pulp chamber is larger. while in old patients the pulp chamber is smaller.

The finished outline should reflect accurately the shape of the pulp chamber. E.g. in premolars the pulp chamber is oval in cross section so the access opening is oval, elongated buccolingually than mesiodistally (following the pulp chamber shape). Sometimes a modification is needed to get the objective of access opening.

The number of individual root canals and their curvature modifies the outline of the access opening. Sometimes we have to remove part of a cusp of a molar or incisal ridge in order to facilitate better visualization to the root canals.

The dentist must be able to see, locate and reach by the instruments each root canal.

Shape of access openings for each anterior tooth

1-Maxillary Central lncisor: The access opening is triangular. The root is straight, single, large, oval at the beginning, then tapered until it becomes rounded apically. **Average tooth length=22.5mm**

2-Maxilla Lateral Incisor: Similar in shape to the max. central incisor, but smaller in size with: disto-palatal curvature at the apex of the root. **Average tooth Length = 21mm**

3-Maxillary canine: the canal is big and it is wider buccolingually than mesiodistally. At the cervical third the orifice is oval, at the middle third: it is oval.. and in the apical third it is rounded. **Average length=26.5mm**

4-Mandibular Incisors: If we take an x-ray from buccal direction we will had small tiny root canal. But if we take an x-ray film from mesial or distal direction, we will fund large, wide pulp “labio-lingually" with a possibility of two canals one labially and the second one is located lingually, so we have to widen the root canal orifIce “Labiolingually”. **Average length=21mm**

In addition, in the lower incisor, sometimes we have slight curvature in the root apex “to the lingual side” so; there is a possibility of perforation during instrumentation.

5-Mandibular Canine: There is one canal, which is big, and oval in shape, Another root canal may be present lingually to the major root canal but this rarely happens. **Average length=22.5mm**

Access opening of each posterior tooth

1-Maxilla first premolar

Access opening: ovoid and elongated buccopalatally. **Average length=21mm**

The canal shape is wide in buccopalatal direction at cervical portion slight ovoid at mid-root and rounded at apical third.

Canal Orifices: below and slightly central to cusps tips. Multiple canal possibilities

(i) 20% single canal in single root, elliptical or figure (8) in shape. wider buccopalatally than mesiodistally. It may be mistaken as two canals.

(ii) 80%: two canals, either single root with either one or two apical foramenae, or two canals with two separated roots “and the palatal one is longet".

(iii) Rarely there are (3) roots with (3) root canals.

2-Maxillam Second Premolar

- Mostly it has a single root and the‘canal shape is ovoid and very wide in buccopalatal direction, ovoid in the mid root, and rounded in the apical area. **Average Length=21.5mm**

-Canal orifice is centrally located and often appears as a slot than as a single ovoid opening.

-Multiple canals possibilities: 40%= 2 canals, 60% = one canal.

3-Mandible First Premolar:

Mandibular first premolar has well developed buccal cusp and a small lingual cusp, the root is more rounded than mandibular second premolar and shorter. The pulp chamber is ovoid and buccal pulp horn higher. **Average length=21.5mm**

-Canal shape: At cervical level is wide in buccolingual dimension. At the mid-root area it is ovoid and at the apical third it is rounded.

-Canal configuration possibilities: Type I = 73.5%, Type II = 6.5%, Type III =19.5% We may also see Type IV.

-Access opening: ovoid and made slightly buccally to the central groove and the final preparation should have a slightly lingual inclination.

4-Mandibular second Premolar:

It has a well developed buccal cusp and much less formed lingual cusp. There is a one root canal, and the pulp chamber is gradually merging with root canal. **Average length=22.5mm**

Canal orifice:

a-At cervical wide in buccolingual dimension.

b-Mid-root level > elongated ovoid.

c-Apical third level > generally round.

5-Maxillaty 1st molar

-There are three roots, with three root canals mesiobuooal distobucoaLand palatal canal which IS the biggest one. **Average length=21mm**

-The final preparation of the access opening is triangular in shape and there are three canals:

a-Mesiobuccal canal: It is a tiny canal, difficult to tind. It is possible to fInd another mesiobuccal canal (70%) lingual to the main one.

b-Distobuccal canal: It is toward the distopalatal side.

c-The palatal canal: It is in between.

6-Maxilla 2nd Molar

-Similar to max. 1“t molar but the distobuccal canal is located in between the mesiobuccal canal and palatal canal and slightly distally. **Average length=20mm**

-Variations: We may have two canals: one buccally and one palatally instead of three canal, in this case the two canals are large in size and opposite to each other.

7-Mandibular1" Molar

-There are three canals, 2 mesially “mesiobuccal and mesiolingual” and one located distally. **Average length=21mm**

-We start preparation in mesial part of the tooth and access opening is triangular, rectangular in shape.

-There is a possibility of 2 canals located distally (33%) “and they may end with separate orifices or joined orifice so if the distal canal is tiny and more toward the buccal side then the possibility of 2 canals is high but if it is in the center buccolingually then the possibility of one canal is high.

8-Mandibular 2nd Molar

-The access opening resembles that of the mand.1“molar with 3 root canals, 2 mesially and 1 distally. **Average length=20mm**

-There is a possibility of 2 canals: mesial canal and distal canal with each canal opposite to other.

NOTE:

Currently, new concepts in endodontic access opening have been developed namely Ninja access opening in order to preserve the amount of tooth structure during root canal treatment procedure. Ninja access opening is one of the important steps towards improving the quality of root canal treatment as well as achieving “a minimally invasive endodontic" concept.

Minimal invasive endodontics: is paramount, even for preparing endodontic access cavity, as removing as little tooth structure as possible allowing us to maintain as much tooth strength as possible. Thus, improving fracture resistance of endodontically treated teeth.

Access Opening Preparation

Guidelines for access cavity preparation:

1) Study the preoperative radiograph: It gives information about the size, shape, number and curvature of the root canals and roots. One should check the depth of preparation by aligning the bur and handpiece against the radiograph.

Preoperative radiograph can help to note the position and depth of pulp chamber

2) Excavate all the carious lesions: No caries should be left in the tooth, because microorganisms of the carious lesion may be introduced inside the canal and infection might occur.

3) Replace any defective filling: The defective filling should be replaced before beginning the access opening because it will not ensure proper seal of the tooth.

4) Remove unsupported tooth structure: Any weak tooth structure might fracture that

causes loss of the seal of the tooth and the reference point which changes the length of the tooth.

Burs used for access cavity preparation

Access openings burs: they are round burs with 16mm bur shank.

Access refining burs: these are coarse flame-shaped, tapered round and diamonds for refining the walls of access cavity preparation

Procedure of Access opening for Anterior Teeth:

1) Entrance is always gained through the lingual surface of all anterior teeth. The initial penetration is prepared in the exact center of the tooth above the cingulum (in the center of the middle third).

2) The initial entry in the enamel is done by a round bur no. 4 operated at a right angle to the palatal surface of the tooth. The guide for enamel penetration is that only the head of the round bur no. 4 should enter the tooth.

The direction of the bur is changed to be parallel to the long axis of the tooth, and drill until the entrance to the pulp chamber. We can know that we reached the pulp chamber when we feel a fall in the resistance to the bur, the bur falls into a space, which is the pulp.

3) Remove the roof of the pulp chamber by working from inside the chamber towards the outside of the chamber (pulling motion).

4) Lingual shoulder is removed by moving the bur from inside towards the outside to give a continuous smooth flaring preparation. Lingual shoulder is a convexity inside the pulp chamber.

5) Finishing and funneling with a fissure bur. The final shape funnels down to the orifice of the canal and flare outwards.

6) Extirpate the pulp by introducing an instrument called the barbed broach in the root canal and by outward movement the barbed broach will catch the pulp and remove it from the root canal.

7) lrrigation of the pulp chamber.

The pulp horns should be eliminated with a round bur no. 2 used laterally and incisally, because if they remain, remnants of necrotic tissue would cause discoloration to the anterior teeth.

Procedure of Access Opening for Premolars:

1) Access is always gained through occlusal surface of all posterior teeth at the center of the central groove. Initial penetration is made parallel to the long axis of the tooth into the exact center of the central groove.

2) A round bur no. 2 or 4 is used to open into the pulp chamber.

3) The bur will be felt to drop it the pulp is reached.

4) We extend into the cavity bucco-lingually by removing the roof of the pulp chamber, working from inside the cavity to the outside (pulling motion).

5) Finishing the cavity walls is done with a fissure bur. The final access opening would be ovoid in shape buccolingually which reflects the anatomy of the pulp chamber and position of the buccal and lingual canal orifices. The pulp chamber of the lower premolars is buccally located rather than lingually so we start access opening and push more buccally.

Access for upper premolars: There are 2 canals, the buccal canal is approached palatally and the palatal canal buccally.

* Floor of the pulp chamber should not be reached.

Anomalies of pulp cavities:

We have certain anomalies which interfere with root canal treatment ex: calcification or complete obliteration of root canal, open apecies, pulp chamber with root canal etc...

1-Dentinogenesls imperfecta: There is a small pulp chamber with root canal obstruction.

2-Hyperparathyroidism: There is a calcafied pulp chamber and loss dura.

3-Hypofunction of pituitary gland: There is a retarded eruption of the teeth and the apecies of the root will be opened.

4-Dentinal dysplasia: There is an obliteration of the pulp chamber and the root formation is defected.

5-Shell teeth: The pulp chamber is quite big with short root.

6-Dense invagination: There is an improper shape of root canal.

Errors in Access Ogening:

1-Perforation: It is common when drilling is continued apically or laterally after we reach the pulp chamber. it is mostly see in

a) Old patients. It is due to pulp recession.

b) Teeth restored by crowns, inlays or big restorations. It is difficult to know the long axis of the tooth so it is better to remove the restoration and work.

d) Tilted teeth. Failure to complete a convenient extension.

2-Cutting more apically: it will lead to flattening of the floor of the pulp chamber and this will weaken the tooth structure which will cause

a) Losing the tunneling shape of the canal orifice.

b) Perforation into the lam.

c) Gauging: Going laterally in the access opening.so the wall of the cavity will not continue with the wall of the root canal.

3-Narrow access opening. This will cause incomplete pulp extirpation and instrumentation through the pulp chamber or pulp horn. This is identified by:

a) Sever bleeding.

b) Change of the color of the floor dentin, to dark blue.

c) Anatomical land marks of the floor of pulp chamber, which are convex floor and presence of grooves connecting the canal orifices, are not seen clearly.

d) If a probe is placed in the pulp chamber and pulled against the walls and it catches in the pulp chamber then there is still roof of the pulp chamber, therefore indicating presence of remnants of pulp tissue.

4) Entrance through labial surface. This is sometimes performed due to severe crowding or caries in labial surface. or proximal surface if the adjacent tooth is missing. This type of access opening causes incomplete pulp extirpation.

5) Extended access opening preparation: This access opening causes undermining and weakening of the enamel walls.

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