CROWN AND BRIDGE

Lecture: 5 **Dr. Farid**

BITE REGESTRATION AND ARTICULATION

To fabricate fixed partial denture according to the patient's occlusion, the working cast plus the opposing cast should be mounted to an articulator.

Interocclusal record (bite registration):

To transfer the relation between the upper and the lower dental arch from the patient mouth to the articulator we need bite registration.

Proper interocclusal record is important to orient the die or dies of the same arch to the opposing arch.

When enough teeth are present in both upper and lower arches we can transfer the relation by hand articulation of the cast. (No bite record is needed in such case). So we can occlude the opposing casts by hand then mount them on the articulator, however, if the remaining teeth are insufficient to produce hand articulation of the cast we have to record the bite by:

1- Pink base plate wax.

2- Bite registration paste.

3- Bite rim or occlusal rim.

How to record?

Whatever the material used to record the relation, you have to guide the mandible to the required relation (centric or eccentric).

JAW MANIPULATION

Accurately mounted casts depend on precise manipulation of the patient's mandible by the dentist.

The Bi-manipulation Technique is recommended as a reproducible technique in this technique, the dental chair is reclined and the patient's head is cradled by the examiner. With the both thumbs on the chin and the fingers resting firmly on the inferior border of the mandible, the examiner exerts gentle downward pressure on the thumbs and upward pressure on the fingers, manipulating the condyle-disk assemblies into their fully seated positions in the mandibular fossae. Next, the mandible is carefully hinged along the arc of terminal hinge closure. The most widely used material to record the occlusal relation pink base plate wax.

Then the record is taken by softening the wax at first, then applies the soft wax over the occlusal surface of the prepared teeth, then, ask the patient to bite on it, keeping in your mind that you have to guide the mandible of the patient to the reference point that you mark it, to have the correct registration.

The patient is asked then to mold the wax at the lingual area by his tongue, while by your finger adapt the wax on the labial side. After complete setting remove it from the patient mouth, trim the excess and attach it to the cast and transfer it to the articulator.

Bite rim: used if we have free end saddle, in this case there are insufficient teeth to provide bilateral stability, obtaining a centric record as described may not be possible. As a result, acrylic resin record bases must be fabricated. To avoid errors caused by soft tissue displacement. So we use bite rim over the record base to record the centric relation (the same as that used for removable partial denture).

Articulator selection

Handheld casts can provide information concerning alignment of the individual arches but do not permit analysis of functional relationships. For an analysis, the casts need to be attached to an articulator.

- It is a mechanical device that simulates mandibular movement. Articulators can simulate the movement of the condyles in their corresponding fossae

CLASSSIFICATION OF THE ARTICULATORS

They are classified according to how closely they can reproduce mandibular border movements. The aim is to create fixed partial denture in functional harmony with the patient's occlusion, also less time will be needed for adjustments at delivery

Small nonadjustable articulators (simple hinge articulator)

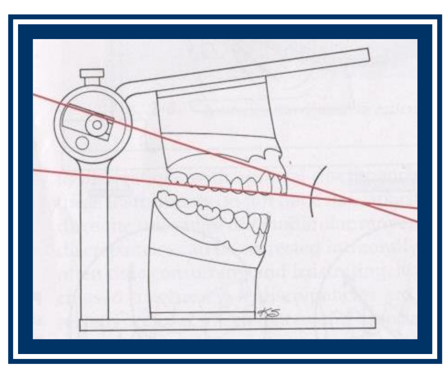
- Permit hinge opening only.
- Some types provide very limited lateral movements.
- The distance between the teeth and the axis of rotation is shorter than in skull, loss of accuracy.

Semi adjustable articulator
Used for most routine fixed partial dentures.
They are about the same size as the anatomic structures they represent.

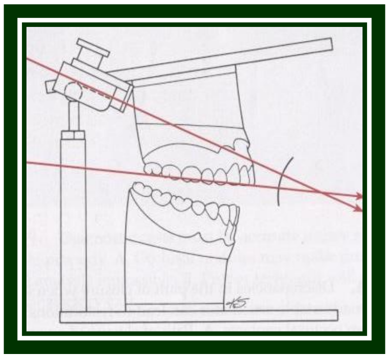
Semi adjustable articulator classified into:

A- NONARCON DESIGN.

- Mostly used for complete denture.
- The condylar elements are placed on the upper portion of the Articulator. As consequences of their design, certain inaccuracies occur in cast restorations.



B- ARCON DESIGN



- The condylar spheres are attached to the lower component of the articulator and the mechanical fossae are attached to the upper member of the instrument. Thus, the arcon articulator is anatomically correct, which makes understanding of mandibular movements easier
- The angulations of mechanical fossae are fixed relative to the occlusal plane of the maxillary cast

•The Mechanical fossae can be adjusted to mimic the movements of the mandible through the use of inter occlusal Records.

FULLY ADJUSTIBLE ARTICULATOR

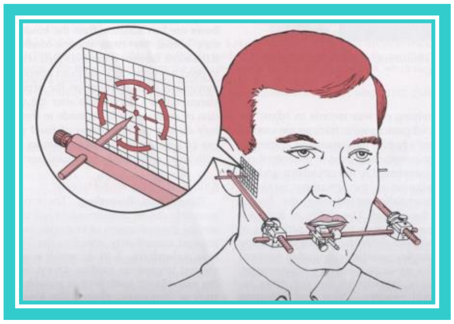
- Give a wide range of positions that can be set to follow the patient's border movements of mandible.
- Require skill and understanding from both dentist and technician.
- Useful in treating complex cases such as full mouth rehabilitation and abnormal jaw movements.
- Can accept kinematics hinge axis face-bow.
- Can register Bennett angle and side shifts of mandible.
- Rather than relying on wax records to adjust the articulator, special pantographic tracings are used to record the patient's border movements in a series of tracings.

Face-bow

- It is a rigid caliper-like device that used for:

1- Locating the condylar axis.

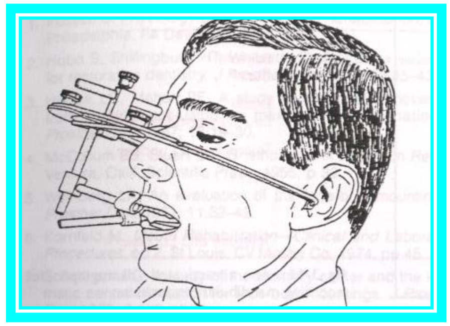
2- Relating the maxillary cast to the same axis on the articulator that is present in the skull.



There are two types of Face-bow:

1- **Arbitrary Face-bow**

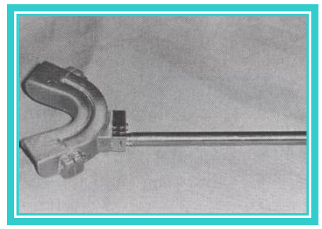
2- **Kinematic Face-bow**



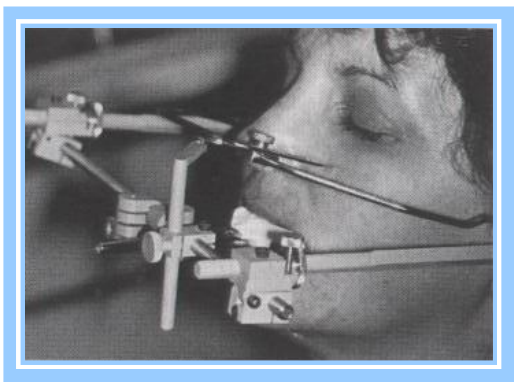
The main difference between them lies in the accuracy in locating the condylar axis. The arbitrary type provides an error of about 5mm between the true hinge axis and an easily identifiable landmark, usually the external acoustic meatus.

The kinematic type is more accurate and can determine the location of the mandible.

The Face-bow of:



A clutch (an impression tray-like metal device) attached onto mandibular arch using heavy body silicon impression material. The Face-bow is fastened to the clutch and adjusted so that its styluses could be positioned lateral to the TMJ's in close proximity to the patient's skin in order to locate the terminal hinge axis during opening and closing of patient's mouth.



Reference: Contemporary Fixed Prosthodontics

PROVISIONAL RESTORATION
(TEMPORARY RESTORATION)

It's important that the prepared tooth or teeth be protected and that the patient is kept comfortable while a cast restoration is being fabricated.

A good provisional restoration should satisfy the following requirements:

1. Pulpal protection: It should prevent the conduction of temperature extremes and the margin should be well adapted to prevent leakage of saliva.
2. Positional stability: The tooth should not extrude or drift in any way.
3. Occlusal function: Being able to function occlusally on the provisional restoration will aid patient comfort and also prevent tooth migration.
4. Easily cleaned: This will help the gingival tissue to be kept healthy and reduce post cementation problems.
5. Non-impinging Margins: it is of the utmost importance that the gingival margins of the provisional restoration not impinge upon the gingival tissue. The resultant inflammation could result in hypertrophy, gingival recession, or at the very least gingival hemorrhage during cementation.
6. Strength and retention: The restoration must stand up to forces that it's subjected without breaking.
7. Esthetic: In some cases, they must provide good cosmetic results.

Types of provisional crowns:

I- Ready made crowns:

1. Metal crowns:

Mainly used for posterior teeth. They are made of stainless steel, nickel chromium or aluminum and the last one is the most useful because it's soft

The metal crowns are of 2 types:

- Flat topped cylindrical types.
- Morphologically contoured type.

Disadvantages include:

1- Unpleasant taste.
2- Unacceptable esthetic.
3- Rapid weariness of the crown.

Clinical procedure:

- Select the proper size and shape of the provisional crown.
- Trim the margin to be fit to the finishing line and to accommodate the vertical height of the prepared tooth.
- Seat the crown over the tooth and check the margins and the occlusion.
- Smooth the margin with a stone bur.
- Cementation with ZOE in the abutment.

2. Celluloid crown forms:

It's mainly used for anterior teeth, but can be used for posterior teeth also.
It acts as a mould for construction of provisional restoration.

Clinical procedure:

Coat the tooth after preparation with Vaseline to facilitate removal of the crown. Make 2 holes in the in the corners of the crown to facilitate the removal of the excess material then we cut it to the same margin of the tooth. Then fill the mold with provisional crown materials with same shade of the tooth; then place it over the tooth, until set. (If the material is exothermic, you have to remove it from the tooth at the simplistic stage so the final polymerization occurs outside the mouth)
After that take it out and remove any excess material and then replicate on the tooth and check occlusion, contact points, fitness and extension. Then polish it and temporally cements it.

3. Acrylic ready-made crown:

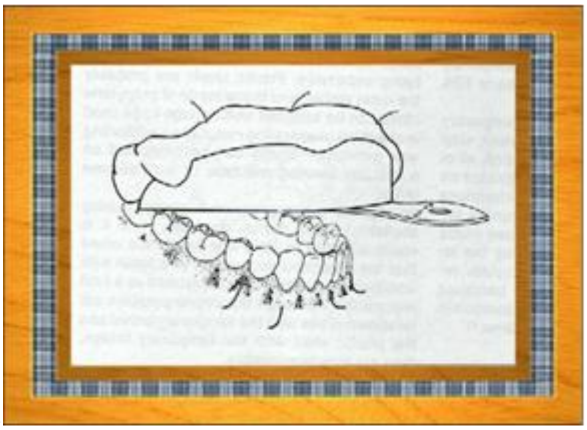
It's mainly used for anterior teeth. It is supplied with different sizes and shades. After choosing the proper size and shade the procedure is similar to that of Aluminum crown.

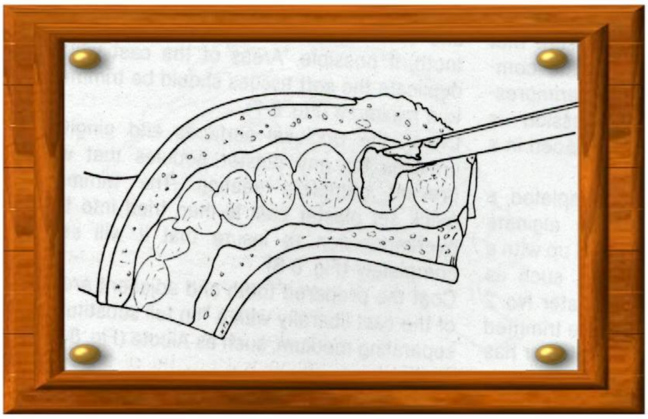
II- custom made provisional restoration:

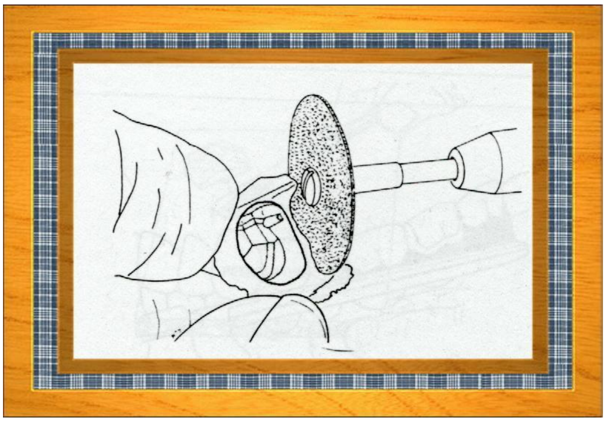
Direct and indirect construction of crown and bridge.

A) Direct impression method:

- A preoperative impression with alginate or silicon rubber base is made and stored until complete preparation is made.
- Coat the tooth with separation medium.
- Mix the provisional crown and bridge acrylic and load the tray on the position of the prepared tooth only and insert it inside the patient mouth.







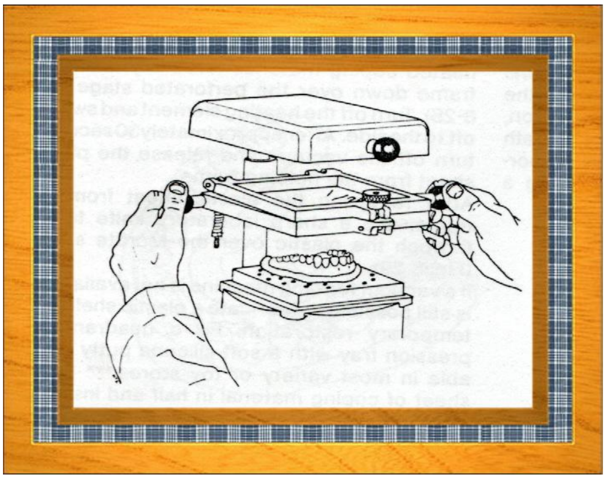
- After complete polymerization (if the reaction is exothermic you have to take it out from the patient mouth before that), the formed crown is removed and any excess material is removed and we check occlusion and the margin, then cementation by temporary cement.

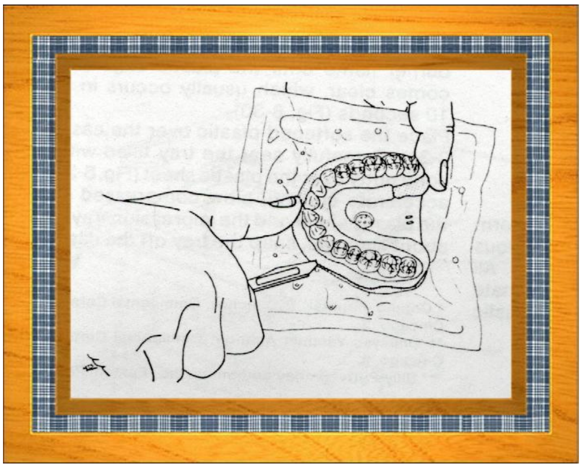
B) Indirect method:

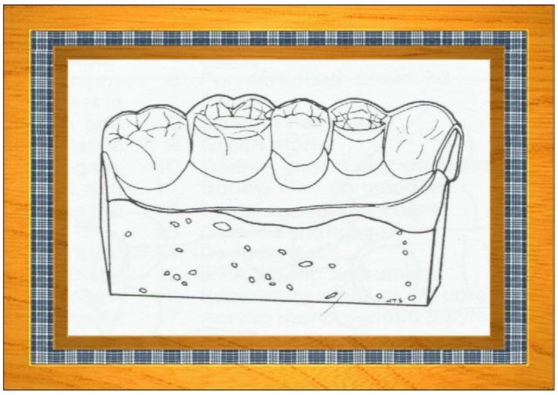
To prevent tooth irritation, we can take 1 preoperative & 2 postoperative impression.
One of them pours it with quick set stone.
After it sets remove the cast & repeat the same steps of direct method on the cast after putting separating medium.
a) No heat and monomer to the tooth.
b) Better margins.
c) Less chair time.

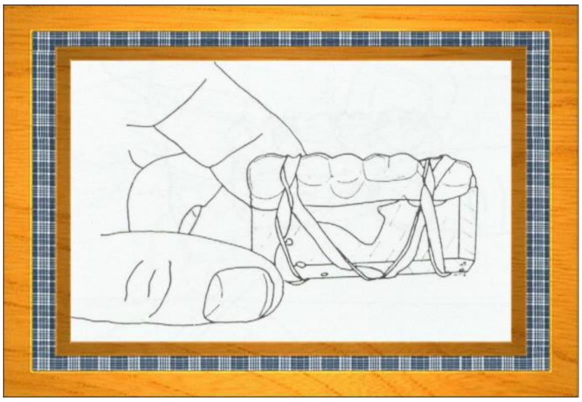
Custom provisional bridge:

When a bridge is to be made, the provisional restoration should also be in the form of a bridge rather than individual provisional crowns.
A preoperative cast is prepared, we put a partial denture tooth in the edentulous area; and then by using a thermal vacuum machine, template celluloid acetate is made as a mold to fabricate the provisional bridge.
The celluloid is 3-4 mm in thickness; it's heated and then placed over the cast and pulled by vacuum over the cast to take its shape.
Then we cut this sheet keeping half a tooth from each side to act as a stopper and 0.5 mm below the margin. Then we load it with the auto-polymerizing resin, place it on the teeth after coating with Vaseline and ask the patient to bite.
After setting remove any excess and temporary cement it.









<u>Provisional post crown tech.</u>

Preformed:

Ready-made provisional crown having a post inside. So you can trim and adapt them to be seated on the prepared tooth.

Custom made:

This can be accommodated for in the use of a standard acrylic crown by placing a piece of a paper clip or other wire into the canal and placing the acrylic filled crown; down over that. After setting you can remove it with the wire attached, and then cement it.

Temporary cement:

A wide variety of temporary cements are available; most of them based on zinc oxide and eugenol.

Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Lecture: 8 **Dr. Farid**

Methods for mixing investing material

In investing, the following points should be considered:

1. The manufacturer's instructions of the water-powder ratio, heating temperatures etc… should be followed.
2. The mix should be free from air bubbles.
3. Temperatures of water should be at room temperature to avoid distortion of the wax pattern.

The methods of mixing the investment material are:

1. Manual: mixing and pouring of the investment is done by the spatula manually.

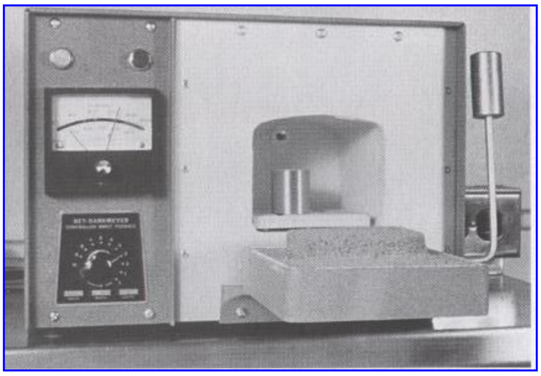
2. Mechanical: Mixing is done by a vacuum mixer to ensure that the mix is completely free from any bubbles. Pouring the investment is done by one of the following methods.

i) Brush technique: The investment is applied to the wax pattern by a brush and then we fill the casting ring.

ii) Vacuum technique: The casting ring is attached to the vacuum mixing bowl.

The bowel is inverted under vibration to fill the casting ring. The filled casting ring is left for 1 hour for setting of the investment, and then the crucible former is removed from the ring which is now ready to the burnout procedure.

Burnout procedure:



It is heating of the invested ring in a thermostatically controlled oven until the traces of wax are vaporized so that the mold cavity is created into which the molten metal can enter.

Advantages of burnout procedure:

1. Elimination of the wax and plastic material from the mold cavity of the investing ring.

2. Elimination of moisture or water from the ring.

3. To produce the necessary expansion in the investment to compensate for the solidification shrinkage of the alloy after casting procedure.

4. To raise the temperature of the mold to the proper point that permits the flow of the molten metal into the mold cavity.

The burn-out procedure step by step:

1. After we separate the ring from the crucible former we place the ring inside the oven and increase the temperature to 200 C and hold for 30 minutes. The wax and water vaporize from the mold cavity.

2. The ring is heated to 480-650 C for the final burnout and left for 45 minutes.

3. The position of the ring should be in the center of the oven so that the atmosphere surrounding the ring is the same that as recorded on the thermal indicator.

4. A too rapid increase of the burnout temperature may cause cracking of the investment and distortion of the mold cavity so the ring should never be placed in an overheated oven.

Casting:

It is defined as introducing the molten alloy into the mold cavity in the investing ring.

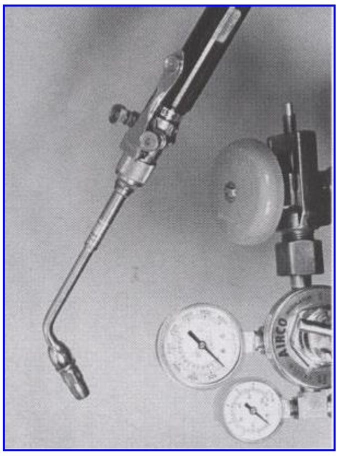
Casting equipment:

The casting machine requires:

1. Heat source to melt the alloy.

2. Casting force to force the molten alloy to the mold cavity.

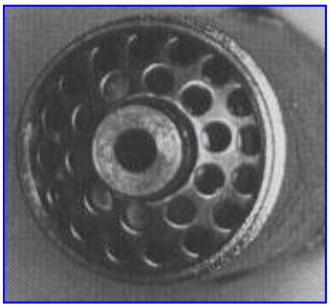
1. The heat source can be either the reducing part of the flame produced from a pipe torch, or electricity.



According to the melting temperature of the casting alloy we have 2 types of pipe torches:

i) Gas-air blow torch or pipe: It is used for melting casting alloy of low melting temperature (gold alloys II, III).

ii) Oxygen-acetylene torch or pipe: It has either a single or multi-orifices. It is used to melt alloy of high melting temperature as porcelain fused to metal. The single orifice torch is used for melting sliver palladium alloy. The multi-orifices torch is used to melt base metal alloy (nickel chromium).



2. The casting force must be enough to overcome:

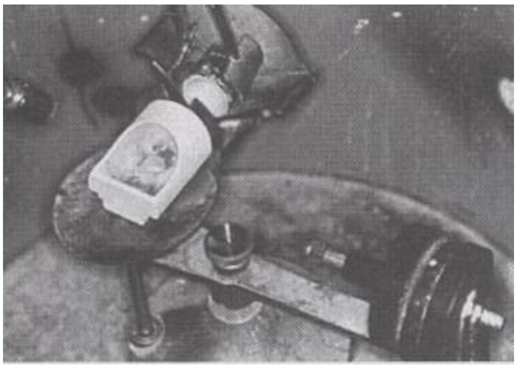
i) The high surface tension of the molten alloy.

ii) The resistance of gas within the mold.

The most common casting machine is the centrifugal casting machine which consists of a device for melting the casting alloy (crucible), and another part for throwing the molten alloy quickly by the centrifugal action into the mold cavity.

Casting procedure:

1. The casting machine gives three clockwise turns (four if metal ceramic alloys), and locked in position with the pin.



2. Adapt a wet asbestos liner to the bottom of the crucible of the casting machine, and then start to heat the liner in place using the flame obtained by pipe torch (the liner will prolong the life of the crucible and protect the metal from contamination).

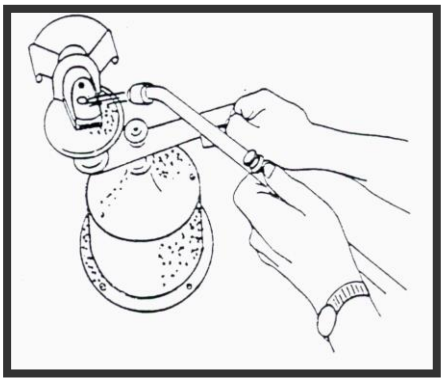
3. Place the casting alloy on asbestos liner and heat the gold alloy with the reducing part of the flame (which is the hottest part of the flame and doesn't produce any contamination) until it flows up and appear yellowish mirror like surface.

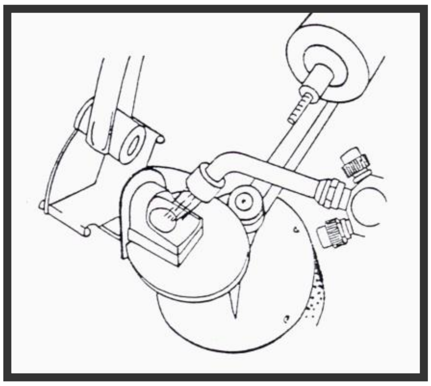
4. Add small amount of flux to the alloy (flux: it is a deoxidizing agent used to prevent oxidation of the alloy and to increase the fluidity of the molten alloy).

5. Remove the ring from the oven and place it on the cradle of casting machine.

6. Slide the platform against the ring.

7. Release the machine (pin), and allow the machine to spin until it stops.





Differences between alloy of low and high melting temperature in casting procedure:

1. The single orifice torch is used to melt gold platinum and silver palladium alloy, and the multi-orifices torch is used to melt base metal alloys.

2. Quartz made crucible is used in melting high melting alloys. The asbestos liner is not used here because the high temperature decomposes the asbestos and cause contamination to the molten alloy.

3. No flux is added to the porcelain fused to metal alloys during melting because it will upset the balance of the alloy and interfere with bonding later.

4. It needs extra winding of the arm of the casting machine to complete casting of the melting temperature alloy.

5. Casting temperature for the gold-platinum (1300 F), base metal alloy (1500 F) which differs from casting temperature of gold alloy (1200 F).

Cleaning of the cast restoration:

1. After casting procedure is completed the casting ring is taken from the casting machine, and thrust under running water or a large rubber bowl. This procedure is called Quenching.

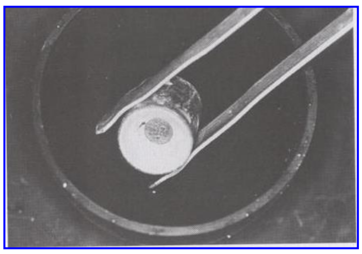
2. After quenching, the cast restoration is cleaned from the investment material by a sharp hand instrument and a tooth brush.

3. The cast restoration is sandblasted to remove the remaining residues of the investment material.

Sandblast: it is a machine that throws sand and compressed air on the cast restoration to clean it.

4. The cast restoration is placed in the pickling solution which a solution is made of 50% hydrochloride acid. It is used to remove the oxide from the surface of the metal and any remnants of investment material.

Now the cast restoration is ready for the next procedure which is the finishing procedure

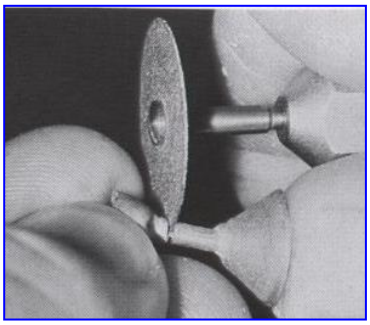


Advantages of quenching:

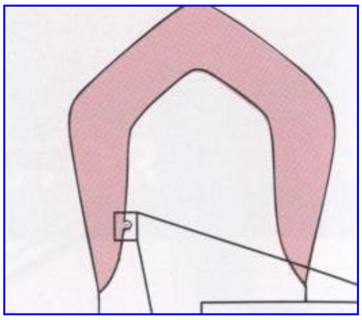
1- To anneal the alloy to provide better working qualities during finishing.

2- Disintegration of the hot investment material when it contacts cold water.

Finishing procedure:



1. The sprue is cut by a separating disc. The excess in the cut area is removed, recontoured and refined with a stone bur to reestablish the proper coronal morphology of the cast restoration.



2. The next step is to inspect the inner surface of the cast restoration for any nodules, bubbles of the alloy that might interfere with seating of the cast restoration on the die. All these irregularities should be removed using a round bur rotating at high speed.

3. The cast restoration is seated on the die. It should seat without any pressure but if there is any interference then the inner side of the cast restoration is inspected and the contact areas are relieved. If the cast restoration is seated with pressure the die will cracked and distorted.

4. After complete seating of the cast restoration on the die, the die is seated on the working cast and slowly adjusts the interproximal relationship to achieve a slight contact with the adjacent teeth.

5. The axial walls of the cast restoration are smoothed by a rubber wheel bur. The areas near the margin of the cast restoration are smoothened by placing the wheel bur parallel to the margin. Afterwards, the occlusal surface is finished with use of small finishing burs.

Finally, the cast restoration is ready to be tried inside the patient's mouth.

Reference: Contemporary Fixed Prosthodontics

Impression Materials and procedure

Impression: It is the negative likeness of the oral soft and hard tissue and their relationship. Because it is neither possible nor desirable to make patterns for fixed prostheses directly in the mouth, an impression is necessary to obtain a cast.

Impression can be made by placing soft or semi soft material in a tray that is inserted into the patient's mouth. When the material has set, it is removed from the mouth. The "negative" impression is filled with dental stone, and a positive likeness or working cast is obtained

Requirements of successful impression: -

1- It must be an exact record of all aspects of the prepared tooth, including sufficient unprepared tooth structure adjacent to the finish line.
2- All teeth in the arch and tissues adjacent to the tooth preparation must be reproduced to permit accurate articulation of the cast and allow proper contouring of the restoration.
3- The impression must be free of air bubbles, tears, and thin spots especially in the area of finish line.

Ideal properties of impression material: -

1- It must become elastic after placement in the mouth, because it must be withdrawn from undercut (that is usually exist on the external tooth surface adjacent to the preparation). So it should be able to return to its original shape after removal.
2- Must have adequate strength to resist tearing when removed from the mouth.
3- It must have adequate dimensional stability and reproduction of the details, so we have the exact negative imprint of the prepared and unprepared teeth.
4- Must have good handling and setting property that meet the dental requirement and should be free of toxic or irritating compounds.

Classification of impression materials:

1- Non elastic impression materials: -

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

These are not used in crown and bridge work because when they set they become rigid so upon removal from undercut they will fracture. Sometimes we use impression compound for single tooth impression with copper band.

2- Elastic impression material: It is the type we use in our work because it is elastic after setting, so when we remove it from the undercut it will not fracture, and there will be slight deformation that it will return to the original shape.

A- Hydrocolloid 1- Irreversible (Alginate) 2- Reversible (Agar- agar)

1- Alginate is used to produce primary impression; it doesn't give us accurate details, so we use it to produce the study cast and articulation cast.

2-Agar-agar gives accurate details but it has low dimensional stability and needs extra equipment, so most of the dentists don't use this type of material although it has accuracy.

B- Elastomric impression material (Rubber bases): -

1- Polysulfide polymer.
2- Silicon A- Condensation type. B- Addition type.
3- Polyether.

This type of impression set by chemical reaction. Usually supplied in different consistencies (viscosity) which depends on the amount of fillers, these are light body (syringe type), medium body, monophase (single-viscosity), heavy body (tray material), and putty

Most of the time, the heavy body is used as tray material while the light body is used with special plastic syringe to be placed on the preparation.

While the medium viscosity, is mostly used in the prosthetic work like partial denture.

Monophase (single-viscosity) impression material

Has a higher apparent standing consistency like heavy body, and yet the same material can have sufficiently high fluidity when injected by a syringe, this material also is described as thixotropic.

*Whatever the consistency of the elastic rubber material, it is supplied as two containers or tubes (the base and the catalyst).

1. Polysulfide:

The first type used in dentistry.

Base: A liquid polysulfide polymer mixed with inert fillers.

Catalyst: Lead dioxide mixed with a small amount of sulfur and oil. Act as oxidation initiators.

Disadvantages:

1. Must be poured as soon as possible after taking the impression (delays of over an hour resulted in clinically significant dimensional change).
2. It has long setting time (about 10 min), induces poor patient acceptance.
3. Humidity and temperature reduce the setting time.
4. Lead dioxide (catalyst) gives brown color for the material and the material after polymerization is sticky so we should be careful in handling this material because it may stain the clothes permanently.

2. Silicon impression material. (Odor less /any shade / less effected by temperature)

(I) Condensation type: -

*Base: Liquid silicon polymer with terminal hydroxyl group and filler particles.

*Catalyst: A viscous liquid consists of ethyl-silicate with organic tin as activator (tin octet).

Disadvantages:

1- Extremely hydrophobic, so it needs dry field during taking an impression and stone pouring.

2- Poor dimensional stability after setting.

Upon mixing condensation reaction take place with the elimination of ethyl alcohol and water as by-product; this is responsible for the dimensional change (Shrinkage) of the material, which result in poor dimensional stability after setting.

Both polysulfide and condensational silicon is condensation polymer.

When we take impression by this material it must be poured 1 hr after we take it.

(II) Addition type (vinyl polysiloxan silicon). (Stiffer than polysulfide, greater dimensional stability)

*Base: silicon with terminal hydrogen group and inert fillers.

*Catalyst: Silicon with terminal viny1 groups, chloraplastinic acid as catalyst and other filler.

Without elimination of by-product which result in a more dimensional stable material.

3- Polyether Impression Material:

This material could be supplied as two-paste system of medium consistency (monophase).

Base: Polyether polymer with terminal ethylene amine group with filler.

Catalyst: Alkyl aromatic sulfonate with filler particles.

This material absorbs moisture that might result in dimensional changes. It must be kept dry after taking the impression, and some times we can pour it after one day.

It stiff material and we should be very careful when separate. We must be careful because we might break the area of the prepared tooth.

All rubber bases are hydrophobic except polyether; so moisture control is essential before taking impression.

General factors that affect most of elastic rubber impression material: -

1- The rubber impression material shrinks during polymerization, so we must be sure about complete setting of the material before we remove it from the patient mouth.
2- The impression must be casted (poured) one hour after removal.
3- The rubber impression materials are most accurate when they are used in thin section and this will necessities the use of special tray when taking the impression to reduce the amount of the impression material so that we reduce the dimensional change that will occur.
4- The temperature and humidity reduce the setting time.
5- Alteration in the ratio of catalyst to base will affect the setting time of the material.
For the final impression we need special tray, special impression syringe and the impression material. The special tray is made on the study cast.

The advantage of study cast: -

1- Diagnosis and treatment planning.
2- Construction of temporary crown.
3- Construction of special tray.

To have a successful impression we must have: -

1- Special tray to reduce the volume (thickness) of the impression material and so reduce distortion by reducing: polymerization shrinkage and the thermal contraction.
2- Knowledge of the physical property of the impression material.
3- Moisture control during taking the impression…
4- If it is necessary we need to do gingival retraction.

The advantages of special tray: -

1- It allows the use of impression material in minimum thickness essential to control the dimensional changes that increase with thick section.
2- It allows more comfortable impression technique of impression taking as it reduces the gag reflex so it will reduce the discomfort of the patient.
3- The small size of the special tray prevents the forcible opening of the mouth.
4- It allows free snappy removal of the impression.

Materials used for special tray are: -

1- Self cure acrylic.
2- Shellac base plate.
3- Thermoplastic material.
4- Photopolymerized material.
Both 2 and 3 are not rigid enough and most of the time we use acrylic to construct special tray.

To construct special tray, we need: -

1- Pink base plate wax.
2- Study cast.
3- Acrylic.

Construction of the special tray

We will construct the special tray on the study cast by the use of cold cure acrylic and pink base plate wax.

1. On the study cast we draw a line by a pencil around the dental arch, which is about 5mm cervical to the gingiva; this line represents the finishing line of our special tray.
2. After that we adapt two layers of base plate wax over the cast, and then we remove the wax from the periphery until we see the line that we draw.
3. Then we create holes (two posterior and one anterior) on the occlusal surface in oblique direction to obtain stoppers for our special tray then after these two layers of wax we adapt a layer of tinfoil.
4. After that we start to adapt the acrylic on the wax and we use it when it reaches the dough stage all around the layer of pink base plate wax and we remove the excess until the finishing line appears, we use the excess to make the handle and wait until complete setting, then we remove it from the cast, which will be facilitated by the layer of tin foil.

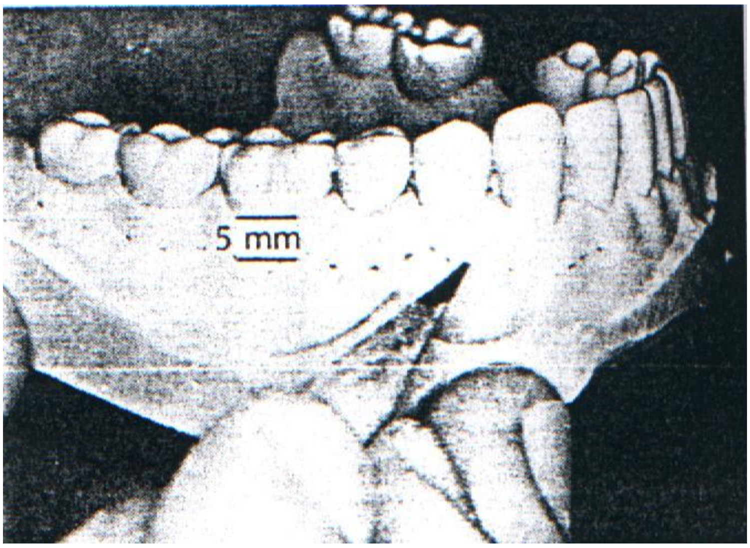
Requirements of special tray: -

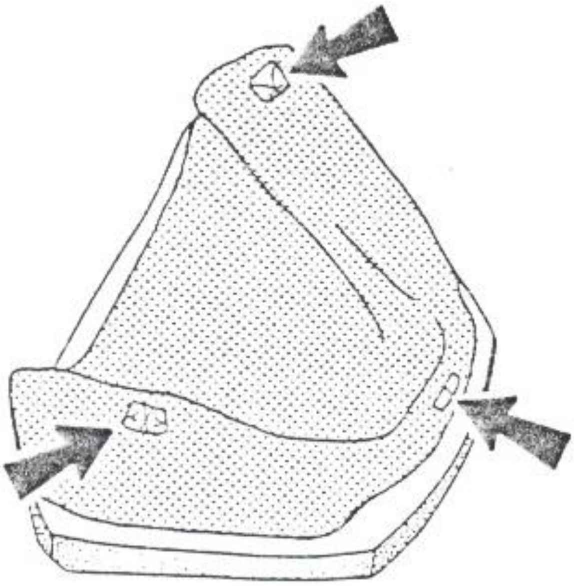
1- Must be rigid and have thickness of 2-3 mm.
2- Should extend about 5mm cervical to the gingival margin.
3- Stable in the cast with stoppers.
4- Made at least 6 hours prior to be used.

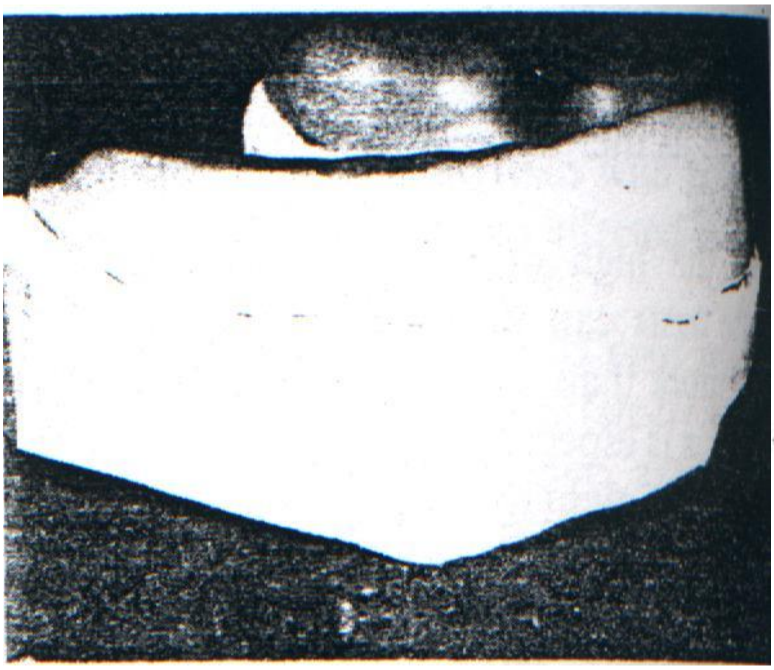
The advantage of the stopper is: -

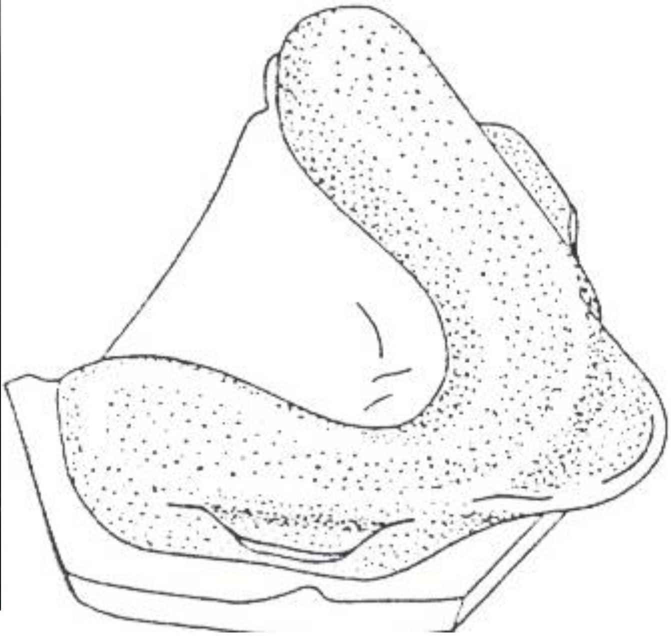
1- To equalize the pressure that is going to be applied on the tray.
2- It gives us benefits to localize our tray in the mouth during impression making.
3- Maintain even space for impression material and prevent making contact with the prepared teeth.

Now we are ready to take final impression.
For making final impression we also need special impression syringe and impression material. Impression syringe is made from clear plastic, and should be available with different nozzle sizes; we need this syringe to carry the light body material from the mixing slab to the preparation.









IMPRESSION TECHNIQUES

1- Single stage technique.
2- Two stage technique.
3- Putty wash technique.

1- Single stage techniques:

Most of the time we use this technique when we have impression material with single viscosity (mostly medium viscosity material), e.g. Polyether, after we mix the impression material part of it is loaded in an impression syringe from the mixing slab, and we place it on the special try, we inject the material over preparation. And we start with the most critical parts (Pin holes, Margins) then the preparation, and the remaining part of the dental arch.

After wards, place the special tray over the dental arch, wait for complete set then remove.

2- Two stage techniques:

Used with materials that has two viscosities light and heavy. We mix the heavy and light body at the same time the heavy body is placed in the special tray; we start to inject the light body on the dental arch starting with the prepared tooth.
After we finish injecting the impression material we place the special tray with the heavy body in the patient's mouth.
The pressure exerted by heavy body will create intimate contact between light body and the prepared tooth and will make direct flow of the light body into the details of the preparation.

Putty wash techniques:

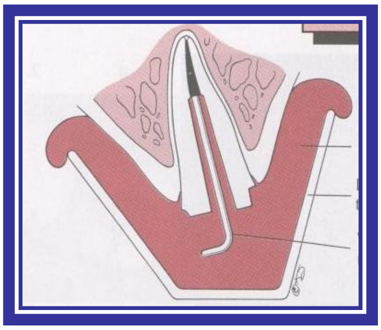
This technique uses a high viscosity material; we start to take impression with the heavy body (before or after preparation).

If we make it before preparation:

We leave the impression material until it sets inside the patient mouth, and then we remove it, and do our preparation. After that we start to mix the light body and load it in the impression syringe and inject it over the preparation and the dental arch then we reseat the tray inside the patient mouth and wait until setting occurs.

If we make the impression after preparation:

We use it with spacer made of polyethylene materials placed over the heavy body and inserted in the patient's mouth and wait until setting then remove the polyethylene (spacer). After that we complete the steps of light body application and impression taking.



* All techniques can be used in any type of preparation but it depends on the material. When we take impression for post crown we need impression for the root canal space so the impression inserted inside the tiny canal and even when it fills the canal it might tear off or distorted during pouring the die materials (stone). So the impression material need a type of reinforcement either by a plastic post or by stainless wire placed before setting, the impression will not be torn or distorted because it is not movable.

We shall make the surface of the wire rough by burs in order not be pulled away from the impression.

After taking the impression we should inspect the impression for the following points: -

1. Finishing line in the impression must be continuous from one surface to the other.
2. No air bubbles present on the surface of the impression especially at the area of finishing line.
3. The attachment of the impression to the tray must be firm (major difference among impression materials that every one has it is own adhesive that used to bind it to the special tray).

Reference: Contemporary Fixed Prosthodontics

Fluid control and soft tissue managment

Complete control of the enviroment of the operative site is essential during restorative dental procedure. For the patient's comfort and safty, and for the operators's access and clear visibility, saliva, as well as water introduced during instrumentation, must be removed from the mouth.

Fluid control:

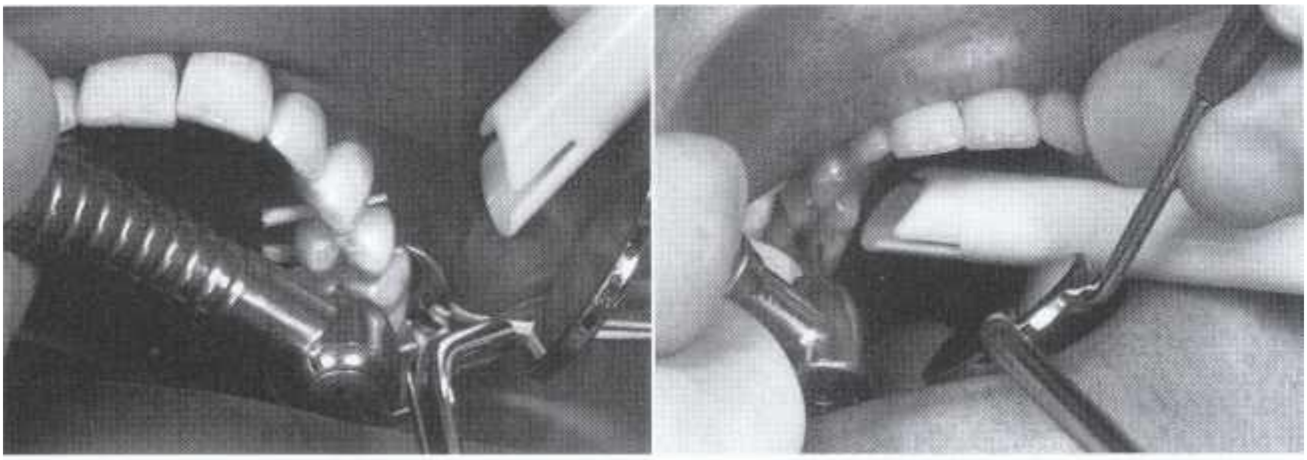
Depending on the location of the preparation in the dental arch, several techniques can be used to create the necessary dry field of operation.

1- Rubber dam:

Rubber dam is the most effective of all isolation devices utilized in restorative dentistry, but it has only limited direct application in the area of cast restorations. It can be used during tooth preparation for inlays and onlays (if the occlusal reduction is done before the dam is placed). It should not be used with polyvinyle siloxane impression material, because the rubber dam will inhibit its polymerization.


2- High volume vacuum:

A high-vacuum suction type is extremely useful during the preparation phases and is most effectively utilized within assistant when wielded by acknowledgeable assistant, it makes an excellent retractor while the operator uses a mirror to retract and protect the tongue.



3- Saliva ejector:

The simple saliva ejector can be utilized effectively in some situations by the lone dentist. It is most useful as an adjunct to high-volume evacuation, but it can be used alone for the maxillary arch. The saliva ejector is placed in the corner of the mouth opposite the quadrant being operated, and the patient's head is turned toward it. It can also be used very effectively on the maxillary arch for impression and cementation simply by adding cotton rolls in the vestibule facial to the tooth being isolated. It can be used on the mandibular arch while cotton roll holder positions cotton rolls facial and lingual to the teeth.

Gingival Retraction

To displace free gingival tissue or to expose the margin of the preparation, so that better impression could be taken. It is used when the margin is sub gingival or with the level of gingival.

The objectives of the gingival retraction are:

1. Create access for the impression material to the area of preparation that is located subgingivally.
2. Provide enough thickness of the impression material at the area of the finishing line to prevent distortion of the impression.
3. Prevent sulcular hemorrhage and fluid seepage which interrupt the flow of impression material.

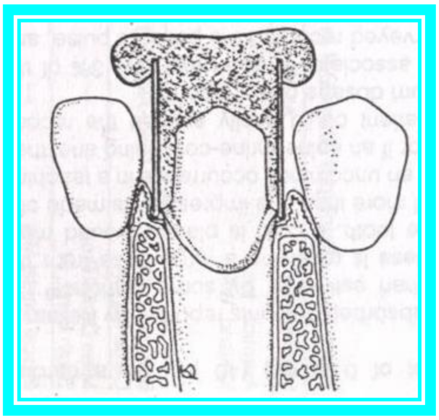
Techniques of gingival retraction could be:

1. Mechanical.
2. Combination of mechanical and chemical (chemo-mechanical)
3. Surgical technique.

1- ***Mechanical***: We apply pressure on the gingival to open the gingival sulcus. May be done by:

A- Construction of temporary crown with long margin and leave it for half an hour. Their effectiveness is limited because pressure alone often will not control sulcular hemorrhage.

B- The most common way to do gingival retraction is by using retraction cord which is special cord made of cotton comes either with or without medicament (vasoconstrictor). The cord that is free from vasoconstrictor is used as mechanical technique.



2- ***Chemomechanical*****:** The cord contains vasoconstrictor (adrenaline). We use it as mechanical and chemical retraction. By packing this cord in gingival sulcus, between the tooth and the free gingival tissue using plastic instrument (Ash no. 6 or 49) so that the cord physically pushes the gingival away from the finish line and the combination of the chemical action and pressure packing help to control seepage of fluid from the wall of the gingival sulcus. We put the retraction cord inside the gingival sulcus all around the tooth; it is left for 10 minutes. The area during our work should be dry then we remove the cord. The area will be expanded providing space to inject the impression material around the tooth at area of finishing line by the impression syringe.

3- ***Radial or surgical:*** Means is sometimes done by using electrosurgical unit to remove gingival tissues from finishing line or sometimes we do gingivectomy in case of periodontal disease or inflammation.

Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Lecture: 9 **Dr Farid**

Try-in & Cementation

The crown should be checked for fitness and adjustment for the occlusal surface with the opposing teeth and also the contact area should be checked and adjusted.

► Remove the provisional restoration and clean the tooth. Then insert the bridge frame and check the followings:

1. **The proximal contact area**: - The proper contact should have a slight resistance to the passage of dental floss. We should have neither too tight (heavy) contact nor too light (loose) contact.

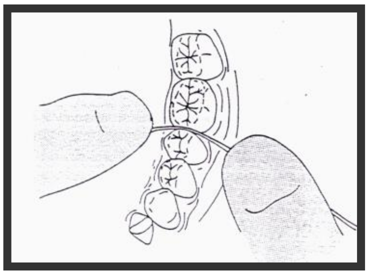
Too heavy contact results in: -

- ✓ Interfere with correct seating of the restoration.
- ✓ Produce discomfort, and make it difficult for the patient to floss.
- ✓ Too much force will be exerted on the adjacent tooth.

Too light contact results in: -

- ✓ Food impaction, which is deleterious to the gingival and annoying to the patient.
- ✓ Drifting of the adjacent teeth, which affect the occlusion of the patient.

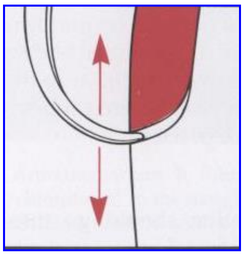
2. **The margins of the retainer (s).**



The margin is the most critical area of the restoration; we should have complete fitness between the restoration margin and finishing line of the preparation.

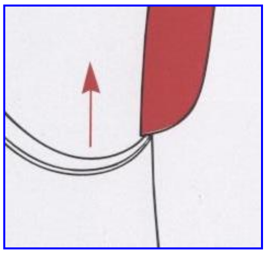
The defective margin of the restoration might be:

- Short margin (under extension), margin is short of finish line. In this case we should check: -



- ✓ If there too tight proximal contact that prevent complete seating.
- ✓ The internal surface of the retainer if it locked into parallel or slight undercut in the tooth surface that prevent complete seating, may be checked by indicator spray that applied to (coat) the internal surface of the retainer, then seat the retainer, remove the retainer and see if there is premature contact spot which is devoid the spray material.

- Long margin (over extending margin), margin beyond finish line. We should cut the excess.
- Open margin: the margin within the finish line but there is space between the restoration margin and prepared tooth. If we can burnish it. Otherwise repeat the impression.



Burnishing depends on the type of metal and the type of finish line.

The burnishable metal usually is gold. The knife edge (feather) and shoulder with bevel finish line could be burnished.

The objective of the margin finishing (burnishing) is to obtain at least one mm wide margin of metal that is closely adapted to the tooth surface at the area of finish line so that any dissolution of luting (cementing agent) is minimized.

Two types of margin need to be considered during finishing procedure:

1- Subgingival margin that can be burnished on the die using a burnisher,
No intra oral finishing is desirable for the subgingival margin because the risk of damaging to the tooth and periodontal structure.

2- Supra gingival margin that can be finished directly on the tooth inside the patient mouth. Margin finishing or adaptation can be improved by using burnisher or round bur.

3. Occlusal Adjustment

It is done by using articulating paper in centric and eccentric relation. Remove the premature contact with stone bur and always check the metal thickness with metal gauge to avoid over thinning of the metal that could affect structural durability. The occlusal relationship of the adjacent teeth with the opposing is used as a guide for any prematurity.

4. **Shade Selection**. It depends on the followings:

A. Observer (dentist). B. Object (patient). C. Light source.

Each of these three factors is a variable and, when any one is altered, the perception of color changes.

Some guidelines for shade selection: -

Use the shade guide that matches the porcelain your technician is using.

The shade should always be matched prior to preparation of the tooth to be restored.

Ask the patient to remove all distractions before attempting to match a shade. Lipstick in particular should be removed and large bright items, such as earrings or glasses.

Be sure that the teeth are clean and unstained before shade selection.

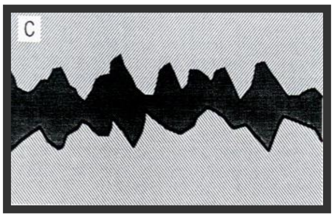
Seat the patient in an upright position with the mouth at the operator's eye level.

Position yourself between the patient and the light source. Observations should be made quickly (5 seconds or less) to avoid fatiguing the retina.

Try to take the shade under natural day light, avoid incandescent and fluorescent lights.

Cementation

Dental cement doesn't contribute to the retention of the restoration. It is used only to fill the micro-spaces or small irregularities between the tooth structure and the restoration when it sets. It provides a mechanical bond (interlocking) that prevents the restoration from removal.



The mechanisms that hold a restoration on a prepared tooth can be divided into: -

- **Non-adhesive (mechanical) luting.**

The non-adhesive luting agent holds the restoration in place by engaging small irregularities on the surfaces of both tooth and restoration. Zinc phosphate cement is an example.

The nearly parallel opposing walls of a correctly prepared tooth make it impossible to remove the restoration without crushing minute projections of cement extending into recesses in the surface

- **Micromechanical bonding.**

The deep micro-spaces or irregularities on the tooth surface produced by acid etching and on the metals by electrolyte etching or chemical etching. Resin cement is an example. It can provide effective micromechanical bonding. The tensile strength of such bonds can sometimes exceed the cohesive strength of enamel.

- **Molecular adhesion.**

Involves physical forces like van der waals and chemical bonds (ionic, covalent) between the molecules of tow different substances. Poly-carboxylates and Glass ionomers are examples.

Function of Cement:

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

Properties of Ideal Luting Agent:

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

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

Zinc Phosphate Cement

It is the traditional luting agent that have proven itself after years of work, it has compressive strength of 14000-16000 PSI, with low PH at the time of cementing (about 3.5) which might irritate the pulp.

Zinc Silico-phosphate Cement

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

Poly-Carboxylate Cement

Adhere to enamel, dentine and stainless steel but not to gold alloy.

The setting PH is (4.8) but because of the large size of poly-acrylic acid molecule, it has less effect on the pulp, high bond strength to enamel (1300 PSI) but its binding to dentine is considerably less 480 PSI.

Glass Ionomer Cement

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

Composite Resin Cements

Resin cements are composites composed of a resin matrix, and a filler of fine inorganic particles. They differ from restorative composites primarily in their lower filler content and lower viscosity. Resin cements are virtually insoluble and are much stronger than conventional cements.

Excessive film thickness and setting shrinkage are the short comes of resin cements.

Plain Zn-oxide is not used for permanent cementation because:

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

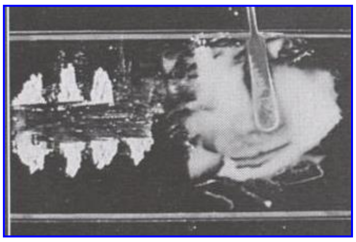
The selection of cement for placement of cast restoration is not clear cut discussion.

Cementation Procedure for Zinc phosphate cement:

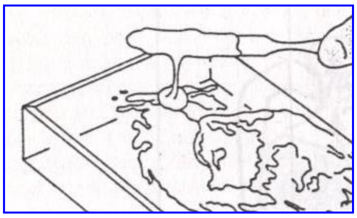
We prepare the tooth inside patient mouth, before start mixing the cement:

1. Remove the temporary crown, cleaning of restoration from any residues of cement, etc:

   Then dry the area of the prep. And with cotton roll isolate the area of work from any salivary contamination to assure complete dryness during cementation procedure.
2. We apply two layers of varnish on the preparation except the margin.
3. Then start mixing cement.

   ZnPC is mixed on a cool cement slab, the cement is divided into increments and it should be done over a wide area of the cement slab, mixing is done with a circular motion to dissipate heat, when the cement reach a creamy mix it should string out of the cement spatula, at this stage the cement is ready for working with.

   
4. Apply a coating of the cement to the inside of clean dry casting restoration, if there is any internal prep. Features such as grooves or boxes apply some cement on these areas of prep.
5. Seat the casting crown on the tooth with pressure and ask the patient to apply force to the occlusal surface of the casting by biting on wooden stick or cotton roll for 3-4 minutes to ensure complete seating.
6. After setting remove any excess cement from the inter-proximal area, and clean it with air water spray.

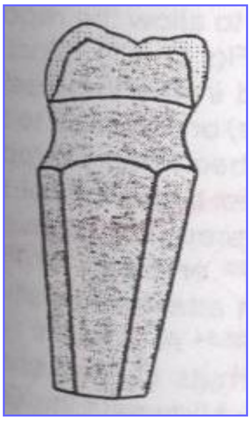
   Note: don't try to cement poorly fit causing crown restoration because the cement will dissolve in oral fluid so caries will develop under the restoration and it will be lost in future.

Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Waxing

Lecture: 7 Dr. Farid



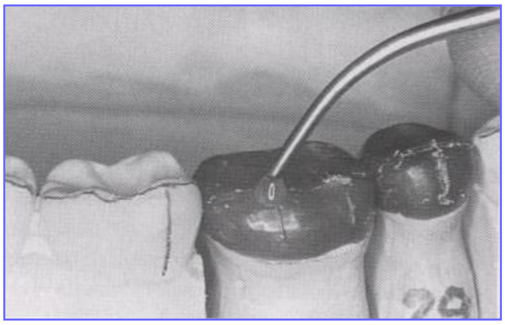
Ditching (Undercutting):

It is trimming of the stone representing the gingival around the prepared tooth that shows the finishing line clearly.

It is done by using a sharp hand instrument.

Wax pattern:

It is the precursor of the final cast restoration that will be placed on the prepared tooth. It should be:



1- Clear and smooth.
2- Duplicates accurately the anatomical features of the original tooth and
3- It should be free from any debris.

Wax is used to construct the wax pattern because:

i) It is easily manipulated.
ii) Inexpensive.
iii) Easily eliminated from the mold cavity during burnout procedure.

The type of wax used in construction of the wax pattern is inlay casting wax. There are two types of this wax which are:

1) Type I inlay casting wax; it is a hard wax and used for intraoral waxing technique. It has a higher melting temperature.

2) Type II inlay casting wax; it is a softer wax than the type I and is used for extra oral wax technique. It has a lower melting temperature. It is used to construct the wax pattern on the cast.

Requirements of good inlay casting wax:

1- It must flow readily when heated and rigid when cooled.

2- It must be carved without chipping when it is done in fine margins.

Techniques of construction of wax pattern:

1- Intraoral technique (Direct technique):

The wax pattern is constructed inside the patient mouth using type I inlay wax. This technique is mostly used to construct the posterior inlay restoration and anterior post-crown.

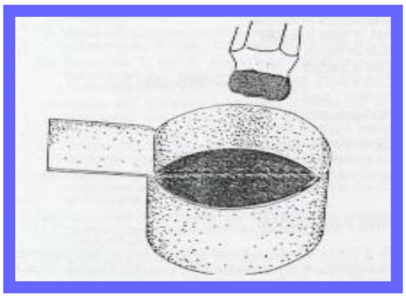
2- Extra oral technique (Indirect technique):

Type II inlay wax is used to construct the wax pattern on the die of the working cast.

Steps in working procedure:

1- Apply a wax lubricant (die spacer) on the die within 1mm from the finish line and leave it to dry (obtain a relive of 20 to 40 microns). Then apply die lubricant (separating medium) to the die.

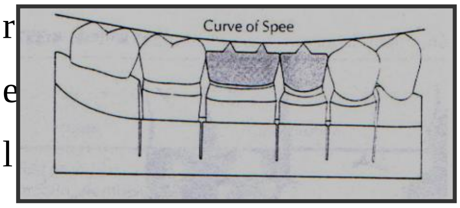
2- Cover all the preparation in one time with molten wax to make a coping of wax. This can be obtained by immersing the preparation in a dish containing molten wax (this is the first layer of wax pattern).

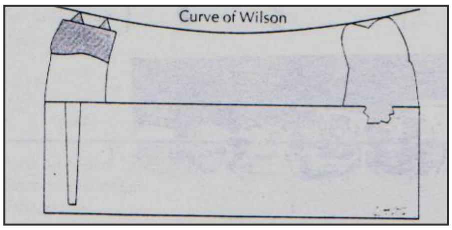


3- Add wax to the proximal surfaces of the preparation to build the proximal surfaces and contact areas with the adjacent teeth.

4- Build the axial wall (buccal and lingual wall) to the normal contour.

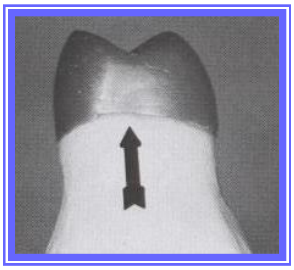
5- Build the occlusal surface of the restoration following the curve of spee and curve of Wilson, then check and adjust the occlusal





relation with the opposing teeth in centric and eccentric relation.

6- Check the margins of the wax pattern to ensure that the margins of the wax pattern have no over or under extension.



Investing:

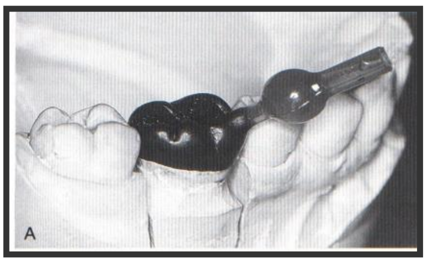
It is the embedding of the wax pattern in a heat resistant material that can accurately duplicate the shape and anatomical features of the wax pattern to obtain the mold after burning the wax pattern (lost wax technique).

Lost wax technique:

It is the process which includes surrounding the wax pattern with mold of heat resistant investment material, eliminating the wax by heating, and then introducing molten metal into the mold cavity through channel called the "sprue".

Sprue:

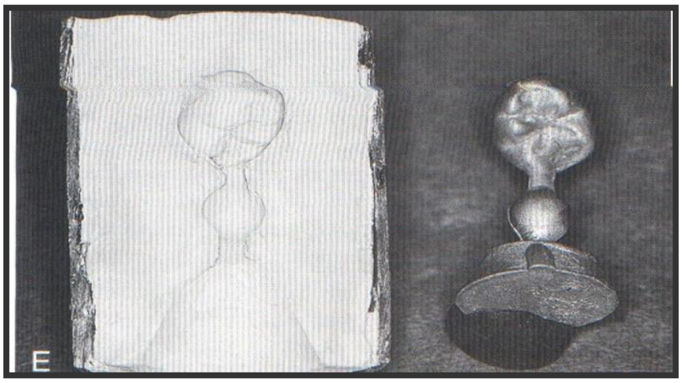
It is a small diameter pin made of wax, plastic or metal, one end of it is attached to the wax pattern



while the other end is attached to the crucible former. It provides a channel after burn out procedure to act as inlet for the gold which is forced in the mold cavity.

Mold cavity:

It is a space created inside the investment after burnout procedure that was occupied by the wax pattern, sprue and crucible former.



Requirements of the sprue:

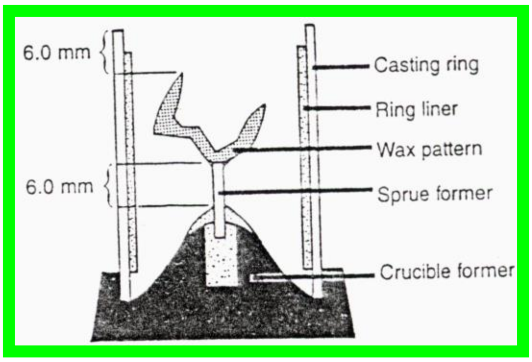
1-The sprue must allow the molten wax to escape from the mold cavity.
2-It must allow the molten metal to flow into the mold cavity with little turbulence as possible.
3-The metal within the sprue must remain molten slightly longer than the alloy that has filled the mold. This will provide a reservoir to compensate for the shrinkage that occurs during solidification of metal casting.

Materials used in the construction of the sprue:

1) Wax: It is the preferable material to make a sprue because it melts at the same temperature of the wax pattern.
2) Plastic: The plastic used should be of a low melting temperature.
3) Metal: It should be made from non-rusting material to avoid possible contamination of wax.

Dimension and location of the sprue:

1- Diameter: The size of the sprue or the diameter of it must be as large as possible to improve the flow of the molten metal into the mold cavity and ensure the reservoir to compensate for the shrinkage of the metal during solidification.



2- Length: The length must be adjusted so that when we attach it to the crucible former, the margin of the wax pattern should be about 6 mm away from the end of the casting ring. It is made so that the wax pattern will be in the center of the casting ring and surrounded by a uniform thickness of investment material.

3- Location: The position of the attachment of the sprue with the wax pattern should be to the bulkiest area of the wax pattern and should be at an angle to allow the incoming gold (or metal) to pass freely to all portions of the mold cavity without any turbulence. The attachment should also be at the bulky non centric area.

Purposes of investing:

1) Provide accurate production of the anatomical form of the wax pattern.

2) Provide sufficient strength to withstand the heat of burnout procedure and the actual casting of the molten metal.

3) Provide compensation expansion equal to the solidification shrinkage of the alloy, therefore, the mold cavity should be larger than the mold (if this does not happen the restoration will be smaller than the wax pattern).

Casting ring:

The casting ring is made of metal used to hold the investment material in place during setting and to restrict the expansion of the mold. If we use the casting ring alone, we will not have expansion.

Ring liner:

The liner is used to line the inside of the casting ring. It is made from a compressible material. E.g. asbestos (0.6mm thick) that allows the investment material to expand to some degree, but as it is carcinogenic other materials as fiberglass may be used. If there is no room for expansion outward the mold cavity would produce a small casting. The liner should be 3mm shorter than both ends of casting ring because it will bind the investment to the ring to prevent the slipping of the whole mass during casting procedure.

Purposes of the liner (advantages):

1- Provide a room of pliable material against which the investment can expand to enlarge the mold cavity to compensate for solidification shrinkage.

2- To permit easier removal of the investment and casting from the ring after burnout procedure.

3- Act as an insulator against loss of heat during casting procedure.

The crucible former:

It is a conical or tall shape base made of rubber or metal. It forms the base of casting ring, to which the other end of the sprue is attached.

The purpose of using the conical crucible former is:

1- To get proper position of the crucible former inside the investing ring.

2- To create conical shape and this is for the direction of molten metal.

Materials used as investment material:

According to the type of the binder we have 2 types**:**

1. **Gypsum bonded investment material.**
2. **Phosphate bonded investment material.**

Both consist of a binder and a refractory material (silica).

1. Gypsum bonded investment material**:**

The binder is calcium sulfate hemihydrate (CaSO4.1/2H2O), it is used with an alloy which has melting temperature decomposition of calcium sulfate occurs which occurs with result in release of sulfur into the mold-mixed with gold-brittle casting, so it is unstable in burnout temperature (above 650 C).

2. Phosphate bonded investment material**:**

Used with high melting temperature alloy. The binder is magnesium phosphate and ammonium phosphate. The binder can withstand high casting temperature therefore it is used for investing and casting alloys with higher casting temperatures.

Types of dental alloys:

There are 3 main types**:**

1. **1-** Precious alloy.
2. **2-** Semiprecious alloy.
3. **3-** Non precious alloy.

1. Precious alloy:

Consists of a minimum of 60% by weight of noble elements, at least 40% of the alloy must be gold.

1) Type I Soft.
2) Type II Moderate.
3) Type III Hard.
4) Type IV Extra hard.

2. Semiprecious alloy:

Minimum of 25% by weight of noble metal, with no requirement for gold.

3. Non precious alloy:

There are two main alloys used which are nickel chromium alloy (75% Ni, 15% Cr) and cobalt chromium alloy (60% Co, 25% Cr). The phosphate bonded investment is used with these alloys to withstand their high melting temperature.

Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

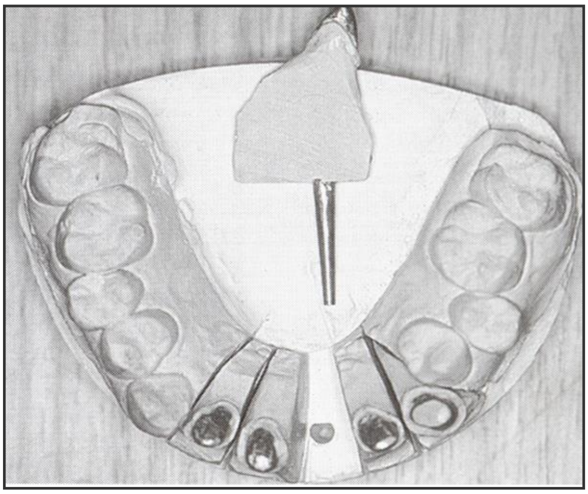
Lecture: 6 **Dr.Farid**

Working casts and dies:

Working cast: It is a replica of the prepared tooth (teeth), ridge area and other parts of the dental arch. It is produced from the final Imp. On which we will make the wax pattern (Lab. Work) of the final restoration.

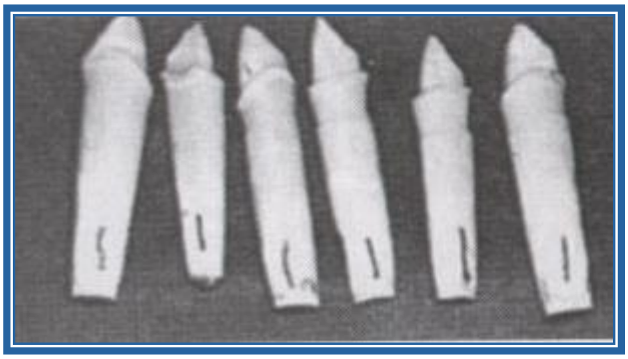
Requirements of good working cast:

1- Must be free from air bubbles especially at the area of the finishing line and occlusal surface.
2- Must reproduce all the details that have been captured by the imp.
3- Must be free from any distortion.
4- It should be trimmed to ensure access for carving of the wax pattern (at the margin).
5- It should allow precise articulation.



Die:

It is the positive reproduction of the individual (single) prepared tooth on which we will do wax pattern. (It's produced from the final imp.).



Requirements of dies:

1- Must reproduce the preparation exactly.
2- Must be free from air bubbles.
3- Must return to its exact position on the cast when it is removed.
4- Must be stable, even when the cast inverted.

Types of dies:

1- Silver-plated dies.
2- Copper plated dies.
3- Amalgam dies.
4- Stone dies.

The two critical properties of die material are the dimensional stability or accuracy and resistance to abrasion, during the construction of wax pattern.

Advantages of stone dies are:

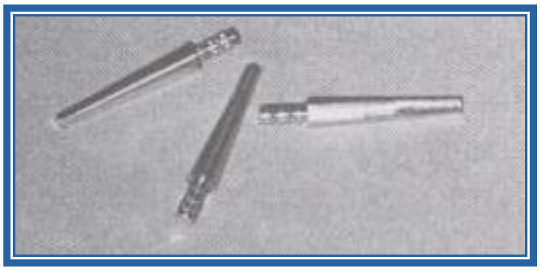
1- Easy to be prepared.
2- Can be used with all types of imp. Material.
3- Cheep.
4- Need less requirements and easy to manipulate.

According to ADA specification (American Dental Association) **we have 4 types of gypsum material:**

I) Type I: Impression plaster.
II) Type II: Model plaster.

III) Type III: Stone.

IV) Type IV: High strength stone (die stone).

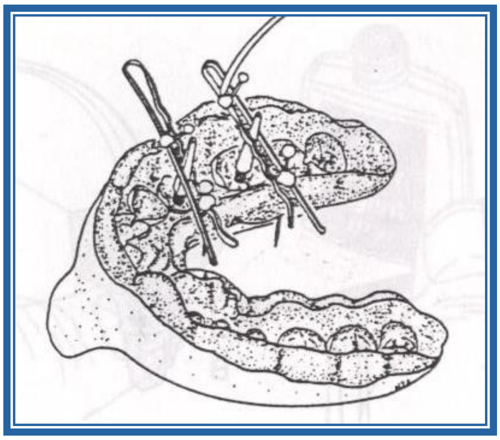


Dowel pin: Ready-made metal pin used as a mean of orienting dies to the original model, which allow them to be easily removed and accurately replaced into the model. The pin is tapered and cylindrical but with one flat side for positive seating.

Constructions of stone die (working cast with removable die):

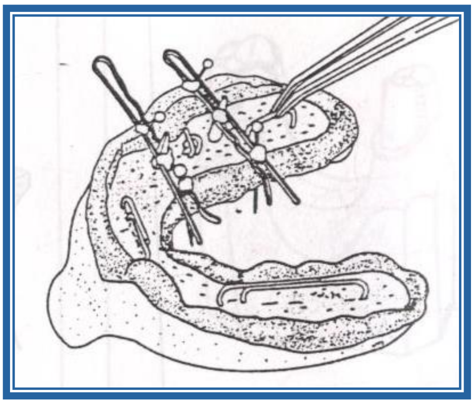
1- Dry the impression.

2- Dowel pin is used for each prepared tooth; it is placed over the center of the prepared tooth parallel to its long axis. We use bobby pin to hold dowel pin in such position by placing it between its arms. The bobby pins then positioned buccolingually across the imp. So that the dowel pin will be centered directly over the prepared tooth. Straight paper pin then is inserted between the arms of bobby pin and into the imp material buccally and lingually.

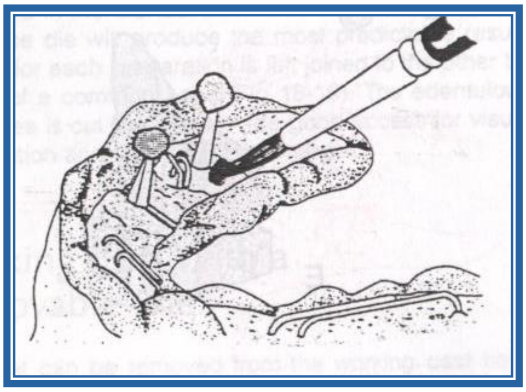


3- Stabilize the dowel pin in the bobby pin and the bobby pin itself against the straight pin with sticky wax.

4- Place the tray over the vibrator, add stone in small increments to about 2mm above the cervical margin (it should cover the serrated end of dowel pin).

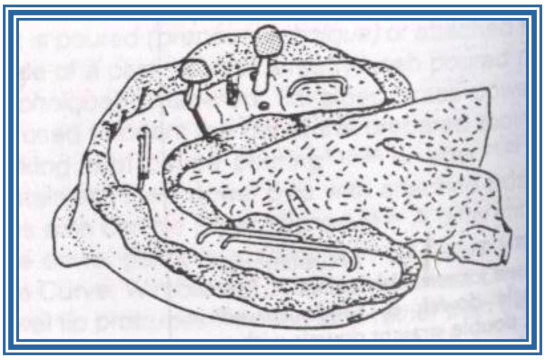


5- A retentive means is placed (paper clips) in the stone before it SSTs to provide retention to the



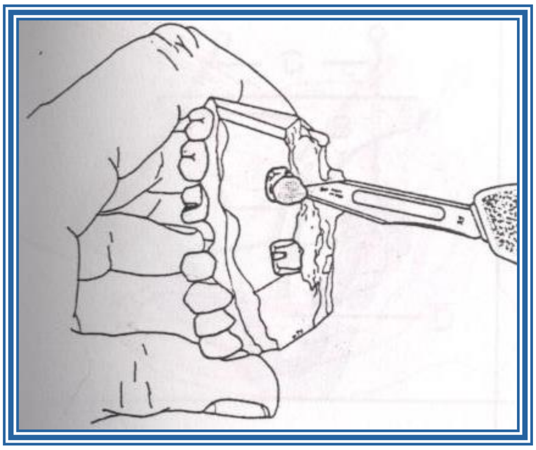
second layer (base) which will be placed later.

6- When stone is set remove the bobby pin and paper pins from the impression. A ball

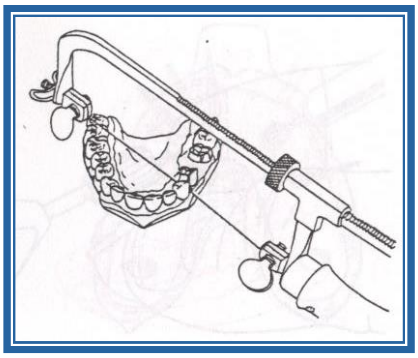


of soft wax is placed on the tip of each dowel.

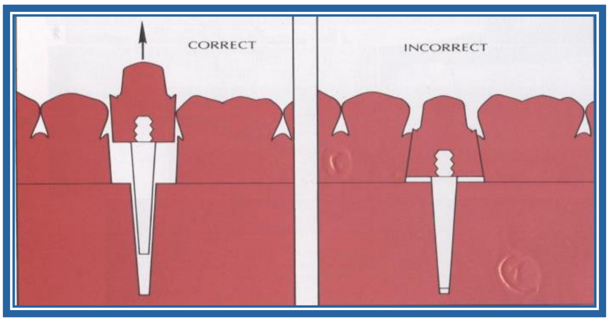
7- Lubricate the surface of the first layer with separating medium. Now pour the 2nd layer (base) with stone till the dowel is completely covered with stone.

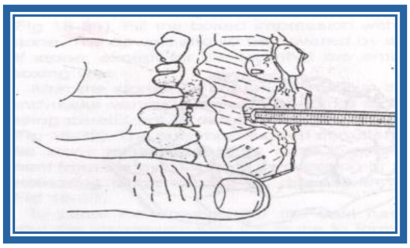


8- After complete setting of stone, remove the cast from the imp. Then using sharp knife remove the wax ball from the end of the dowel pin. Section the proximal sides, (mesial and distal) of the prepared tooth using saw in bucco-lingual direction to obtain the die. The cut should be through the 1st layer only, and the cutting should be diverging toward the occlusal surface. Otherwise it is difficult to remove the die.



9- Gently tap on the end of dowel (after removal of the ball of soft wax) with hand instrument to loosen the die.





Reference:

Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Lecture: 13 **Dr. Farid**

FAILURES IN CROWN AND BRIDGES

Every dentist would like to be able to answer the patient questions: how long will the crown or bridge lost? Because crown and bridge are a custom made device of a daily use and perform their service in a hostile biological environment submerge in water (saliva), and the failures more liable to occur.

Failures can be grouped into 6 categories, with severity increasing from Class I to Class VI

Class I: Cause of failure is correctable without replacing restoration.

Class II: Cause of failure is correctable without replacing restoration; however, supporting tooth structure or foundation requires repair or reconstruction.

Class III: Failure requiring restoration replacement only, supporting tooth structure and/or foundation acceptable.

Class IV: Failure requiring restoration replacement in addition to repair or reconstruction of supporting tooth structure and/or foundation.

Class V: Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Fixed prosthodontic replacement remains possible through use of other or additional support for redesigned restoration.

Class VI: Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Conventional fixed prosthodontic replacement is not possible.

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- **LOSS OF RETENTION:**

A good diagnostic test for a loose retainer is to examine the bridge carefully without drying the teeth, pressing the bridge up and down and looking for small bubbles in the saliva at the margin of the retainers.

The possible causes of retention loss are:

1- Deformation of the metal cast on the abutment teeth.

2- Inadequate tooth preparation.
3- Bad technique of cementation:
- Inadequate isolation. - Poor mixing or using improper ratio.
- Not removing any remnants that interfere with retention.
- Movement of the patient during cementation.
4- Solubility of the cement due to open margin or perforation in the bridge
5- Caries which cause leakage at the margin.
6- Over much spacer materials on the die.
- When only one retainer become loose without a cement seal, plaque forms in the space between the retainer and the abutment tooth and caries develops rapidly across the whole of the dentine surface of the preparation.

- **MECHANICAL FAILURES OF CROWN AND BRIDGE COMPONENTS**

Typical mechanical failures are:

1- Porcelain fracture. 2- Failure of solder joints. 3- Distortion 4- Occlusal wear and perforation. 5- Lost facings.

1// Porcelain fracture:

It is fracture of pieces of porcelain in metal ceramic crowns, or the loss of the entire facing due to failure of metal- ceramic bond. It is due to:

1- Inadequate thickness of metal.
2- Excessive thickness of porcelain contributes to inadequate support predisposes to eventual feature. This is often true in the cervical portion of a pontic.
3-The metal surfaces to be veneered not smooth and not free of surface pits or irregularities will cause incomplete wetting by the porcelain slurry, leading to voids at the porcelain metal interface that reduce bond strength and increase the possibility of mechanical failure.
4- Sharp angles on the veneering area must be avoided; they produce increased stress concentrations that could cause mechanical failure.
5- Excessive occlusal function or trauma.
6- Improper laboratory procedures.

All Porcelain Crown or Bridge Fracture:

Stresses are developed within porcelain jacket crowns as a result of contraction on cooling after the firing cycle. These Stresses produce failure if the crown is subjected to sufficient force. These Stresses are concentrated around sharp internal angle of fit surface (so should be rounded). If the fracture is due to trauma, and particularly if the restoration had served successfully for some time, it should be replaced by another all ceramic restoration. if the failure occurs during normal function, the replacement should be metal ceramic.

2// Failure of solder joints:

Occasionally a solder joint that appears to be sound fails under occlusal loading, this may be due to:

a) A flaw or inclusion in the solder itself.

b) Failure to bond to surface of the metal.

c) The solder joint not being sufficiently large for the conditions in which it is placed.

A problem, particularly with metal-ceramic bridge work, is that too much restriction of the solder connectors, buccally, gingivally and incisally can lead to inadequate area of solder failure.

It is better to join multiple unit bridges by solder joints in the middle of pontics before the porcelain is added, strengthened by porcelain covering.

There are no satisfactory intraoral repair methods, and it is not possible to re-solder (whole bridge has to be remade).

3// Distortion:

Distortion of all metal bridges may occur, for ex. hygienic. Pontics are made too thin or if a bridge removed using too much force when this happen the bridge has to be remade.

In metal ceramic bridges distortion of the framework can occur during function, or as result of trauma. This is likely if the framework is too small in cross section for the length of span and the material used.

4// Occlusal wear perforation:

a) In sufficient occlusal preparation lead to less thickness of the metal and this may lead to perforation, which may occur in the finishing and polishing.

b) Even with normal attrition, the occlusal surfaces of teeth wear down substantially over a lifetime.

If perforation has been the result of normal wear and it is spotted before caries has developed, it may be repaired with an appropriate restoration.

5// Lost Facings:

Laboratory made ceramic or acrylic facing, may be entirely lost. With acrylic facing, wear and discoloration are also common.

The causes:

1. Poor retention. 2. Heavy occlusion on the facing.

3. The facing is not protected by the metal completely.

- **Changes in the abutment tooth:**

A\\ Periodontal Disease:

Periodontal disease may be generalized, or in a poorly designed, made or maintained restoration, its progress may be accelerated locally, If the loss of periodontal attachment is diagnosed early enough, and the cause removed, no further treatment is usually necessary.

However, if the disease has progressed to the point where the prognosis of the tooth significantly reduced then the crown or bridge, or the tooth it may have to be removed.

Most the clinical and laboratory causes are:

1 - Position of the crown margin subgingival margin may have better appearance initially but will often a degree of gingival inflammation which may lead to more serious periodontal disease.

2- Thick margins with poor seating of the restoration and poor axial contour that will ultimately cause periodontal problem.

3- Over margin which lead to a pressure on the gingiva.

4- Coarse or rough margins (not smooth).

5- Remnants of excessive cementing material.

B\\ Problems with the pulp: -

Great care is needed to prevent pulp injuries during fixed Prosthodontic procedures, the main causes of injury are:

1- Temperature during tooth preparation.

2- Chemical irritation by dental material.

3- Microorganisms. 4- Recurrent caries.

5- More reduction of tooth structure without provisional restoration. Every one of them can cause irreversible pulpits.

C\\ Fracture of the prepared natural crown or root:

Fractures of the tooth may be occurring as a result of:

1- Trauma. 2- Recurrent caries.

3- Removing the prosthesis intact with using large force.

4- Tooth structure is thin, especially with pulp less teeth (so the post core is necessary).

D\\ Recurrent caries:

May be due to:

1- Over extension of the margin, will cause plaque formation and periodontal problem due to resorption of the cement which close the space between the cast teeth.
2- Short casting will leave rough cementum or dentin which causes collection of debris.

3- Open margin will allow the saliva and cariogenic organisms to enter between the tooth the restoration.
4- Wearing of the cast will cause resorption of the cement, exposure of the tooth surface which causes caries later on.
5- Looseness of one of the retainers. 6- Poor oral hygiene of the patient.
7- Using a wrong type of retainer.
Dental caries is the most common cause of failure of a cast restoration. Its detection can be very difficult particularly with complete crown.
The caries is often detected only after irreversible pulp involvement had resulted.
Disease may rapidly progress to the point, where tooth loss or the fabrication of a new prosthesis becomes inevitable.
The cause of the problem should be identified dealt with before repair or replacement is started.

- **Design Failures:**

A)) Abutment preparation

Inadequate crown preparation is a common cause of failures:

1- Taper of preparation when it exceeds 20˚ (ideal 5˚ – 10˚) failure through loss of retention.
2- Improper path of insertion lead to the finished restoration can not be seated.
3- In sufficient reduction at the margin can result an over built crown produce a plaque retention area at the margin.
4- The un rounded external angles of crown preparation man lead to:
a- The stone die materials may not flow into the sharp angles of the impression producing bubbles.
b- The sharp edges may be damaged at the wax up stage.
c- Investment material may not flow adequately into the wax pattern.
d- It may be difficult to remove entirely the investment material from sharp internal angles without damaging the casting.
e- Cement will flow less readily around sharp angles increasing the likelihood of unnecessary thick cement layer at the margins.

B)) Inadequate bridge Designs:

Designing bridges is difficult; it is neither a precise science nor a creative form of art. It needs knowledge, experience judgment, which takes years to accumulate. Simple classification of these failures is:

1- Under-prescribed bridges.

These include designs that are unstable or have too few abutment teeth for ex**:** a cantilever bridge carrying pontics that cover too long span, or a fixed-movable bridge where again the span is too long, or where abutment teeth with too little support has selected.

2 -Over-prescribed bridges:

The dentists sometimes include more abutment teeth than are necessary retainer which fails:

* The 1st lower premolar might be included as well as the 2nd premolar 2nd molar in a bridge to replace the lower 1st molar, this is not necessary.

* Upper canines and both premolars on each side are replacing the four incisors. As well as being destructive, or this gives rise to unnecessary practical difficulties in making bridge.

The retainers themselves may be over prescribed with complete crowns being used where partial crowns or intra-coronal retainers would have been quite adequate or metal-ceramic crowns might be used where all metal crowns would have been sufficient.

- **Inadequate clinical or laboratory technique.**

It is helpfully to allocate problems in the construction of crowns and bridges to one of three groups: Minor problems to be noted and monitored but where on action is needed, the type of inadequacies that can be corrected in site, and those that can not.

1- Marginal Deficiencies:

a- ***positive ledge (overhang*)**:** A positive ledge is an excess of crown material protruding beyond the margin of the preparation. These are more common with porcelain than any other margins. This easy to recognize and correct before the crown then without other-wise disturbing the restoration.

b- Negative ledge:

This is deficiency of crown material that leaves the margin of the preparation exposed but with no major gaps between the crown and the teeth. It is a fairly common fault, particularly with metal margins, but that is difficult or impossible to correct at the try-in stage **causes:**

1- The impression did not give a clear enough indication of the margin of the preparation.
2- The die was over-trimmed, resulting in under-extension of the retainer.
3- The die is not separated.

Supragingival margin or just at the margin, it is possible to adjust the tooth surface of the crown.

Subgingival margin can be adjusted with a pointed stone, although this will cause gingival damage. However, the best solution is remade the restoration.

2- Marginal discrepancy:

Fitness is the gap between the crown and preparation margins; there are four possible causes of improper fitness:

1. The crown or retainer did not fit and the gap was present at try-in (faults during waxing or impression taking).
2. The crown or retainer fitted at try-in but at the time of cementation the hydrostatic pressure of the cement, particularly if the cement was beginning to set, produced incomplete seating.
3. With a mobile bridge or splint abutment, the cement depressed the mobile tooth in its socket more than the other abutment teeth, thus leaving the gap.
4. No gap was present at time of cementation but one developed following the loss of cement at the margin and crevice has been created by a combination of erosion, abrasion and possibly caries. For these cases, the choice is to remove the bridge, restore the gap with a suitable restoration or leave it alone and observe it periodically.

3 - Poor shape or color (esthetic problems):

1. A common mistake in preparing upper incisors for crowns is to remove in sufficient material from the buccal \ incisal third of the preparation. These result in either a crown that is too thin, so that the opaque core material shows through, or in a bulbous crown.
2. Insufficient thickness of porcelain.
3. Too much adjustment is done, the incisal shade of porcelain will be ground away and the esthetic effect spoiled.
4. The stone should be held perpendicular to the junction otherwise the metal particles may contaminate the porcelain.
5. Absent the embrasures will recognize the teeth as artificial
6. Excessive glazed anterior teeth will look unnatural.
7. Inaccurate shade selection.

Any problem in the waxing may create a problem on the final restoration such as:

1. When the wax pattern left of the die lead to distortion because stresses occur in the wax as a result of the heating and manipulation of the wax during fabrication.
2. Wax pattern should be over sized slightly mesiodistally finishing and polishing without creating an open contact in the finished restoration.
3. Most common error relating to axial contour is the creation of bulge or excessive convexity leading to accumulation of food debris plaque causing gingival inflammation, which is encouraged rather than prevented.
4. During the margin finishing, don’t approach the finishing line on the die with sharp instrument that can remove die material causing the final restoration will not fit on the prepared tooth. The margins are a critically area of any wax pattern.

5. Any roughness in the wax near the margin leads to plague irritation and inflammation of adjacent gingival tissues.

***4. Poor investing and casting procedures**:*

1. Vacuum mixing of investment materials highly recommended for obtaining consistent results in casting with no surface defects, especially when phosphate bonded investment are being used.
2. Cooling and reheating of the investment can cause casting inaccuracy, since the refectory and binder will not revert to their original forms. Inadequate expansion and cracking of the investment are typical results.
3. Excessive burn out temperature has led to increased surface roughness on this casting.
4. Alloys from different manufacturers when they mixed even if they are similar leading to defect in the casting. Over heated or otherwise abused alloys as well as grinding and old restorations are best returned to the manufacturer as scarp rather than reused.

5. Defects in the casting:

<u>a- Nodules</u>: bubbles of gas trapped between the wax pattern and the investment produce nodules on the casting on the casting surface. When they are large or situated in a margin, the restoration should be remade.

<u>b- Fins</u>: are caused by cracks in the investment that have been filled with molten metal. These cracks can result from:

1. Weak mix of investment (high water \ powder ratio)
2. Excessive casting force.
3. Steam generated from to rapid heating.
4. Reheating invested pattern.
5. Improperly situated pattern (too close to the periphery of the casting ring).
6. Premature rough handling of the ring after investing.

c*<u>- Incompleteness</u>*:

1- If an area of wax is too thin (less than 0.3 mm) incomplete casting may result (veneering surface of a metal ceramic restoration).
2- Inadequate heating of the metal.
3- Incomplete wax elimination.
4- Excessive cooling (freezing) of the mold.
5- Insufficient casting force.
6- Not enough metal or metal spillage.

d- Voids or porosity:

Voids may be caused by debris trapped in the mold, commonly a particle of the investment. A well waxed small sprue will help prevent them. Porosity resulting from:

1. Solidification shrinkage occurs if the metal in the sprue solidifies before that in the mold, as may happen when a sprue is too narrow, too long, or incorrectly located or a large casting is made in absence a chill vent.
2. Gases may dissolve in the molten alloy during melting leave porosity defects.
3. Back pressure porosity may be caused by air pressure in the mold as the molten metal enters.

Reference: Contemporary Fixed Prosthodontics

Lecture: 12

RESIN-BONDED
FIXED PARTIAL DENTURES

Dr. Farid

INTRUDUCTION

One of the disadvantages of conventional fixed partial dentures is the destruction of tooth structure required for the abutment preparations upon which the retainers will be placed.
The patient usually asks "it is really necessary to cut away that entire good tooth?" This question troubled dentists in prescribing the replacement of a missing tooth.

Some dentists have tried to minimize the problem by eliminating one of the abutment teeth and fabricating a cantilever fixed partial dentures. While this type of restoration does have its place in carefully selected situations, it is discriminate use can result in failures that are costly both in money spent for subsequent replacement and in loss of periodontal support around previously sound teeth.

Others have tried to use unilateral removable partial denture to avoid undesirable destruction of tooth structure, but these are usually wanting in both retention and stability, and may present the risk of aspiration if they become dislodged.

The development of acid etching of enamel to improve the retention of resin has proven to be a means of attaching fixed partial dentures to teeth by less destructive means.
First trials were consisting of attaching acrylic resin pontic to an unprepared tooth using a composite bonding resin, as intermediate replacement of a missing tooth.

METAL FRAMEWORK

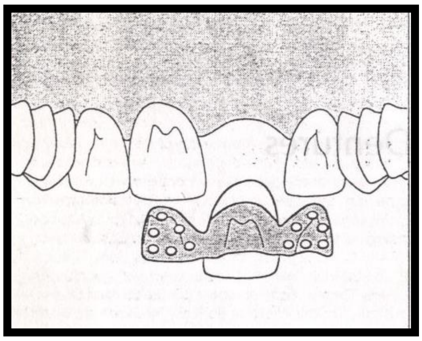
The addition of a metal substructure and "wings" or retainers, extending onto the abutment teeth was a logical progression in the development of the restoration.

The Classification of Resin-Bonded Fixed Partial Dentures: -

1. *ROCHETTE BRIDGE.*
2. *MARYLAND BRIDGE.*
3. *CAST MESH FPD.*
4. *VIRGINIA BRIDGE.*
5. *ADHESION BRIDGE.*

These classifications are reflection of the metal surface finishing technique employed.

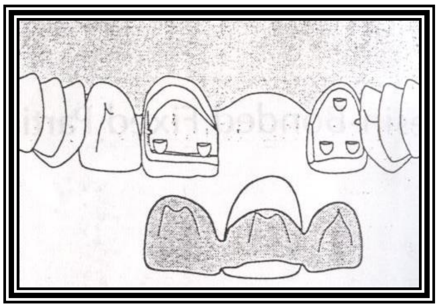
ROCHETTE BRIDGE:



First used by Rochette in 1973. It consists of a wing like retainer attached to the pontic, with funnel-shaped perforations through the wing (retainer) to enhance resin retention (mechanical retention in addition to application of a saline coupling agent to produce adhesion to the metal).

Used for both anterior and posterior fixed partial dentures.

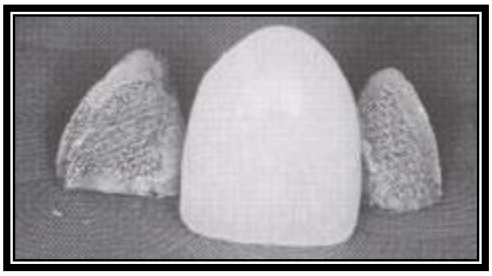
MARYLAND BRIDGE:

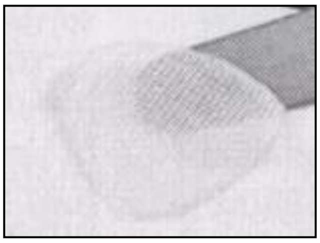


The searchers postulated that the retentive resin extruding through the perforated framework in Rochette design were exposed to increased stresses as well as abrasion and leakage that diminished their longevity.

The new design of the wing is perforation free, and the retention to the resin could obtained by producing micro-spaces in the wing (retainer) internal surface through various ways such as electrochemical pit corroding technique (metal etching).

CAST MESH FPD:





In this design, they used a non-etching method to produce metal surface roughness before the alloy is cast. A ready made net-like nylon mesh can be placed over the lingual surfaces of the abutment teeth on the working cast. It is then covered by and incorporated into the retainer wax pattern, with the undersurface of the wing (retainer) becoming a mesh-like surface when the retainer is cast.

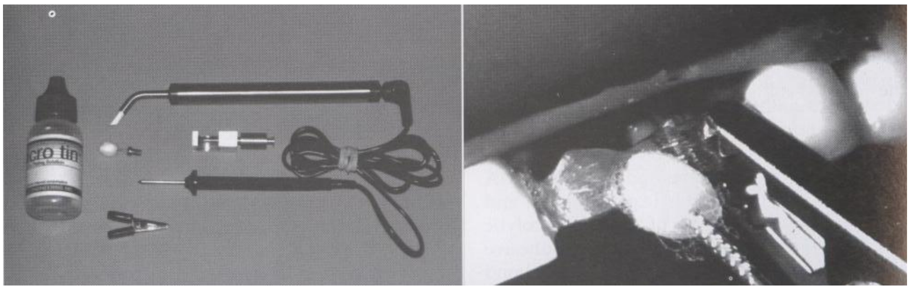
VIRGINIA BRIDGE:

This design produced particle-roughened retainers by incorporating salt crystals into the retainer patterns to produce roughness on the inner surfaces; this method is known as the lost salt technique for producing Virginia bridges.

The framework is outlined on the die with a pencil, and the area to be bonded is coated first with model spray and then with lubricant, then salt crystals (NACL) ranging in size from 149-250Mm are sprinkled over the outlined area. The retainer pattern is fabricated from resin, leaving a 0.5 to 1.0mm wide, crystal free margin around the outlined area. When the resin has polymerized, the patterns are removed from the cast, cleaned with a solvent, and then placed in water in an ultrasonic cleaner to dissolve the salt crystals. This leaves cubic voids in the surface that are reproduced in the cast retainers, producing retention for the fixed partial denture.

Adhesion Bridge

In this design there is no need to made any surface modification before casting, after casting, we clean the surfaces with air abrasion, then prepare the retainer inner surface for adhesion by various methods such as tin plating which carried intraorally. The bond in this design depends on the inherent bond ability of the newer resin cement to the alloy.



Advantages of Resin-Bonded Fixed Partial Dentures

1- Reduced cast and chair time by as much as 50 percent.
2- Conservative, minimum tooth structure needs to be removed; the preparation is confined to enamel only.
3- Anaesthesia is not used during tooth preparation (aid to monitor the proximity of the preparation to the DEJ by the patient comfort’s level).
4- Supragingival margin is mandatory in resin-bonded fixed partial dentures.
5- The restoration can be rebounded.

Disadvantages

1- Uncertain longevity, the longevity of the prostheses is less than that for conventional prostheses.
2- Irreversible.
3- No space correction, if the edentulous space is wider than the mesiodistal width of the tooth that would normally occupy the space.
4- No alignment correction, good alignment of the abutment teeth is required because the prosthesis’s path of insertion is limited by enamel thickness.
5- Difficult temporization.

Indications:

- ***Mandibular incisor replacements***

It is the treatment of choice for replacing one or two missing mandibular incisors when the abutment teeth are undamaged.

- ***Maxillary incisor replacements***

In case of moderate overbite.

- ***Periodontal splint***

The splinting of periodontally involved teeth was the first use of resin-bonded fixed partial dentures.

- **Single posterior tooth replacements**

Contraindications

✓ ***Extensive caries***

Because it covers relatively little surface area and relies on bonding to enamel for its retention.

✓ ***Deep vertical overbite***

So much enamel must be removed from the lingual surface of a maxillary incisor in this occlusal relationship, the retention would be drastically reduced because of the poor bonding strength afforded by the exposed dentin.

Tooth Preparation

The tooth preparation includes axial reduction and guide planes on the proximal surfaces with a slight extension onto the facial surface to achieve faciolingual lock.

The preparation should encompass at least 180 degrees of the tooth to enhance the resistance of the retainer.

The preparation must be extended as far as possible to provide maximum bonding area, there should be a finish line which is a very light chamfer and should be placed about 1.0 mm supragingivally.

Occlusal clearance which is about O.5mm is needed on maxillary incisors, the thickness of enamel on the lingual surfaces of maxillary anterior teeth are shown in the table.

Tooth	Millimeters from cementoenamel junction					
	1	2	3	4	5	6
Central incisor	0.3	0.5	0.6	0.7	0.7	0.7
Lateral incisor	0.4	0.5	0.5	0.6	0.7	0.7
Canine	0.2	0.4	0.6	0.7	0.9	0.9

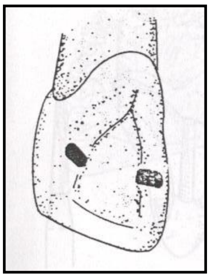
Vertical stops are placed on all the preparations. On the lingual surface of maxillary incisor two or three flat countersinks are placed.

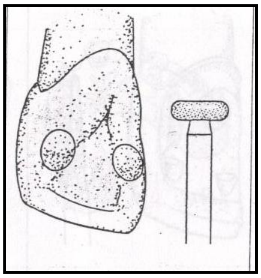
The cingulum rest seat on canine, or an occlusal rest seat on a premolar or molar are contributing to both resistance and rigidity.

The resistance features normally are grooves.

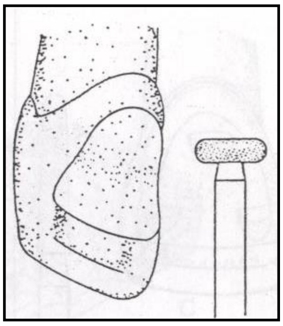
Preparation Sequence: for maxillary incisor.

1. The centric occlusal contacts are marked with articulating paper. To ensure adequate occlusal clearance in this area, use a small wheel diamond to remove 0.5mm of tooth structure, this step is necessary only on maxillary anterior teeth.

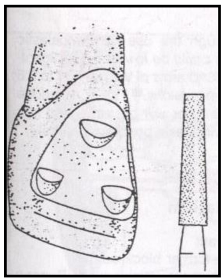




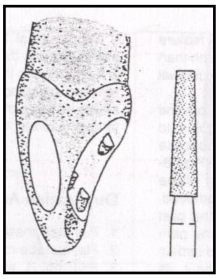
2. Wheel diamond bur is also used to create a concave reduction on the entire cingulum surface, producing 0.5mm of lingual clearance. End this reduction 1.5 to 2.0mm from the incisal edge.



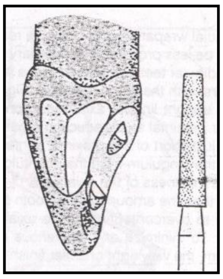
3. Use a flat-end tapered diamond to prepare flat notches or countersinks on the lingual surface of the tooth to provide resistance to gingival displacement.



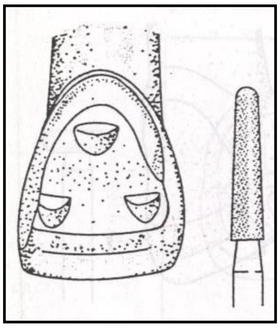
4. Proximal reduction on the surface adjacent to the edentulous space is done with a tapered diamond, as follows: -



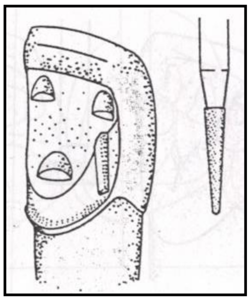
A. Producing a small plane that extends slightly facial to the facio-proximal line angle. This helps produce facial wraparound to enhance resistance.



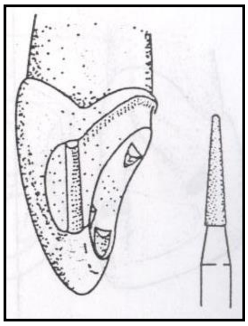
B. A second plane is produced lingual to the first with the same diamond.



5. Light upright lingual axial reduction is done from bi-planar proximal axial reduction around the cingulum to appoint just short of the proximal contact on the opposite side of the cingulum from the edentulous space.



6. A short groove is placed at the facial most extension of the reduction on the opposite side of the cingulum with a short needle diamond.



The same diamond used to place a groove in the vicinity of the wraparound or break between the facial and lingual planes of proximal axial reduction adjacent to the edentulous space.

Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Lecture: 11 **Dr. Farid**

ALL-CERAMIC RESTORATION

It is the most esthetically pleasant prosthodontic restorations. Because there is no metal to block light transmission, they can resemble natural tooth structure better in terms of color and translucency than any other restorative option.

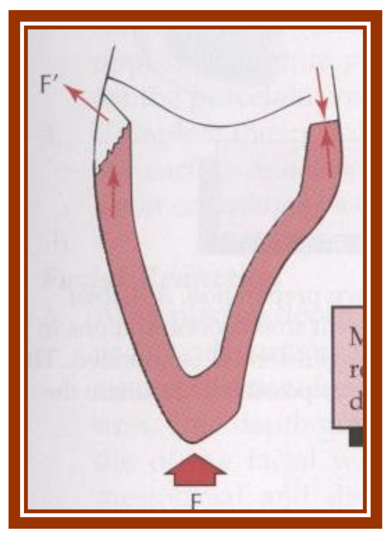
Their chief disadvantage is their susceptibility to fracture, although this is lessened by use of the resin – bonded technique.

Differ from other cemented crowns because it is not cast in gold or other metal. It is capable of producing the best cosmetic effect of all dental restorations. However, since it made entirely of ceramic, a brittle substance, it is more susceptible to fracture.

Complete Ceramic Crowns: -

Preparation design of this type should give maximum support to the porcelain.

Design features that give maximum support to the porcelain.



- Preparations should be left as long as possible. An overshortened preparation will create stress concentrations in the labiogingival area of the crown, which can produce a characteristic 'half –moon' fracture in the labiogingival area of the restoration.
- A shoulder of uniform width 1 mm is used as gingival finish line to provide a flat seat to resist forces directed from the incisal. A 90-degree shoulder (cavosurface angle) is needed to prevent unfavorable distribution of stresses.
- The incisal edge is flat and placed at a slight inclination toward the linguogingival to meet forces on the incisal edge and prevent shearing.
- All sharp angles of the preparation-should be rounded to reduce the danger of fracture caused by points of stress concentration.

Advantages: -

- Superior esthetics, excellent translucency.
- Good tissue response.
- Labially more conservative than metal – ceramic crown (lack of reinforcement by a metal substructure permits slightly more conservative reduction of the facial surface than is possible with the metal – ceramic crown, although the lingual surface needs additional reduction for strength).
- The appearance of the complete restoration can be influenced and modified by selecting different colors of luting agent.

Disadvantages: -

1- Reduced strength due to absence of reinforcing metal substructure.

2- Because of the need for a shoulder type margin circumferentially, significant tooth reduction is necessary on the proximal and lingual aspects. Porcelain brittleness, when combined with the lack of a reinforcing substructure, requires a circumferential support with a shoulder. Thus, by comparison, the proximal and lingual reductions are less conservative than those needed for a metal- ceramic crown.

3- Remember the “Un forgiving” nature of porcelain if an inadequate tooth preparation goes uncorrected, can result in fracture

4- All –ceramic crowns are not effective as retainers for a fixed partial denture: although the strongest systems may be suitable for anterior application the brittle nature of porcelain requires that connectors of large, cross-sectional dimensions (minimum of 4x4mm) be incorporated in the FPD design typically this leads to impingement on the interdental papilla by the connector, with increased potential for periodontal failure.

INDICATIONS:

1- High esthetic requirement.

2- Considerable proximal or facial caries, that no longer be effectively restored with composite resin.

3- Relatively intact incisal edge. Thickness of porcelain should not exceed 2mm; otherwise, brittle failure of the material will occur.

4- Favorable distribution of occlusal load. Centric contacts are best confined to the middle third of the lingual surface, leaving the crown out of contact is not recommended, future eruption may lead to protrusive interference, which results in fracture.

CONTRAINDICATION:

1- When a more conservative restoration can be used.

In molar rarely we use all ceramic crowns because the increased occlusal load and the reduced esthetic demand make metal-ceramic crown the treatment of choice.

2- Teeth with short clinical crown don't have enough preparation length to support the lingual and incisal surface of the restoration.

3- Thin teeth faciolingually.

4- Bruxism.

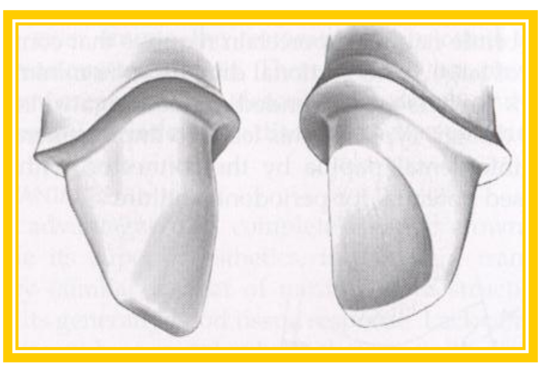
5- Should be avoided on teeth with an edge-to-edge occlusion that will produce stress in the incisal area of the restoration, also it should not be used when the opposing teeth occludes on the cervical fifth of the lingual surface tension will produced…half-moon fracture.

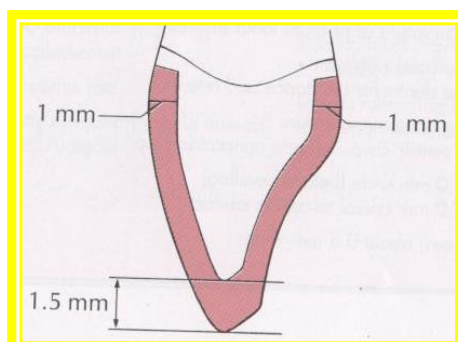
PREPARATION:

The preparation sequence for a ceramic crown is similar to that to that for a metal-ceramic crown; the principle difference is the need for a 1-mm-wide shoulder circumferentially.

All-ceramic crown made over shoulder finish line exhibit greater strength than those made over chamfer.

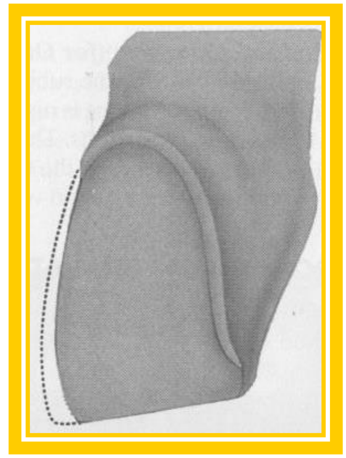
Care must be taken not to create undercuts in the axial walls where they join the shoulder.





Porcelain laminates veneers

It consists of thin shell of porcelain applied directly to tooth structure; it is a conservative method of restoring the appearance of discolored, pitted, or fractured anterior teeth. It consists of bonding thin ceramic laminates onto the labial surfaces of affected teeth.



Uses:

1- Improve the color of stained teeth.

2- Alter contours of misshapen teeth.

3-Close inter proximal spaces.

Advantages:

1- Conservative of tooth structure.

2- Wear and stain resistance.

Esthetic veneers should always be considered as a conservative alternative to cemented crowns and have largely replaced M-C-crowns for the treatment of multiple discolored but otherwise sound teeth.

Disadvantage

1- Increase tooth contour.

2- The main disadvantage is the difficulty in obtaining restoration that is not excessively contoured.

Preparation: -

Preparation is minimal and remaining within enamel,

Step –by- step procedures:

The gingival third and proximal line angles are often over contoured with these restorations. Therefore, maximum reduction should be achieved with minimum penetration into the dentin.

1- Make a series of depth holes with a round bur, the required amount of reduction will depend on the extent of discoloration. A minimum of 0.5mm is usually adequate. The reduction should follow the anatomic contours of the tooth.

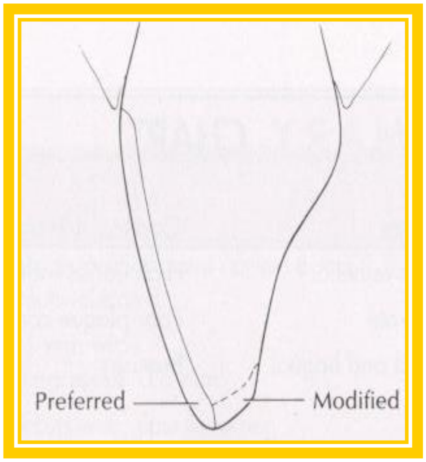
2- Place the (long chamfer) margin. This design has an obtuse cavo-surface angle which exposes the enamel prism ends at the margin for better etching.

3- Wherever possible, place the preparation margin labial to the proximal contact area to preserve it in enamel. Sometimes the proximal margins are extended lingually to include existing restoration.

4- If possible, do not reduce the incisal edge, this helps support the porcelain and makes chipping less likely.

- If the incisal edge length is to be increased, the preparation should extend to the lingual, care is taken to avoid undercuts with this modification.

5- To prevent areas of stress concentration in the porcelain, be sure that all prepared surfaces are rounded.



Reference: Contemporary Fixed Prosthodontics

CROWN AND BRIDGE

Lecture: 10 **Dr Farid**

Ceramics and metal-bonded ceramics

The word ceramic is derived from the Greek word keramikos, which literally means 'burnt stuff' but which has come to mean more specifically a material produced by burning or firing.

Composition of traditional dental porcelain:

The main ingredients are feldspar, silica, kaolin and pigments, only the purest ingredients are used in the manufacture of dental porcelain

The improved translucency of the modern dental ceramic materials was mainly achieved by the lowering of the kaolinites content or its complete removal from the composition.

1- Kaolin

Kaolin is a hydrated alumino-silicate. Only the purest clay or kaolin is used in porcelain. Kaolin gives porcelain its properties of opaqueness, when mixed with water, it becomes sticky and aids in forming a workable mass at the porcelain during molding.

2- *Silica*

Pure quartz crystals ($SiO2$) are used in dental porcelain, silica remains unchanged at the temperature normally used in firing porcelain, and this contributes stability to the mass during heating by providing a framework for other ingredients.

3- Feldspar

Feldspar is the lowest fusing component and it is this which melts and flows during firing, uniting the other components in a solid mass.

Natural feldspars are mixtures of albite Na2AL3 Si_6O_{16} and orthoclase K2AL7Si6O16 with free crystalline quartz. These feldspars are never pure and the ratio of soda (Na_2O) to potash (K_2O) may vary quite considerably, for dental purposes, high potash content feldspar is generally selected because of its increased resistance to pyro-plastic flow.

Feldspar contains oxides of both potassium and sodium; these break down the Si-O network and thus are known as glass modifiers.

Two consequences result:

1. The softening temperature of the glass is reduced.
2. The coefficient of thermal expansion is increased and extensive breakdown of the Si-O network may occur, and devitrification results from crystallization of the glass. This occurs if porcelain is fired too often, and it is typically associated with loss of physical properties and appearance

4- Pigments

The coloring pigments added to the porcelain mixture are called "color frits", they are prepared by grinding together metallic oxides with fine glass and feldspar, these frits are added in small quantities (less than 1%) to obtain the delicate shade necessary to imitate the natural teeth.

Types of porcelain

*According to the firing temperature porcelain is classified as:

A. High – fusing: 1290 to 1370C (2350 to 2500F).

B. Medium – fusing: 1090 to 1260C (2000 to 2300F).

C. Low – fusing: 870 to 1065C (1600 to 1950F).

D. Ultra – low fusing < 850C (1562F).

High–fusing porcelains are considered superior in strength, solubility, translucency, and maintenance of accuracy in form during repeated firing. Low firing temperatures are a definite assist in the fusion of porcelain to metal, since the differences in the coefficients of expansion of the porcelain and metal can be tolerated better at lower temperature ranges. The low–fusing and ultra–low–fusing porcelains are used for crown and bridge construction, some of the ultra–low–fusing porcelains are used for titanium and titanium alloys because of their low – expansion coefficients that closely match those of the metals and because the low firing temperature reduces the risk for growth of the metal oxide. One problem regarding low–fusing porcelains lies in their surface and color stability.

low–fusing porcelain was developed to offset the major disadvantages of traditional dental porcelains representing a major change in direction, one of the basic differences between this formulation and those that have been used for long periods of time is a significant reduction in the firing temperature being as 760C for a newer type (finease) versus around 940C for conventional type. It permits the clinician to generate a highly polished surface at chair side, thereby eliminating the need for reglazing after possible adjustments.

Another advantage regarding low–fusing porcelain reported was the less potential for abrading any materials against which it occludes.

Properties of porcelain

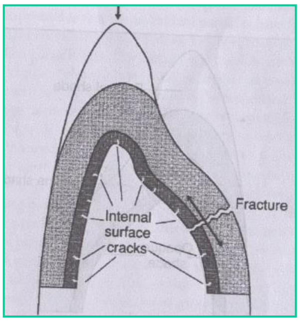
- ✓ Dental porcelain provides excellent aesthetics that do not deteriorate with time. Unfortunately, its brittleness, low tensile and shear strengths render the porcelain restoration liable to fracture during mastication. Brittle dental ceramics are incapable of absorbing appreciable amounts of elastic strain energy before fracture.

✓ It is available in a range of shades and at various levels or translucency such that a most life-like appearance can be achieved.

✓ Although the compressive strength of dental porcelain is high, its tensile strength is very low, which is typical of a brittle solid. Porcelain (glasses) is extremely sensitive to the presence of surface microcracks. The superficial cracks which result due to thermal stresses are best avoided by slow cooling from the firing temperature.

Fracture can be initiated from the followings: -

❖ Small surface scratches in the outer surface caused by grinding and these should be eliminated by smoothing or by further fusing.



❖ Cracks in porcelain crowns invariably initiate from the inner, unglazed fitting surface and propagate outwards towards the exposed surface material.

❖ The brittleness of dental ceramics is compounded by their tendency to undergo ' static fatigue'. This is time-dependent decrease in strength, even in the absence of any applied load. The process is thought to occur through alkaline hydrolysis of Si-O groups within the porcelain structure. Alkalinity within the material results from a solubilization of Na20 and K20 which forms part of the feldspathic component of porcelain. Dynamic mechanical loading further accelerates the weakening and the whole process has been likened to stress corrosion cracking, which can occur with metals and alloys. Attempts to overcome some of these problems involved reducing the proportions of Na20 and K20 within the materials.

✓ Porcelain is compatible with soft tissue and it possesses high wear resistance

✓ Porcelains are poor conductors and therefore are excellent insulators for the abutment teeth against thermal and electrical shock. This fact is of importance when gross amounts of enamel and dentine are to be replaced and the residual layer of dentine may be of minimal thickness.

- ✓ Correctly formulated porcelain is very resistant to chemical attack, being unaffected by the wide variations of pH which may be encountered in the mouth.
- ✓ The relatively poor mechanical properties of porcelain can be improved using alumina, or metal supporting structures: -

A. Alumina inserts and aluminous porcelain:

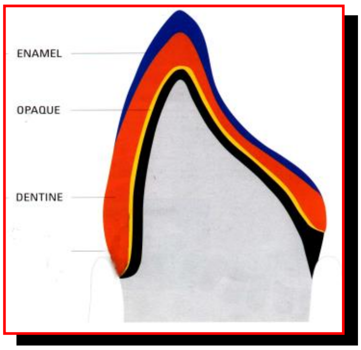
The major disadvantage of porcelain is brittleness and this is the factor, which most limits its use. Several methods are available which are aimed at preventing the formation or propagation of cracks on the inner surface of porcelain restorations.

- One approach is to use a core of pure alumina on which the porcelain crown is constructed. Alumina particles is a very hard (stronger than the glass), opaque material which is less susceptible to crack propagation (crack stoppers) than porcelain.
- Powdered alumina may be added to porcelain in order to achieve a significant strengthening. The mechanism of strengthening is that the alumina particles act as 'crack stoppers' preventing the propagation of a crack throughout the body of the porcelain.

B. Metal bonded porcelain

It involves a marrying of the good mechanical properties of casting dental alloys with the excellent aesthetic properties of porcelain.

Types of porcelain:



1- **Opaque porcelain**: It is applied as a first ceramic layer and performs two major functions: it masks the color of the alloy, and it is responsible for the metal ceramic bond.
2- **Body porcelain**: this is fired onto the opaque layer, usually in conjunction with the incisal porcelain. It provides some translucency and contains oxides that aid in shade matching. Body porcelains are available in a wide selection of shades, to match adjacent natural teeth.
3- **Incisal porcelain**: this is rather translucent; as a result, the perceived color of the restoration is significantly influenced by the color of the underlying body porcelain.

The Alloy-Porcelain Bond Mechanism

A proper bond between the porcelain and the alloy is one that is stronger than the porcelain itself; therefore, the porcelain rather than the bond will fail cohesively.

An understanding of the bonding mechanisms is essential for successful metal–ceramic restoration.

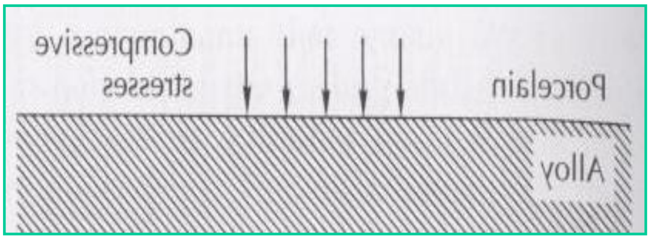
Mechanisms have been described to explain the bond between the ceramic veneer and the metal substructure: -

A. Mechanical entrapment

By interlocking the ceramic with microabrasions in the surface of metal coping, takes place by penetration of the porcelain within the roughness of the casting surface which is produced by finishing the metal with non contaminating stone or disc and air abrasion.

B. Compressive forces (Physical Bonding)

This bond is developed by a properly designed and a slightly higher coefficient of thermal expansion for the metal coping than for porcelain veneered over it. This will cause porcelain to “draw” toward the metal coping when the restoration cools after firing, so the porcelain will be firmly bounded to the metal .



C. Chemical bonding

Metal and porcelain react chemically in an oxidizing atmosphere at approximately 1000^{o}C to bond together. It is indicated by the formation of an oxide layer on the metal.

It is the ability of the fused porcelain to absorb ions from the metal that produces a chemical bond between a metal and porcelain (migration of indium or tin to the alloy surface to form an oxide that combines with the porcelain during its firing). The alloy must contain at least one component that will be soluble in the fused porcelain without losing its contact with the basic chemical structure of the metal.

Requirements of the alloys:

1- The alloy, having been previously cast into the desired shape, should be capable of withstanding porcelain firing without melting or suffering creep. Hence the alloy must have a high fusion temperature.
2- The alloy should be sufficiently rigid to support a very brittle porcelain veneer otherwise a fracture of the veneer is inevitable.
3- The alloy should be capable of forming a bond with the porcelain veneer in order that the latter does not become detached.
4- The alloy should have a value of coefficient of thermal expansion similar to that for the porcelain to which it is bonded.

Reference: Contemporary Fixed Prosthodontics

Crown and Bridge

Lecture: 1 **Dr. Farid**

An introduction to fixed prosthodontics:

The scope of fixed prosthodontic treatment can range from the restoration of a single tooth to the rehabilitation of the entire occlusion. Single teeth can be restored to full function, and improvement in cosmetic effect can be achieved. Missing teeth can be replaced with fixed prostheses that will improve patient comfort and masticatory ability, maintain the health and integrity of the dental arches, and in many instances, elevate the patient's self-image.

Steps in crown construction:

1- Diagnosis
2- Tooth Preparation.
3- Final impression.
4- Temporary restoration (Crown).
5- Construction of working model.
6- Waxing.
7- Investing.
8- Wax Elimination.
9- Casting.
10- Finishing and polishing.
11- Cementation of the restoration

History:

A patient history should include all necessary information concerning the reasons for seeking treatment, along with any personal details and past medical and dental experiences that are pertinent. It is important that a good history be taken before the initiation of treatment to determine if any special precautions are necessary.

Chief complaint

The accuracy and significance of the patient's primary reason(s) for seeking treatment should be analyzed first. This may be just the tip of the iceberg and careful examination will reveal problems and disease of which the patient is often unaware: nevertheless, the patient perceives this chief complaint as the major problem. The inexperienced clinician trying to prescribe an "ideal" treatment plan may lose sight of the patient's wishes.

Chief complaints usually fall into one of the following four categories:

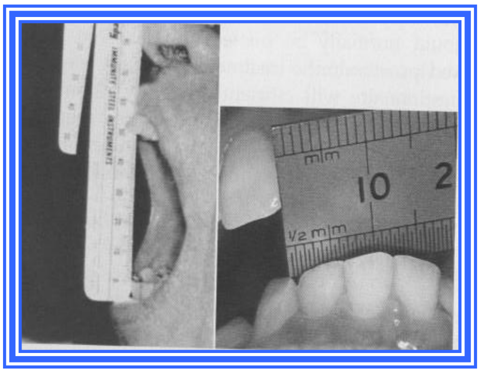
- Comfort (pain, sensitivity, swelling)
- Function (difficulty in mastication or speech)
- Social (bad taste or odor)
- Appearance (fractured or unattractive teeth or restorations, discoloration)

Extra oral examination

- ***Evaluation of the TMJ:***

The clinician locates the **TMJs** by palpating bilaterally just anterior to the auricular tragic while having the patient open and close. With light anterior pressure helps identify any potential disorder in the posterior attachments of the disc.

Tenderness, clicking, or pain on movement is noted, maximum jaw openining of less than 40mm indicates restriction, because the average openining is greater than 50mm. Any deviation from midline is also recorded. Maximum lateral movement can then be measured (normal is about 12mm)



- **Muscles of mastication.**

Many patients suffer from muscle pain as a result of parafunctional jaw activity related to stress or sensitivity to faults in their occlusion. Habits such as clenching the teeth and "playing with the bite" during the course of the daily routine may result in fatigue and muscle spasm.

Observe the physical appearance and activities of this type of patient. Many times they will have a square-jowled appearance, with masseter muscles that are over-developed from hyperactivity. They may be clenching their teeth even as they converse with you. A brief palpation of the masseter, temporalis, medial pterygoid, lateral pterygoid, trapezius, and sternocleidomastoid muscles may reveal tenderness. Palpation is best accomplished bilaterally and simultaneously. This allows the patient to compare and report any differences between left and right side to the clinician. The patient may demonstrate limited opening due to spasm of the masseter and/or temporal muscles. This can be noted by asking the patient to open "all the way". If it appears that the opening is limited, ask the patient to use a finger to indicate the area that hurts. If the patient touches a muscle area, as opposed to the TMJ, there is probably some dysfunction of the neuromuscular system.

- **LIPS.**

The clinician next observes the patient for tooth exposure during normal and exaggerated smiling. This may be critical in treatment plannining and particularly for margin placement of metal-ceramic crowns. Some patients show only their maxillary teeth during smiling. More than 25% do not show the gingival third of

the maxillary central incisors during an exaggerated smile. The extent of the smile will depend on the length and the mobility of the upper lip and the length of the alveolar process.

When the patient laughs, the jaws open slightly and a dark space is visible between the maxillary and mandibular teeth. This has been called the negative space. Missing teeth, diastemas, and fractured or poorly restored teeth will disrupt the harmony of the negative space and often require correction.

Intra oral Examination:

The patient's general oral hygiene…

❈ The amount of plaque on the teeth.

❈ The existence of pockets should be entered in the record and their location and depth charted. The presence and amount of tooth mobility should be recorded.

❈ The condition of prospective abutment teeth, note the presence and location of caries, the areas of gingival lesions and decalcification, and evaluation of plaque retention, can offer some prognosis for the new restorations. It will also help to determine the preparation designs to be used.

❈ Previous restorations and prostheses should be examined carefully, to determine their present suitability or their need to be replaced. The age of existing restorations can help establish the prognosis and probable longevity of any future fixed prosthesis that may be indicated.

Evaluation of occlusion:

The patient's occlusion must be evaluated to determine if it is healthy enough to allow the fabrication of such restorations. If the occlusion is within normal limits, then all treatment should be designed to maintain that occlusal relationship.

If the occlusion is dysfunctional in some manner, further appraisal is necessary to determine whether the occlusion can be improved prior to the placement of the restorations or whether the restorations can be employed in the correction of the occlusal problem.

- **Initial tooth contact (centric relation)**

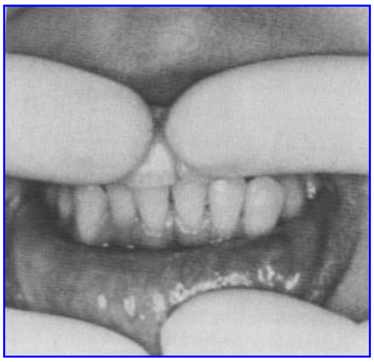
The relationship of teeth in both centric relation and the intercuspal position should be assessed. The centric relation position (CR) of the patient should coincide with the maximum intercuspation (MI).

- **General alignment**

The teeth are evaluated for crowding, rotation, supra-eruption, spacing, and malocclusion.

Tipped teeth will affect tooth preparation design or in severe cases, need for minor tooth movement before restorative treatment.

- **Lateral and protrusive contacts**



In the presence or absence of tooth contact in eccentric movements, teeth may exhibit hypermobility, open contacts, or abnormal wear. Hypermobility of an individual tooth or opposing pair of teeth is called (fremitus), which often an indication of excessive occlusal force. Such contacts frequently can be detected by placing the tip of the index finger in the mucobuccal fold over the root portion of the mobile tooth and asking the patient to tap the teeth together

Diagnostic casts:

Articulated diagnostic casts can provide a great deal of information for diagnosing problems and arriving at a treatment plan.

They allow an unobstructed view of the edentulous spaces and an accurate assessment of the span length, as well as the occlusogingival dimension. The curvature of the arch in the edentulous region can be determined, so that it will be possible to predict whether the pontic(s) will act as a lever arm on the abutment teeth.

The length of abutment teeth can be accurately gauged to determine which preparation designs will provide adequate retention and resistance.

The true inclination of the abutment teeth will also become evident. Mesiodistal drifting, rotation, and faciolingual displacement of prospective abutment teeth can also be clearly seen.

Full-mouth radiographs (periapical series):

Radiographs are the final aspect of the diagnostic procedure. The radiographs should be examined carefully for:

❈ Signs of caries, both on unrestored proximal surfaces and recurring around previous restoration.

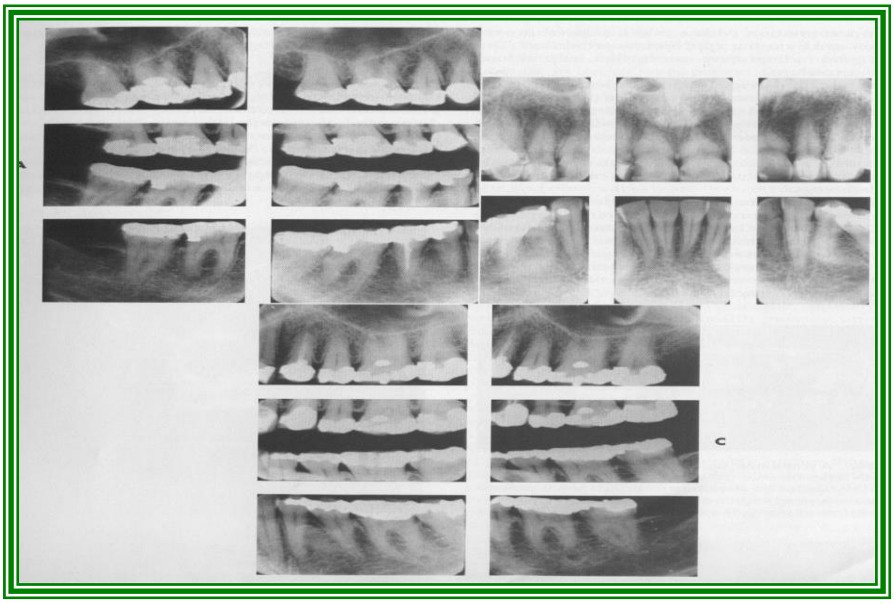
❈ The presence of periapical lesions, as well as existence and quality of previous endodontic treatment, should be noted.

❈ General alveolar bone levels, with particular emphasis on prospective abutment teeth, should be observed.

❈ The crown-root ratio of abutment teeth can be calculated.

❈ The length, configuration, and direction of those roots should also be examined.

❈ The presence of retained root tips or other pathosis in the edentulous areas should be recorded.



Reference: Contemporary Fixed Prosthodontics

lec.9/ 5th stage L. AYAD MAHMOOD

Restoration of Endodontically Treated Teeth

Teeth requiring endodontic treatment need to be assessed restoratively prior to initiating endodontic care. The canals may be identified, instrumented, and obturated successfully, but if the tooth cannot be predictably restored, the clinical success is guarded.

After endodontic treatment, restoration of root filled teeth can be challenging due to structural differences between vital and non-vital root filled teeth. Irreversible chemical—physical (dehydration of dentin; reduction of micro-hardness; collagen alteration; effects of irrigants and medicaments) and especially bio-mechanical changes (loss of tooth structure; loss of proprioception), due to the endodontic treatment, increase the propension to dental fracture and condition the restoration options for the clinician. Restoring a tooth after endodontic treatment needs to conserve as much remaining tooth structure as possible. Posterior teeth should be restored with restorations that cover and protect the occlusal surface of the tooth as onlay. Crown coverage of teeth is only indicated when the tooth has multiple large restorations or it lost great amount of tooth structure.

Types of treatments according to tooth loss

1- Direct Composite Restorations

When a minimal amount of coronal tooth structure has been lost after endodontic therapy, a direct resin composite restoration can be done. Composites have compressive strengths of about 280 MPa, and the Young modulus of composite resins is generally about 10 to 16 GPa, which is close to that of dentin.

Endodontic treatment that has both marginal ridges intact and only the endodontic access is not native tooth structure or a very limited occlusal restoration was present may be restored with an adhesive composite as the final restoration. Those teeth may be treated by removal of the obturation material to the canal orifice or several millimeters apical to the canal orifice, followed by an adhesively bonded composite restoration. Any preparation that is deeper than 6 mm will not permit adequate light intensity from the curing light to complete polymerization of the resin in the preparation.

Due to the depth of the composite to be placed, use of a dual-cure resin is recommended to ensure complete curing of the resin. Utilization of an adhesive that is either self-cure or has a dual-cure promoter is also recommended, as the curing light may be unable to reach the depths of the preparation and leave uncured adhesive, limiting the bond of the overlaying composite to the remaining dentin. Since self-cure and dual-cure composites often are more opaque when set, esthetics may be improved by overlaying the final 2 mm with a light-curable composite if required or desired.

2- Indirect Restorations: Composite or Ceramic Onlays.

Ceramic or resin composite onlays can be used to restore endodontically treated teeth. Endocrowns combine the post in the canal, the core, and the crown in one component.

Both onlays and endocrowns allow for conservation of remaining tooth structure, whereas the alternative would be to completely eliminate cusps and perimeter walls for restoration with a full crown.

Onlays are constructed in the laboratory from either hybrid resin composite or ceramics. Onlays, overlays, and endocrowns can also be fabricated from resin composites processed in the laboratory. Using various combinations of light, pressure, and vacuum, these fabrication techniques may increase the conversion rate of the polymer and consequently the mechanical properties of the restorative material.

There is no clear evidence to favour ceramic or composite resin inlays, but composite resin onlays—overlays are, in general, less expensive and easier to prepare and repair.

When one marginal ridge is intact but the other is missing, a restoration that will limit cuspal flexure is indicated. If the missing tooth structure at the center of the occlusal surface is less than one-third of the buccal-lingual width of the tooth, an onlay may be chosen for restoration of the tooth, as this provides cuspal shoeing that will limit flexure and potential cuspal fracture.

Premolars have a narrower mesial-distal dimension than molars and are more prone to cuspal fracture when the marginal ridges are not native tooth structure.

3- Full Crowns

when a significant amount of coronal tooth structure has been lost by caries, restorative procedures and endodontics, a full crown may be the restoration of choice.

The crown can be directly built on the remaining coronal structure which has been prepared accordingly. More frequently, the cementation of a post inside the root canal is necessary to provide retention for the core material and the crown. The core is anchored to the tooth by extension into the root canal through the post and replaces missing coronal structure. The crown covers the core and restores esthetics and function of the tooth. An additional role of the post and core is to protect the crown margins from deformation under function therefore preventing coronal leakage. The post and its luting material used to cement it, the core and the crown will all influence the longevity of the tooth.
When a post is needed it gives retention to the core but it does not strengthen the tooth against fracture especially metal posts. Adequately condensed gutta-percha can be safely removed immediately after endodontic treatment. Both rotary and hot instruments can be safely used to remove gutta-percha. Tapered posts are the least retentive posts and threaded posts are the most retentive but these threads increase the possibility of stress concentration at the edges of the post and end in root fracture.

When greater than one-third of the occlusal width is missing, or both marginal ridges are not native tooth structure, a fullcoverage crown is the best restoration. In those situations, typically a post is needed to retain the core, as minimal tooth structure will be present following preparation for a crown. The practitioner may view the tooth as having sufficient tooth structure so that a post is not required, but the remaining native tooth structure lies on the buccal and lingual of the tooth, and the majority of this will be removed with the crown preparation.

The Ferrule

A ferrule effect is defined as a 360^0 metal collar of the crown surrounding the parallel walls of the dentine extending coronal to the shoulder of the preparation. The result is an elevation in resistance form of the crown from the extension of dentinal tooth structure before any core material begins.
If the clinical situation does not permit a circumferential ferrule, an incomplete ferrule is considered a better option than a complete lack of ferrule.
The more tooth structure that remains, the better the long-term prognosis of the restoration. The coronal tooth structure located above the gingival level will help to create a ferrule. The ferrule is formed by the walls and margins of the crown, encasing at least 2 to 3 mm of sound tooth structure. A

properly made ferrule significantly reduces the incidence of fracture in endodontically treated teeth by reinforcing the tooth at its external surface and dissipating forces that concentrate at the narrowest circumference of the tooth. A longer ferrule increases fracture resistance significantly. The ferrule also resists lateral forces from posts and leverage from the crown in function and increases the retention and resistance of the restoration.

In teeth with no coronal structure, in order to provide a ferrule, the clinician may consider two options: surgical crown lengthening or orthodontic extrusion. In such a clinical situation, an adequate ‘‘biologic width’’ and distance between crown margin and alveolar crest should be ensured. Biological width was defined as ‘‘the dimension of the junctional epithelial and connective tissue attachment to the root above the alveolar crest’’.

Requirements of crown shape and crown preparation;
1. The ferrule (dentin axial wall height) must be at least 2 to 3 mm.
2. The axial walls must be parallel.
3. The restoration must completely encircle the tooth.
4. The margin must be on solid tooth structure.
5. The crown and crown preparation must not invade the adjacent tissues.

Posts

A post is a rigid restorative device placed in the radicular portion of non-vital teeth. During the restoration of an endodontically treated tooth, a post may be required. Its success depends on the quality of endodontic treatment, shape of the canals, status of the remaining tooth structure, and the periodontal support available.
Dentin has a degree of flexibility and posts can be flexible material can behave exactly like dentin, a post with functional behavior similar to that of dentin is beneficial when the post must be placed next to dentin.
Fiber posts have a modulus of elasticity closer to dentin than that of the metal posts. An ideal post should be resilient enough to cushion an impact by stretching elastically, thereby reducing the resulting stress to the root. It would then return to normal without permanent distortion. Therefore, the perfect post would combine the ideal degree of flexibility and strength in a narrow-diameter structure.

Classification of posts

1- Custom made posts (gold or base metal alloys)
2- Prefabricated posts
a) Metal (gold, stainless steel or titanium posts)

b) Carbon fiber
c) Glass fiber
d) Quartz
e) Zirconia

Posts should provide as many of the following clinical features as possible:

1- Maximal protection of the root from fracture
2- Maximal retention within the root and retrievability
3- Maximal retention of the core and crown
4- Maximal protection of the crown margin seal from coronal leakage
5- Pleasing esthetics, when indicated
6- High radiographic visibility
7- Biocompatibility

Procedure for post space preparation and post placement

1- Take an x ray to evaluate the condition, length and width of the tooth.
2- Preserve as much as possible of the tooth structure coronally but at the same time offers an easy access of the Pesso drill to the root canal.
3- The gutta-percha is removed by the Pesso drill with as minimum tooth structure removal as possible.
4- A suitable sized post should be placed to fit the space in the root canal.
5- The post is cemented in the root canal with a luting agent (composite luting cement or glass ionomier cement) in the root canal.
6- The core is built up with a suitable material as composite or amalgam.

The material used to lute the post into the root is dependent on the type of post. A luting material that works with metallic posts may not be recommended for fiber posts. It is universally recommended that fiber posts require luting with a resin material. Glass ionomer does not provide adhesion between the cement and post of sufficient bond strength to prevent disruption of the interface under function. Glass ionomer cements do not provide adequate pull-out strength of the post from the tooth and may lead to restorative failure over time. Resin cements have been reported to provide twice the pull-out strength of glass ionomers. With this in mind, use of resin cement is recommended when placing a fiber post.

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ENDODONTICS

Lec.8/ 5th stage ***L. AYAD MAHMOOD***

Apical third filling

The rational behind root canal obturation has inclined toward mechanical rather than biological treatment.

It has been recognized for decades that the ideal end results of root canal therapy would be the closure of apical and all lateral foramina with reparative cementum. This permits re-establishment of a complete attachment apparatus and precludes future failure caused by pulpo-periodontal fluid exchange and retro invasion of bacteria.

The apical barrier must be biocompatible with tissues and ideally, should stimulate closure or sealing of the root canal at its most apical extent. The barrier should also have a good sealing ability and must provide a resistant wall against which filling materials can be compacted or condensed. Clinically, the intentionally placed apical barrier is designed to prevent the overextension toxic material into the periradicular tissues and to separate these toxic materials from contact with vital tissue.

Dentin chips apical:

As the quest for more biologically compatible materials continues, the interest in using dentin fillings placed as an interface between the periapical tissue and the endodontic filling material is continued. Dentinal plugs inadvertently formed, even when clinician was trying to avoid forming them, seemed to create an effective apical barrier against which healing could occur. Probably, some of the so-called “miraculous cures” occur periradicularly, to the prepared but unfilled canals, because the apical foramina have actually been obturated by dentin chips from the preparation.

After the canal is totally debrided and shaped, a Gates-Glidden drill or Hedstrom file is used to produce dentin powder in the central position of the canal. These dentin chips may then be pushed apically with the butt end and then the blunted tip of a paper point. They are finally packed into place at the apex using a pre-measured plugger or file one size larger than the last apical enlarging instrument. One to two millimeters of chips should block the apical foramen. Completeness of density is tested by resistance to perforation by a No. 15 or 20 file. Finally, the gutta-percha is then compacted against the plug. Care should be taken during plug production not to perforate or weaken the canal wall.

Calcium hydroxide:

Calcium hydroxide $Ca(OH)^2$ was first introduced by Hermann in 1930 as a pulp-capping agent. He demonstrated the ability of the pulp to build a dentinal bridge adjacent to calcium hydroxide as an apparent healing process. Today calcium hydroxide occupied a prominent position as a versatile medicament for use in endodontics.

Calcium hydroxide has been used in endodontics as a root canal filling material or as a sealant in conjunction with the solid core material.

The pure calcium hydroxide powder can be used with normal saline, methylcellulose, intracanal medicament or local anesthetic solutions. The pH of all these mixtures has been found to be similar to a range of 12.3-12.5. The exact mechanism of action of calcium hydroxide is unknown. Several factors have been suggested to be responsible for the action of calcium hydroxide. The hydroxyl group is considered the most important component as it provides an alkaline environment, which is antibacterial and induces superficial necrosis of adjacent tissue. This necrotic tissue seems to be the template upon which a calcified barrier is formed. The alkalinity of calcium hydroxide has also been suggested as promoting hard tissue formation by stimulation of enzymes such as alkaline phosphatase and inhibition of osteoclastic acid phosphatase.

Calcium hydroxide can be placed as an apical plug in either dry or moist state. Dry calcium hydroxide powder may be deposited in the coronal orifice from a sterilized amalgam carrier or endodontic messing gun. The bolus may then be forced apically with a pre-measured plugger and tapped to place with the last size apical file that was used.

Moist Calcium hydroxide can be placed in a number of ways: with amalgam carrier and plugger, with a lentulo spiral, or by injection from one of the commercial syringes loaded with calcium hydroxide like calacept.

Kerr and Madison reported that the placement of calcium hydroxide powder with messing gun had several advantages:

- Greater control in the placement of the powder, thereby minimizing undesirable overfills.
- Greater powder density in the canal thereby minimizing voids.
- Greater ease in preparation
- Greater ease in placement in a short period of time.

MTA: a new endodontic material

Introduction:

Mineral trioxide aggregate (MTA) is a material recently developed by Dr. Mahmoud Torabinejad at Loma Linda University School of Dentistry. MTA (contain trace amounts of SiO2, CaO, MgO, K2SO4, and Na2SO4) is FDA approved and is commercially available as ProRoot MTA (Tulsa Dental Products, Tulsa, OK). The material has undergone extensive research for its sealing ability and biocompatibility. MTA can be used for vital pulp therapy, an apical barrier in teeth with open apices, repair of root perforation, root-end filing, coronal barrier prior to internal bleaching, and possibly other applications.

Composition and characteristics:

MTA is a powder composed of several mineral trioxides with bismuth oxide as the main radio-opaque. Hydration of MTA leads to a colloidal gel, which cures in approximately four hours. MTA has an initial pH of 10.2 that rises to 12.5 three hours after mixing. Its compressive strength is similar to that of super EBA(Super EBA is a reinforced zinc oxide cement based on a mixture of 32% eugenol and 68% ethoxy benzoic acid (EBA)) and IRM (IRM is zinc oxide-eugenol cement reinforced by addition of 20% polymethacrylate by weight to the powder) but it is more radio-opaque.

Biological and physical properties:

The ideal root filling and perforation repair material should provide a tight seal to prevent penetration of microorganisms and their byproducts into the periradicular tissue. The same properties are desirable for a pulp capping material to allow pulpal healing. Dyes, bacteria and their byproducts have been used to test the sealing ability of MTA. As a perforation repair material, MTA has been shown to have superior resistance to microleakage compared to IRM and amalgam. When used as a root-end filling material, studies showed that MTA provided a significantly better seal than IRM, amalgam, or super EBA.

Moisture contamination is always a concern when restorative materials are used for repair of root perforations or defects. In 1994, Torabinejad et al. conducted an in-vitro dye study of currently used root-end filling materials. They found that MTA sealed significantly better than Super EBA, IRM, or amalgam with or without blood contamination.

In-vivo and in-vitro tests have shown that MTA is biocompatible. When assessed for cytotoxicity in cell culture tests, MTA was found to be the least toxic in one cell-culture test and slightly more toxic than fresh amalgam in another cell-culture technique. In vitro tests in guinea pigs, dogs, and monkeys have convincingly demonstrated that dentin forms against MTA in vital pulp applications and cementum forms adjacent to MTA when the material is placed in root perforations and in root-end preparations.

<u>Preparation and mixing:</u>

MTA is mixed with water in a 3:1 powder/water ratio to use. The consistency of the mix can easily be altered by either adding a little extra moisture or by wicking it away. Mixing is accomplished on either wax paper or glass slab using plastic or metal spatulas. During its placement, proper moisture and hemorrhage control is essential. In wet conditions, MTA can become too soft and unmanageable. It is hydrophilic and requires the presence of moisture to set. In cases of perforation or other intra-canal use, a moist cotton pellet, for a minimum of four hours, provides the needed moisture. When used as a root-end filling, interstitial tissue fluid from the periradicular tissues serves the same purpose.

Clinical applications

Vital pulp therapy:

MTA can be used for vital pulp therapy in patients with traumatic crown fractures exposing vital pulp tissue, and in children with carious exposure of pulps in teeth with incompletely formed roots. In traumatic crown fractures, a shallow (partial) pulpotomy is performed in which MTA is placed directly against the pulp wound. In children with carious pulp exposure, usually in molars with incompletely formed roots, the coronal pulp tissue is removed, allowing placement of MTA against the pulp tissue at the floor of the pulp chamber. For the purpose of curing the MTA, moist cotton is placed against the material and covered with a temporary restoration. At a subsequent appointment, a definitive restoration can be placed directly against the cured MTA.

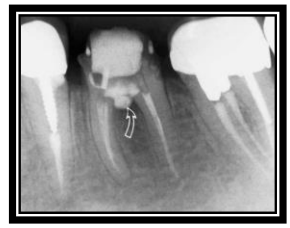
Apical barrier

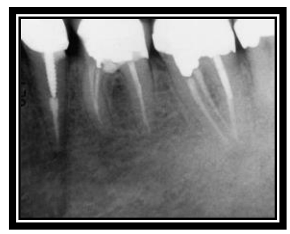
To obdurate a root canal properly, an apical barrier is indicated in a tooth with an open apex. The root canal is cleaned, shaped and disinfected prior to MTA placement. A 3-4 mm plug of MTA is placed and packed into the apical root

canal, and checked radiographically. If short, the material can be condensed further apically to a more desirable position. After placement of MTA, the material must not be rinsed, as this will result in a washout. When the MTA is set, the remainder of the root canal can be filled using a sealer and gutta-percha or filled with composite bonded resin to strengthen the root canal walls in teeth with poorly developed roots. Healing of the periradicular tissues should be monitored periodically.

Perforations

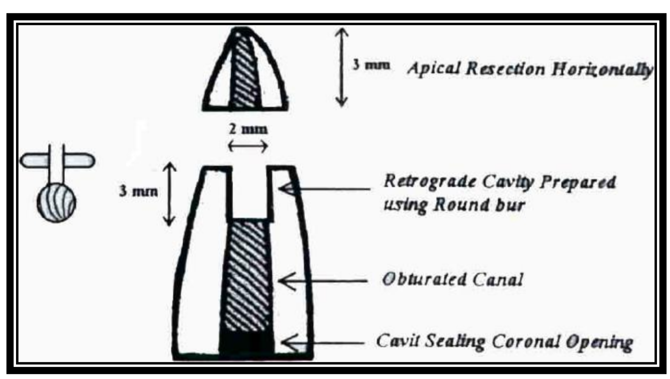
For perforation, MTA is placed such that it seals the unwanted opening to the PDL space. For apical perforation, an MTA plug is placed as described in roots with open apices. After the MTA sets, the canal space coronal to the MTA is filled using the sealer and gutta percha. In coronal canal perforations, cleaning and shaping of the apical canal space should be completed first, followed by obturation apical to the perforation site. Subsequently, the perforation site can be repaired with MTA. In cases where the apical portion of the canal cannot be obturated with gutta-percha and sealer, the entire canal can be filled with MTA. Again, the permanent restoration is placed during a subsequent visit when the MTA has fully set.





Root end filling

When used as a root-end filling material, MTA is placed into the root end cavity preparation and the excess is removed with a small piece of moist gauze. Hemorrhage is then induced to fill the bony cavity surrounding the root apex, and the flap closed. A variation to this procedure may be followed: After completion of root-end filling procedures, the surgical wound should not be irrigated because unset MTA can be able washed out of the root-end cavity preparation. To prevent such washout and still be able to irrigate the wound, MTA can be temporarily covered with Zylactin (Zila Pharmaceuticals, Phoenix, AZ) and following



irrigation, the Zylactin can be removed with a cotton pellet saturated with 100% alcohol. The soft tissue is then repositioned and sutured. Periodic monitoring of the outcome is indicated as with all surgical procedures.

Limitations

Because MTA's compressive strength is similar to that of IRM or super EBA, it is not recommended as a permanent restorative material. When used for root end fillings, it is essential to keep the field of operation dry. If the area is too wet, the material becomes very soft and unmanageable.

Set MTA shows no signs of solubility in water; it is, however, readily recorded in an acidic environment. As acids can be generated by foods, beverages, and bacteria, MTA's exposure to the oral environment is contraindicated. Because of its gray color, surrounding dentin may appear dark; therefore, its use should be carefully considered in esthetic areas.

There are several treatment options for a necrotic or infected immature permanent tooth. Traditionally, the apexification procedure has been recommended for treating an immature tooth with an open apex.

Apexification is a procedure that promotes the formation of an apical barrier to prevent the extrusion of filling materials. The most critical drawback is the reduction in root strength due to the use of calcium hydroxide, and this increases the possibility of root fracture. Another drawback is the long time span of the entire treatment.

Regenerative endodontic treatment

Regenerative endodontic treatment is a treatment procedure designed to replace damaged pulp tissue with viable tissue which restores the normal function of the pulp-dentin structure. After regenerative endodontic treatment, continued root development and hard tissue deposition on the dentinal wall can occur under ideal circumstances.

Regenerative endodontic treatment has the advantages of further root development and reinforcement of dentinal walls by deposition of hard tissue, thus strengthening the root against fracture.

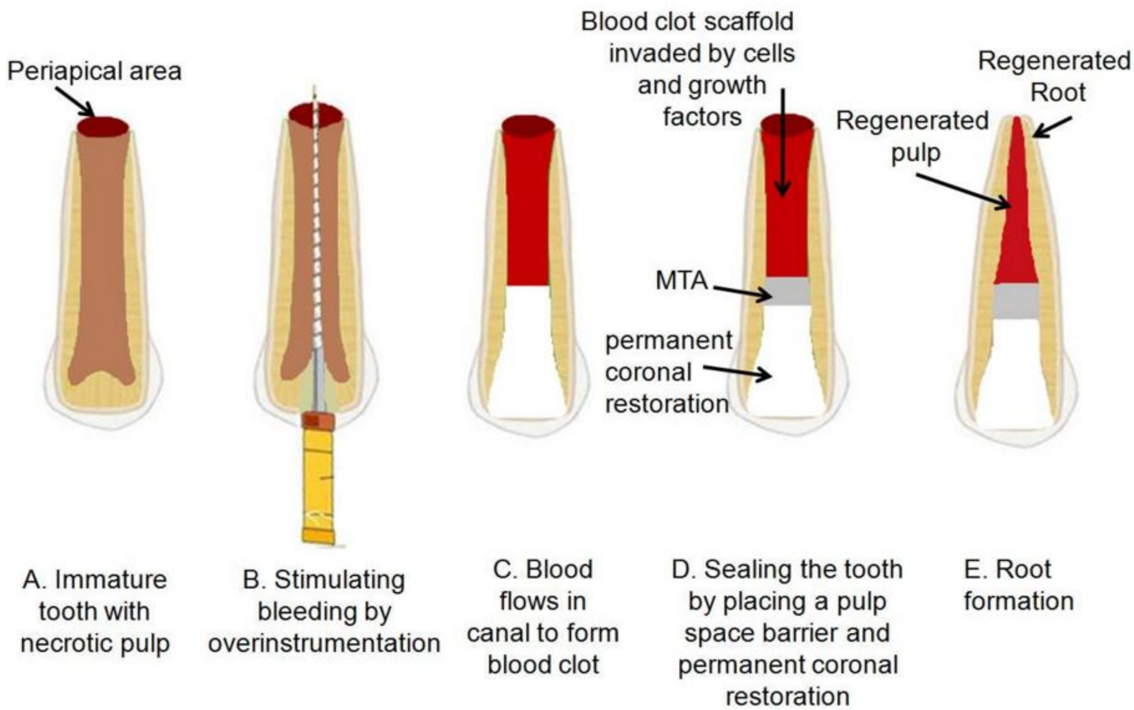
Current regimen of regenerative endodontic treatment procedures by American Association of Endodontics (AAE)

The tooth is anesthetized and isolated with a rubber dam for creating an access opening. Copious, gentle irrigation with 20 mL sodium hypochlorite (NaOCl) using an irrigation system that minimizes the possibility of extrusion of irrigants into the periapical space and lower concentrations of NaOCl are advised to minimize cytotoxicity to stem cells in the apical tissues.

The root canal is then dried with sterile paper points, and the antimicrobial medicament is applied into the canal space. A triple antibiotic paste is applied to disinfect the canal space. The triple antibiotic paste has the advantage of being a very effective antibiotic combination against intracanal microorganisms. On the other hand, calcium hydroxide has the advantage of being widely available, but it may be cytotoxic to stem cells.

At the second appointment, the patient is evaluated for resolution of signs or symptoms of an acute infection. If there are no symptoms or signs of infection, it is appropriate to proceed with the next step of the regenerative endodontic treatment.

The tooth is irrigated with 20 mL of ethylenediaminetetraacetic acid, followed by normal saline, and the antimicrobial medicament is carefully removed. After drying the canal with a paper point, a file is placed a few millimeters beyond the apical foramen and bleeding is induced up to 3 mm from the cemento-enamel junction (CEJ). To position the mineral trioxide aggregate (MTA),



Colla-Plug, which serves as a resorbable matrix, is placed into the canal. Then about 3 mm of MTA is placed, followed by placement of the final restoration. A 12 to 18-month recall is probably the minimal time to judge radiographic evidence of root development and to conduct the clinical examination.

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lec.7 / 5th stage L. AYAD MAHMOOD

Obturation of the root canal system

Objectives of canal obturation:-
1- Prevention of percolation of periapical exudates into the root canal space.
2- Prevention of reinfection of the root canal during transient bacteremia.
3- Creation of a favorable biological environment for the process of tissue healing.

Criteria for root canal obturation
1- Asymptomatic tooth.
2- Dry canal
3- No sinus tract
4- No foul odor
5- Negative culture

Heat softened gutta-percha techniques

Warm lateral condensation

This technique depends on a heated spreader to soften the gutta-percha during lateral condensation to improve the adaptation of the gutta-percha to the wall of the root canal.

Technique
1- Heating the spreader is done by hot glass beads which is then inserted in the root canal.
2- Lateral condensation is done to create space for the accessory cones.
3- This procedure is repeated until the canal is completely filled.
4- An electrically heated spreader may be used.

Warm vertical gutta-percha filling technique

It is a method of filling the radicular space in three dimensions. The canal should be with a continuously tapering funnel and keeping the apical foramen as small as possible. The armamentarium includes a variety of pluggers and a heat source.

Technique:

I- The master cone should fit short of the corrected working length (0.5 to 2 mm) with resistance to displacement. This ensures that the cone diameter is larger than the prepared canal.

2- After the adaptation of the master cone it is removed and sealer is applied in the root canal.

3- The cone is placed in the canal and a heated spreader or plugger is used to remove portion of the coronal gutta-percha and soften the remaining material in the canal.

4- A plugger is inserted into the canal and the gutta-percha is compacted, forcing the plasticized material apically.

5- The process is repeated until the apical portion has been filled.

6- The coronal canal space is back filled, using small pieces of gutta-percha. The sectional method consists of placing 3-4 mm sections of gutta-percha approximating the size of the canal into the root, applying heat, and compacting the mass with a pluggcr.

Continues Wave Compaction Technique

It is a variation of warm vertical compaction. The manufacturing of cones to resemble the tapered preparation using rotary instrumentation permits the application of greater hydraulic force during compaction when appropriately tapered plugger are used.

Technique

1- After selecting an appropriate master cone, a plugger is prefitted to fit within 5 to 7 mm of the canal length.

2- The heat source (ex. System B unit) is set to 200^0C.

3- The plugger is inserted into the canal orifice when the master cone is present in the root canal and activated to remove excess coronal material.

4- Compaction is initiated by placing the cold plugger against the gutta-percha in the canal orifice.

5- Firm pressure is applied and heat is activated with the device. The plugger is moved rapidly (I to 2 s) to within 3 mm of the binding point.

6- The heat is inactivated while firm pressure is maintained on the plugger for 5 to 10 seconds.

7- After the gutta-percha mass has cooled a 1 second application of heat separates the plugger from the gutta-percha, and it is removed.

Thermoplastic Injection Techniques

Heating of gutta-percha outside the tooth and injecting the material into the canal is an additional variation of the thermoplastic technique. This technique is used to obturate irregularities difficult to fill by other techniques as internal resorption. The obtura Ill, Calamus, Ultradent and Guttaflow devices and systems are examples of this type.

Technique:

1- Canal preparation is similar to other obturation techniques and the apical foramen should be as small as possible to prevent extrusion of gutta-percha.
2- The canal walls are coated with sealer using the master apical file.
3- A gutta-percha pellet is preheated in the gun, and the needle is positioned in the canal so that it reaches within 3 to 5 mm of the apical preparation.
4- Gutta-percha is then gradually, passively injected by squeezing the trigger of the "gun."
5- The needle backs out of the canal as the apical portion is filled.
6- Pluggers dipped in alcohol are used to compact the gutta-percha. Compaction should continue until the gutta-percha cools and solidifies to compensate for the contraction that takes place on cooling.
7- Both overextension and under extension are common results.

Carrier-Based Gutta-Percha

Thermafil and Soft Core cones were introduced as a gutta-percha obturation material with a solid core. The technique has a central plastic core which facilitates the adaptation of the α-phase gutta-percha to the root canal walls apically and laterally.

Advantages included ease of placement and the pliable properties of the gutta-percha.

Technique:

1- Size verifiers should fit passively at the corrected working length.
2- After drying the canal a light coat of sealer (Grossman sealer) is applied and a carrier is marked, set to the predetermined working length.
3- Removal of the smear layer is strongly recommended because it enhances the seal.
4- The carrier is disinfected with 5.25% NaOCI for 1 minute and rinsed in 70% alcohol.
5- The carrier is then placed in the heating device to the specified temperature.
6- When the carrier is heated, it has approximately 10 seconds to be inserted it into the canal. This is accomplished without rotation or twisting.
7- The position of the carrier is verified radiographically.
8- The gutta-percha is allowed 2 to 4 minutes to cool A before resecting the

coronal portion of the carrier.
9- Vertical compaction of the coronal gutta-percha can be accomplished.
10- An advantage to this technique is the potential for movement of gutta-percha into lateral and accessory canals but extrusion of material beyond the apical extent of the preparation is a disadvantage.

Solvent Techniques

Gutta-percha can be plasticized with solvents such as chloroform, eucalyptol, and xylol. A gutta-percha cone is softened and placed into the canal to adapt better to the root canal wall; the mass hardens as the solvent evaporates. Disadvantages of this technique include:
1- Shrinkage occurs with the evaporation process causing voids.
2- Irritation of periradicular tissues by the solvent.

Pastes

Pastes have same requirements of the root canal obturating materials. They can adapt to the complex internal canal anatomy; however, the flow characteristic can result in extrusion or incomplete obturation. Some pastes are toxic because they include paraformaldehyde therefore they are not used now.

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Root canal filling materials[1, 2]

Sealers

They are paste like material that is essential to seal the space between the dentinal wall and the gutta-percha.

Functions of the root canal sealer:

1- Cementing the core material to the canal wall.
2- Filling and marking irregularities that cannot be filled by gutta-percha (lateral and accessory canals).
3- Act as a lubricant to ease the placement of the master cone.
4- Act as a bactericidal agent.

Properties of an ideal Sealer:

1- Exhibits tackiness when mixed to provide good adhesion.
2- Produce a hermetic seal.
3- Radiopaque.
4- Very tine powder to get a smooth mix with the liquid.
5- No shrinkage on setting.
6- No staining of tooth structure.
7- Bacteriostatic.
8- Exhibits a slow set.
9- Insoluble in tissue fluids.
10- Tissue tolerant.
11- Soluble in common solvents.

Zinc Oxide and Eugenol:

Zinc oxide-eugenol sealers have been used for many years. They have certain properties as:

1- Exhibit a slow setting time.
2- Shrinkage on setting.
3- Solubility especially when extruded outside the root canal.
4- Stain tooth structure.
5- It has antimicrobial activity.

Types of zinc oxide eugenol sealers:

1- Rickert sealer. This powder/liquid sealer contains silver particles for radiopacity. It stains tooth structure if not completely removed. This sealer is popular when using thermoplastic techniques.

2- Procosol sealer. It is a modification of rickert's formula in which the silver particles have been removed.

3- Roth's sealer. This is a modification of the Rickert' sealer as it is no staining.

4- Tubli-Seal. It is a catalyst/base zinc oxide-eugenol sealer. It has a faster setting time when compared with the liquid/powder sealers.

Calcium Hydroxide Sealers:-

They were developed for their antimicrobial activity and osteogenic-cementogenic potential. These actions were very limited. From the types of this group are Sealapex (catalyst/base system), Apexit and Apexit Plus.

Noneugenol Seaters:-

They are root canal sealers without the irritating effects of eugenol.

Glass lonomer Seaters:-.

The glass ionomers have been developed in root canal obturation because of their dentin-bonding properties. An example from this group is Ketac-endo.

Properties of this group:

1- It enables adhesion between the material and the canal wall.

2- It is difficult to properly treat the dentinal walls in the apical and middle thirds with modifying agents to receive the glass ionomer sealer.

3- It has minimal antimicrobial activity.

Resin resin sealers.

These sealers provide adhesion, and do not contain eugenol.

Types of this group are:

1- Ah-26. It is a slow-setting epoxy resin that releases formaldehyde when setting.

2- Ah Plus. It is a modified formulation of Ah-26 in which formaldehyde is not released. It exhibits a working time of approximately 4 hours.

3- EndoreZ. It is a methacrylate resin with hydrophilic properties. When used with endoreZ resin-coated gutta-percha cones the dual cure endoreZ sealer bonds to both the canal walls and the core material.

4- Diaket. It is a polyvinyl resin sealer.

5- Epiphany and RealSeal. They were introduced for use with the resilon filling material.

Silicone Sealers.

1- RoekoSeal is a polyvinylsiloxane that is supposed to expand slightly on setting.

2- GuttaFlow is a cold flowable matrix that is triturated. It consists of gutta-percha added to roekoSeal. Sealing ability is comparable to other techniques.

Bioceramic sealers.

It is composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, and various filling and thickening agents.

Properties of this group:

1- It is a hydrophilic sealer it utilizes moisture within the canal to complete the setting reaction.

2- It does not shrink on setting.

3- It is biocompatible.

4- It exhibits antimicrobial properties during the setting reaction.

Semi Rigid types materials for obturation of the root canal

1- Gutta-Percha

Gutta-percha is the most commonly used root canal filling material. It is a linear crystalline polymer that melts at a set temperature, with a random but distinct change in structure resulting. It occurs naturally as 1, 4-polyisoprene and is harder, more brittle, and less elastic than natural rubber. The crystalline phase has two forms, the alpha phase and the beta phase. The alpha form is the material that comes from the natural tree product. The processed, or beta, form is used in gutta-percha for root fillings.

When heated. gutta-percha undergoes phase transitions. The transition from beta phase to alpha phase occurs at around 46° C. An amorphous phase develops at around 54° C to 600 C. When cooled very slowly gutta-percha crystallizes to the alpha phase.

Normal cooling returns the gutta-percha to the beta phase. Gutta- percha cones soften at a temperature above 64° C.

These cones can easily be dissolved in many solvents as chloroform, halothane and xylene. Modern gutta-percha cones that are used for root canal fillings contain only about 20% gutta-percha. The major component is zinc oxide (60% to 75%). The remaining 5% to 10% consists of various resins, waxes, and metal sulfate.

Antiseptic gutta-percha with various antimicrobial agents as chlorhexidine and calcium hydroxide may be seen. Gutta-percha cannot be heat sterilized, therefore NaOCl can be used to disinfect the cones by dipping them for 1 minute.
Pressure applied during root canal filling procedures does not compress gutta-percha, but rather compacts the gutta-percha cones to obtain a more three- dimensionally complete fill of the root canal system. After heating, while cooling, there is a slight shrinkage of approximately 1% to 2% when the gutta-percha has solidified.
Gutta-percha cannot be used alone as a filling material; it lacks the adherent properties necessary to seal the root canal space. Therefore, a sealer is always needed for the final seal. Gutta-percha cones are available in tapers matching the larger tapered rotary instruments (#.02, #.04, and #.06).

Advantages of gutta-percha
1- Inert
2- Dimensional stability
3- Non allergic
4- Antibacterial
5- Non staining to dentin
6- Radiopaque
7- Compactable
8- Softened by heat
9- Softened by organic solvents

Disadvantages of gutta-percha
1- Lack of rigidity
2- No adherence to dentin
3- No complete adaptation to narrow areas.

<u>2- Resilon</u>
It is a thermoplastic, synthetic, polymer-based root canal filling material. It was developed to create an adhesive bond between the solid-core material and the sealer.
Resilon can be supplied in the same ISO sizes and shapes (cones and pellets) as gutta-percha. When manufactured in cones, Resilon's flexibility is similar to that of gutta-percha. Based on polyester polymers, Resilon contains bioactive glass and radiopaque fillers (bismuth oxychloride and barium sulfate) with a filler content of approximately 65%. It can be softened with

heat or dissolved with solvents such as chloroform.

Solid type materials for obturation of the root canal

1- Semi rigid materials as silver cones which are not used now. They are flexible and fill narrow curved root canals. When silver cones contact tissue fluids or saliva, they corrode. The corrosion products are cytotoxic.

2- Rigid materials as Vitalium cones which are inflexible and were used as endodontic implants.

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Intracanal Instruments 2

Rotary Instrumentation systems using Nickel Titanium[1-3]

ProFile system

The ProFile system was introduced in 1994. ProFile instruments have increased tapers compared with conventional hand instruments.
The tips of the ProFile Series 29 rotary instruments had a constant proportion of diameter increments (29%). Cross section of a ProFile instrument has a U-shape design with radial lands. Lateral views show a 20-degree helix angle, a constant pitch, noncutting tips and with a neutral or slightly negative rake angle. This configuration facilitates a reaming action. The preferred speed is 275-325 rpm.

ProTaper Universal system.

The ProTaper system is based on another concept and composed of six instruments:
1- Three shaping files.
.2- Three finishing files.
This set is increased by two larger finishing files and a set designed for retreatment procedures.in cross section, ProTaper shows a modified K-type file with sharp cutting edges and no radial lands: this creates a stable core and sufficient flexibility for the smaller files. The cross section of finishing files F3, F4, and F5 is slightly relieved for increased flexibility. The difference in design of this system is the varying tapers along the instruments' long axes. The three shaping files have tapers that increase coronally, and the reverse a:tern is seen in the five finishing files.

Shaping files #1 and #2 have tip diameters of 0.185 mm and 0.2 respectively, 14-mm-long cutting blades. The diameters of these files at D14 are I.2 and I.1 mm, respectively. They are used in the coronal and middle third of the root canal.

The finishing files (Fl-F5) have tip diameters of 0.2, 0.25, O3,0.4. C and 0.5 mm, respectively, between D0 and D3, and :the apical tapers are .07, .08,

.09, .05, and .04, respectively. The finishing files have rounded noncutting tips. They are used in the apical third of the root canal.
The convex triangular cross section of ProTaper instruments reduces the contact areas between the file and the dentin. The greater Cutting efficiency of this design has been improved by balancing the pitch and helix angle, preventing the instruments from threading into the canal. ProTaper instruments can be used with 250 to 300 rpm.
Two usage characteristics are recommended for the ProTaper system:
1 -The preparation of a glide path.
2- The use of a more lateral "brushing" Working stroke. Such a stroke allows the Clinician to direct larger files coronally away from danger zones and counteracts any "threading-in" effect.

ProTaper Next

This system is composed of 5 files, namely X1, X2, X3, X4 and X5.
These files Corresponds to sizes 20/04, 25/06, 30/07, 40/06 and 50/06 respectively.
The X1 and X2 have variable tapered design whereas X3-X5 files have a fixed taper from D 1 -D3 then a decreasing percentage tapered design over the rest of their active portions.
This system has a rectangular cross section that is off centered which allows 2 points contact with the dentin wall and the rest of the space free for storing debris which will be removed by the file swaggering motion.

Wave One single file reciprocating system

This system is a single-use, single file system to shape the root canal. In most cases, the technique only requires one hand file followed by one single Wave One file to shape the canal completely using the reciprocation motion that engages and cut dentine in a 150-degree counter-clockwise (CCW) direction and then, before the instrument has a chance to taper lock, disengages 30 degrees in a clockwise (CW) direction. The net file movement is a cutting cycle of 120 degrees and therefore after three cycles the file will have made a reverse rotation of 360 degrees.
The file is made with M-wire technology which improves strength and resistance to cyclic fatigue about four times the traditional rotary NiTi files.
The system is composed of:
- The Wave One small file. It is used in narrow canals. The tip has an ISO of 20 with a continuous taper of 6%.
-The Wave One primary file. It is used in the majority of canals. The tip has

an ISO of 25 with an apical taper of 8% that reduces towards the coronal end.
- The Wave One large file. It is used in wide canals. The tip has an ISO of 40 with an apical taper of 8% that reduces towards the coronal end.
The instruments are designed to work with a reverse cutting action. All instruments have a modified convex triangular cross section at the tip end and a convex triangular cross section at the coronal end. This design improves instrument flexibility. The variable pitch flutes along the length of the instrument improve safety.

Wave One Gold

To improve the Wave One system the Wave One Gold system was introduced. It is composed of four tip sizes:

1. Small (20.07, yellow)
2. Primary (25.07, red)
3. Medium (35.06, green)
4. Large (45.05, white)

The various tip sizes and tapers afford the clinician the ability to clinically prepare a wider range of apical diameters and endodontic anatomy.
The cross-section of Wave One GOLD is a parallelogram with two 85-degree cutting edges in contact with the canal wall, alternating with off-centered cross-section where only one cutting edge is in contact with the canal wall.
Decreasing the contact area between the file and the canal wall reduces binding (taper lock) and, in conjunction with a constant helical angle of 24 degrees along the active length of the instrument, ensures little or no screwing in. The additional space around the instrument also improved debris removal.
The tip of Wave One GOLD is roundly tapered and semi-active, modified and reproducible penetration into the canal

XP Endo shaper

It is rotary file system made with MaxWire alloy which offers better:
1 - Flexibility
2- Fatigue resistance
3- Ability to progress within the canals with ease, expanding or contracting according to the canal morphology.
4- Shape memory principles enabling the instrument to take on a predefined shape at 35°C.

The instrument has the Booster Tip which has the following properties:
I - Six cutting edges for optimal guidance.
2- Starts shaping at minimum ISO diameter 1 5 to achieve a final diameter of ISO 30 with only one instrument. It increases the taper from .01 to at least .04. It allows reaching a final canal preparation of minimum 30/.04 with only one instrument.

Group IV: Engine—Driven Three-Dimensionally Adjusting Files (Self adjusting file)

The se1f adjusting file (SAF) represents a new approach in file design and mode of operation.
The file is a hollow device, designed as a cylinder of thin-walled delicate NiTi lattice with a lightly abrasive surface. An initial glidepath is established with#20 K-file to allow the insertion of the SAF file.
The file compresses from its 1.5 mm diameter into dimensions equivalent to those of a #25 K-file. The handpiece generates in-and-out vibrations with 5000 vibrations per minute and 0.4 mm amplitude. The compressed file will adapt itself to the root canal walls, applying a uniform cutting action gradually removing a uniform dentin layer from the canal walls. There a continuous flow of irrigant which removes the tissue debris and the dentin powder generated by the file.

Group V: Engine-Driven Reciprocating Instruments:

The Giromatic handpiece, a rotary instrument in use since 1 969, delivers 3000 quarter-turn reciprocating movements per minute. Rasps and barbed broaches are most often used in Giromatic handpieces, but K-type and H-type instruments also can be used.

Group VI: Sonic and Ultrasonic Instruments

Files or ultrasonic tips can be activated by electromagnetic ultrasonic energy. This energy activates an oscillating sinusoidal wave in the file with a frequency of upto 30 kHz.
There are two types of such energy:
1 - Ultrasonic: Devices which operate at 25 to 30 kHz, include the magnetostrictive and the piezoelectric. Ultrasonic devices use regular types of instruments (e.g., K-files),

2- Sonic: Devices which operate at 2 to 3 kHz which may use metal files or plastic tips as Endoactivator.
Although similar in function, piezoelectric units have some advantages over the magnetostrictive systems. For example, piezoelectric devices generate little heat, so no cooling is needed for the electric handpiece. The magnetostrictive system generates excessive heat, and a special cooling system is needed in addition to the irrigation system for the root canal.
The file in an ultrasonic device vibrates in a sinus wave like fashion. A standing wave has areas with maximal displacement (i.e., antinodes) and areas with no displacement (i.e., nodes). The tip of the instrument exhibits an antinode. Ultrasonic devices proved very efficient for irrigating root canal systems.
During free ultrasonic vibration in a fluid, two effective physical effects are formed:
1 - Cavitation. During oscillation in a fluid, a positive pressure is followed by a negative pressure causing implosion.
2- Acoustic streaming: This is small, intense, circular fluid movement around the instruments.

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Intracanal Instruments 1

Classification of intracanal instruments[1-3]

They are divided into six groups:

Group I: Manually-operated instruments, such as barbed broaches and K type and H type instruments.

Group Il: Low-speed instruments with a latch-type attachment. Typical instruments in this group are Gates-Glidden (GG) burs and Peeso reamers. They are typically used in the coronal part of the canal and never used in a canal curvature.

Group III: Engine-driven nickel-titanium rotary instruments. They consist of a rotating blade that can safely be operated in, and adapt itself to curved root canals. Most engine-driven instruments available today belong to this group.

Group IV: Engine-driven instruments that adapt themselves three-dimensionally to the shape of the root canal. Like other nickel-titanium instruments, they adapt to the shape of the root canal longitudinally but additionally they adapt also to the cross- section of the root canal. There is currently only one instrument in this group: the self- adjusting file (SAF).

Group V: Engine-driven reciprocating instruments.

Group VI: Ultrasonic instruments.

Group I: Manually-operated instruments.

Barbed Broaches They were the earliest endodontic instruments used to extirpate the pulp. They are manufactured by hacking a round, tapered wire with a blade to form sharp, projecting barbs that cut or snag tissue. A barbed broach does not cut or machine dentin; this instrument is mostly used to engage and remove soft tissue from the canal. It is an excellent tool for removing cotton or paper points that have accidentally become lodged in the root canal.

K-type instruments. The K-file and K-reamer are the oldest useful instruments for cutting and machining dentin. They are made from a stainless steel wire that is ground to a tapered square or triangular cross-section and then twisted to create either a file or a reamer. A file has more flutes per length unit than a reamer. K-type instruments are useful for penetrating and enlarging root canals.

The instrument works primarily by compression- and-release destruction of the dentin surrounding the canal. Generally, a reaming motion (constant file rotation) causes less transportation than a filing motion. Transportation is the excessive loss of dentin from the outer wall of a curved canal in the apical segment. As the instrument is increased in width its flexibility is decreased.

K-flex file It has a cross-section that is rhomboid in shape. It is a twisted instrument and has a series of cutting flutes. It has 2 acute edges and 2 obtuse edges. The acute angle cuts into the dentin while the obtuse angle provides more area for debris collection and removal. The cutting efficiency and flexibility is greater than the K-type file.

Flex-O-File _This instrument resembles the K-type file but it is triangular in cross-section. There is better cutting action and more room for the debris, better flexibility and more resistance to fracture. The tip of the instrument is non-cutting so no apical ledge formation is possible.

Flex-R- file

The design of the tip of this instrument eliminates the possibility of ledge formation by removing the cutting surface of the tip's leading edge. This guides the instrument in the canal rather than cut. It has a triangular cross-section which increases its flexibility. It cuts more efficiently in anti-clockwise motion and can be used for filing action.

H-type instruments.

An H-type instrument has spiral edges arranged to allow cutting only during a pulling stroke. An example is a Hedstrm file. An H- type instrument is better for cutting than a K- type instrument, because it has a more positive rake angle and a blade with a cutting rather than a scraping angle. Bending a Hedstrm file results in points of greater stress concentration than occurs with K-type instruments. These concentration points can lead to the propagation of cracks and fatigue failure. All H-type instruments are ground from a tapered blank. Hedstrm files are formed by grinding a single continuous flute.

S-file (Uni-file)

This instrument is a ground S-shaped cross-section instrument. This is stiffer than the Hedstrom file. The cutting mode may be with filing or reaming action.

Traditional instrument modifications

1- Nickel titanium file.

Files made from nickel titanium showed greater elastic flexibility and resistance to torsional fracture than stainless steel. This file has a non-cutting tip and it tends to maintain the curvature of the root canal.

2- Golden mediums

These instruments are a series of intermediate size instruments. They correspond in size to halfway between standard ISO sizes and correspond to 12, 17,22,27,32 and 37 in number.

3- Canal Master U

This hand instrument is used to prepare the apical third of the canal. It has a non-cutting pilot tip, 1 mm length cutting blade and a narrow parallel sided shaft. It is used to allow for better cutting with more space for debris accumulation and further removal. It reduces the possibility of ledge or transportation.

Group II: Low Speed Rotary Instruments

Many types of rotary instruments are used during endodontic procedures. In addition to conventional burs, burs with extended shanks for low-speed contra-angle handpieces are useful for providing good visibility during deep preparation of the pulp chamber. This is particularly important when using an operating microscope when performing such procedures after access to the pulp chamber has been achieved. Straight-line access to the initial point of curvature can be accomplished using rotary instruments such as Gates-Glidden burs and Peeso instruments. Use of these instruments should be limited to the straight portion of the canal preparation. The risk of perforation with these instruments is a possibility. The risk of lateral cutting resulting in perforation is lower with Gates-Glidden burs than with the Peeso drills. The Peeso reamer is used mostly for post space preparation.

Group III: Rotary Instruments for Canal Preparation

Components of file

1 - The taper. It is expressed as the amount the file diameter increases each millimeter along its working surface from the tip toward the file handle for example, a size #25 file with a #.02 taper would have a 0.27 mm diameter 1 mm from the tip a 0.29 mm diameter 2 mm from the tip, and a 0.31 mm diameter 3 mm from the tip. Some manufacturers express the taper in terms

of percentage (e.g., a #.02 taper is a 2% taper).
2- The flute of the file. It is the groove in the working surface used to collect soft tissue and dentin chips removed from the wall of the canal. The effectiveness of the flute depends on its depth, width, configuration, and surface finish.
3- Helix angle. It is the angle the cutting edge forms with the long axis of the file. It gathers debris collected in the flute from the canal. This angle is important for determining which file technique to use.
4. If a file is sectioned perpendicular to its long axis, the rake angle is the angle formed by the leading edge and the radius of the file. If the angle formed by the leading edge and the surface to be cut (its tangent) is obtuse, the rake angle is said to be positive or cutting. If the angle formed by the leading edge and the surface to be cut is acute, the rake angle is said to be negative or scraping.
5- The pitch of the file is the distance between a point on the leading edge the corresponding point on the adjacent leading edge. The smaller the pitch or shorter the distance between corresponding points, the more spirals the file has the greater the helix angle.

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Pain Control in Endodontics

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The pain reaction threshold (PRT) is defined as that point at which a person will feel the pain. With endodontic therapy hyper response to stimulation is significantly increased.

Factors that lower the PRT include:
1- Presence of pain in the beginning of treatment.
2- Fatigue.
3- Fear and anxiety.

By increase of pain sensation, blood level of catecholamine suddenly elevates with an increase in blood pressure and heart rate. This might induce fainting, angina pectoris, asthma and psychiatric reactions. To reduce the possibility of such conditions happening the anesthesia has to be introduced slowly and in supine position.

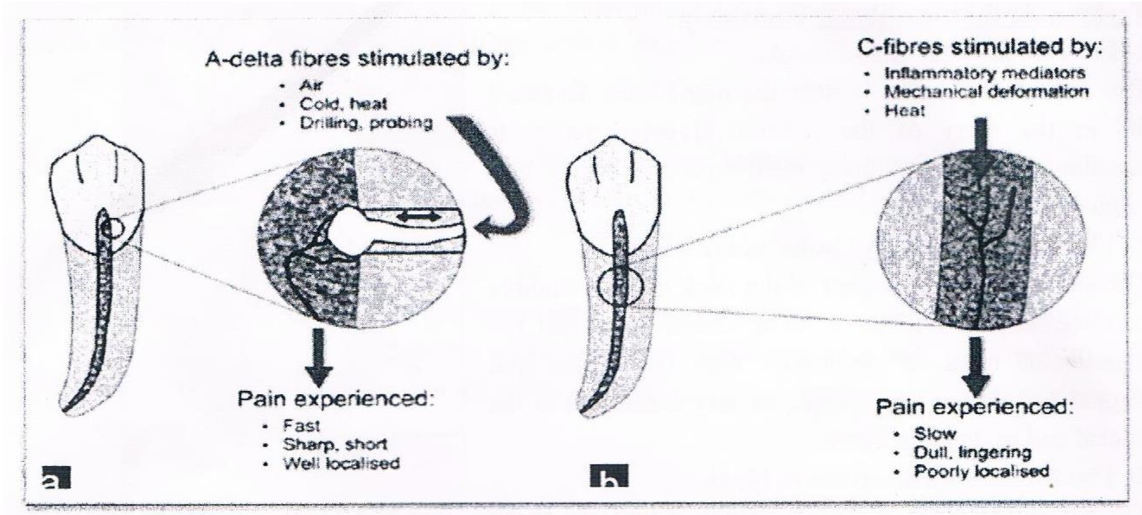
Differential diagnosis of dental pain

Pain in the facial region may be of different origins as:
1- Dental: This type is due to reversible pulpitis, irreversible pulpitis and symptomatic apical infection.
2- Musculoskeletal: As ternperomandibular joint disease.
3- Neuropathic: Pain may be due trigeminal neuralgia or herpes infection.
4- Inflammatory conditions: As migraine.
5- Inflammatory conditions: As sinusitis.
6- Systemic disorders: As cardiac pain.
7- Psychogenic.

Dental Pain

A-fibres in the pulp are responsible for the sensitivity of dentine and thus for the mediation of the sharp pain induced by dentinal stimulation. Prepain sensations induced by electrical stimulation result from activation of the lowest threshold A-fibers some of which can be classified as beta-fibers according to their conduction velocities. Therefore in reversible pulpitis the A fibres are sensitized.

Intradental C-fibers are activated only if the external stimuli reach the pulp proper. Their activation may contribute to the dull pain induced by intense thermal stimulation of the tooth and to that associated with extensive pulpal inflammation.[1-3]



<u>Local anesthesia</u>

It is the temporary loss of sensation or pain in a certain part of the body produced by a topically applied or injected agent without depressing the level of consciousness. Prevention of pain during dental procedures eliminates fear and anxiety.
Knowledge of the anatomy prevents problems during anesthetic injection as muscle truisms, hematoma and intravascular injection.

There are 2 general types of local anesthetic chemical formulations:
1- Esters as procaine, benzocaine.
2- Amides as lidocaine, mepivicaine, prilocaine and articaine.
Local anesthetics are vasodilators, absorbed in the circulation and have a systemic effect directly to the blood plasma level. Vasoconstrictors in the local anesthetic constrict the blood vessels to lower the absorption of the local absorption into the blood stream to prolong the anesthetic effect in the area and decreasing the possibility of toxicity. It may be used to stop bleeding by infiltration of few drops in the bleeding area.
The condition of patients with hyperthyroidism, cardiovascular disease, diabetes and having drugs as tricyclic antidepressants and MAO inhibitors need a consultation with the physician before injection with a local anesthetic having vasoconstrictor.

If the local anesthetic is injected in an infected area, its onset will be delayed. The inflammatory process in an area of infection lowers the pH of the extracellular tissue from its normal value to 5-6 or lower. This low pH inhibits anesthetic action because little of the free base form of the anesthetic is allowed to cross into the nerve sheath to prevent conduction of nerve impulses. Inserting a needle into an active site of infection may spread the infection.

Topical anesthetic

It is effective to minimize surface discomfort of injection of the needle (2-3 mm in depth). This anesthetic is composed of benzocaine (up to 20%) or lidocaine as solution or ointment (5%) or spray (up to 10%).

Techniques for mandibular anesthesia

1- Inferior alveolar nerve block.
The site of deposition is near the mandibular foramen before the entry of the inferior alveolar nerve. It anesthetizes the mandibular teeth with the buccal and lingual soft tissues.

2- The Gow-Gates mandibular nerve block.
The site is the lateral aspect of the neck of the mandible condyle. It is a V3 nerve block anesthetizing all the mandibular teeth in the region with the buccal and lingual soft tissues. It provides sensory anesthesia of the buccal and mylohyoid nerve.

3- The Akinosi-Vazirafli nerve block.
The site is the height of the mucogingival junction of the maxillary third molar near the maxillary tuberosity. This is used where there is limited mouth opening.

4- The Incisive nerve block.
The site is buccaly between the mandibular two premolars. It provides anesthesia to the premolars and anterior teeth in the region.

Why Don't Patients With Irreversible Pulpitis Achieve Pulpal Anesthesia?

Endodontic patients who are in pain and have pulpal pathosis have additional anesthetic problems. There are a number of explanations for failure:

1. The inferior alveolar nerve block does not always provide profound pulpal anesthesia.
2. There is a theory that the lowered pH of inflamed tissue reduces the amount of the base form of anesthetic to penetrate the nerve membrane. Consequently, there is less of the ionized form within the nerve to achieve anesthesia. But it is difficult to correlate local pH changes with failure of the inferior alveolar nerve block.
3. Nerves arising from inflamed tissue have altered resting potentials and decreased excitability thresholds. Therefore, local anesthetic agents do not prevent impulse transmission due to these lowered excitability thresholds.
4. Tetrodotoxin-resistant (TTXr) class of sodium channels that have been shown to be resistant to the action of local anesthetics.
5. Finally, patients in pain are often apprehensive, which lowers their pain threshold.

Techniques for maxillary anesthesia

1-The posterior superior alveolar nerve block.
The site is in buccal fold of the maxillary 2 molar. It anesthetizes the maxillary molars and buccal soft tissues.

2-The middle superior alveolar nerve block.
It anesthetizes the 2nd maxillary premolars and the site of injection is in the buccal fold of the premolars.

3-The anterior superior alveolar nerve block.
The site is the buccal fold of the first maxillary premolar and aimed at the infraorbital foramen. The areas anesthetized are the anterior teeth and premolars with overlying soft tissues.

Supplemental injection techniques
1- Periodontal ligament (PDL) injection.
This technique is used when no other technique can be used. The needle is inserted between the tooth and PDL with bevel of needle toward the root. Anesthetic solution of 0.2 ml is placed per root. Onset of anesthesia is

immediate but duration is variable.

2- Intraosseous anesthesia.
Local anesthetic (LA) is directed into the bone surrounding the root. A small perforation is made in the cortical plate of bone with a small bur and the needle is inserted to introduce the LA.

3- Intrapulpal anesthesia.
When full anesthesia is not gained by other techniques, intrapulpal approach is used. The needle is inserted directly in the pulp and LA introduced with force. Onset is immediate.

Dental and referred pain.

Most of oral and dental pain can be traced to its source. There are cases whereby pain might be experience away from its source as the same side but other jaw, ears, eyes and sinus. Careful diagnosis reveals the affected tooth or related anatomic structure (in non-dental pain).

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Endodontic2019-2020

Lec.2 /5TH STAGE L. AYAD MAHMOOD

Endodontic radiography

Radiographs are essential to all phases of endodontic therapy. They inform the diagnosis and the various treatment phases and help evaluate the success or failure of treatment. Because root canal treatment relies on accurate radiographs, it's necessary to master radiographic techniques to achieve films of maximum diagnostic quality[1].

Requirements:

1) Radiograph: - should depict the tooth in the center of the films. Because the center of the films contains the least amount of distortion.

2) At least 3mm of bone must be visible beyond the apex of the tooth. Failure to capture this bony area may result in misdiagnosis or incorrect determination of file lengths for canal cleaning and shaping.
3) The image on the film must be as anatomically correct as possible, (no elongation or shortening).

Importance of radiology in endodontics:

- Diagnosis
1) Identifying pathosis
2) Determining root/ pulpal anatomy
3) Signs of additional canals
4) Characterizing normal structures
- Treatment
1) Determining working lengths
2) Identifying/moving superimposed canals
3) Locating canals
4) Evaluating obturation
- Recall
1) Evaluating healing
2) Identifying new pathosis

Application of radiography to endodontics:[2]

1) *Pre-endodontic diagnostic radiography:*
i) Aid in the diagnosis of hard tissue alterations of the teeth and periradicular structures.
ii) Determine the number, location, shape, size, and direction of roots and root canals

iii) Localize hard-to-find or disclose unsuspected, pulp canals by examining the position of an instrument within the root.

iv) Aid in locating a pulp that is markedly calcified and/or receded.

2) *Estimate and confirm the length of root canals before instrumentation.*
3) *Confirm the position and adaptation of primary filling point.*
4) *Aid in the evaluation of the final root canal filling.*
5) *Evaluate, in follow-up films, the outcome of endodontic treatment.*
6) *Endodontic surgery.*

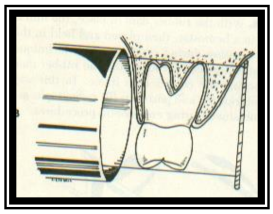
- **SINUS TRACT TRACING: -** All sinus tracts should be traced, i.e. have gutta-percha inserted and radiographed.

<u>Film placement and cone angulation:</u>

<u>Paralleling technique:</u>

For endodontic purposes, the paralleling technique produces the most accurate periradicular radiograph. Also known as the long cone or right-angle technique.

The film is placed parallel to the long axis of the teeth, and the central beam is directed at right angles to the film and aligned through the root apex. To achieve this parallel orientation, it's often necessary to position the film away from the tooth, toward the middle of the oral cavity, especially when the rubber dam clamp is in position.



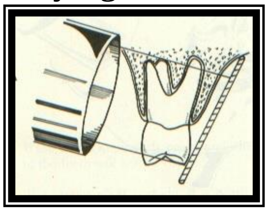
The long-cone aiming device is used in the paralleling technique to increase the focal spot-to-object distance. This has the effect of directing only the most central and parallel rays of the beam to the film and teeth, reducing size distortion. This technique permits:

1- More accurate reproduction of the tooth's dimensions, thus enhancing a determination of the tooth's length and relationship to surrounding anatomic structure.
2- Reduce the possibility of superimposing the zygomatic processes over the apices of maxillary molars, which often occurs with more angulated films, such as those produced by means of the bisecting-angle technique.
3- It will provide the clinician with the films with the least distortion, minimal superimposition, and utmost clarity.

Bisecting-angle technique:

The bisecting-angle technique is not preferred for endodontic radiography, however, when a modified paralleling technique can not be used, there may be no choice because of difficult anatomic configurations or patient management problems.

The basis of this technique is to place the film directly against the teeth without deforming the film. The structure of the teeth, however, is such that with the film in this position there is an obvious angle between the plane of the film and the long axis of the teeth. This causes distortion because the tooth is not parallel to the film. If the x-ray



beam will be shorter than the actual tooth. If the beam is directed perpendicularly to the long axis of the teeth, the image will be much longer than the tooth. Thus by directing the central beam perpendicular to an imaginary line that bisects the angle between tooth and film, the length of the tooth's image on the film should be the same as the actual length of the tooth.

Although the projected length of the tooth is correct, the image will show distortion because the film and the object are not parallel and the x-ray beam is not directed at right angles to both. This distortion increases along with the image toward its apical extent. The technique produces additional error potential because the clinician must imagine the line bisecting the angle. In addition to producing more frequent superimposition of the zygomatic arch over the apices of maxillary molars, the bisecting angle technique causes greater image distortion than the paralleling technique and makes it difficult for the operator to reproduce radiographs at similar angulations to assess healing after root canal treatment.

Comparison of techniques

Paralleling	Bisecting-Angle
Less comfortable film placement	More comfortable film placement
Less distortion	More distortion
More difficult with rubber dam in place	Easier with rubber dam in place
Easy to reproduce	Difficult to reproduce
Film holder required	Film holder sometimes required
Cone cuts are rare	Cone cuts more likely
Zygomatic arch usually above apices	Arch often superimposed

[3]

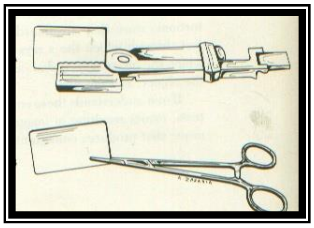
Film holder and aiming devices:

Film holder and aiming devices are required for the parallel technique because:

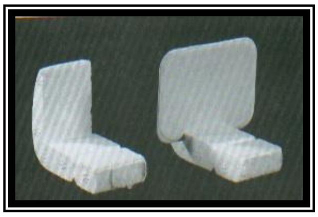
1) They reduce geometric distortion caused by misorientation of the film, central beam, and tooth.
2) They also minimize cone cutting.
3) Improve diagnostic quality.
4) Allow similarly angulated radiographs to be taken during treatment and at recall.
5) Eliminating the patient's finger from the x-ray field and thus the potential for displacing the film.
6) Help to minimize retakes and make it easier for the patient and clinician to properly position the film.

<u>Types of film holder devices:</u>

1- Hemostat: one of the most versatile film-holding devices, the operator positions a hemostat held film, and the handle is used to align the cone vertically and horizontally. The patient then holds the hemostat in the same position and the cone is positioned at a 90-degree angle to the film.

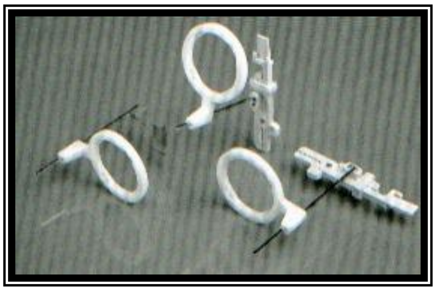


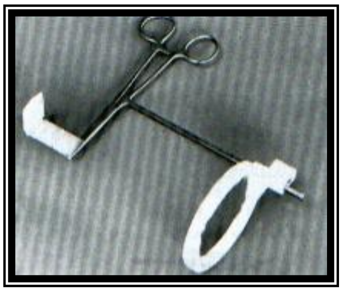
2- Green stabe: it's ideal for taking preoperative and postoperative films. It's a disposable film holder.



(2) (4) (7)

3- Dunvale Snapex system.
4- XCP: extension cone paralleling.
5- Endo Ray endodontic film holder.
6- Uni-Bite film holder.
7- Snap-A-Ray film holder.
8- Snap Ex system film holder.
9- Crawford film holder.





(8) (9)

Generally, these holders all have an x-ray beam-guiding device (for proper beam to film relationship) and a modified bite block and film holder, for proper positioning over or around the rubber dam clamp.

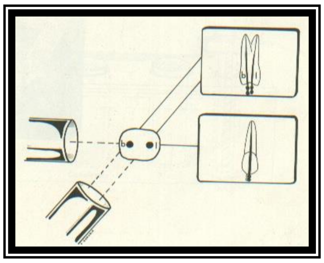
Buccal-object rule (cone shift):

In endodontic therapy, it's imperative that the clinician knows the spatial or buccolingual relation of an object within the tooth or alveolus. The technique used to identify the spatial relation of an object is called the cone or tube shift technique; other names for this procedure are the buccal-object rule, Clark's rule, and the SLOB (Same Lingual, Opposite Buccal) rule.

Proper application of the technique allows the dentist to locate:

1- Additional canals or roots.
2- Distinguish between objects that have been superimposed.
3- Distinguish between various types of resorption.
4- Determine the buccal-lingual position of fractures and perforative defects.
5- Locate foreign bodies.
6- Locate anatomic landmarks in relation to the root apex.

The principle states that the object closest to the buccal surface appears to move in the direction opposite the movement of the cone or tube head when compared with a second film. Are objects closest to the lingual surface appear to? Thus "same lingual, opposite buccal" rule.



Cone alignment for the various teeth in endodontics

Horizontal angulation

Right angle ("straight-on")
- Maxillary anteriors
- Maxillary molars

Mesial
- Maxillary premolars
- Mandibular premolars
- Mandibular canines

Distal
- Mandibular incisors
- Mandibular molars
- Maxillary molars (to display MB_2 canal, if present)

Vertical angulation

10° downward for mandibular premolars and molars

Digital radiography:

As dentistry parallels photography, in the move from silver halide film to digital photography and computer processing, the profession will undergo continued growth toward digital radiographic systems. Digital radiography used in dentistry is available in three variations:

1) Direct digital system: use a solid-state sensor such as a charge-coupled device (CCD), these systems have a cable that connects the sensor to the computer and in turn to screen monitor.

2) Storage phosphor system: use a photo-stimulable phosphor plate that stores the latent image in the phosphor for subsequent readout by an extra-oral laser scanner.

3) Indirect digital system: use a scanning device connected to a computer for digitizing traditional silver halide dental films.

Advantage of digital radiography:

1) Image enhancement, contrast stretching and reversing.
2) Storage.
3) Retrieval.
4) Transmission of images to remote sites in a digital format.
5) Obtained immediately.
6) Radiation exposure is reduced from 50% to 90% compared with conventional film-based radiography.

Disadvantages:

1) High initial cost.
2) Reduction in image quality when compared with conventional radiography.

<u>Direct digital systems have three components:</u>

1) Radio component: consists of a high-resolution sensor with an active area that is similar in size to conventional film. The sensor is protected from x-ray degradation by a fiber-optic shield, and it can be cold sterilized. For infection control, disposable plastic sheaths are used to cover the sensor when it's in use.

2) Visio component: consists of a video monitor and display-processing unit. As the image is transmitted to the processing unit, it's digitized and stored by the computer.

3) Graphy component: high-resolution video printer that provides a hard copy of the screen image, using the same video signal.

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Endodontics2019/2020

Lecture1 5th stage **L. AYAD MAHMOOD**

Endodontic Diagnosis

Diagnosis: It is the procedure that:
1- Accepts the patient.
2- Recognizes that he/she has a problem.
3- Determine the cause of the problem.
4- Develop a treatment plan to treat the problem.

Requirements of a diagnostician

1- Knowledge: A dentist must depend on himself and his scientific background. .
2- Interest and curiosity: The dentist must be interested in solving the problem of the patient and curios about the result of the diagnosis.
3- Patience: The dentist needs time and patience to understand the reasons of the problem which not always are visible and needs some time and investigations to reveal the cause of the problem.

Systematic endodontic diagnosis

History A complete medical history should contain the vital signs, give early warning of unsuspected general disease and find risks to the health patient (during treatment) and the dental staff.
Chief complain. It is a description of the dental problem of the patient.
Present dental illness. Pain is the main reason for the patient's complaining. It ranges from dull to severe which indicates the severity of the problem. It may indicate the source which may be dental or the surrounding structures.
Medical history. It is very important in patients with medical problems that may interfere with the dental treatment as history of bleeding, heart diseases, diabetes. Any medications taken by the patient may affect the dental procedure as aspirin.

Clinical examination

Examining the patient clinically with the patient's history will make the diagnosis of the problem.
Vital signs
1- Blood pressure. The normal pressure is 120/80 mm Hg for patients under age of 60 years; 140/90 mm Hg for patients over the age of 60 years. Any pressure exceeding this limit needs consultation with the cardiologist before

dental treatment.
2- Pulse rate and respiration. The normal pulse rate is 60-100 beats/minute and the respiration is 16-l 8 breaths/minutes. They may be elevated due to stress and anxiety.
3- Temperature The normal temperature of the body is 37^{o}C (98.6 F). Any elevation in the body temperature may be a sign of general illness.
4- Cancer screen. This examination should include the face, lips, neck and intraoral soft tissues for lumps and white spots.

Extraoral examination
Inflammatory changes originating intraorally and observable extraorally may indicate a serious spreading problem. The extraoral examination includes the face, lips and neck which may need palpation. Painful and/or enlarged lymph nodes indicate the spread of the inflammation as possible malignancy. The extent and manner of jaw opening may give a sign of possible myofascial pain and dysfunction.

Intraoral examination
The oral vestibules and buccal mucosa should be examined for localized swelling and sinus tract or color changes. The lingual and palatal soft changes should be then checked. Finally the teeth should be inspected for a carious lesion, faulty restoration, loss of teeth, presence of deciduous or supernumerary teeth.

Pulpal evaluation
There are many tests that indicate the pulpal health state. These tests reveal the extent of the problem arid give a clue about the treatment as irreversible pulpitis needs endodontic treatment whereas reversible pulpitis may need a normal filling.

Pain history
Initially, information on pain is obtained by asking questions regarding the current problem(s).
This examination is subjective, frequently asked questions include:
. Location. Occasionally a patient may identify the location of the pain; however, one must be cautious as pulpal pain may be referred to a different area. Pain may be felt in any of the orofacial structures.
. Type and intensity of pain. The patient may describe pain in many ways. Examples include sharp, dull, throbbing, stabbing, burning, electric shock like, deep or superficial. The more the pain disrupts the patient's lifestyle

because of its intensity, the more likely it is to be irreversible in origin.
. Duration. For how long after removal of the stimulus does the pain continue? The longer the pain continues after the stimulus, the more likely it is to be irreversible.
. Stimulus. Many different stimuli may initiate the pain, for example hot, cold, sweet, biting, posture. Alternatively the pain may be spontaneous. Special tests may be selected on the basis of what causes the main complaint.
. Relief Pain-relieving factors, especially type and frequency of analgesics, antibiotics, sipping cold drinks.

Periodontal evaluation
The complete diagnosis is performed when examination is done to the tooth and surrounding tissues. The periodontal pathology as gingivitis and periodontal pockets may affect the pulp therefore periodontal treatment may be necessary before/with the endodontic treatment.

Clinical endodontic tests
These tests obtain the condition of the tooth's pulp and supporting structures. One test is not enough for a decisive diagnosis therefore a combination of tests is necessary.
Thermal tests.
It is divided to cold and hot stimuli.

1- Cold testing. It differentiates between reversible and irreversible pulpitis and identifying necrotic teeth. If a tooth is sensitive to a cold stimulus which subsides after removal of stimulus then the condition is reversible. If the sensitivity takes time more than few seconds then the condition may be irreversible. Teeth with calcified canals need more time for the cold stimulus to reach the pulp. Cold testing may be done by air blast, cold drink, ice stick or ethyl chloride.
2- 2- Hot testing. The use of a hot stimulus can help locate a symptomatic tooth with necrotic pulp. Heated gutta percha stick or hot water may be used.

Percussion. This is used to find if the apical periodontium has been affected by the pulpal pathology. Any hard instrument may be used to tap the incisal/occiusal surface of the tooth.

Thermal Test False Responses

Cold/heat false-positive responses may arise due to a gingival response, patient anxiety, or the response of an adjacent tooth. Limit cold false-positives by being careful to apply refrigerant onto only the test tooth.

False-negatives responses are more common, and can occur due to chamber/canal calcification (age, calcific metamorphosis, secondary dentin), an inadequate stimulus, a thick or poorly conducting restoration, immature root (open apex), or recent trauma (transient paresthesia).

Oftentimes, the electric pulp test will elicit a response when cold will not.[1]

Palpation.

This test signals the further spread of inflammation from the periodontal ligament to the periostium overlying the bone. This test checks for luctution and possible asymmetry of the surfaces around the tooth.

Mobility

A mirror handle is placed on one side of the tooth and a note made of the degree of movement:

up to 1 mm scores 1, over 1 mm scores 2 and vertically mobile teeth score 3.

Occlusal analysis

It is important to examine suspected teeth for interferences on the retruded arc of closure, intercuspal position and lateral excursions. Interferences in any of these positions could result in a degree of occlusal trauma and institute acute apical periodontitis.

Sinus tract exploration

Where a sinus tract is present, it may be possible to insert a small gutta-percha point. A radiograph is then taken to see which root the tract/point leads to.

Transilumination

Transillumination with a fibre optic light show cracks in teeth. These cracks cause stretching of the pulp tissues when a lateral pressure is exerted on the tooth therefore causing pain.[2]

Periodontal probing

Detailed periodontal probing around suspected teeth may reveal a sulcus within normal limits.

However, deeper pocketing will be identified. A narrow defect may be an indication of a root fracîure or an endodontic lesion draining through the gingival crevice. This causes an endodontic-periodontal lesion.

Radiographs

Radiographs should be taken using film holders and a paralleling technique and be viewed using an appropriate viewer with magnification as necessary. They will not show early signs of pulpitis as there is no periodontal widening at this stage of pulpal degeneration. Radiographs may provide important information to help to confirm a diagnosis, but they should not be used alone. Radiographic findings may include the loss of lamina dura (laterally or apically) or a periradicular radiolucency indicative of pulp necrosis.
Alternatively, radiographs may show pulp chamber or root canal calcification, which may explain reduced responses to pulp sensitivity testing. This emphasizes the need for considering using more than one test. Radiographic examination may also reveal tooth/root resorptive defects.

Test cavity

Occasionally, as a last resort, an access cavity is cut into dentine without local anaesthesia as an additional way of sensitivity testing.[3]

Selective anaesthesia

Selective anaesthesia can be useful in cases of referred pain to distinguish whether the source of pain is mandibular or maxillary in origin. It is less useful for distinguishing pain from adjacent teeth, as the anaesthetic solution may diffuse laterally.

Electric pulp test. It provides limited but useful infomiation about the response of the nerve fibres in the pulp. Many factors affect the level of response as enamel thickness, area of probe placement (in the middle third of the labial surface), dentin calcification, restorations and patient’s level of anxiety. False positive and negative results may happen. A newly erupted tooth may give a negative response whereas a traumatised young tooth may not respond to testing. Multirooted teeth give inconclusive readings because there are many roots with different degrees of pulp inflammation in each root canal.

EPT False Responses

False-positives are very common with the EPT, and are most often caused by anxiety, or a misconception by the patient as to what the sensation should be. Gingival tissue responses. Occasionally, a nonvital pulp will produce a very slight or “different” response at high output level. These false positive responses are rare and due to liquefaction necrosis, which may conduct current to the attachment apparatus.

False-negative responses are very rare with the EPT, and are due to inadequate tip contact/conducting medium, low/dead batteries, or partial pulpal necrosis. As with thermal testing, a recently traumatized tooth, one with excessive calcification, or one with an immature apex may not respond.

Clinical Findings in Reversible Pulpitis

Visual	Check for decay, fracture lines, swelling, sinus tracts, orientation of tooth, and hyperocclusion
Palpation	Not sensitive
Percussion	Not sensitive
Mobility	None (unless periodontal condition exists)
Perio probing	None (unless extensive periodontal disease exists)
Thermal	Hypersensitive to heat or cold (quick response lasting for seconds)
Electric Pulp Test	Responds
Translumination	Not used unless a fracture is suspected
Selective anesthesia	Not necessary
Test cavity	Not necessary, tooth is vital
Radiographic	Periapical x-ray shows normal periapex

Clinical Findings in Irreversible Pulpitis

Visual	Check for decay, fracture lines, swelling, sinus tracts, orientation of tooth, and hyperocclusion
Palpation	No response initially; may be sensitive in later stages
Percussion	No response initially; may be sensitive in later stages
Mobility	None (unless periodontal condition exists)
Perio Probing	None (unless extensive periodontal disease exists)
Thermal	Hypersensitive to hot and cold with prolonged response
Electric Pulp Test	Responds
Translumination	Not used unless fracture is suspected
Selective Anesthesia	May help identify offending tooth
Test cavity	Not necessary, tooth is vital
Radiographic	Normal or thickened periodontal ligament

Clinical Findings in Necrotic Pulp

Visual	Check for decay, fracture lines, swelling, sinus tracts, orientation of tooth, and hyperocclusion
Palpation	Sensitive
Percussion	Mild to severe pain (depends on periapical inflammation)
Mobility	None to moderate (depends on bone loss)
Perio Probing	None (unless extensive periodontal disease exists)
Thermal	No response
Electric Pulp Test	No response
Translumination	Not used unless fracture is suspected
Selective **anesthesia**	May help identify offending tooth
Test cavity	May be used if vitality is suspected
Radiographic	Periapical radiograph may show normal or thickened periodontal ligament, or radiolucent lesions

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