Crown & Bridge Prosthodontics

Lecture 1

Prosthodontics (prosthetic dentistry or prosthodontia)

The dental speciality that concerned with restoring & maintaining oral functions, comfort, appearance & health of the patients by making artificial replacements for missing parts of the mouth and jaw.

Branches of Prosthodontics

1. Fixed Prosthodontics FPDs
2. Removable Prosthodontics
    a) Complete Denture
    b) Removable Partial Denture RPDs
3. Implant Prosthodontics
4. Maxillofacial Prosthodontics

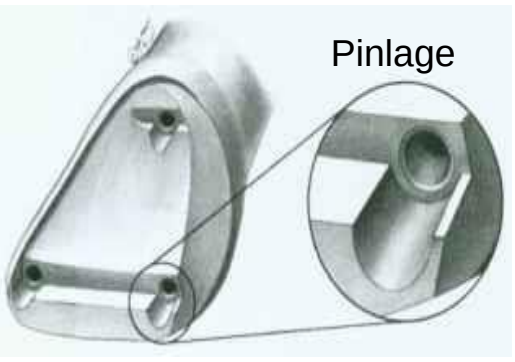
Fixed prosthodontics (Crown & Bridge Prosthodontics):

It's a branch of dental science that deals with restoring damaged teeth with artificial crown & replacing the missing natural teeth by a dental prosthesis permanently cemented in place (Fixed partial denture).

Types of Fixed Prostheses

1) Extracoronal: It involves all restorations that seat over the tooth such as all types of crown restorations (Full metal crown, partial crown, PFM, all ceramic crown) & direct or indirect veneer restoration.

2) Intracoronal: It involves all restorations that seat inside the tooth such as inlay, onlays, pinlage.



The Crown: It's a fixed extracoronal artificial restoration for the coronal portion of a natural tooth. It must restore morphology, function & the contour of the damaged portion of a tooth and must protect the remaining tooth structure from further damage.

Types of crowns: (Classifications)

A) According to the coverage area

1. **Complete crown:** It covers the coronal portion of the tooth, such as full metal crown, All- ceramic crown (made of ceramic material).

2. **Partial Crown:** It is covers part of the coronal portion of the tooth such as 3/4 Crown, 7/8 Crown.

3. **Complete replacement:** it involves those which replace the natural crown entirely while retains itself by means of a metal extended inside the root canal space of the tooth such as a post crown.

According to materials used in the construction of C&B restorations

1. **Metal Crowns:** Gold alloy and its alternatives

2. **Non-Metal crowns:** Acrylic resin, Zirconium or Porcelain as in jacket crown.

3. **A combination:** of metal and plastic materials as in PFM crown restorations.

Fixed Partial Denture (Bridge)

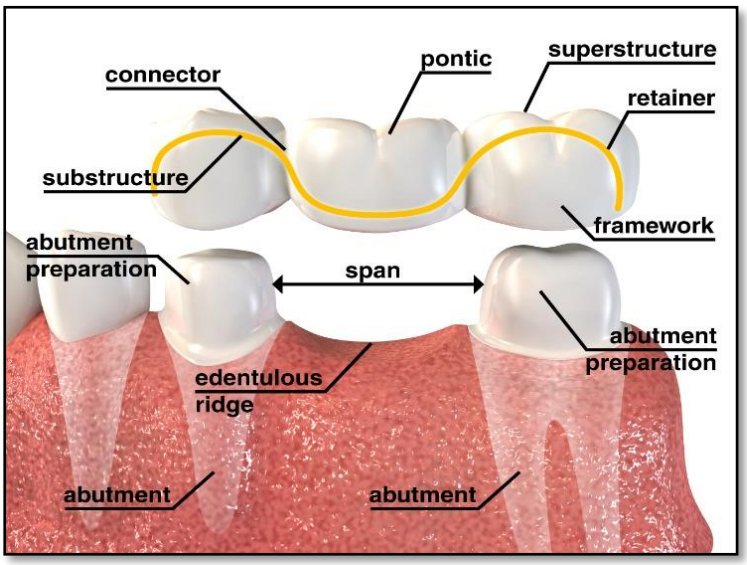
It is a fixed dental prosthesis (appliance) which replaces and restores function and aesthetic of one or more missing natural teeth. It cannot be removed from the mouth by the patient and primarily supported by natural teeth or root.

Components of the bridge:

1. **Retainer:** It's the part that seat over (on or in) the abutment tooth connecting the pontic to the abutment. It is either major or minor retainer, or it could be crown, inlay, post & core.

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

3. **Connector:** It's the part that join the individual components of the bridge together (retainer& pontics), which could be fixed (rigid) or movable (flexible) connector. When the retainer is attached to a fixed connector it's called a major retainer, but when it is attached to a flexible (movable) connector it is called a minor retainer.



Definitions (terminology)

Abutment: a tooth to which a bridge is attached.

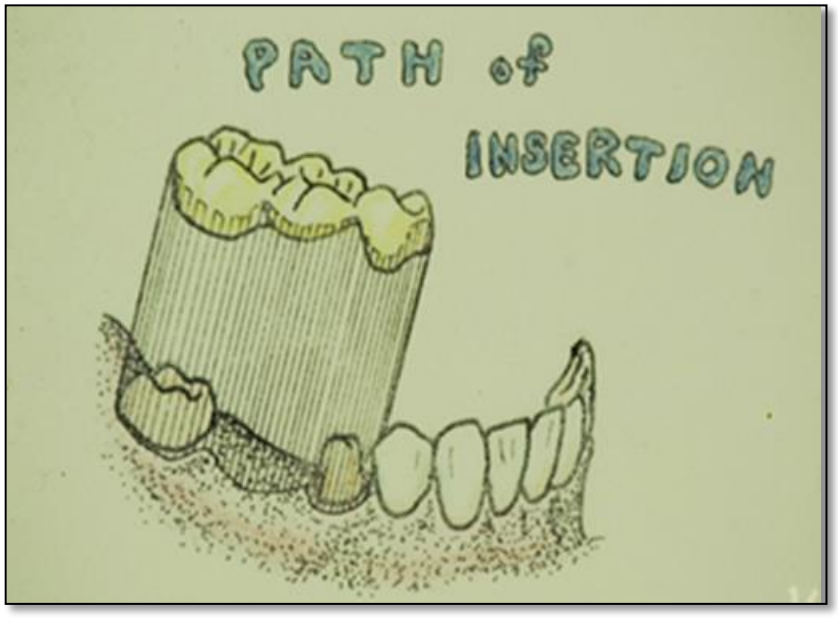
Span: is the space between natural teeth that is to be filled by pontics.

Saddle: is an area of the edentulous ridge over which the pontic lies.

Pier: is an abutment standing between two abutments & supporting two pontics, each pontic being attached to further abutment.

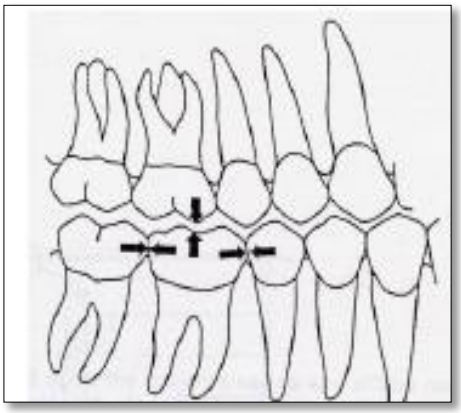
Unit: when applied to bridgework, means either a retainer or a pontic, thus a bridge that replaces a premolar using two abutments is referred as three Unit Bridge.

Path of insertion: An imaginary line along which the restoration can be inserted and removed without any interferences or causing lateral force on the abutment.



Why do a Fixed Partial Denture?

The stability of an individual tooth depends on a balance of the forces exerted on that tooth by the adjacent, opposing teeth, supporting tissue & by the soft tissue of the cheek, lips & tongue



When a single tooth is not replaced (after loss), this balance is upset, & the consequence may by:

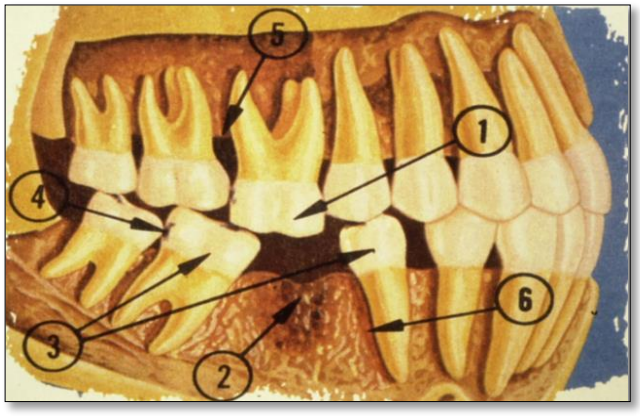
1. Super eruption of the opposing tooth or teeth:

a) Gingival recession

b) Traumatic occlusion or lacking of bite

c) Loss of bony support for that tooth.

d) Loss of the proximal contact



2. Loss of function on the affected side:

a) Diffuse atrophy.

b) Heavy deposition of plaque & this lead to gingivitis & periodontal disease.

c) Trauma to the soft tissue during function.

d) Loss of tissue (contraction of both soft tissue & alveolar bone).

3. Tilting (drifting) of the adjacent teeth.

4. Loss of the proximal contact to:

a) Food stagnation & pocketing

c) Sub-gingival caries

5. Periodontal problem & mobility

Posterior Bite Collapse:

The posterior teeth support the vertical height of the face. If they are lost, the face tends to lose height and close down; this is called “posterior bite collapse”

Figure 1: The back teeth and front teeth work in harmony. The back teeth support facial height & chew food while the front teeth cut food, protect the back teeth in lateral jaw movements and provide your smile

Figure 2: The loss of the back teeth place excessive pressure on the front teeth causing shifting of teeth and slight loss of facial height.

Figure 3: Without replacement of the back teeth, the teeth start to shift and excessive pressure causes the front teeth to spread forward. Loss of facial height occurs

The general effects of tooth loss:

1) Generalized collapse of lower & upper dental arches.

2) Premature contact causing deviation in the normal movement of the mandible which might lead to TMJ dysfunction & muscle spasm that cause pain.

3) Tooth loss may lead to unilateral mastication on the opposite side of the dental arch which results in periodontal problems, caries on the affected side due to deficient mechanical cleaning afforded by the act of mastication.

4) Posterior bite collapse these changes also put pressure on the front teeth which tend to move or splay forward.

Treatment at this stage prevents further disruption, it may be insufficient to ration back to full health, it need extended treatment plans including, ortho. Treatment, additional cast restoration to correct the disturbed occlusal plane.

Reasons for treating tooth loss

1) Aesthetic.

2) Function (ability to eat).

3) Pain due to TMJ dysfunction & muscle spasm

4) Maintenance of dental arch (occlusal stabilization & prevent tilting)

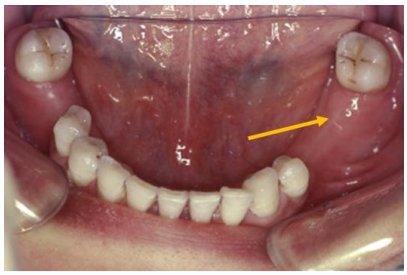
5) Speech (particularly lower incisors).

Methods of treating tooth loss

- Orthodontic.
- Removable partial denture.
- Fixed partial denture (tooth supported partial denture).
- Implant (Osseo-integrated implant).
- Combination.

In some case the decision might be no prosthetic treatment

1) Long standing edentulous space (long span) into which there has been little or no drifting or elongation of the adjacent teeth.
2) Lack of distal abutment.
3) If the patients perceives no functional, occlusal or aesthetic impairment.



Crown & Bridge Prosthodontics

Lecture 2

Fixed Partial Denture (Bridge)

Purposes (Benefits) of fixed bridges

1. Correcting abnormal oral conditions.

2. Restoring mastication to full functional efficiency.

3. Maintaining the health of the remaining dentition & prevent further injury.

4. Restoring appearance & aesthetic

Indications

A) General:

1- Psychological: The FPDs are rapidly tolerated by patients than RPDs

2- Systemic: as in epileptic patients (attack of unconsciousness), the FPDs have adequate strength & retention, while in RPD, there is a potential for fracture or inhalation.

3- Orthodontic consideration: FPDs are indicated for stabilizing the orthodontic results (e.g., FPD used to replace missing lateral incisor after diastema between two centrals has been closed).

4- Speech: RPDs are bulky, which cause difficulty in speech. In contrast, in FPDs, the size of pontics are similar to the missed teeth which rarely cause difficulty in speech.

5- Periodontal reasons: FPDs can stabilize teeth with minor mobility using fixed splint (bridge), to prevent further movement that leads to drifting or over extrusion with more loss of bony support, additionally, to ensure that the mastication forces are eventually distributed over several teeth rather than overloading on a tissue that is seriously weakened by the disease.

Figure 6: [A] Preoperative photograph of a periodontally compromised lower anteriors, [B] Post non-surgical periodontal therapy, [C] Resin bonded cast metal splint with ceramic pontic (Lingual view), [D] Labial view of ceramic pontic

B) Local:

1) The bridges are indicated wherever there are properly distributed healthy teeth that serve as abutments.

- ✓ Vital tooth or endodontically treated with no radiographic evidence of pathology
- ✓ Adequate crown/root ratio
- ✓ Good periodontal condition
- ✓ Root configuration & angulations

2) Tooth suitable as abutment which require cast restoration (the same tooth lie adjacent to edentulous space & suitable as abutment).

3) Unfavourable angulations of teeth for removable prosthesis (badly tilted teeth).

4) It is advisable to restore edentulous space with fixed rather than RPD, because the force of occlusion transmitted to periodontium, then to the alveolar bone (natural), while in the RPD the occlusal force is transmitted to muco-periostium, and then the underlying bone (which is not designed this function).

Contraindication:

A- General:

1- Uncooperative patient: difficult to achieve satisfactory result.

2- Social problem: FPDs are more expensive than RPDs. Usually the patient must be given what he wants, which makes him sometimes unsatisfied for the results.

3- Occupation: boxers, hockey players, and pipe smokers are not advisable for FPDs (fracture of teeth or restorations)

4- Poor oral hygiene: The bad attitude toward dentistry limit the decision to make FPDs unless the patients are positively motivated before treatment.

5- Age: FPDs are preferred to be done after the age of 18 yrs. especially in the posterior region due to the large pulp size or teeth are not fully erupted. They are not indicated for elderly patient when there is a lack of resilience of the periodontal membrane or teeth attrition which increase the size of occluding surfaces.

B- Local:

1- Absence of distal abutment.

2- A considerable bone loss in the visible area of the mouth.

3- Long span.

5- Abutment related factors (tooth not suitable as abutment: length, shape, caries, and periodontal support).

Advantages of the bridges: They improve appearance, function, & speech. They maintain the occlusal stability, provide periodontal splinting, and restore occlusal vertical dimension.

Disadvantage of the bridges: They may induce tooth & pulp damage, potential secondary caries, periodontal problem added to the high cost.

Comparison & advantages of fixed bridges over RPDs:

1) More stable & comfortable because it covers less tissue surface (there is no acrylic base, flanges or clasps).

2) More aesthetics.

3) More stable occlusion with even distribution of the occlusal forces.

4) Provide a splinting action, while the RPDs push the teeth and cause mobility.

5) Easier cleaning using tooth brushes and dental floss (when there is a point contact between pontic & the underlying tissue), in contrast, the RPD must be removed to be cleaned.

6) Do not irritate tissues or apply pressure on them.

7) Psychological patients can easily tolerate FPD rather than removable one.

8) The FPDs are preferred for handicapped, epileptic patients, and patient with Parkinson disease due to the possibility of fracture or inhalation of the RPD.

9) No speech difficulty in FPDs

10) Badly tilted abutment teeth may interfere with the construction of PD (due to the presence of undercut that lead to food stagnation). A telescopic bridge with metal coping, or fixed-movable bridge or proximal half-crown can be used.

11) Anatomical limitation of RPDs such as abnormally large tongue, muscular disorder, mandibular tori (torous), and palatal surface tissue.

Classification of dental bridges (Types of bridge):

A. Depending on the materials used

1. Cast metal FPDs

2. Metal-ceramic FPDs

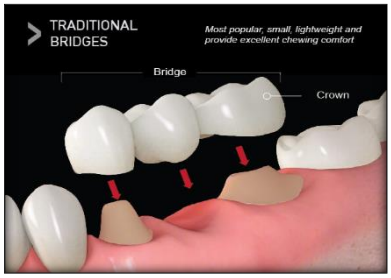
3. All-ceramic FPDs

4. Resin-veneered FPDs

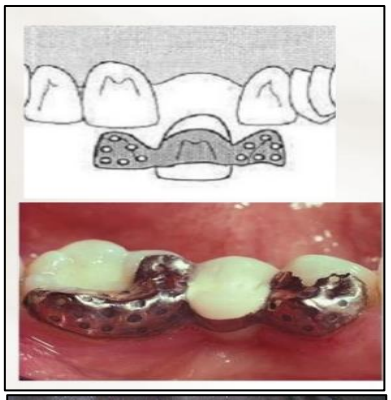
B. Depending upon location: Anterior FPDs, and posterior FPDs

C. Depending on number of teeth: Two units FPDs, Three units FPDs.

D. Depending upon the tooth reduction



1. Conventional (Conventional preparation) bridges: where a substantial tooth reduction is necessary for the abutment teeth.



2. Minimally-prepared bridges: (adhesive, acid etched, resin-bonded bridge): These bridges are luted to the unprepared or minimally prepared surfaces of the abutments with resin adhesives.

3. Hybrid bridges: A combination of conventional & minimally prepared teeth. The figure shows a Fixed-movable with a minimal- retainer carrying the movable connectors

4. **Implant-Supported FPDs**: Bridges that are totally supported by implant fixers, usually are not attached to the adjoining natural teeth, which are either can be removed by the dentist only, or can be removed by the patient for cleaning or any other reasons.

5. **Removable bridges**: Bridges that are totally supported by teeth which differ from the RPDs. They are either be removed by the dentist only, or can be removed by the patient for cleaning or any other reason. They are designed to overcome problems associated with long span FPD, such as Andrew s bridge system that is indicated for edentulous ridges with sever vertical defect. The prosthesis consist of a fixed & a removable component

Figure 1: Preoperative and post teeth reduction for porcelain fused to metal restorations

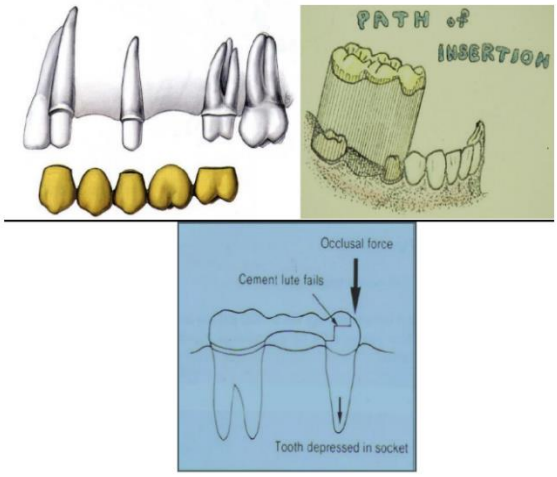
Fig. 2: Metal try-in, and waxed up trial denture for RPD

Fig 3. Post-operative Picture: Andrew's Bridge replacing

E. Depending upon the connectors (Basic bridge designs)

1. Fixed-fixed bridge:

- Preferred for long-span bridges
- Have rigid connector at both end of the pontic.
- Maximum retention & strength.
- All retainers are major which require extensive tooth reduction.
- Unconservative, more destruction of the tooth structure & trauma to the pulp



- Must have only one path of insertion (the preparations of both abutments need to be parallel).

-The entire occlusal surfaces of both abutments must be covered with retainers otherwise the occlusal forces will be directed on the unprepared area which depress the tooth downward & break the connectors.

- All retainers must have approximately the same amount of retention reducing the risk of dislodgement when the force is applied on weak retainers.

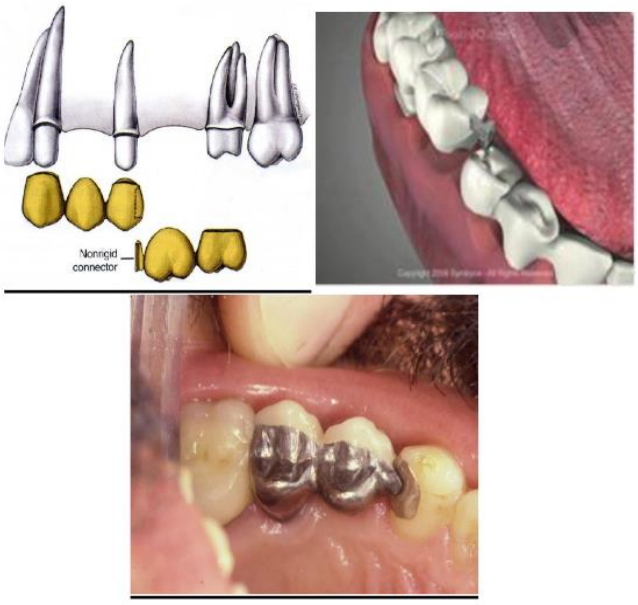
-. Abutment teeth are splinted together (adequate in case of mobile teeth).

- Cemented as one piece.

2. Fixed- mobile design:

- Have rigid connector (major) at the distal end of pontic & mobile (minor) connector mesially.

- More conservative to tooth structure than fixed-fixed design, because minor retainers need less tooth reduction.



- It allows minor tooth movement (lateral & vertical).

- Limited to one missing tooth (limited length of span).

- Parts of the bridge can be cemented separately.

- Lab. construction is complex & difficult.

- Preparation of abutment does not need to be parallel.

- It is indicated to be used in divergent abutment teeth (unparallel), whenever a pier abutment is present (complex bridge), and for aesthetic consideration (class III inlay on distal of canine).

3. Simple cantilever:

- The support for the pontic at one end only.
- Pontic may attach to one or two retainer.
- Abutment tooth is either mesial or distal to the span.
- It is the most conservative design
- Limited cases, as in lateral incisor replacement using the canine as abutment when the occlusion is favourable.
- The design can be used to replaced upper or lower first premolar & second molar.

4. Spring cantilever

-The pontic attach to a long metal arm (flexible bar) run into the palate & terminate with rigid connector on the palatal side of a single retainer on upper 4 or pair 4 & 5.

- Tooth retained and tissue borne.
- Forces are absorbed by the springing of the arm and by displacement of the soft tissue of the palate.
- The abutments are usually posterior teeth (tooth need restoration is better to be used)
- Contraindicated in V-shape palate & in the lower arch
- It is indicated only for replacing missing upper incisor when the adjacent teeth are sound, midline diastema, spacing of anterior teeth, or posterior teeth need crown.

- Not advised for the lower arch due to the instability of the sub-mucosal tissue, and a potential for plaque & calculus deposition.

5. Combination designs (Complex or compound bridge)

It is a combination of two or more of conventional designs incorporated in the general design of bridge, such as:

- Fixed-fixed with simple cantilever.
- Fixed-fixed with fixed-mobile.

Benefits:

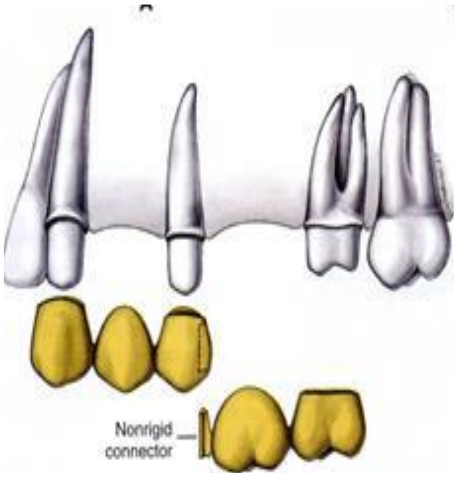
- Simplify the construction of the prothesis.

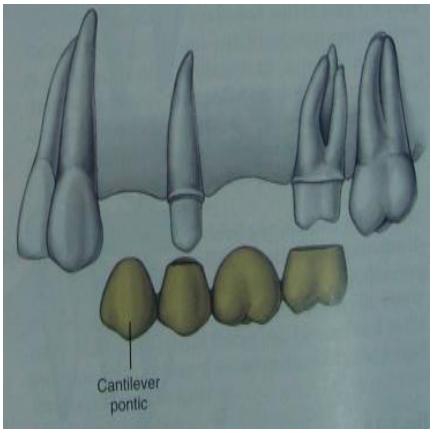
- Unfavourable angualtion of abutments.

- Simplify the preparation and conserve tooth tissues.

- Easily repaired after fracture.

- Precision retainers permit the seperation of two or more components.



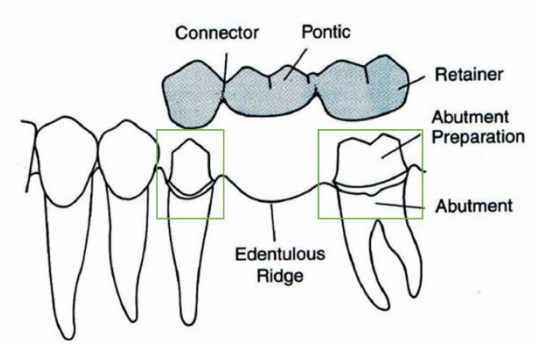


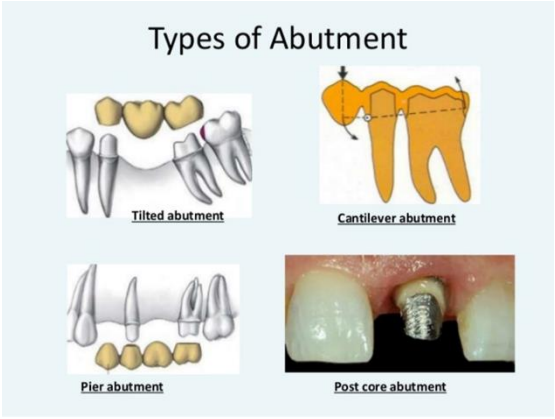
Crown & Bridge Prosthodontics

Lecture 3

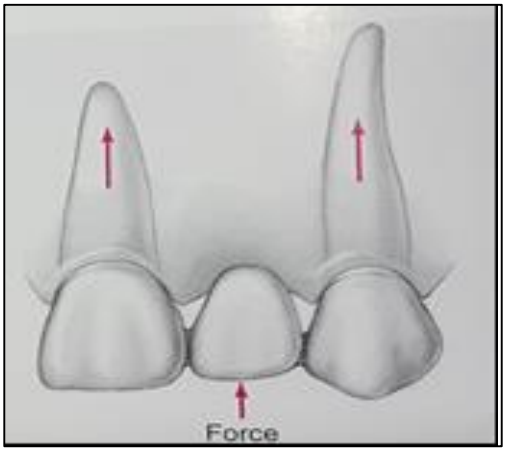
Evaluation Abutment tooth

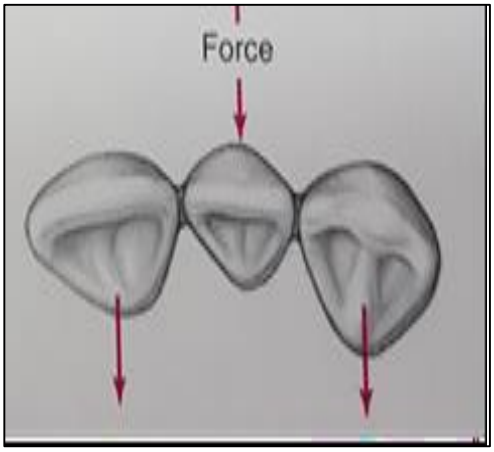
Abutment in fixed prosthodontic terminology is a tooth or portion of a tooth that supports and/or retains a fixed bridge or part of the bridge, to which the retainer is connected (cemented).





All forces that are absorbed by the missing tooth are transmitted, through the pontic, connectors, & retainers to the abutment teeth. Abutment teeth must withstand forces that are normally directed to the missing teeth, in addition to those usually applied to the abutments, therefore, the choice of abutment is important because it has to withstand the forces that acting on it and on the pontic.





So the clinician have to evaluate the abutment teeth carefully

Considerable time & expense are spared by thoroughly investigating each abutment tooth before proceeding the preparation. Radiographs are made & the pulpal health is assessed by evaluating the response to thermal & electrical stimulation.

Evaluation Aids:

They include; clinical examination using examination tools, vitality test, radiographs, diagnostic casts, & periodontal probe.

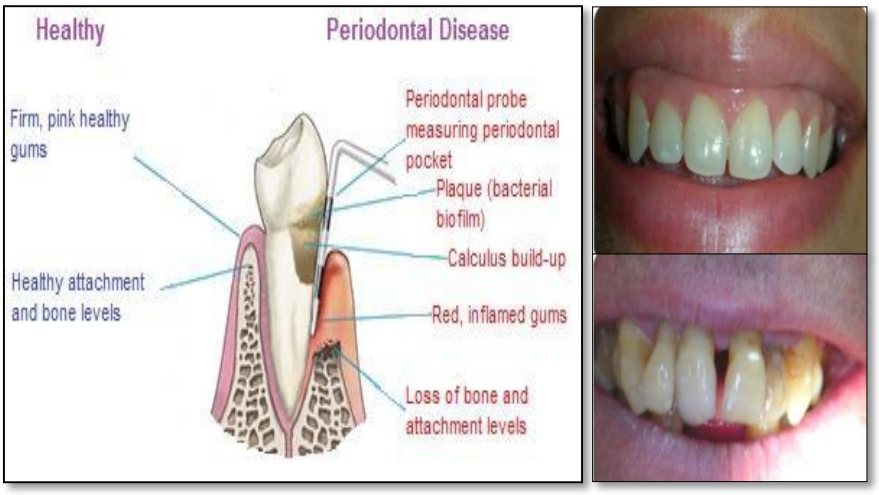
Requirements:

1- The abutment must withstand forces normally directed to the missing teeth, whenever possible the abutment should be vital tooth.

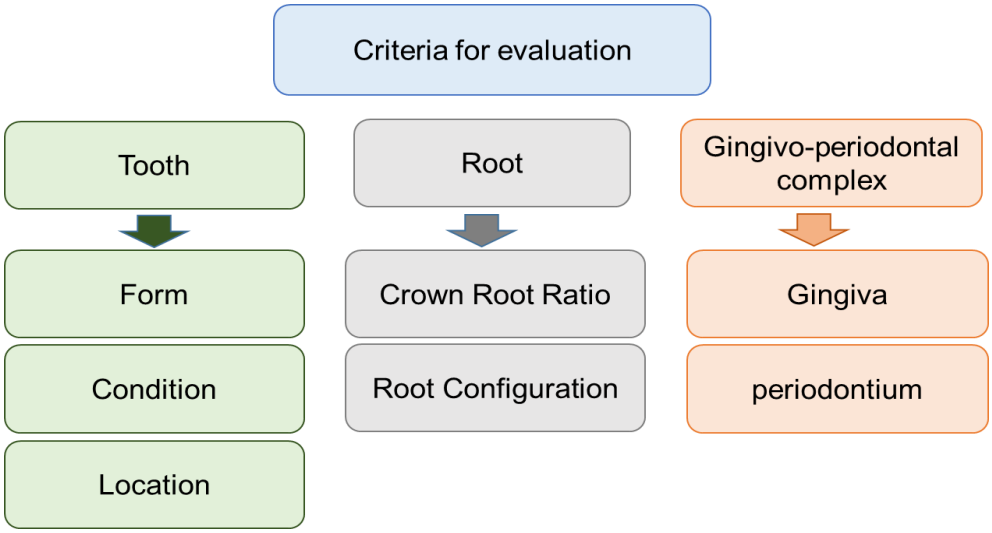
2- A symptomatic endodontically treated teeth with a radiographic evidence of good seal & complete obturation of the canal can serve as abutment (post & core for retention & strength).

3) The supporting tissue surrounding the abutment teeth must be healthy & free of inflammation.

4) Abutment teeth must not exhibit any mobility, since they will be carrying an extra load. Sever uncorrectable periodontal disease is contraindicated for FPDs.



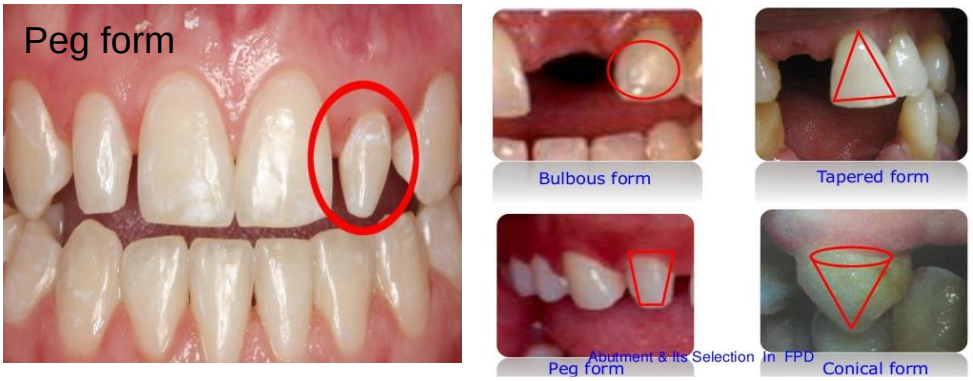
Abutment evaluation (selection):



Factors related to tooth (abutment)

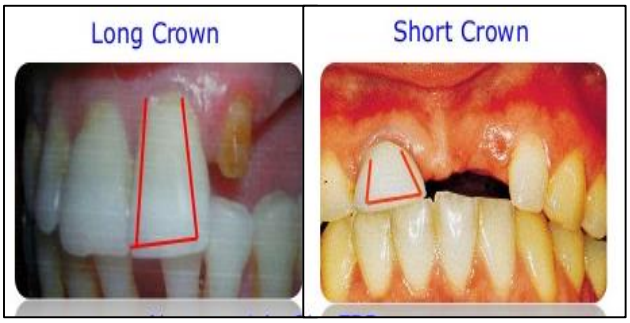
1. Shape:

Some teeth have conical, peg, bulbous or tapered crown form that interfere with the preparation parallelism, necessitating full coverage crowns to improve aesthetics and retention. Examples; Peg laterals, anterior teeth with poorly developed cingula and short proximal walls, mandibular premolars with poorly developed lingual cusps & short proximal surface, and thin incisors.



2. Crown length

- Abutment teeth must have adequate occlusocervical crown length to achieve sufficient retention. Full coverage restorations & crown lengthening are considered with short clinical crowns to ensure adequate retention.

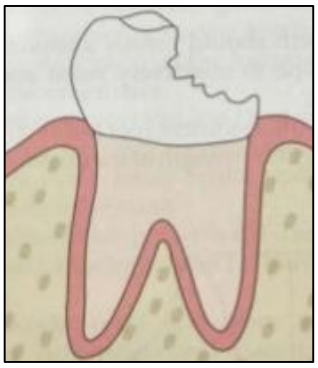


3. Size of the crown:

It determines the type of retainer to be used. For example: short, thin, conical, tapered teeth are poor indication for partial veneer crown.

3. Health of abutment (caries or pulpal):

- A sound abutment tooth permits ideal type of preparation. Carious tooth may be used as abutment if the caries is removed with pulp protection (lining) and then restored to its original form by suitable filling material.



- Degree of mutilation of the crown: The size, number & location of the carious lesion or restorations in a tooth will influence the type of the retainer on the abutment. If the caries is small and far away from the margin, the retainer design will extend beyond the caries area. If the mutilation/fracture is severe, removal of the tooth might be indicated.

-Vital teeth are preferred, however, pulpless teeth can be used only after endodontic treatment. Pulp capped teeth should be avoided because they are under risk of requiring RCT.

- Modifications like dowel core and pin retained restorations may be needed to restore crown morphology in grossly destructed teeth.

4. Axial relationship:

a) Rotation, tilting, over lapping, malposition might lead to a decision of excluding such a tooth to be used as abutment (because rotation or torque can damage the supporting structure or cause retainer to become loose).

b) It may indicate the use of specific retainer (over reduction lead to weaken the tooth & endanger pulp health).

c) Rotation lead to either increase or decrease of space available for pontic (size of pontic planned).

Factors related to root

1. Root configuration (root shape, angulation & length)

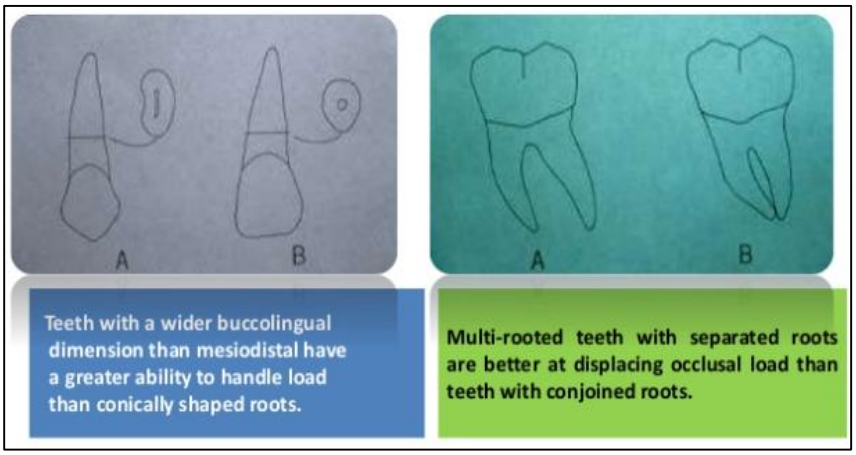
- The shape of the roots determine the ability of the roots to handle the occlusal forces. Root that is wider labiolingually than mesiodistally with elliptic cross-section offers better support than a tooth with similar root surface area but has a circular cross-section.

- Parallel-sided roots with developmental depressions are better to resist occlusal forces than smooth-sided conical roots which can be used for short span bridge, if the other factors are optimal.

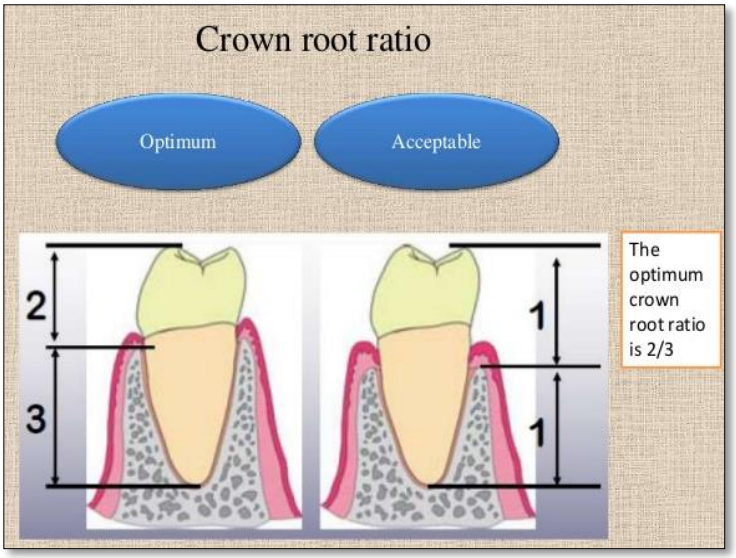
- A single-rooted tooth with irregular configuration or with some curvature at the apical third of the root is preferable than tooth that has a nearly perfect taper.

- Multi-rooted teeth with separated roots provide greater stability than single-rooted teeth or teeth with conjoined roots.

- Teeth with longer root are stronger abutment than shorter one, since root length is directly proportional to the stability & strength of the prosthesis.



2. Crown - root ratio: It is a linear measurement of the length of the tooth occlusal to the crest of alveolar bone (crown) compared to the length of the tooth that is embedded in the bone (root).



- 2:3 Crown/Root ratio is the optimum for a tooth to be used as abutment.

- 1:1 Crown/Root ratio is the minimum acceptable ratio. It might be considered adequate if the opposing occlusion is mobile or periodontally involved, or it composed of artificial teeth, which reduce occlusal forces that acting on the abutment which means less stress on the abutments.

Factors related to Gingivo-Periodontal complex

- Abutment teeth must be free from periodontal disease, periodontal pockets, osseous defect, and gingival inflammation with adequate zone of attached gingiva.

- The supporting tissue surrounding the abutment teeth must be healthy & free of inflammation. The abutment teeth should not exhibit any mobility, since they will be carrying an extra load. Intra oral radiograph should be used to evaluate bone architecture.

- The alveolar bone support is one of most important factors that aid to evaluate an abutment which must be healthy, have good trabecular architecture with no sign of bone defect or bone loss.

3. Root surface area (Periodontal ligament area):

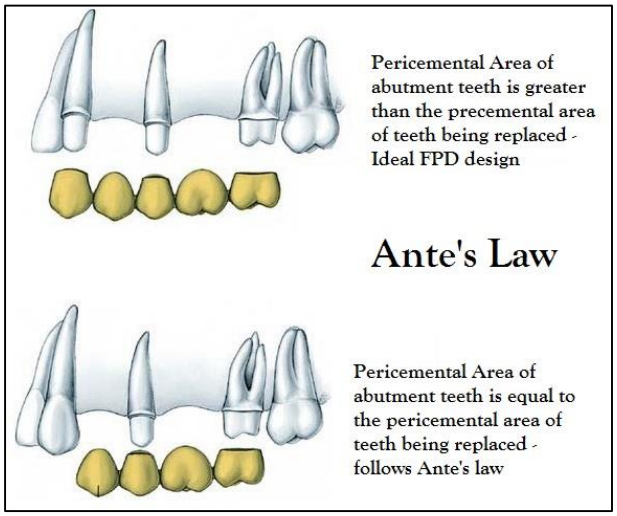
- The periodontal ligament area can be used as a scale or measurement to determine the potency of an abutment for FPDs.

- Tylman stated that "Two abutment teeth could support two pontics".

- Johnston et al improvised Tylman's statement and proposed the famous ANTE's Law

Periodontal surface area "Ante's law":

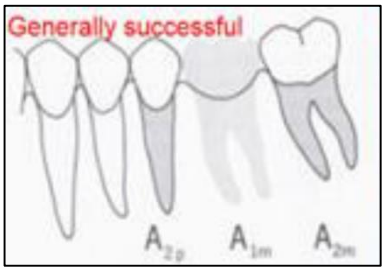
- The root surface area of abutment teeth (embedded in bone) (pericemental area) must be equal or greater than root surface area of teeth to be replaced.
- If the periodontal surface area seems inadequate, the use of multiple teeth for abutments may be indicated depending on other biomechanical factors.



Example: Missing 1st molar alone or with 2nd premolar, the root surface areas of both are equal to the root surface area of abutments (second molar & first premolar).

According to this premise:

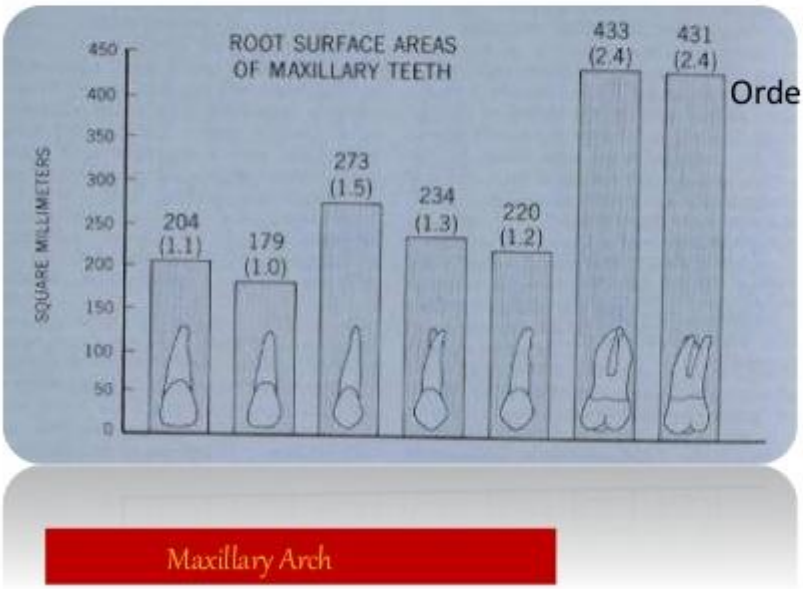
- One missing tooth can be successfully replaced if abutment teeth are healthy. In selected case and in order to increase the capability of the bridge to withstand the loading force 1st premolar can be used as a secondary abutment.
- If two teeth are missing, a FPD can probably replace the missing teeth but the limit is being approached.
- If three missing posterior teeth (1st molar & two premolars) or when the root surface area of the teeth to be replaced by pontics are greater than that of the abutment teeth, then a high risk or an unacceptable situation for FPD is exists.



- Jespen (1963) reported average measurements of root surface areas that can be used to calculate the abutment to pontic ratio

Abutment Evaluation

- Periodontal Surface Area (Ante's Law)

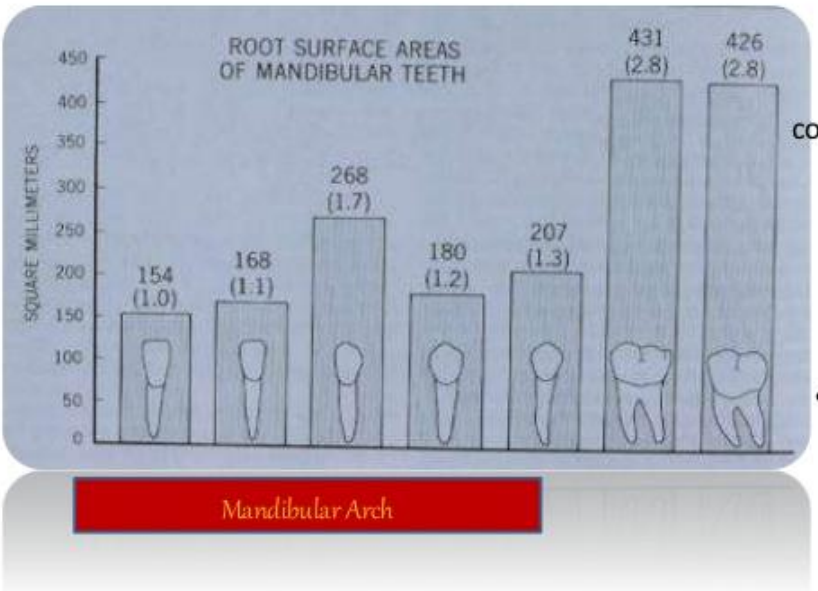


Order of Abutments concerning Periodontal Surface Area:

- First Molar
- Second Molar
- Canine
- First Premolar
- Second Premolar
- Central Incisor
- Lateral Incisor

Abutment Evaluation

- Periodontal Surface Area (Ante's Law)



Order of Abutments concerning Periodontal Surface Area:

- First Molar
- Second Molar
- Canine
- Second Premolar
- First Premolar
- Lateral Incisor
- Central Incisor

Crown & Bridge Prosthodontics

Lecture 3

Biomechanical Considerations of Fixed Partial Denture

Management of the destructive forces

- The design of the bridge must handle the occlusal & dislodging forces such as torque, flexure and tension.
- Occlusion must be designed to optimize the distribution of occlusal forces evenly throughout the envelope of motion over the entire mouth.

The biomechanical considerations include the role of span dimension, pontics' characteristics, the connecters or joints of the prosthesis, abutment tooth & acting forces (masticatory) on the success of the constructed bridge.

Span length

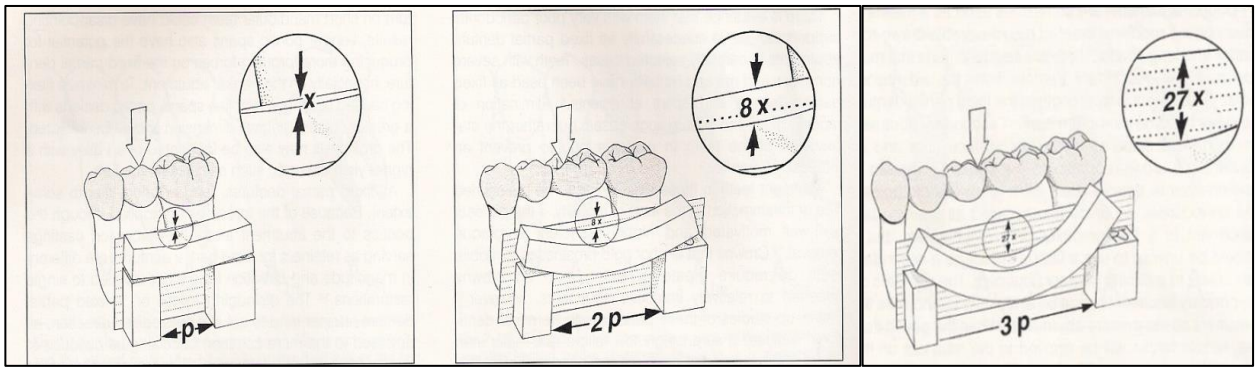
The distance between abutments that affects the feasibility of placing FPDs.

- One missing tooth is ideal for replacements.
- 2-3 adjacent teeth requires careful evaluation of other factors (crown-root ratio, root length & form, periodontal health, mobility, occlusal force & biomechanical factor).

The dimensions of the span (MD length and OG height) affect the number of the selected abutments, type of retainers & materials that are used for bridges' construction. In addition to the increased load placed on the periodontal ligament by long span FPDs, longer spans are less rigid. All FPDs flex slightly when subjected to a load, the longer the span the greater the flexing. Bending or deflection varies directly with the cube of the length & inversely with the cube of the occlusogingival thickness of the pontic.

Length of the span (Law of beam)

It is an engineering principle states that as the length of the span increases, the flexure of a system will be the increase in length to the power of three (cubed)

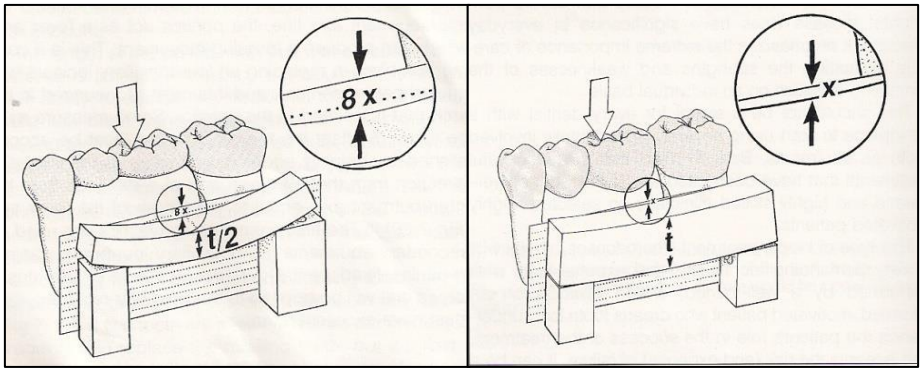


Compared with a FPD having a single-tooth pontic span, a two-tooth pontic span will bend 8 times as much. A three-tooth pontic span will bend 27 times as much as a single pontic.

This mean replacing three missing posterior teeth with FPDs rarely has favourable prognosis, especially in the mandibular arch (Treatment with RPDs or implant supported prosthesis).

Height of the connector (Law of beam)

As the height of the span decreases, the flexure of a system will be the increase in length to the power of three (cubed). Therefore, halving the connector height would yield 8 times the flexure.



A pontic with a given occluso-gingival dimension will bend 8 times as much if the pontic thickness is halved.

Therefore, a long span FPD on short mandibular teeth can have disappointing results. Excessive flexing under occlusal loads may lead to failure of the long span FPDs (fracture of the porcelain veneer, connector breakage, retainer loosening and caries, or unfavourable tooth or tissue response).

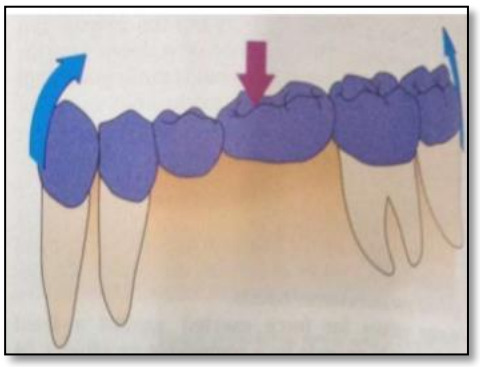
To minimise flexing:

- Select pontic design with greater occlusogingival direction.
- Pontics & connectors should be made as bulk as possible to ensure optimum rigidity without jeopardizing gingival health.
- Long span or unfavourable crown/root ratio then used double abutments to enhance the retention & support the long span FPD.

Double abutment

It refers to the use of two adjacent abutment teeth at one or both ends of a FPD

Indications

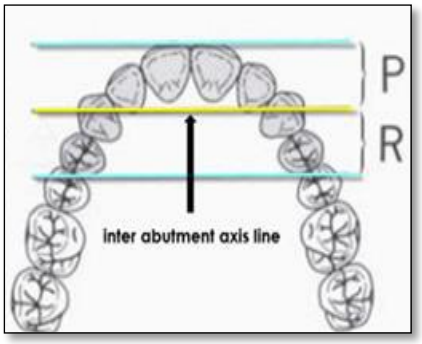


- To increase the retention of the restoration
- To increase area of supporting periodontal ligament and bone.
- Un favourable crown-root ratio
- Long span FPDs
- Splint & stabilise periodontally compromised teeth.

Criteria for double abutment

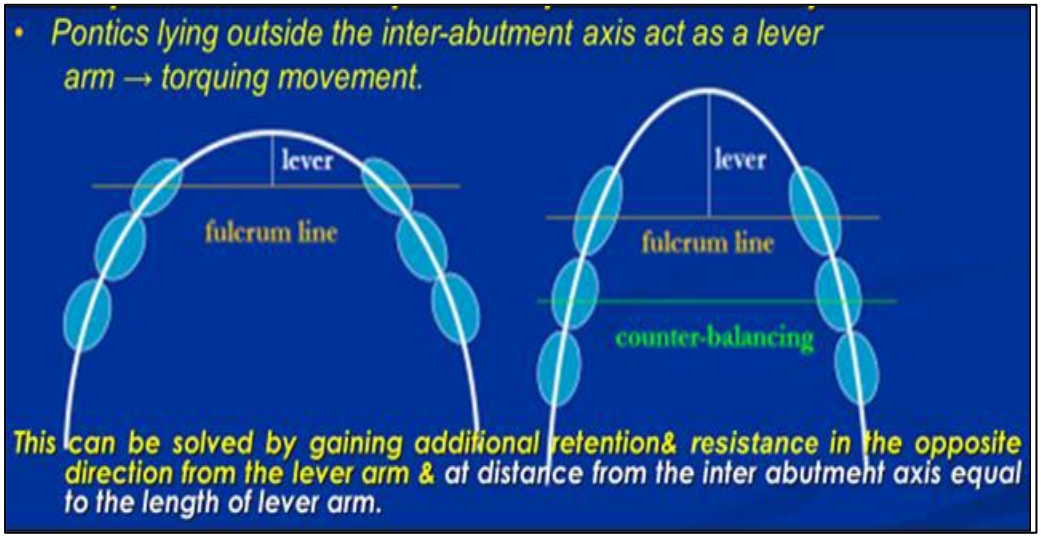
- Secondary abutments must have as much root surface area & a favourable crown root ratio as the primary abutment.
- The retainers on secondary abutment must be at least as retentive as on primary abutments because when the pontic flexes, tensile forces will be applied on the retainers of the secondary abutments.

Arch curvature:



When pontics lie outside the interabutment line, they act as a lever arm, which can produce a torqueing movement.

- This is a common problem in replacing all four maxillary incisors with a FPD.
- It is more pronounced in pointed taper arch anteriorly. The more the taper of the arch, the longer will be the lever arm, the more stress or torqueing force, while the more circular arch curvature reduces such a problem.

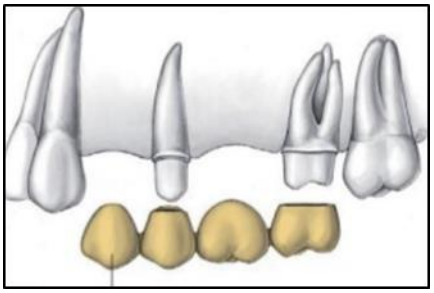


To solve such problem and offset the torque, additional retention is obtained in the opposite direction from the lever arm & at distance from the inter abutment axis equal to the length of lever arm, this mean, that **two abutment teeth at each end of long span anterior FPD** must be used in order to resist this tipping forces. This mean first premolars are used as secondary abutments for a maxillary four pontic canine-to-canine FPD.

Pier (intermediate) abutment:

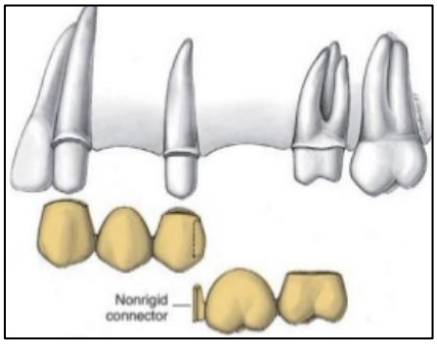
It is a natural tooth located between terminal abutments that serve to support fixed or removable prosthesis. Because it lies in the middle of the span, it creates huge stresses on the terminal abutments and acts as a fulcrum causing failure of the weaker retainer. These forces loosen the retainer or the casting, or may lead to leakage around the margin leading to extensive caries.

To overcome such complication, you can select one of the following approaches:



1) The use of extremely retentive retainers.
2) When periodontal support is adequate, a much simpler approach would be to cantilever one segment of the bridge on one side of pier abutment.

3) Use of non-rigid connector.



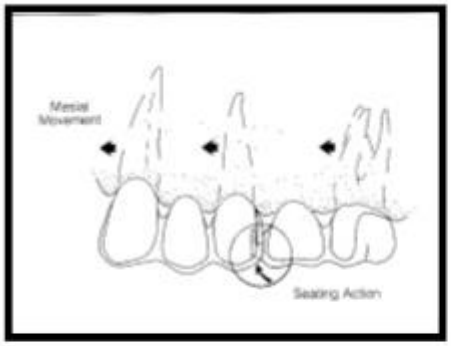
- It is a broken stress mechanical union of retainer (dovetail keyway) & pontic (T- shaped way).
- It transfers shear stress to supporting bone rather than the connectors.
- It appears to minimize mesiodistal torquing of the abutment, while permitting them to move independently.
- The most commonly used non-rigid design T- shaped key that is attached to the pontic & a dovetail keyway placed in the retainer

Location of the key & key way:

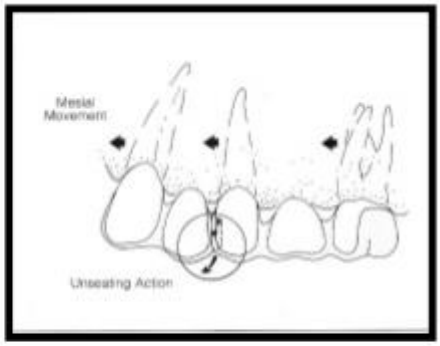
- Keyway should be placed within the distal contours of pier abutment.
- Key should be placed on the mesial side of the distal pontic.

Why keyway should be placed on the distal not on mesial of pier abutment?

Long axes of posterior teeth usually lean slightly in a mesial direction and tilt more mesially when subjected to occlusal forces. **Therefore, if keyway is placed on the distal of pier abutment**, then the mesial movement seats the key into the keyway more solidly. **If placement of the keyway is on the mesial side** then it causes the key to be unseated during the mesial movement which in time can cause a pathologic mobility in the canine or failure of the canine retainer.



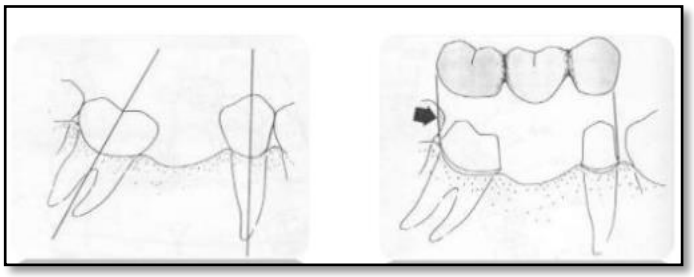
Nonrigid connector on distal side of pier abutment.



Nonrigid connector on mesial side of pier abutment.

Tilted molar abutment: Mesially tilted second molars

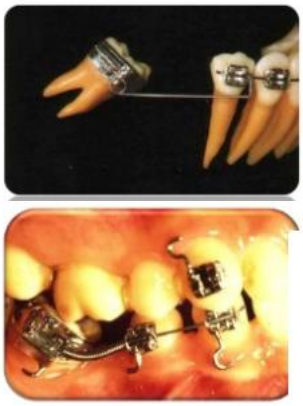
The early loss of mandibular 1st molar due caries is still relatively common. If this space is ignored, the 2nd molar will tilt mesially with the eruption of 3rd molar which inturn might be drifted & tilted with the 2nd molar. Then it becomes difficult to make a satisfactory FPD, due to the positional relationship no longer allows for parallel path of insertion without interferences from adjacent teeth



To solve this problem:

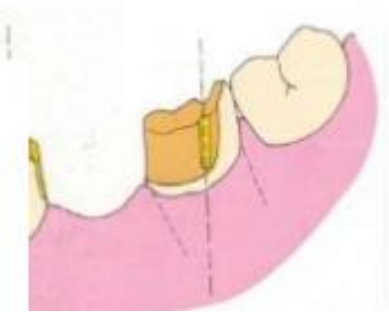
1- Ortho treatment (Uprighting the tilted tooth)

If the tilting is severe, uprighting of the molar is indicated by orthodontic treatment. This helps in distributing the occlusal forces & eliminating the bony defects along the mesial surface of the root. In such case the 3rd molars, if present, are better to be extracted to facilitate movement of 2nd molar (Average treatment time 3 months).

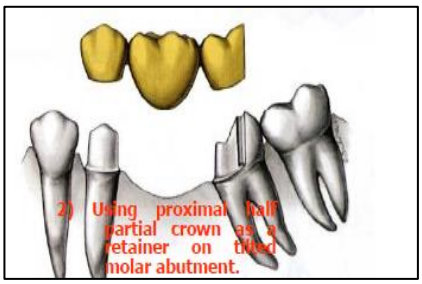


2- Using proximal hall partial crown as a retainer on tilted molar abutment.

Proximal half-crowns can be used as a retainer on distal abutment. This is simply a three-quarter crown that has been rotated 90 degrees so that the distal surface is uncovered. It is possible only if:

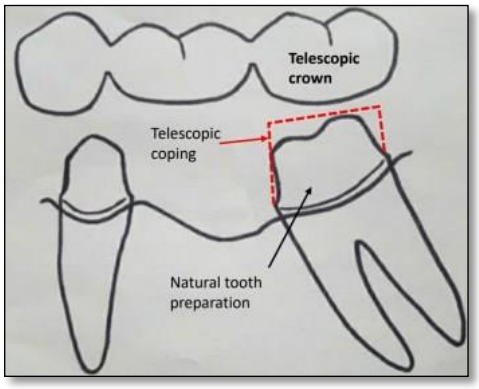


- The distal surface is caries free.
- The distal surface is not decalcified.
- There is a very low incidence of proximal caries throughout the mouth.
- The patient is able to keep the area exceptionally clean.



3- Using telescope crown & copping as retainer.

A telescope crown & coping can be used as a retainer on the distal abutment

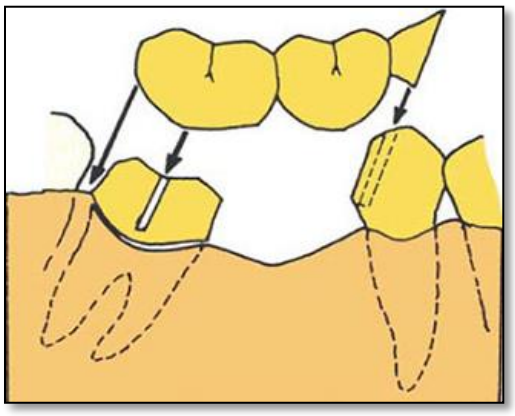


i.e. full crown preparation with heavy reduction is made to follow the long axis of tilted molar. An inner coping is made to fit the tooth preparation and a proximal half-crown that will serve as a retainer for the FPD is fitted over the coping.

Advantages: it allows total coverage of the clinical crown while compensating for the discrepancy between the path of insertion of the abutments.

4- Non rigid connector is another solution to the problem.

A full preparation is done on the molar with its path of insertion parallel with the long axis of the tilted tooth. A box form is placed on the distal surface of the premolar to accommodate a keyway in the distal aspect of the premolar. Reasons for NOT placing the non-rigid connector on the mesial aspect of the tipped molar is that it can lead to greater tipping of the tooth.

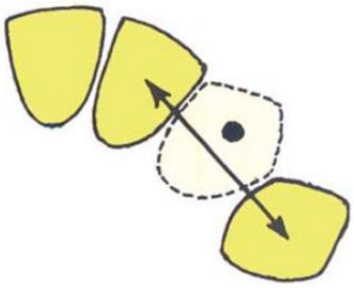


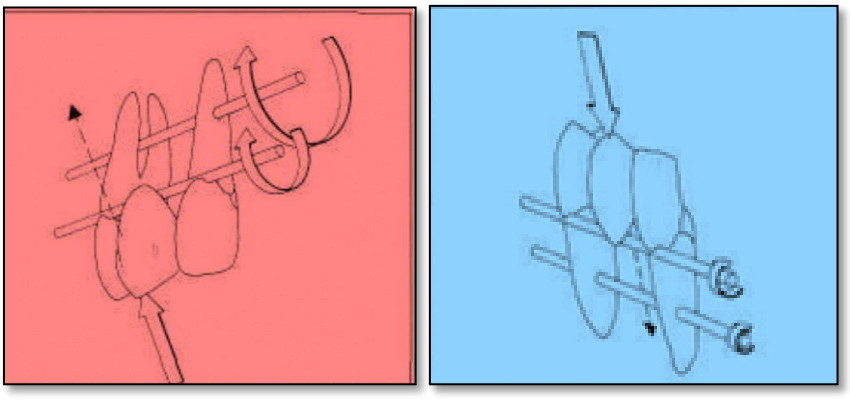
It is indicated when the molar exhibits marked lingual as well as mesial inclination because the routine FPD in such cases will lead to drastically overtapered preparation with no retention.

Because telescope crowns and non-rigid connectors both require tooth preparations that are more destructive than normal, the selection of one of these would be influenced by the nature of previous destruction of the prospective abutment tooth for e.g. the presence of a dowel core or a D.O amalgam on the premolar would favour placement of a non-rigid connector- while extensive facial and / or lingual restorations on the tilted molar would call for the use of a telescope crown.

Canine replacement fixed partial denture

Fixed partial dentures replacing canines can be difficult because the canine often lies outside the interabutment axis. The prospective abutments are the lateral incisor usually the weakest tooth in the entire arch, and the first premolar, the weakest posterior tooth. A FPD replacing maxillary canine is subjected to more stress than that replacing a mandibular canine since forces are transmitted outward (labially) on the maxillary arch, , against the inside of the curve (its weakest point) ,while ,on the mandibular canine the forces are directed inward (lingually), against the outside of the curve (its strongest point).





So in cases of canine replacement FPD, you should consider the following points:

- Any canine replacement FPD must be considered a complex
- No FPD replacing a canine should replace more than one additional tooth (the support from secondary abutments will have to be considered).
- An edentulous space created by the loss of a canine and any two contiguous teeth is best restored with Implants or a RPD.

Evaluation of the path of insertion

- Path of insertion should be check before imprint.
- Parallelometer-mirror can easily spot the positional relationship of the prepared abutments, especially in difficult case or inexperience dentist.

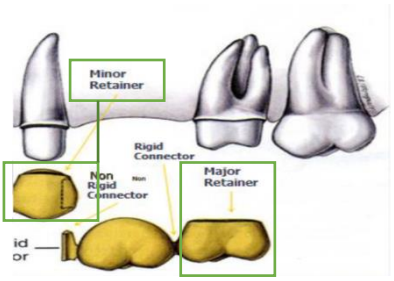
Crown & Bridge Prosthodontics

Lecture 5

Components of Bridge: Bridge Retainers:

The bridge retainer unites the abutment to the restoration. It takes the support from the abutment tooth and provides stabilization & retention to the prosthesis. It could be either seated over or in the abutment tooth, connecting the pontic to the abutment. Retainers could be (divided into):

1. **Major retainer:** They are used in fixed-fixed, spring & cantilever bridges. In the fixed-mobile bridge, the major retainer is located at one end of the pontic only. In conventional bridges, the major retainer must be retentive & cover the whole occluding surface of the tooth (rigid connection to pontic).



2. **Minor retainer:** Represent the lesser retainer of fixed-mobile bridge into which a movable connector from a pontic seated on or attach to it. It doesn't need full occlusal coverage (Flexible connection to pontic).

Types of retainers: Major or Minor Retainer Designs

1. Based on preparation design:

1) Extra coronal retainer: complete crown or partial crown.

2) Intra coronal: Inlay, onlay

3) Intra radicular: Post & core.

Specific Retainer design: Standard: Full Metal Crown, 3/4 Crown, 7/8 Crown, Post Crown, PFM, full Zirconium, Combination.

Non-Standard: Implant, Inlay, Onlay, Resin Bonded “Maryland Bridge”

2. Based on material used

1) All-metal retainers 2) Metal-ceramic retainers 3) All-ceramic retainer 4) Zirconium retainers 5) Acrylic retainers.

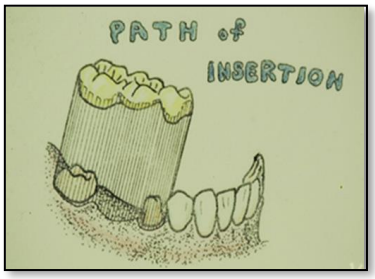
All metal retainers are the most conservative one, the simplest to prepare & least expensive. They are used in posterior region when aesthetic is not critical. Metal-ceramic, All Ceramic & Zirconium are used for anterior replacements where aesthetic is essential. Acrylic retainer used with temporary bridge.

Criteria for choosing suitable retainer (assessment factors):

The alignment of abutment teeth, the retention required, aesthetic, the condition of abutment teeth, periodontal, conservation of tooth structure, cost & Caries susceptibility.

1) Alignment of abutment teeth:

When abutment teeth are more or less parallel to each other, either complete or partial crown retainer can be used. If the abutments are not parallel, complete crown retainer will be less conservative.



2. Appearance (Aesthetic): The aesthetic of retainer must be acceptable to patients. If aesthetic is critical, PFM, All Ceramic, Zirconium or ¾ crown can be used. Some patient may worry about metal display on occlusal surface of posterior teeth, this needs to have porcelain extend to cover occlusal surface of metal. This led to a destructive preparation which is not always possible or desirable.

3. The condition of abutments: Extensive caries or large restoration involving the buccal surface, or loss due to fracture, necessitate complete coverage retainers. Pulp condition play a vital role in the selection of retainer design,

incisal relationship has great effect especially when the clinical length of the crown is short in anterior & posterior teeth (worn teeth).

4. Conservation of tooth structure:

Inlays, Onlays > partial coverage > complete coverage. Full metal> PFM > All ceramic crown. It the buccal enamel and dentin are sound, partial coverage provides a conservative preparation, reduce the harmful effect on the pulp & periodontium, and will not destroy the natural appearance. However, if there is sound indication for complete crown, this must be done.

5. Cost: Partial crown & complete crown (Retainer) may be less expensive than PFM, which is less expensive than All Ceramic or Zirconium retainers. Metal Retainer are least expensive. When there is no other factor affecting choice, this is obviously of considerable importance.

6. Size and position of the abutment: Partial crown needs sufficient large and long tooth. Position may affect aesthetic.

7. Caries susceptibility: Patient with poor oral hygiene is indicated for complete crown.

8. Retention required: The retention of a bridge retainer should be at least as great as for similar restoration made as single unit. Retention of crown vary according to preparation feature, crown material properties and type of luting cement.

Factors affecting the amount of required retention:

1) Length of span & rigidity: The longer the span the greater the stresses on the retainer & the more will become un cemented. Furthermore, the casting will be more liable to flex, so you must a certain they are sufficiently rigid (The longer the span, the stronger must be all the component bridge).

2) Type of bridge: Certain types of bridges induce greater stresses on the cementing media of retainers than other. Thus, strong retainers are required for fixed-fixed than fixed-mobile bridge. Indeed, little retention is needed for the minor retainer of fixed-mobile design, to preserve the tooth tissue. For ex, the replacement of max 1st premolar by fixed-mobile bridge using full coverage on 2nd premolar as major retainer & a class III inlay on the distal of canine as the minor retainer. This design will be conservative, aesthetic with intact labial surface.

3) Strength of the bite: The strength of the bite determines the degree of retention required, this will vary with age, sex & muscular development of the patient. The heavier the bite the stronger & thicker the retainer material is needed to prevent failure of the retainer or pontic.

4) Tooth or teeth to be replaced: The size & position of the pontic have a direct effect on the type of retainer required (stress amount). Thus, the replacement of a molar causes greater stress to the abutment than lower incisor, and the forces acting on canine are more likely than on an incisor.

5) Occlusal coverage: Full occlusal coverage is always indicated for fixed-fixed bridges. It gives the abutment complete protection during mastication and protect cusps from fracture especially in large restorations or endodontically-treated teeth. The occlusal reduction must be sufficient to provide enough thickness for the material to be rigid.

6) Habits of patient: Habits might induce stress on the bridge retainer such as pipe smoking, clenching & bruxism. If many teeth severely worn, then any metal retainer will similarly wear unless the habit can be corrected. Therefore, retainer must be thicker & stronger than normal.

Requirements of ideal retainer:

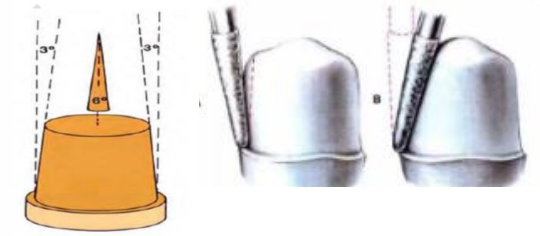
1) Provide maximum retention 2) Maximum aesthetic 3) Preserve the vitality of the prepared teeth 4) Conservative preparation (less amount of traumatic reduction) 5) Biologically accepted to the surrounding tissues 6) Withstand masticatory forces 7) Easily constructed.

General factors in tooth preparation:

In order to obtain these ideal retainer requirements as far as related to tooth preparation, if the case permit, the design of the preparation of abutment tooth for a metal or porcelain crown restorations are limited by five principles: 1) Preservation of tooth structure 2) Retention & resistance from 3) Structural durability of restoration 4) Preservation of periodontium 5) Marginal integrity.

2. Factors affecting retention & resistance of crown restorations:

1) Taper of the preparation: The more nearly parallel the opposing walls of preparation the greater will be the retention. To avoid undercut & seating problems, 5-6° convergence angle is used to provide the needed retention. Tooth preparation must be kept minimum because of the adverse effect on retention.



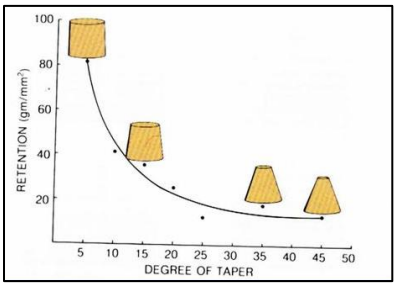
2) Surface area of the preparation,

3) Length and height of the preparation.

4) Diameter of the tooth (tooth width).

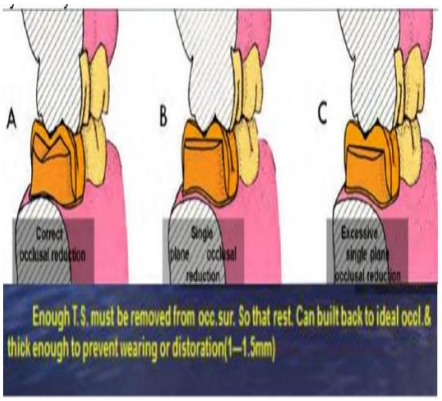
5) Texture of the preparation.

6) Accessary mean.



3. Structural Durability of the restoration

The crown must be rigid enough to avoid flexing, perforation or fracture. Rigid restorations need bulk which require sufficient tooth reduction, so the restoration can withstand the forces of occlusion, prevent wearing holes in metal & allow proper contouring & carving of anatomy in the restoration.



4. Preservation of periodontium: Whenever possible the margin of the preparation must be placed supragingivally. The casting should have proper contact, embrasure form, occlusion with healthy occluso-gingival contour.

5. Marginal Integrity: The restoration margins must fit as closely as possible against the finishing line of preparation, and be placed in an area where the dentist can prepare and finish easily, and the patient can clean properly. The margin affects both marginal adaptation & degree of seating of the restoration.

Margin (Finishing line) placement:

1. Supragingival: Placing the margin above the gingival tissue is considered to be more conservative, when placed on hard enamel. Easy preparation, finishing, visibility & impression making and more hygienic as the patient can keep the area clean easily.

2. Subgingival: Placing the margin below the gingival tissue.

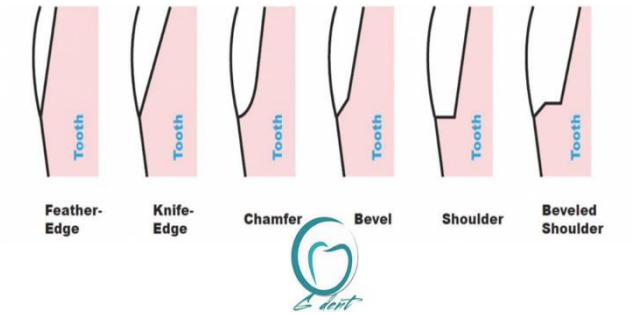
3. Equigingival: Placing the margin with in the level of the gingiva.

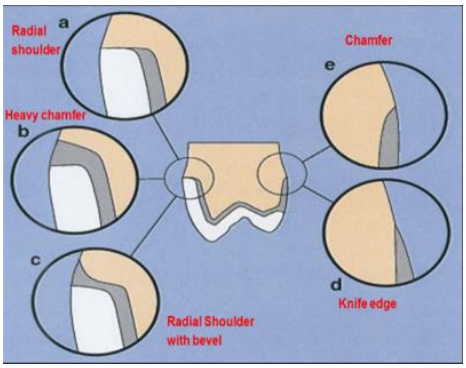
The factors that affect the position of finishing line are: a- Aesthetic b- Extra retention is needed c- When there is caries or filling near the margin at the area of finish line.

Requirement of finishing line: It must be clear, smooth, well defined, continuous from one surface to the other, and at sound tooth structure.

Factors affecting design of the FL: Type of the restoration, materials used in construction & the amount of occlusal force (stress).

Types (design or configuration) of finish line: The designs depend on the type of the crown restoration: knife edge, shoulder, shoulder with bevel, radial shoulder, chamfer & heavy chamfer. The configuration of F.L. determines the shape and the bulk of the restoration.





Complete Cast Crown (Full metal):

It is the most conservative crown, indicated in posterior region when aesthetic is not needed. It provides better retention & resistance, because all the axial surfaces of teeth are included in the preparation. It is indicated when the abutment teeth show extensive tooth destruction as a result of caries or trauma, can receive clasp, endodontically treated teeth and patient with high caries index.

Advantages: Greater retention & resistance, high resistance to deformation (Strong) even in thin sections, preserve tooth structure (conservative) & easy to be prepared. **Disadvantages**: Poor aesthetic, difficulty to test the vitality of the abutment tooth especially by electrical pulp tester, interfere with taste, tarnish & corrosion so it needs prophylactic measures.

Porcelain Fused to Metal:

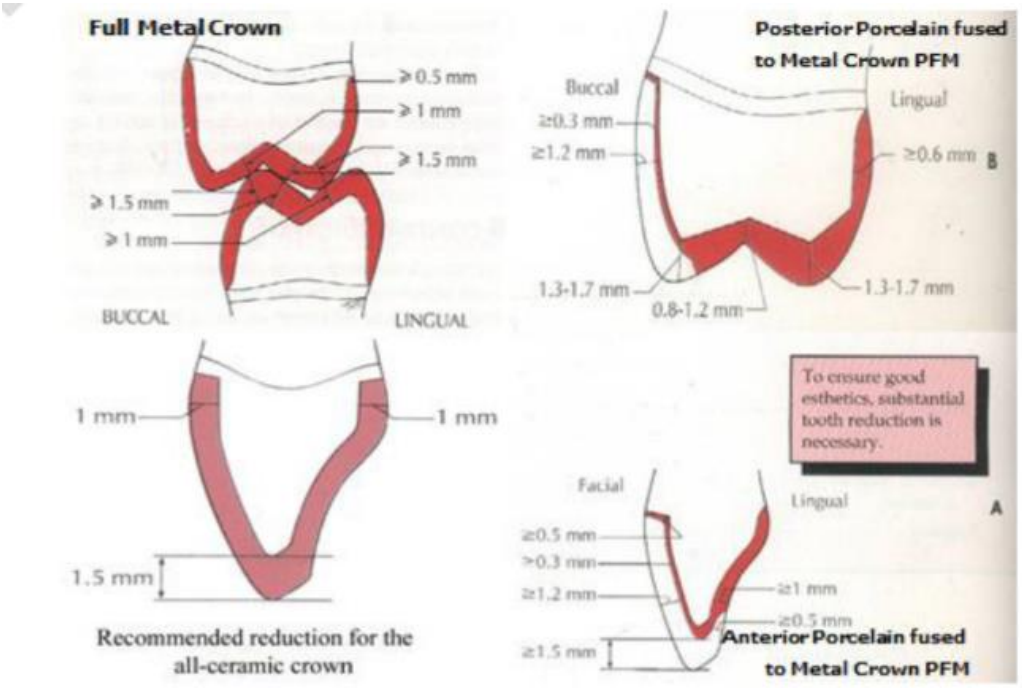
The most widely used retainer when aesthetic is a factor. It combined the strength of full metal crown & the aesthetic of all ceramic crown. It is indicated when aesthetic, excessive retention & resistance are needed. But it is contraindicated in case of large pulp chamber, intact buccal wall & when more conservative retainer is required.

Advantages: Combined strength of FM & aesthetic of all ceramic crown. **Disadvantages:** 1) Substantial removal of tooth structure 2) More subjected to fracture because of brittle nature of porcelain 3) Shade selection might be difficult 4) Inferior aesthetic compared to All Ceramic Crown 5) More expensive

All Ceramic Crown:

It is the most aesthetically pleasing retainer as it made entirely from ceramic substance with no metal substructure to block light transmission. It resembles the colour & translucency of natural teeth more than other restoration. It is indicated when high aesthetic is needed, considerable proximal caries, endodontically treated teeth with post & core & favourable distribution of occlusal load.

But it is contraindicated when high strength is needed, thin teeth faciolingually & insufficient coronal tooth structure, unfavourable distribution of occlusal load, and in bruxism.



Partial veneer crown (3/4 crown):

Cast restorations that cover 3/4 of the clinical crown leaving intact buccal or labial surface. It has less retention & resistance to displacement compared to full metal, full veneer with facing. It is indicated in short span bridge, teeth with good clinical crown length & thickness labio-lingually, good oral hygiene & low caries index.

Good axial relationship of abutments to facilitate the path of insertion. It is contra-indicated in short teeth, poor oral hygiene, grossly caries teeth, long span bridges, poorly aligned abutment & endodontically treated teeth.

Advantages: Conservative, good aesthetic, reduced pulpal and periodontal insult during tooth preparation, less periodontal irritation because all margins of the crown are placed supergingivally, the vitality test can be done on the unprepared surfaces, easy finishing by dentist & oral hygiene by patient.

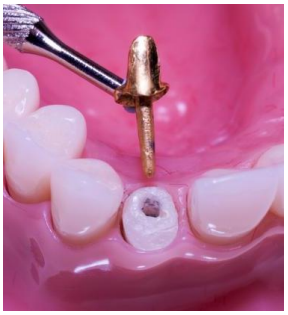
Disadvantages: Recurrent caries along to cavosurface line angle, possibility of showing gold especially in the lower anterior & posterior teeth, and difficulty in preparation compared to other types of crowns, limited adjustment can be done in the path of placement.

Telescopic retainers

Design involves fabrication of two copings one over the other. The internal or primary coping function to modify the morphology of tooth, changing the path of insertion, while the secondary or external coping to fit over the primary one. It is recommended when the path of insertion of FPD does not coincide with long axis of abutment.

Post crown

It is a fixed artificial restoration which replaced the coronal portion of the natural tooth completely. It retained by a mean of post (dowel) that extended and cemented to the root canal space of endodontically treated tooth. The post crown will reinforce the remaining tooth structure against forces by distributing the forces to the supporting tissue. It is indicated for endodontically treated abutments, abutment tooth with short clinical crown & realignment of malposed abutment. For multi-rooted posterior teeth, the post should be placed in the largest canal. Ex, the palatal canal in maxillary molar, the distal canal in mandibular molars, and the buccal in maxillary premolar.



The retention of post crown depends on:

1) Taper of the root canal: parallel-sided preparation is more retentive than tapered one (diverge occlusally)

2) Post length: The longer length the more retention (2/3 length of root, equal to length of clinical crown, 4-5 mm from apex, 8 mm deep from CEJ)

3) Post diameter: One third the root diameter at CEJ and should be at least 2 mm less than root diameter at mid-root area

4) Post surface texture.

Factors affect the selection of a tooth for post crown retainer:

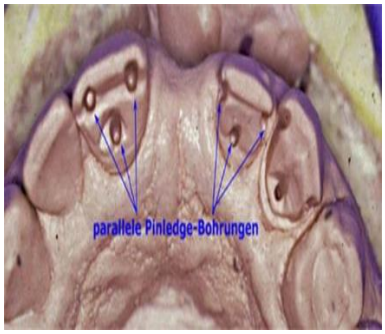
The root of the abutment must have sufficient length, width and without sharp angulations in the middle third. The root should be without internal or external resorption. Good quality of root-filling which must be well-condensed especially in the apical 3rd of the canal.

Resin bonded retainers:

It's the most conservative retainer that requires minimal tooth preparation, acid etched, aesthetically attractive, economical & do not irritate soft or hard tissues.

It is indicated as retainers when the abutment tooth has sufficient enamel surface for etching. It stabilizes teeth after orthodontic treatment. But contraindicated in patients with sensitivity to base metal alloys, when the facial aesthetic of abutment is not efficient, inadequate enamel surface to bond (caries, existing restoration, attrition), & in thin incisors.

Pinledge: A partial veneer retainer. The preparation incorporating pins holes to provide retention. It is indicated when the anterior teeth are not damaged, high aesthetic requirement, when proximal grooves are impossible to prepare, also to alter lingual contour of maxillary anterior teeth.



Inlay

A fixed intracoronal restoration made outside of a tooth to correspond to the form of the prepared cavity, which is then luted into the tooth. Inlay may be used as a single tooth restoration or as a minor retainer for FPD. They made up of gold alloy or ceramic material. It is contraindicated in patient with high caries index, poor oral hygiene, MODs & poor dentin support that require wide preparation.

Onlay

A restoration that restores one or more cusps and adjoining occlusal surfaces or the entire occlusal surface and is retained mechanically or by dental adhesive. It is used to restore extensively damaged posterior teeth that needs wide mesio-occluso-distal restorations. It can be used as a retainer for FPDs. It is contraindicated in patient with high caries risk, poor oral hygiene, short clinical crown, extruded tooth and in bruxism.

Crown & Bridge Prosthodontics

Lecture 6

Components of Bridge: Pontic:

It is the suspended portion of the FPD that replaces lost natural tooth/teeth to restore function and aesthetic. It is connected to the retainer by a rigid connection (solder joint) or non-rigid flexible connection (key & key way) in the stress-breaker type of bridges. It consists of metal backing, solder joint and facing.

Materials used in Pontic fabrication

They are made either entirely from cast metal, porcelain or zirconium, or a combination of metal backing with porcelain or acrylic facing. The full metal pontic is used for the posterior region while metal with facing or full ceramic and zirconium are used in anterior region.

Functions of the Pontic:

1) Mastication
2) Speech (phonetics): It helps to restrict air passage through edentulous area to aid in the reestablishment of normal sounds
3) Esthetics (appearance): It fills empty spaces that observed during talking and smiling, providing the support for lips and cheeks to allow normal facial form (Well-aligned teeth and a pleasing smile afford a positive social status)
4) Maintenance of teeth relationship: They maintain the integrity of dental arches by preventing movement of adjacent and opposing teeth from their normal position.

Ideal Pontic Requirements

A- Aesthetic requirements: The pontic must meet the demand of aesthetic & comfort, the deciding factor for the esthetic value is “the smile line”, which is an imaginary line running from the incisal edges of maxillary incisors and coincides with the curvature of the lower lip together with upper lip line.

It determines the appearance zone of the facial aspect of teeth, which is quite true for the upper teeth, however for the lower teeth, most of the time only the higher portion of the facial aspect as well as the occlusal surface lie in the appearance zone.

As a general guideline, the lip line is optimal (average smile) when the upper lip reaches the gingival margin, displaying the total cervicoincisal length of the maxillary central incisors, along with the interproximal gingivae (75-100% of maxillary anterior crown height). A high lip line (high smile) exposes all of the clinical crowns plus a contiguous band of gingival tissue, whereas a low lip line (small smile) displays less than 75% of the maxillary anterior teeth.

The matter of concern here, is the form of the facial aspect of pontic that is related to appearance, so to fulfill the aesthetic requirement, the pontic must:

1) look like the replaced tooth 2) The tissue contact appears as normal tooth 3) The lower lip line helps to evaluate buccolingual position of the incisal edge and the curvature of the incisal plane.

In excessive bone loss, it is possible to construct a pontic with a length coincide with clinical requirement for that patient but for esthetic reason you can add pink porcelain to the apical portion of pontic to simulate gingival tissue. Root can be stained to simulate exposed dentin, while pink porcelain was used to simulate the gingival tissues.

B- Biologic Requirements:

1. The pontic must be hygienic; permit the maintenance of high standard of oral hygiene through providing a good access for cleaning the underlying soft tissue. Furthermore, the pontic must prevent soft and hard tissue irritation. Pontic design must allow the use of cleaning devices such as brushes, super floss and dental floss without difficulties.

2. The design of the tissue surface of pontic must not cause any problem to the underlying soft tissue (ulceration and inflammation) by pressure, a pressure free contact is indicated (passive contact, thickness of a film of saliva is sufficient for esthetical demand if the facial surface lies within the appearance zone). The design and materials may also case tissue irritation due to improper food staff shading that leads to plaque formation, so the tissue surface of pontic must be convex made from ceramic.

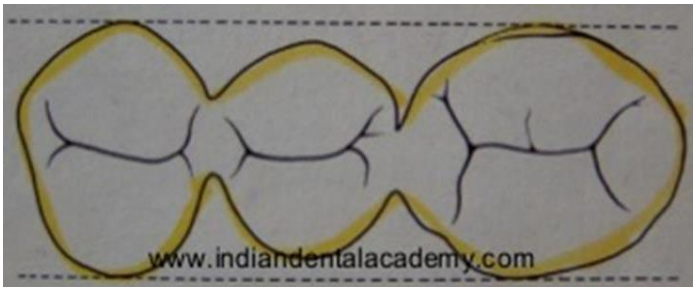
3. Glazed porcelain and highly polished metal (gold) are the preferred materials for tissue contact. Because of the porous nature and difficulty to obtain a highly polished surface, resins must not be used near the soft tissue. However, even highly polished surfaces will accumulate plaque if oral hygiene measures are ignored

4. The contact area or solder joint must guard the interproximal area, the embrasure (mesial, distal and lingual) should be opened wide to allow massage of the gingival tissue.

5. The contour of the labial and lingual surfaces of the pontic must be proper and lie with the same line of contour of the adjacent teeth so it will allow stimulation as well as protection of the underlying tissue

C- Mechanical Requirements

The pontic must be strong enough to withstand forces without deformation (Rigid & resistant to deformation). Part of pontic that subject to force usually made supported by metal. All metal pontic may be needed in situation of high stress rather than metal ceramic pontic which is more susceptible to fracture. Mechanical problems may be due to; improper choice of material, poor framework design, week connectors, poor occlusion, & poor tooth preparation. It must restore the function of replaced tooth properly. Sometime it is desirable to reduce the occlusal surface width by 20% to reduce torque on retainers and abutments and simplify the cleaning with minimal soft tissue contact. However, the width of pontic governed by esthetic, span length, abutment teeth strength, ridge form and occlusion.



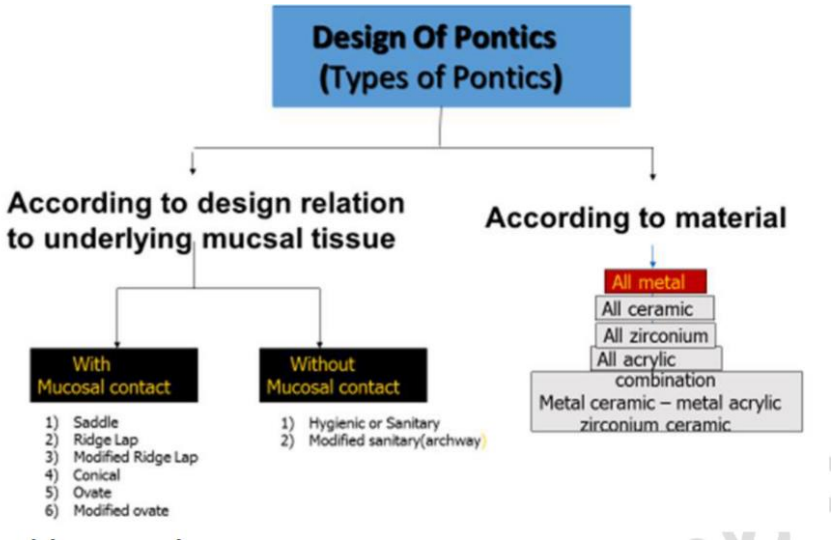
Summary of pontic Requirements

Aesthetic: Looks like the replaced tooth & tissue contacts as normal tooth.

Biologic: Can maintain healthy tissues, cleansable.

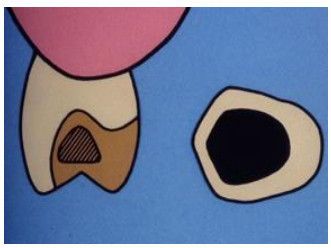
Mechanical: Strong enough to withstand functional forces, rigid & resistant to deformation, provides normal function.

Designs (Types) Of Pontic



(A) Pontics with mucosal contact:

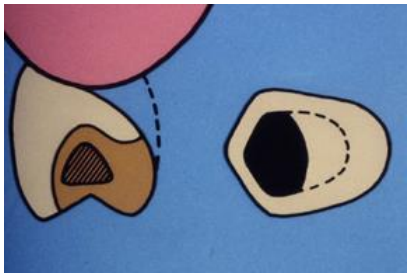
1. Ridge lap (Saddle Pontic):



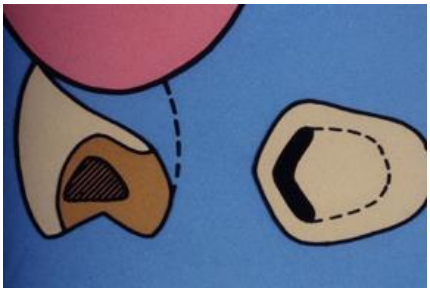
The tissue surface is concave buccolingually overlying the residual ridge buccolingually simulating the contours of emergence profile of missing tooth on both sides of the residual ridge. It is used for limited occlusal-gingival space, and for patients who reject the presence of a lingual space.

It has the largest area of contact (overlaps the ridge) with most natural feeling. But it is the most difficult to clean. SHOULD NEVER BE USED

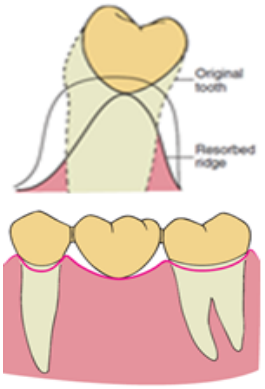
2. A: Modified Ridge Lap Pontic: It resembles a saddle on buccal, and convex on the lingual. More cleansable than saddle design. Less tissue irritation, giving an illusion of a tooth. It combines best features of saddle & hygienic pontics. It can be used when the tooth lies in the appearance zone (max & man.)



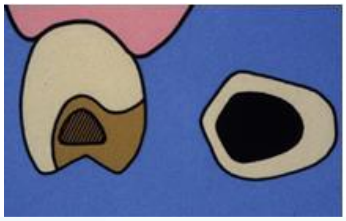
2. B: Modified Ridge Lap Pontic: It contacts the underlying tissue on the most facial surface of the pontic only. It is the most cleansable design with least tissue irritation. The space between pontic and tissue lingually can be unacceptable to the patient. It can be used when the tooth lies in the appearance zone (max & man.)

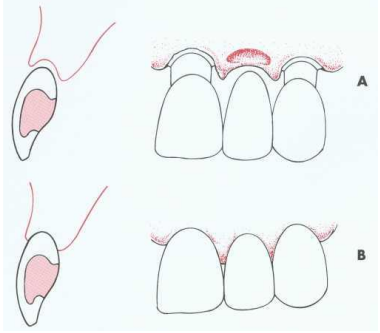


3. Conical Pontic (bullet, spheroid): It is an egg or spheroid-shaped, used in non-esthetic areas. It is convex with one-point contact with the residual ridge. The easiest design to be cleaned. It can be used when occlusal 2/3 of the facial surface lies in the appearance zone but not gingival 1/3 (lower incisors, premolars and molars). It is not indicated for broad flat ridge, as it leads to debris trapping embrasure space. Clinical applications: Knife edge ridge, posterior teeth (where aesthetic is not needed)

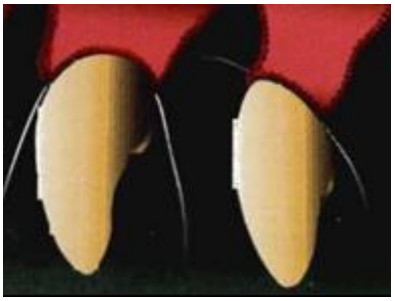


4. Ovate Pontic: Excellent aesthetic. It is convex tissue surface resides in a soft tissue depression or hollow in the residual ridge, which makes it appear that a tooth emerging from the gingiva. Careful treatment planning is necessary for successful results, it gives natural feeling for patient. But it has a difficulty in cleaning with potential tissue irritation. Used for maxillary incisor & premolars, requires surgical preparation.



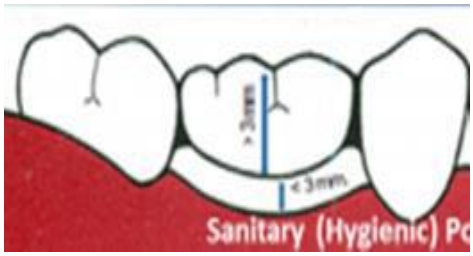


5. Modified Ovate Pontic: It is a modification of the ovate pontic that involves moving the height of contour at the tissue surface from the center of the base to a more labial position 1-1.5 mm apical and palatal to gingival margin. This pontic does not require as much faciolingual thickness to create an emergence profile.



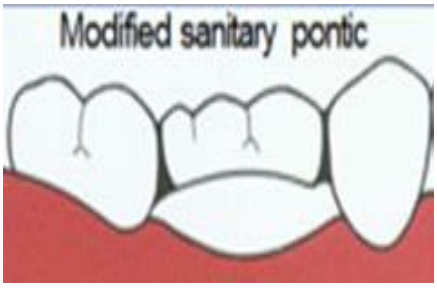
It gives excellent aesthetics with fulfilled functional requirements. Greater ease of cleaning compared to ovate pontic. Less convex design. The major advantage over the ovate is that there is little or no need for surgical augmentation of the ridge

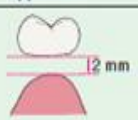
7. Hygienic Pontic (sanitary, wash through): It is made entirely from metal, doesn't have any contact with underlying tissue. It is advocated for the non-appearance zone in mandibular posterior regions. Most cleansable design, convex-shaped, with no tissue contact, 3 mm space with 3 mm thickness. However, the patient acceptance is questionable.



8. Modified Hygienic Pontic (Archway pontic): It is a modified version of the sanitary pontic. The gingival portion is shaped like archway between the retainers. This geometry added bulk for strength in the connectors which decreases the stress concentrated in the pontic and connectors.

It made entirely from metal, doesn't have any contact with underlying tissue. Primary design for the non-appearance zone in mandibular posterior regions and limited OG height. The access for cleaning is good. No tissue contacts with questionable patient acceptance.



Pontic Design	Appearance	Recommended Location	Advantages	Disadvantages	Indications	Contraindications	Materials
Sanitary/hygienic		Posterior mandible	Good access for oral hygiene	Poor esthetics	Nonesthetic zones Impaired oral hygiene	Where esthetics is important Minimal vertical dimension	All metal
Saddle/ridge-lap		Not recommended	Esthetic	Not amenable to oral hygiene	Not recommended	Not recommended	Not applicable
Conical		Molars without esthetic requirements	Good access for oral hygiene	Poor esthetics	Posterior areas where esthetics is of minimal concern	Poor oral hygiene	Metal-ceramic All resin All ceramic
Modified ridge-lap		High esthetic requirement (i.e., anterior teeth and premolars, some maxillary molars)	Good esthetics	Moderately easy to clean	Most areas with esthetic concern	Where minimal esthetic concern exists	Metal-ceramic All resin All ceramic
Ovate		Very high esthetic requirement Maxillary incisors, canines, and premolars	Superior esthetics Negligible food entrapment Ease of cleaning	Necessitates surgical preparation Not for residual ridge defects	Desire for optimal esthetics High smile line	Patient's unwillingness to undergo surgery Residual ridge defects	Metal-ceramic All resin All ceramic
Modified ovate		Very high esthetic requirement Maxillary incisors, canines, and premolars	Superior esthetics Negligible food entrapment Ease of cleaning	Necessitates surgical preparation	Where horizontal ridge width is not sufficient for a conventional ovate pontic	Patient's unwillingness to undergo surgery	Metal-ceramic All resin All ceramic

Pretreatment assessment of Pontic area

1) Available pontic space

One function of the FPD to prevent tilting or drifting of the adjacent teeth in to the edentulous space. If such movement has already occurred, the space available for the pontic may be reduced and its fabrication complicated. Space discrepancy (reduce pontic space) less problem in posteriors. Overly small pontics are undesirable because they trap food and are difficult to clean, Furthermore, in anterior its unacceptable aesthetically. Orthodontics repositioning, modification of abutments with complete coverage retainers.

2) Residual ridge contour

An ideally-shaped ridge should have smooth, regular surface of attached gingiva, which facilitates that maintenance of a plaque-free environment. Sufficient height to allow placement of pontic such that it appears to emerge out from the ridge (mimics appearance of neighboring teeth). Losses of residual ridge contour may lead to an aesthetic open gingivally embrasures (black triangles). This leads to food accumulation and saliva percolation (food entrapment)

Classification of residual ridge deformities: Siebert has classified residual ridge deformities into:

Class I defects: faciolingual loss of tissue width with normal height

Class II defects loss of ridge height with normal ridge width

Class III defects a combination of loss in both dimensions.

Residual ridge Preservation: Preservation of the residual ridge can be achieved using the following techniques

a) Alveolar architecture preservation technique

The preservation of the alveolar process can be achieved through immediate restorative and periodontal intervention at the time of tooth removal. The procedure involves preparing the abutment teeth prior to extraction and provisional FPD can be fabricated indirectly, to be ready for immediate insertion. The tissue-side of the pontic must be an ovate form. After preparation

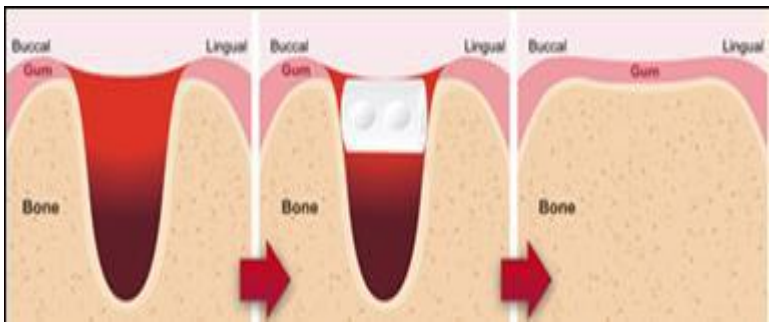
of the extraction site, a carefully shaped provisional FPD is placed and seat it on the abutments.

According to Spear's the pontic of the bridge should extend approximately 2.5 mm apical to the facial free gingival margin of the extraction socket. Because the soft tissues of the socket will begin to collapse immediately after the tooth extraction, the pontic will result in tissue blanching as it supports the papillae and facial/ palatal gingiva. The contour of the ovate tissue- side of the pontic is critical and must conform to within 1 mm of the interproximal and facial bone contour to act as a template for healing.

b) Conditioning the extraction site (Alvelac pack)

Another approach of preserving the alveolar process can be achieved by conditioning the extraction site and providing a matrix for healing. The pre-extraction gingival architecture (or "socket") can be preserved. Alvelac can be used at the time of tooth removal, it is porous, osteoconductive and biocompatible, and biodegradable synthetic scaffold made from polylactic co glycolic PLGA and polyvinyl alcohol. It is a rigid structure specifically designed to prevent collapse of the buccal and lingual walls in achieving width maintenance.

It is designed to maintain socket height and width, which will allow for natural bone healing. In addition, it will be resorbed in approximately two to six months. It is strategically placed in extraction socket with the top of scaffold in line with the crest of the socket in order to raise the forming blood clot to that level thus



achieving height maintenance. The size of Alvelac™ does not occupy the whole socket thus allowing maximum space for blood to fill the socket. This allows for the patient's own bone to form naturally within that space. Within a short period of time, patient's own bone will form fully in the socket, to speed up the preservation of the alveolar ridge.

For pre-existing residual ridge: It might need Ridge Modifications that involve

A. Ridge Reduction: It is indicated when there is an excessive or irregular soft tissue that might occur because of recent extraction, ill-fitting prosthesis or other irritations like; in adequate space for pontic, and poor cleansable area.

B. Ridge Augmentation: It is indicated to treat a Defect in pontic space when there is a bone resorption after extraction, or require long, unaesthetic pontic. The periodontal surgery is done using fibrous, osseous or synthetic materials to augment space and treat the defect.

3) Occlusion

Components Of Fixed Partial Denture (Bridge): Connector

It is that part bridge or FPD which joins the individual components (retainers or pontics) together, retainer with pontic, retainer with retainer or pontic to pontic. This can be accomplished by non-rigid movable (flexible) connector or, most commonly, rigid (fixed) connector

Materials used in pontic fabrication

- Maximum aesthetics vs. maximum strength.
- All Metal Connector can be used to provide maximum strength when esthetic is not critical.
- Metal ceramic or All ceramic, can be used to provide maximum esthetic when strength is not critical.

Types of Connectors: Rigid: All metal, Metal-ceramic, All ceramic, **Non-Rigid:** Prefabricated in plastic or metal and incorporated into the wax pattern, Milled into the wax pattern or casting

RIGID CONNECTORS

Rigid connectors in metal can be divided into (according to fabrication technique):

a) Cast connectors: It made by casting multiunit bridge in a single piece. Cast connectors are stronger than soldered and possible to carve them to provide the maximum appearance bridge is often cast

b) Soldering connectors:

The pontic and connector are made separately. Then after casting, they soldered together by using an intermediate metal alloy whose melting temperature is lower than that of the parent's metal.

c) Welded connectors: Melting the adjacent surfaces with heat or pressure.

d) Loop connectors: Sometimes required when an existing diastema is to be maintained in a planned fixed prosthesis.

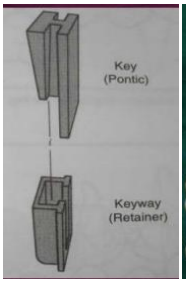
NON-RIGID CONNECTORS

It is indicated when it is not possible to prepare two abutments for a FPD with a common path of placement. So segmentally the design of large, complex FBD into shorter compartments (multiple pieces) to make bridge seating easier, furthermore, it can be used in cases that need reduction of occlusal force that acting on abutment (weak).

Movable Joint (key-key way, slide channel):

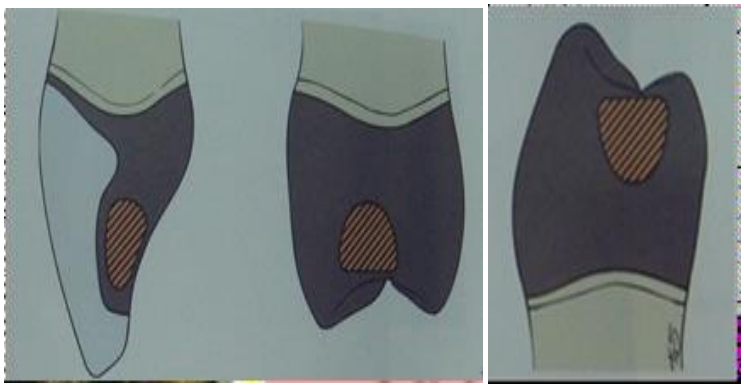
This is stress-breaking design of joints allows some movement between the components of the joint, of 2 pieces:

The piece that is attached to the mesial terminal of the pontic (key slide). The key is fitted in the second piece (key-way channel) that is attached to the distal aspect of anterior abutment (minor retainer).



Principles of Connectors Design

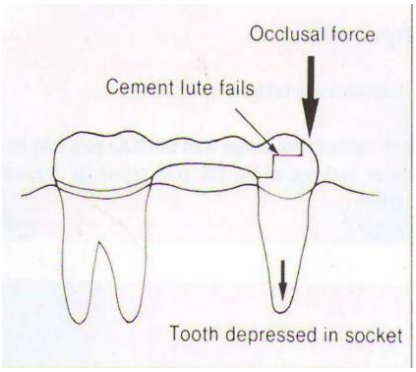
1- **Size:** Connectors must be sufficiently large to prevent distortion or fracture during function, but, not too large to that induce a periodontal problem over time.
2- **Shape:** The tissue surface of the connector should be curved faciolingually, highly polished and smooth to facilitate cleaning with a satisfied appearance.
3- **Position:** The location of the contact area should be established correctly which affects the success and stability of the prosthesis. In the anterior teeth, the connector should place lingually. In the posterior teeth, located in the occlusal third of the crown and more lingually



Occlusal coverage:

Major Retainer that is rigidly connect to the pontic (fixed-fixed bridge design) need full occlusal coverage while Minor Retainer that have movable connection with pontic doesn't need that.

Full Occlusal Coverage is always indicated because: It gives abutment complete protection during mastication with no possibility of cusp fracture (MOD inlay, or endo. Treated teeth), cement lute doesn’t fail



Lecture 7

FLUID CONTROL & SOFT TISSUE MANAGEMENT

Moisture control

FLUID SOURCES OF THE ORAL CAVITY

- Saliva (pair of parotid &submandibular and sublingual glands). Saliva flow rate 0.26 +/- 0.16 ml/min and that of saliva while chewing different foods was 3.6 +/- 0.8 ml/min.
- Inflamed gingival tissues/ Iatrogenic soft tissue damage (Gingival bleeding during tooth preparation)
- Water / dental materials (Rotary instruments, triplex syringe, etchants, irrigant solutions). Average a high speed rotatory cutting instrument is 30 mL per minute.
- Gingival crevicular fluid (sulcular fluid). Gingival crevicular fluid 0.05 to 0.20 µL per minute.

WHY SHOULD ISOLATE THE OPERATIVE SITE?

- To obtain a dry clean operating field
- For easy access and visibility
- To improve the properties of dental materials
- To protect the patient and the operator
- To improve the operating efficiency

How is moisture control important?

1. **Patient related factors**
   - Provides comfort.
   - Protects from swallowing or aspirating foreign bodies.
2. **Task/technique being performed**
   - Dental materials are moisture sensitive, success of adhesion and physical properties relies on a dry field.
3. **Operator related factors**
   - Infection control to minimize aerosol production
   - Increased accessibility to operative site
   - Improves visibility of the working field
   - Less fogging of the dental mirror.
   - Prevents contamination.

Depending on the location of the preparations in the dental arch, a number of techniques can create fluid control & the necessary dry field of operation.

1) Mechanical method

a) Rubber dam

When all margins are supra-gingival, moisture control with a rubber dam is probably the most effective method. In most instances, however, a rubber dam cannot be used, so a Multiple Isolation Techniques should be performed to achieve optimal saliva control. Advantages of rubber dam are Isolation of 1 or more teeth, eliminates saliva from the operating field and retracts the soft tissues.

b) Cotton roll

Absorbent cotton rolls must be placed at the source of the saliva, the muco-buccal fold or in the sublingual area, In the maxillary arch, placing a single cotton roll in the vestibule immediately buccal. If a maxillary roll does not stay in position but slips down, it can be retained with a finger or the mouth mirror. When a mandibular impression is made, placement of additional cotton rolls to block off the sublingual and submandibular salivary ducts is usually necessary. A horseshoe shape cotton in the maxillary and mandibular muco-buccal folds may be also effective.

c) Cotton roll holder

Holds cotton rolls in place, have two advantages over cotton roll alone,

Cheek and tongue are slightly retracted and Enhances visibility.

d) Absorbing cards

Another method for controlling saliva flow. These cards are pressed-paper wafers that may be covered with a reflective foil on one side. The paper side is placed against the dried buccal tissue and adheres to it. In addition, two cotton rolls should be placed in the maxillary and mandibular vestibules to control saliva and displace the cheek laterally. The tongue can cause problems when work is being done in the mandibular arch. Saliva evacuators may help eliminate excess flow.

e) Saliva evacuators

If lingually placed cotton rolls repeatedly become dislodged (or in conjunction with a conventional saliva evacuator, fail to control moisture adequately), a flange-type evacuator (e.g., the Svedopter [E. C. Moore Company] or the Speejector [Pulpdent Corporation]) should be considered. To avoid the risk of soft tissue trauma, this device must be placed carefully. A cotton roll placed between the blade and the mylohyoid ridge of the alveolar process minimizes intraoral discomfort for the patient and avoids potential injury of the soft tissues A disposable saliva ejector designed to displace the tongue may also be effective

2) Chemical method

a) Local anesthesia

In addition to the pain control normally needed during tissue displacement, local anesthesia may help considerably with saliva control during impression making. Nerve impulses from the periodontal ligament form part of the mechanism that regulates saliva flow; when these are blocked by the anesthetic, saliva production is considerably reduced.

b) Medications

When saliva control is difficult a medication with anti-sialagogic action (drugs that inhibit parasympathetic innervation, this will inhibit action of myo-epithelial cells of salivary gland thereby reduce secretions) may be considered. Dry mouth is a side effect of certain anticholinergics. This group of drugs **includes atropine1 tablet of 0.4mg per day, Methantheline bromide (banthine):50 mg 1 hour before procedure dicyclomine, and Propantheline bromide (pro-banthine): 15 mg 1 hour before procedure.** Anticholinergics should be prescribed with **caution** in older adults and should not be administered to any patient with **heart disease**. They are also **contraindicated** in individuals with **glaucoma** because they can cause permanent blindness **Clonidine hydrochloride: 0.2 mg 1 hour before procedure, an antihypertensive drug**, has successfully **reduced salivary output**. It is **considered safer than anticholinergics** and has no specified contraindications. However, it should be used cautiously in hypertensive patients. Clonidine hydrochloride (antihypertensive)

Gingival Retraction

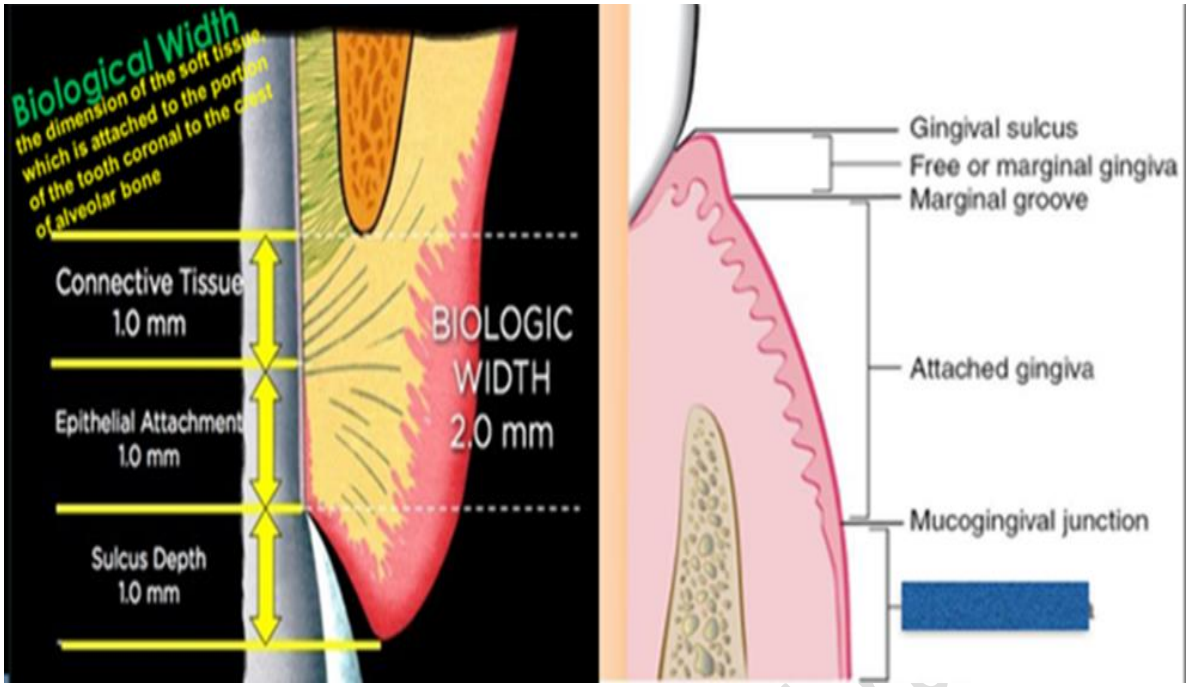
A procedure by which the finishing line is temporarily exposed by enlarging the gingival sulcus to create a space both laterally and vertically between the gingival margin and the gingival termination so that the printing material penetrates in sufficient quantity to obtain good impression which involves the details of the end margin of the preparation that is located subgingivally (the exact copy of the preparation).

Gingival Sulcus (Crevice)

A shallow groove around the tooth bounded on one side by the surface of the tooth and on the other by the epithelial lining of the free margin of the gingiva. It is “V” shaped with its base at the most coronal level of the epithelial attachment to the tooth root.

Biological Width

Biologic width is defined as **the dimension of the soft tissue, which is attached to the portion of the tooth coronal to the crest of alveolar bone.** There is a definite proportion between the sulcus depth, the epithelial attachment, the connective tissue attachment and the alveolar crest. The **total width of junctional epithelium** (range between **0.71 to 1.35mm, mean 0.97mm)** and **supraalveolar connective tissue attachment** (rang **1.06 - 1.08mm**, **mean 1.07mm**) forms the **biologic width** is 0.97 + 1.07 = **2.04 mm**. They established the mean sulcular depth as 0.69.



What is its function? (**Its importance in restorative dentistry)**

The significance of biologic width is that**, it acts as a barrier and prevents penetration of microorganisms into the periodontium.** Maintenance of biologic width is essential to preserve the periodontal health and to remove any irritation that may damage the periodontium. It is said that a minimum of 3mm space between the restoration margin and the alveolar bone is required to permit adequate healing and to maintain a healthy periodontium. This 3 mm consists of 1mm of supraalveolar connective tissue, 1mm of junctional epithelium and 1mm of sulcular depth. This allows for adequate biologic width (2.04mm) even when the margins are placed 0.5mm within the sulcus.

How to preserve?

The location, fit and finish of restorative margins are critical factors in the maintenance of periodontal health. So, a huge consideration and care should have performed during isolation and retraction (even with digital impression techniques) besides tooth preparation to the biological width to ensure the healthy standards and maintenance the normal values of the periodontium.

Objectives of gingival retraction

1. Create an access for the impression material to the area of the preparation that is located subgingivally.
2. To provide enough thickness of the impression material at the area of the finishing line to prevent distortion of the impression.
3. Providing the best possible condition for the impression material, fluid control.
4. Reduce fluid a mount in the sulcus that might cause void in the impression.

Gingival retraction techniques

1) Mechanical (plain retraction cord, retraction crown, copper band or tube , anatomic compression caps, Matrices and wedges, Rubber dam)
2) Chemo mechanical (combination of mechanical and chemical)
   a) Impregnated retraction cord, with one of the following:
      - aluminum sulfate
      - epinephrine
      - ferric sulfate
      - zinc chloride
      - aluminum chloride
   b) Displacement polymer & paste (cordless technique)

3) Radical or surgical means or technique (electro surgery, Laser).

1) Mechanical

It might be done by either of the followings:

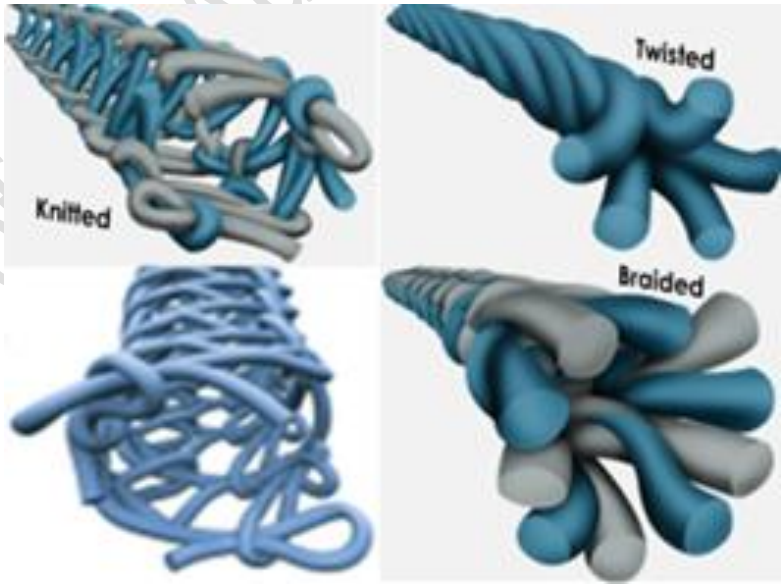
- Retraction cord
- Retraction Crown
- Copper band or tube
- Anatomic compression caps
- Matrices and wedges
- Rubber dam

Generally, in this technique, we apply pressure on the gingiva through gingival sulcus. This mechanical pressure, after certain period of time, physically push the gingiva away from the finishing line. It might be done by the construction of temporary crown with slightly long margin leaving it for 24 hours, or by using rubber clamp, or by using plan retraction cord(free of medicament)….etc. **The most common way by using retraction cord.**

Retraction cord is a special cord made of cotton comes either with or without medicament (vasoconstrictor). Cord without a vasoconstrictor is used to obtain a mechanical gingival retraction.it come in different size

Classification of retraction cords

1. **According to chemical treatment**
   - Plain cord without any medicament.
   - Impregnated cord (impregnated with hemostatic agent).
2. **According to configuration**
   - Twisted
   - Knitted
   - Braided



Twisted and braided cords can't offer ease of packability and tissue displacement like knitted ones.

Advantages of knitted cord over other types

1) Afford greater inter-thread space than braided cord.
2) Form an interlocking chain of thousands of tiny loops, making it
   - Easy to pack below the gingival margin
   - Stays put when packed into place.
3) Compresses upon packing, then expands for tissue displacement.

3. According to thickness (diameter)

According to its size, we have different thickness of retraction cord (color-coded thickness):

- **Black - 000**
- **Yellow – 00**

  Both are recommended for anterior teeth with minimal crevicular space.
  Also can be used as a primary cord for the double cord technique.
- **Purple - 0**
- **Blue – 1**

  Both are recommended for bicuspids. Also #0 is used as the primary cord for the double cord technique, while #1 cord is recommended to be used as the secondary cord
- **Green - 2**
- **Red – 3**

  Both sizes are used for molars where tissue friability permits.

Some textbook divide retraction cord into three main size:

- **SMALL-** involve (#000 &# 00) to be used in anterior teeth, where thin firmly tissue is present
- **MEDIUM-** involve (#0, #1 & #2) to be used where greater bulk is encountered e.g. posterior teeth
- **LARGE-** involve size (#3) should be used with caution as can produce soft tissue trauma.

Cord packing instruments

Cord packers are dental instruments used to pack gingival retraction cord into the sulcus. Most cord packing instruments have a slightly rounded tip with serration to hold the cord while it is positioned intra-sulcularly.

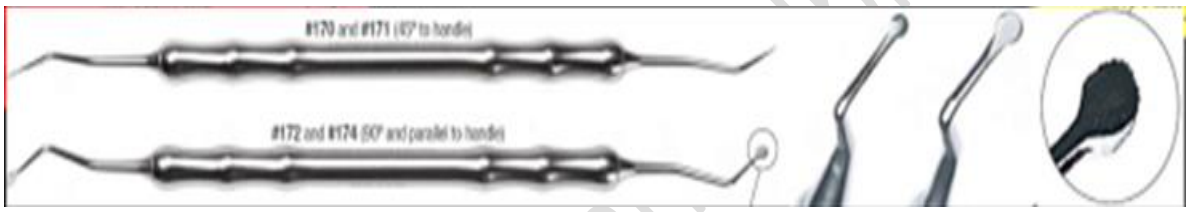
Fischer packer is a cord packing instrument. Furthermore, plastic instrument (Ash No. 6) can be used for cord packing.

The cord packers with round, non-serrated working ends are used for atraumatic cord placement; serrated cord packers should only be used with braided cord.


Fischer packing instrument

These specially designed packers ease the packing of Ultrapak® knitted cord. Their thin edges and fine serrations sink into the cord, preventing it from slipping off and reducing the risk of cutting the gingival attachment. It available in two form

- **45° to handle:** with heads at 45° to the handle with three packing sides. Circular packing of the prep can be completed without the need to flip the instrument end to end. Use the small packer on lower anterior and upper lateral incisors.
- **90° and parallel to handle:** Same size and three-sided heads as the 45º to handle packer, except one of the heads is in line with the shank and the other is at a right angle to the shank.



2) Chemo mechanical

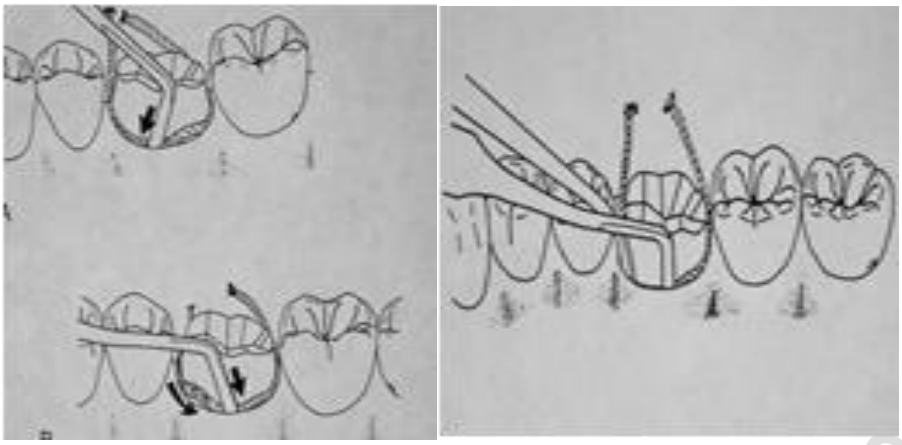
Usually in this technique, we use retraction cord that contain a vasoconstrictor (adrenaline or AL.sulfat). Cords are soaked in the Hemostatic solution before placement or Some cords are already impregnated with hemostatic solution eliminating this step (adrenaline 8%, aluminium sulfate, or Aluminium chloride 5-10%).

Whether plain or impregnated cord, the cord pack into the gingival sulcus between the tooth and the gingival tissue, using a plastic instrument (fischer packing instrument or Ash no.6) , the cord will physically push the gingiva away from the finishing line and the combination of the chemical action and pressure packing will cause transit gingival ischemia, this will lead to shrinkage of gingival tissue and control fluid seepage from gingival sulcus, we put the retraction cord inside the gingival sulcus all around the tooth for 10 minutes , the area of our work should be kept dry during this period ,then, the cord can be removed leaving the gingival tissue in an expanding state and this, will provide space to inject the impression material around the tooth at the area of finishing line by the use of impression syringe.

Step-by-Step Procedure

1- Isolate the prepared teeth with cotton rolls, place saliva evacuators and any other aids as required, and dry the field with air. Do not excessively desiccate the tooth because this may lead to postoperative sensitivity.
2- Cut a length of cord sufficient to encircle the tooth.
3- Dip the cord in astringent solution and squeeze out the excess with a gauze square. An impregnated cord can be placed dry but should be slightly moistened in situ immediately before removal from the sulcus, to prevent the thin sulcular epithelium from sticking to it and tearing when it is removed. A convenient way to limit the amount of moisture added is to apply water held between the tips of a dental forceps by opening it.
4- Twist non-braided cords tightly for easier placement.

5- Loop the cord around the tooth, and gently push it into the sulcus with a suitable instrument.



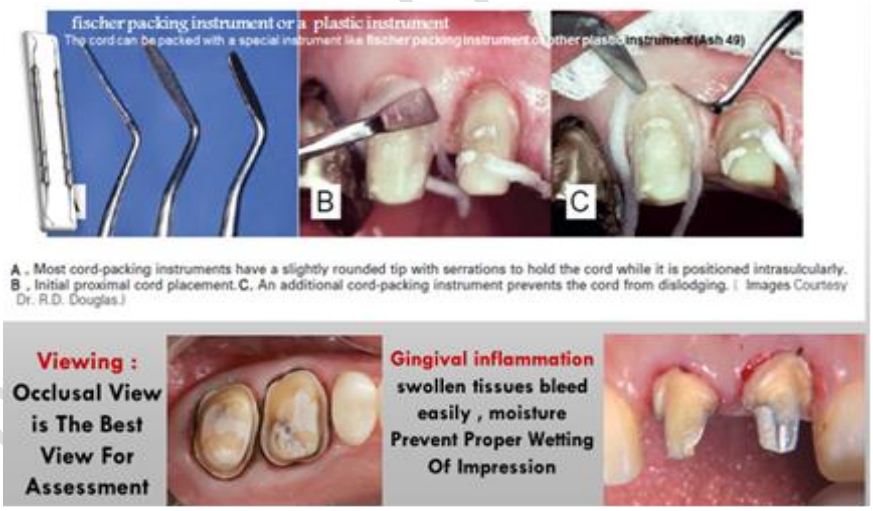
These notes should be considered during cord placement procedure

1- Starting point: It is easiest to start inter-proximally, because more sulcular depth available than facial or lingual.

2- Instrument angulation: The instrument should be angled slightly toward the tooth so that the cord is pushed directly into the sulcus, also be angled slightly toward any cord previously packed; otherwise, it might be displaced. A second instrument holding the cord may aid in subsequent placement.

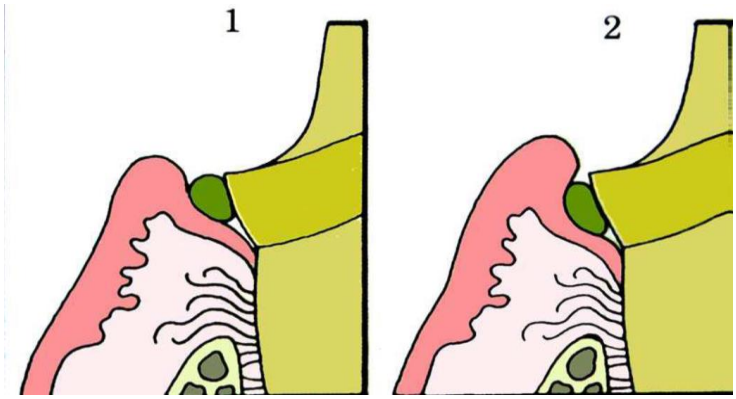
3- Placement and pressure: Gentle and Firm Pressure applied to the cord, it should place apical to the margins of preparation.

4- Over packing and repeated use of displacement cord should be Avoided it could cause tearing of the gingival attachment, which leads to irreversible recession.

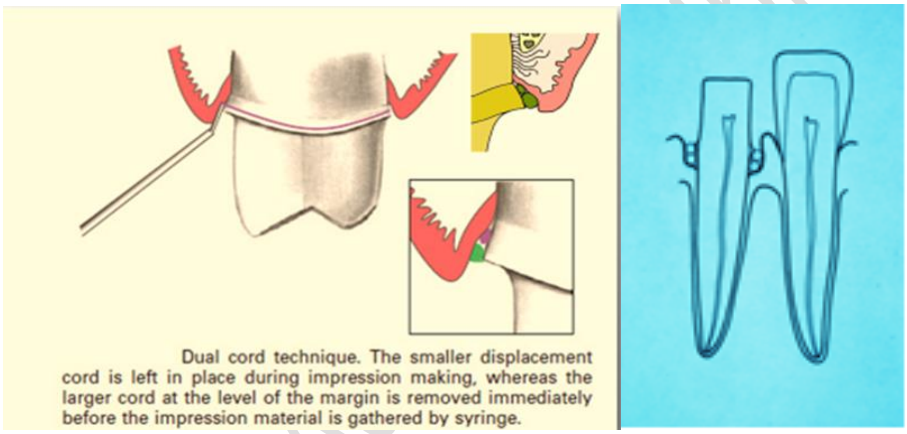


Double (dual) Cord Technique

With a deeper subgingival preparation, after removing the cord, the sulcus 'closes' not allowing the ingress of the impression material in the subgingival area, so in such a case you might need to use 2 or double cords.



When 2 cords are need, it requires that about 1 mm of intact tooth structure remains between the top of the initial cord and the preparation margin. The first cord is thin, left during impression taking, while the second cord is thick. In this technique, a thin cord is placed without overlap at the bottom of the gingival crevice. A second cord is placed on top to achieve lateral tissue displacement. The latter is removed immediately before impression making, whereas the initial cord is left in place to help minimize seepage during Impression, be careful not to exert excessive pressure on the tissues, which can damage the epithelial attachment (Biological Width).



Dual cord technique. The smaller displacement cord is left in place during impression making, whereas the larger cord at the level of the margin is removed immediately before the impression material is gathered by syringe.

This technique is indicated when we have:

1. Impression of multiple prepared teeth
2. Impression for compromised tissue health
3. Excess gingival fluid exudates.

Advantages

1) The first cord remains in place within the sulcus thus reducing the tendency of the gingival cuff to recoil and displace partially set impression material.
2) Helps to control gingival hemorrhage and exudate.
3) Overcomes the problem of the impression tearing because of inadequate bulk, an especially important consideration with hydrocolloids, which have low tear strength.

Remember: Never pack a dry cord

- Dry cord adheres to the cervicular epithelium and may tear the epithelium upon its removal and may elicit a wound healing reaction.
- Dry cord is harder to pack into the sulcus, leads to more bleeding upon cord removal and an unacceptable impression, and makes it more likely that a less than ideal gingival response will follow.

Gingival retraction pastes (Cordless technique)

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

Expasyl retraction paste

It is an AlCl3-containing paste (Aluminum chloride 15%) is injected into the dried sulcus with a special delivery gun. Advantages of this system include good hemostasis with less discomfort than with traditional cord. However, less tissue displacement is achieved than with cord. Improved displacement may be achieved if the paste is directed into the sulcus by applying pressure with a hollow cotton roll.

Magic Foam Cord (Coltène/Whaledent)

Magic foam is a polydimethylsiloxane with a tin catalyst. The resulting release of gas resulted in a fourfold(x4) volumetric expansion. When the paste was applied into the sulcus, reaction between base and catalyst take place with gas release that resulted in volumetric expansion of the material that cause an apically directed flow that enlarged the gingival sulcus and allowed impression making, a hollow cotton roll is used to apply pressure to the expanding foam to directed expansion apically.

Other cordless retraction materials, e.g**., Racegel** (Septodont) **Traxodent** (Premier); **GingiTrac** (Centrix) provide for excellent hemostasis and some gingival retraction.

Whatever is the material, after isolation of the area, the material is injected inside the gingival sulcus starting from the deepest area at interproximal area, leave the material for 5 to 10 minutes then clean the area and inspect the result.

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

3) Surgical technique (radical or surgical means)

Some methods that use the surgical approaches to improve the visualization of the preparation margins of the tooth are not true retraction techniques. This is because they actually remove some part or all of the overlying gingival tissue in order to expose the finish line of the preparation and/or control hemorrhage. These techniques are more invasive and should only be used in cases where there is adequate amounts of attached gingiva. These methods include the following:

▶ ROTARY GINGIVAL CURETTAGE (GINGETTAGE)

It is a toughing technique involves preparation of the tooth sub-gingivally while simultaneously curetting the inner lining of the gingival sulcus (a portion of the epithelium within the sulcus is removed to expose the finish line). It should be done only on the healthy gingival tissue

CRIETERIA TO BE FULLFILLED FOR GINGETTAGE

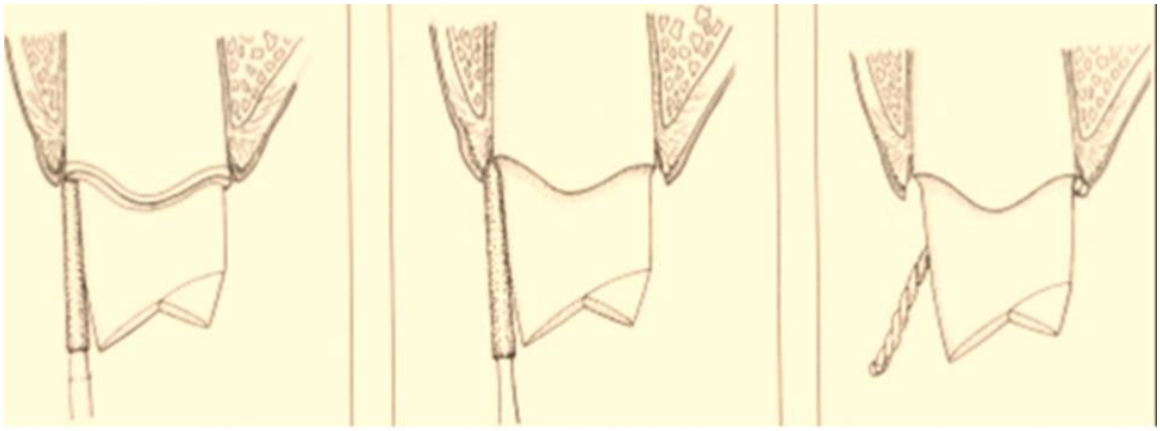
- There should be no bleeding on probing
- The depth of the sulcus should be minimum of 3 mm

DISADVANTAGES OF GINGETTAGE

- Instrument has poor tactile sense so this technique is very sensitive
- It can potentially damage the periodontium

TECHNIQUE OF GINGETTAGE

- It is usually done simultaneously along with finish line preparation.
- Portion of sulcular epithelium is removed using a torpedo diamond bur.
- To improve tactile sense hand piece is run very slowly.
- Abundant water should be sprayed during the procedure.
- A retraction cord is impregnated with $AlCl_3$ can be used to control bleeding



Prior to rotary curettage a shoulder F.L. is formed to the level of the gingival crest

A torpedo diamond point simultaneously form a chamfer F.L. and removes the epithelial lining of the sulcus

A cord is placed in the troughed sulcus for heamostasis

▶ Electro-surgical method

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

Indications:

- ❑ For minor tissue removal before taking impression, toughing the inner epithelium lining of gingival sulcus, improving access for the subgingival margin.
- ❑ Control post-surgical hemorrhage.

Contra-indications:

- ☐ Thin attached gingivae (lower anterior, upper canines)
- ☐ Electronic medical devices Cardiac Piece Makers
- ☐ Metallic restoration & Instruments

▶ Soft issue Laser

Soft tissue lasers have been introduced into dentistry and can provide an excellent adjunct for tissue management before impression making for gingival retraction, Nd- YAG lasers are used.

Advantages of Laser:

1. Certain laser dentistry procedures do not require anesthesia.
2. Laser procedures minimize bleeding because the high-energy light beam aids in the clotting (coagulation) of exposed blood vessels, thus inhibiting blood loss.
3. Precise recontouring of gingiva.
4. No gingival recession and no discomfort to the patient.
5. Bacterial infections are minimized because the high-energy beam sterilizes the area being worked on.
6. Damage to surrounding tissue is minimized.
7. Wounds heal faster and tissues can be regenerated.

Lecture: 8

Final Impression in Fixed Prosthodontics

Conventional impression

An impression is a negative likeness or an imprint of the form and the relationship of the teeth and the surrounding oral tissues. In crown and bridge.

Requirements for a good impression in crown and bridge prosthodontics:

1) It should be an exact duplication of the prepared tooth, including all of the preparation, and enough uncut tooth surface beyond the preparation to allow the dentist and technician to be certain of the location and configuration of the finish line.
2) Other teeth and tissue adjacent to the prepared tooth must be accurately reproduced to permit accurate articulation of the cast and to allow proper contouring of the restoration.
3) The impression of the preparation must be bubble free, which might result in inaccuracy especially in the area of the finish line.

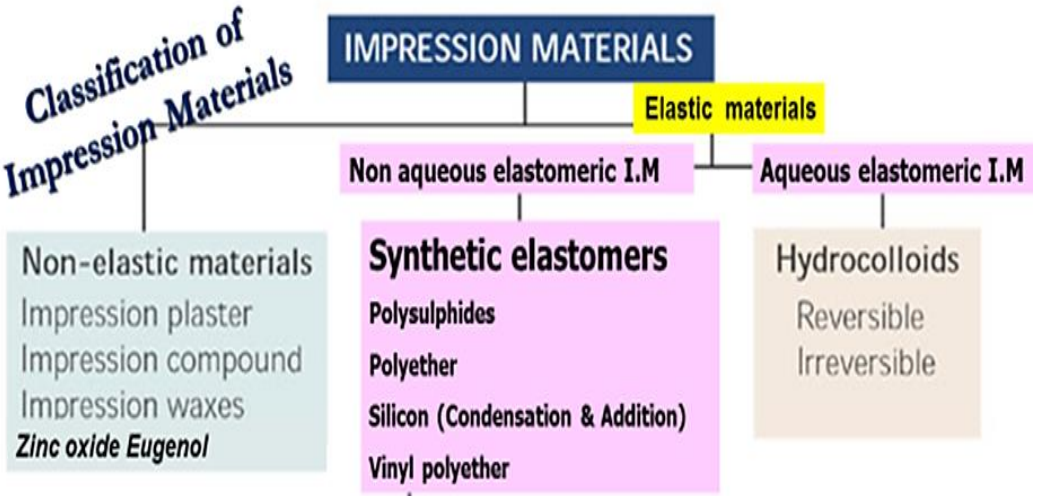
Properties of material used for final impression in crowns and bridges:

1) It must be elastic after placement in the mouth because it must be withdrawn from the undercut regions that exist on the external tooth surface adjacent to the prepared tooth. A satisfactory impression must register some of these undercut surfaces without distortion or fracture.
2) The hydrophilicity of impression material, hydrophilic materials have a high affinity for moisture (low contact angle), provide good surface wetting, and allow for a high degree of surface detail. Hydrophobic impression materials have a low affinity for moisture (high contact angle), provide poor surface wetting, a lower degree of surface detail, and require strict moisture control.
3) It must have adequate tear resistance (adequate strength to resist breaking or tearing on removal from the mouth).
4) It must have adequate dimensional stability, accuracy and reproduction of the details so that it is exact negative imprint of the prepared and unprepared teeth. The dimensional stability of the material, which is critical for accurate replication of the intraoral structures. ***Dimensional changes*** *may occur due to (1) contraction*

from polymerization, (2) liberation of a by-product or accelerator component, (3) water absorption from a wet or humid environment, (4) a change in temperature.

5) It must have handling and setting properties that meet the clinical requirements.
6) It must be free of toxic or irritating components.

Classification of impression materials.



Non-aqueous elastomeric impression materials (Elastomers):

The elastomeric impression materials, set by chemical reaction, and usually supplied in different consistencies: **putty, heavy, medium and light bodies.** In crown and bridge work, we use the ***light consistency*** as ***syringe material*** to inject over the prepared teeth , remaining dental arch and try material (putty or heavy consistency) , while, ***putty and heavy consistency*** used as **tray material** to seat over the light consistency during final impression **procedure** . Whatever the consistency of the elastic material, it is supplied as two containers or tubes: base and catalyst.

1) *Polysulfide impression material:*

- The material is supplied as a two-paste system (base and accelerator or catalyst).
- Available in a range of viscosities: **light body, medium or regular body, heavy body**.

Advantages:

1) Accurate if poured without delay (maximum storage time is 48 hours)
2) Long working time (multiple preparations cases)
3) Excellent tear resistance (high tensile strain before tearing)

Disadvantages:

1) Messy with objectionable odor
2) Long setting time
3) Shrinkage towards the tray (wider and shorter preparation)
   - ✓ Evaporation of water as a setting by-product
   - ✓ Continuous setting reaction after apparent setting time
   - ✓ Unrecovered strain

Recommendations:

- ☐ Use a special tray with a 4 mm spacer
- ☐ Remove impression in a single sift pull.

2) Polyether impression material:

Polyether impression material has excellent dimensional stability (upon polymerization mechanism unlike other elastomers. No volatile by-product), was **initially available in single "regular" viscosity (Impregum) A recently heavy light bodied system has been introduced**

Advantages.

1) Fast setting time of less than 5 minutes
2) Has no setting reaction byproduct
3) Dimensionally stable
4) Relatively hydrophilic
5) Adequate tear resistance and very good elastic properties

Disadvantages:

1) If stored in high humidity conditions, they tend to swell due to water absorption.
2) Relatively rigid material when set, thus considerable force is required to remove the impression from the mouth and stone cast

3) Silicon impression material:

A. Condensation Silicon impression material:

Condensation silicone has been developed to overcome some of the disadvantages of polysulfide. It is odorless and can be pigmented to virtually any shade. An additional advantage of condensation silicone over polysulfide is its relatively short setting time in the mouth (typically 6-8 minutes). As a result, patient acceptance is better than polysulfide. It is also less affected by high operatory temperatures and humidity. Unfortunately, its dimensional stability is less than that of polysulfide although greater

than that of reversible hydrocolloid. The material **available in all viscosities (Present in four viscosities ranging from very high (putty) to low. Setting time 5-7 minutes).**

Advantages:

1) Accurate if regular or heavy body are cast within 6 hours of recording
2) Very good elastic properties, recovery of strain, adequate tear strength, neutral color and taste

Disadvantages:

1) poor wetting characteristics because it is extremely hydrophobic
2) Volatile by-products (ethyl alcohol) result in weight loss and shrinkage on storage

B. Addition Silicon impression material (vinyl polysiloxane silicon):

1) The main difference between the addition silicone and the condensation silicone is that it has much greater dimensional stability than the condensation type as its polymerization reaction does not give off any by-product. The material is also supplied as a two-paste system (base and accelerator or catalyst). The material **available viscosities are extra low, low, medium, heavy, and very heavy (putty) consistencies.** Impression pouring should be delay 1-2 hours (liberate hydrogen gas during polymerization, air bubbles will result)

Advantages:

1) The most dimensionally stable material (no by-product).
2) Accurate, high elastic properties, adequate tear resistance, nontoxic, neutral color and taste.

Disadvantages:

1) **Hydrophobic** thus strict moisture control is mandatory (some manufactures added surfactant (detergent) to make it more hydrophilic).
2) Surfactants improve surface wettability.
3) New hydrophilic addition silicone (Take 1, Kerr).
4) Sulfur contamination from **natural latex gloves inhibits the setting** of addition silicone
5) Touching the tooth with **latex gloves** before seating the impression can inhibit the setting of critical surface next to tooth

6) **Vinyl Polyether Silicon**

- It is formulation that combines the properties of the addition silicones and polyethers.
- The material has dimensional properties similar to those of the addition silicones and polyethers.

Available Elastic Impression Materials

Material	Advantages	Disadvantages	Recommended Uses	Precautions
Irreversible hydrocolloid	Rapid setting Straightforward technique	Poor accuracy and surface detail	Diagnostic casts Not suitable for definitive casts	Must be poured immediately
Reversible hydrocolloid	Low cost Hydrophilic Long working time Low material cost No custom tray required	Low tear resistance Low stability Equipment needed	Multiple preparations Problems with moisture	Must be poured immediately For use only with stone
Polysulfide polymer	High tear resistance Easier to pour than other elastomers	Messy Unpleasant odor Long setting time Stability: only fair	Most impressions	Must be poured within 1 hr; takes 10 min to set
Condensation silicone	Pleasant to use Short setting time	Stability: only fair Hydrophobic Poor wetting	Most impressions	Must be poured immediately Care is needed to avoid bubbles during pouring
Addition silicone	Dimensional stability Pleasant to use Short setting time Automixing available	Hydrophobic Poor wetting Some materials release H_2 Hydrophilic formulations imbibe moisture	Most impressions	Pouring of some materials must be delayed Care is needed to avoid bubbles during pouring
Polyether	Dimensional stability Accuracy Short setting time Automixing available	Set material: very stiff Imbibition Short working time	Most impressions	Care is needed not to break teeth when separating cast

Rosenstiel SF, Land MF, Fujimoto J. Contemporary Fixed Prosthodontics-E-Book. Elsevier Health Sciences; 2015 Jul 28.

General factors that affect most of elastomeric rubber impression materials:

1) The rubber impression materials shrink 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 poured within 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.

Advantages of the study cast:

1) Diagnosis and treatment planning.
2) Construction of provisional restoration.
3) Construction of special tray.

Advantages of special tray:

1) It allows the use of impression material in minimum thickness to reduce its dimensional changes.
2) It reduces the discomfort of the patient because it is well fitted to the patient's mouth.
3) Its small size prevents the forcible opening of the mouth.

4) It allows free snap-removal of the impression (without applying rotary movements).

☐ **impression syringe:**

Most of time it is made from clear plastic and should be available with different nozzle sizes, we need this syringe to carry light body impression material from the mixing slab and inject it, then, to the different areas of preparation.

Impression techniques:

According to number of steps and the Viscosity of impression Materials used during impression registration we have the following techniques;

1. **One step Impression technique**
   - **I.** Monophase Single Viscosity
   - **II.** Heavy-Light
2. ***Two steps Impression technique***
   - **I.** Spaced Putty Wash
   - **II.** Un Spaced Putty Wash

1) **One step (monophase Single viscosity) technique.**

Most of the time, we use this technique when we have impression material with single viscosity (medium body with polyether impression material) after we mix the material, part of the impression material is loaded in the syringe from the mixing slab, the other mixed part of the material is loaded into the tray. The impression material is injected from the syringe around the preparations starting with the most critical parts (pin holes, finishing lines then, the preparations and the remaining part of the dental arch then), the special tray loaded with impression material were then inserted inside the patient mouth and seat over the whole dental arch., wait for complete setting of the impression material then, it can be removed from the patient's mouth.

2) **One step (heavy light or Double mix) technique.**

Usually used with materials that have two viscosities (heavy and light bodies), we mix the heavy and light bodies at the sometime then, the light body is loaded in the syringe while, the heavy body is loaded in the special tray. We start to inject the light body on the dental

arch starting with the prepared tooth then, the special tray with heavy body is inserted inside the patient's mouth and seated over the dental arch The pressure created by the heavy body will create

- An intimate contact of light body with the prepared tooth surface.
- make direct flow of the light body into details of the preparation.

3) Two steps Putty wash technique.

This technique uses a high viscosity putty material; we start taking the impression with the putty body which could be before or after tooth preparation. Putty impression be:

1) ***Un-spaced putty impression***; putty impression is recorded first after tooth preparation, then, after setting it reline relined with a thin layer or wash of light body impression material.
2) ***Spaced putty impression as for*** un-spaced except a space is created inside the putty impression for the wash (light body) layer. ***Space could be created by:***
   I. Record with putty before teeth preparation
   II. Record with putty after teeth preparation. Create space using **polyethylene spacer.**
   III. Record with putty after teeth preparation. Create a space and escape channels using a scalpel.

Impression Procedure;

Step one:

☐ ***Spaced PWT;***

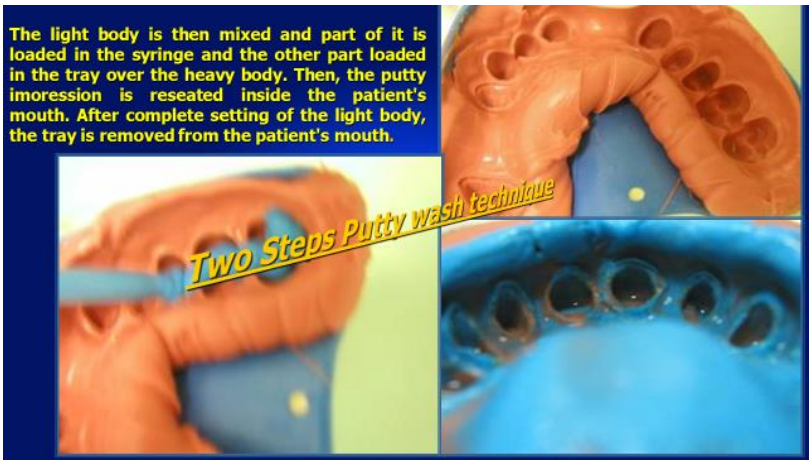
Putty impression of dental arch including the prepared tooth or teeth is firstly taken, space inside impression is created by one of following means:

1) **Before preparation**: we take a preoperative impression with the putty body only prior to tooth preparation, and after complete setting of the heavy body, remove the impression tray from the patient's mouth and leave it aside. Then we do tooth preparation.
2) After preparation: in this technique, after mixing of the putty body and loading it in the tray, a spacer made of polyethylene is placed over the heavy body and the tray is inserted inside the patient's mouth. After complete setting of the heavy body, the tray is removed and the spacer is removed.
3) Or you can take putty impression after teeth preparation without spacer, then, after removal of the putty impression tray from the patient's mouth create a space and escape channels by removing from inside using a scalpel.

- **Un spaced PWT : as previous except that putty** impression recorded after teeth preparation , no space is created her whether by using spacer or removal of surface layer of putty by scalpel, then, after complete setting, it is removed from the patient's mouth and left a side .

Step two:

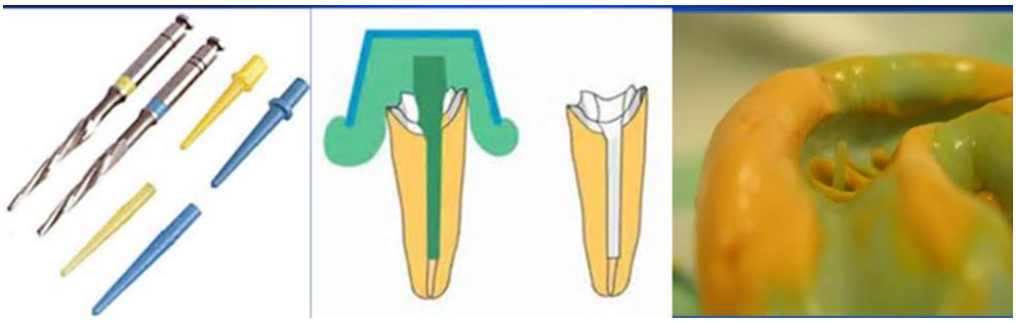
Whether spaced or un spaced putty wash technique, the next step is to mix the light body impression material, part of the mix loaded into the impression syringe while the remaining portion of the mix is placed into the tray over the heavy body impression. The light body is then injected around the preparation and the whole dental arch, the heavy body impression is then reseated inside the patient's mouth over the injected light body impression material and wait for the complete setting of the light body.



Impression for the post crown:

We need an impression for the root canal space, so, the impression material most of the time is difficult to be inserted inside the tiny canal and even when it fills the canal it

might tear during removal or might be distorted during pouring with die stone (during construction of working cast). Therefore, So the impression material need a type of reinforcement, this can be obtaining either by a plastic post or by stainless wire, which is inserted into the canal after injecting the light body inside the canal, this will support the impression material and prevents its tearing or distortion during removal of the impression, after the setting of the material, from the patient mouth.



The impression should be inspected for the following:

1. Finishing line should be continuous from one side to another.
2. Presence of air bubble in the area of preparation.
3. Good attachment of the impression material to the tray.

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

1) Special tray.

2) Impression syringe.

3) Gingival retraction when needed.

4) Good understanding of the physical properties of the impression material which results in good handling of the material.

5) Dry field of operation. This is because all elastic impression materials, except hydrocolloids, are hydrophobic. i.e., they don't displace moisture; therefore, any moisture if present will result in voids or folds within the final impression.

Digital impression

Digital impression represents the most recent development in Dentistry. It is procedure of recording the information related to the prepared teeth using scanning device that going to convert the shape of the prepared teeth into three dimensional (3-D) image display on the computer monitor. The operator then designs a restoration shape using a special computer software, which is connected with a milling machine. This procedure is termed CAD-CAM (Computer Aided Designing - Computer Aided Manufacturing). The CAD/CAM system utilize a process chain consisting of scanning, designing and milling phases. The introduction

of CAD/CAM systems in 1980s to dental field resolved a wide range of these limitations founding in the conventional impression techniques that required many steps; preparation of the abutment teeth, tray selection, impression making, impression disinfection, wax up and finally casting. As a result, several factors could effect on the accuracy of the traditional impression technique. Furthermore, CAD/CAM provides speed, storing the captured images with no distortion, 3D pre-visualization and checking the preparation and restoration before cementation.

Based on their production methods the Digital scanning can be divided Digital impression into:

1) **Indirect (extra oral) digital impression (Dental laboratory models):**

The indirect systems scan a stone cast or die of the prepared tooth, in the dental lab (eg Cerec-in lab).Many of this system produce copings which require the dental technician to add esthetic porcelain for individualization and characterization of the restoration.

Dis-advantages

- A cast need to be fabricated so, impression making is must, however master cast fabrication is time consuming and error prone method.
- Shadowing effect limits use of extra oral digitization method.

2) Direct (intra oral) digital impression:

Most widely and commercially used in Cerec System. This system can scan the tooth preparation intraorally using an intra-oral camera (scanner) to capture the desired image (optical impression). This image is then electronically transferred either to in office CAD CAM or in lab CAD CAM (a manufacturing facility) and by selecting appropriate materials, the restoration can be fabricated and seat within a single appointment. This procedure is termed CAD-CAM (Computer Aided Designing - Computer Aided Manufacturing).

The main advantages of Direct (intra oral) digital impression, It allows the dental care professional to take the data directly from the prepared tooth and there is no necessity of taking an impression and fabricating a cast. However, the only disadvantage of this technique that Tongue and saliva may pose some problems.

Types of intra oral digital scanner

Based on data files created intra oral camera (scanner) might be;

1) Open-system software

Architecture files, typically termed STL files (standard file format also STL sometime referred as “Standard Tessellation Language” or “Standard Triangle Language”, are not

dependent on the manufacturer, and can be used virtually in any design software to fabricate final restoration (Allow the adoption of the original digital data by CAD software and CAM devices from different companies)

2) Closed-system software

Architecture collects and manipulates data modules by the same manufacturer, offering laboratory owners security and a one-stop for resolving problems (All the steps are integrated into one system, and there is no interchangeability between different systems from other companies

Scanning procedure

After the tooth preparation is completed and the tissues are retracted to visualize the tooth margins, the tooth is dried and readied for scanning. Some scanning systems require the use of an oxide powder on the tooth to remove optical highlights from the surface of the preparation and to enhance the scan quality. Scanners use either a series of static images or a stream of video images to capture the geometry of the tooth preparation.

Advantages of digital impression

1. Digital impressions eliminate the uncomfortable experience of making a physical impression.
2. Evaluation of your preparation.
3. The image on the monitor shows you if you have captured all the needed details before sending it to the lab.
4. The accuracy of the mounting, bite registration, and stability of the dies create a model that allows the laboratory technician to fabricate a final restoration that has excellent marginal fit and incredibly accurate occlusion.
5. The ability to see if proper occlusal reduction has been achieved.
6. Recordkeeping. The digital impression can be stored and saved in PCs.
7. Disinfection of impressions is now a non-issue with a digital system.
8. Reducing Chairside time

Disadvantages of Digital impression.

1- The large size and the weight of the camera head and the device size.

2- Digital equipment's are complex and trained operator is required to operate and maintain the device.

3- High Cost.

Disinfection of Impressions

Set impressions are a source or reservoir for pathogens. They have been found to contain microorganisms – bacteria, fungi and viruses – following their removal from the patient's mouth, through transport to the laboratory and have also been shown to transmit microorganisms into stone and plaster while models are being poured. As such, they represent a risk for disease transmission to dental healthcare workers, transporting personnel, and laboratory personnel through indirect contact. Therefore, irrespective of the purpose, an appropriate infection prevention protocol must be followed before, during and after impression taking to avoid cross-contamination and the risk of disease transmission.

Disinfectants VS Antiseptics

Antiseptics, define as, Chemicals that destroy or inhibit the growth of microorganisms on living things (cell), while, **Disinfectants are,** Stronger Chemicals that destroy or inhibit the growth of microorganisms on object or non-living things. Accordingly, *disinfection of impression is The process of destruction or removal of all pathogenic organisms, or organisms capable of giving rise to infection from impression.*

Disinfectant protocol & Types of Impression Materials

Impression materials include the use non-elastic (such as compound) and elastic impression materials. The vast majority of procedures use elastic impression materials – aqueous hydrocolloids (typically alginate) and non-aqueous elastomeric materials including vinylpolysiloxanes (VPS or addition reaction silicones) (e.g., Aquasil), condensation reaction silicones (e.g., Xantopren), polysulfides (e.g., Permlastic) and polyethers (e.g., Impregum). The characteristics of these materials with respect to their hydrophilicity, the presence or absence of surfactant and their tolerance of immersion in water or other fluids are key elements in understanding disinfection protocols for impression materials. For example, VPS is hydrophilic and will absorb water and other liquids, changing its dimensions, and surfactant may also leach out affecting the wettability of the impression; polyether is also hydrophilic and can leach; and alginates are sensitive to wet and dry environments.

An Overview of the Disinfection Procedure

Impression materials cannot tolerate heat and must therefore be chemically treated, as with heat-sensitive instruments (except handpieces). However, while instruments can be cold sterilized by immersing them in a hospital-level disinfectant for several hours (the number depending on the chemical), impression materials are sensitive to long-term immersion and are therefore disinfected, as opposed to cold-sterilized which takes longer.

Disinfectant materials

- ***Glutaraldehyde / Cidex (2% alkaline NaHCO3):***

It is a high level disinfectant. Especially active against tubercle bacilli, fungi and viruses. Less toxic than formaldehyde. Exposure time: > 10hrs.

- ***Phenols:***

Acts by cell membrane damage thus releasing cell contents and causing lysis**.**Eg. Cresol (LYSOL), chlorhexidine (SAVLON), chloroxylenol (DETTOL) and hexachlorophen. Phenol is commonly found in mouthwashes, scrub soaps and surface disinfectants. Low efficiency disinfectant

- ***Halogens:***

Bleaching powder or hypochlorite solution mostly used disinfectant for HIV infected material. In concentration of 0.05 or 0.5% used for surface material and instruments disinfection. Should be prepared daily because of instability of sodium hypochlorite solution. Active against bacteria, spores, fungi and viruses (HB, HIV)

- ***Iodophors & Iodine***

Active against bacteria, spores & some viruses & fungi. (7.5% Povidone+iodine= Betadine The manufacturer's directions for disinfection must be followed.

Advantages and Disadvantages of disinfectant materials

MATERIAL	ADVANTAGES	DISADVANTAGES
CHLORINES	➢ Rapid action ➢ Broad spectrum ➢ Economical	➢ Prepare solution daily ➢ Diminished activity by organic matter ➢ Corrosive
IODOPHORES	➢ Broad spectrum ➢ Few reactions ➢ Residual biocidal activity ➢ Few reactions	❖ Unstable at high temperatures ❖ Dilution and contact time critical ❖ Discoluration ❖ Prepare solution daily SYNTHETIC
PHENOLS	➢ Rapid action Broad spectrum ➢ Compatible with most metal	➢ Degrades certain type of plastic over time ➢ Difficult to rinse ➢ Film accumulation ➢ Alchol base products are fair to poor cleaning ability

The general steps in the disinfection procedure are as follows:

- Blood and bioburden must first be cleaned off the impression prior to disinfection
- Cleaning should be performed immediately after taking the impression, before blood and bioburden has a chance to dry onto the impression material. While instruments can be pre-soaked to loosen debris, impression materials have limited tolerance of immersion in liquids and this should therefore be minimized and controlled
- The impression material is next disinfected using any of disinfectant material
- After disinfecting the impression, it must be rinsed under running water before being further processed or sent to the laboratory. Failure to properly rinse the disinfectant off the impression can result in a substandard model due to incorporation of residual disinfectant into the mixed stone or plaster

METHODS OF DISINFECTING IMPRESSIONS

The required exposure time for a disinfectant is an important element in its selection for disinfecting impressions. The impression is soaked by either **spraying or immersing** the impression material. Both techniques have been found to be effective in controlling bacterial contamination and preventing cross-contamination. Immersing a given impression material in disinfecting solutions and other fluids for too long a period risks dimensional and surface changes – and, therefore, inaccuracies in dies and models.

Whether **Disinfecting Solution or Sprays,** the manufacturer's recommendations must be followed. When removed from patient mouth, all impression material has been come in contact with body fluid. After removal from mouth the impression is immediately rinsed with tap water and dried with air syringe. Suitable chemicals should be used for disinfection such as glutaraldehyde Solution or iodophor sprays. Because of it tendency to distort and absorb moisture, polyether and hydrophilic addition silicon impression materials should be sprayed and stored in a plastic bag rather than submerge and soaked in a glutaraldehyde solution. For more detail read the below table.

Recommended Disinfection Method by Impression Material

Disinfection	Irreversible* Hydrocolloid	Reversible* Hydrocolloid	Polysulfide	Silicones	Polyether†
Glutaraldehyde 2% (10-minute soak time)	Not recommended	Not recommended	Yes	Yes	No
Iodophors (1:213 dilution)	Yes	Yes	Yes	Yes	No
Chlorine compounds (1:10 dilution of commercial bleach)	Yes	Yes	Yes	Yes	Yes
Complex phenolics	Not recommended	Limited date	Yes	Yes	No
Phenolic glutaraldehydes	Not recommended	Yes	Yes	Yes	No

*Immersion time should be minimized. Dip in glutaraldehyde, rinse in sterile water, dip again, and delay pouring for 10 minutes while maintaining a humid environment. Alternatively, spray with sodium hypochlorite, rinse, and respray with a similar 10-minute delay before pouring.

†Imbibition distortion results from prolonged immersion. For 1:10 hypochlorite or chlorine dioxide: spray, rinse, repeat, spray again, and delay pouring for approximately 10 minutes.

Crown and bridge Prosthodontics

Lecture:9

Inter occlusal Record (Bite Registration Record)

an imprint of the positional relation of opposing teeth or jaws to each other, made of the surfaces of occlusal rims or teeth with a bite registration material such as plaster of paris, wax, zinc oxide-eugenol paste, or acrylic resin.

Objective of bite registration:

1) To transfer the relation between the upper and lower dental arches from the patient's mouth to the articulator we need bite registration. Proper interocclusal record is important to orient the die (s) of the same arch to the opposing arch.
2) An accurate interocclusal record and correct mounting of the casts on an articulator allow the laboratory technician *to create proper contours and alignment of the metal substructure of the restoration as well as the proper contour and intercuspation of the teeth in porcelain.*
3) *Failure to capture an accurate interocclusal record will result in time-consuming chairside adjustments, the need for remounting casts and possible refabricating of the prosthesis*

Accuracy of an interocclusal record Influenced by the following factors:

1) Material properties.
2) Recording technique.
3) Reliability of the mandibular position influenced by the occlusal contacts.
4) Muscular action.
5) Tissue changes within the joints.

According to Dawson *criteria for accuracy* in making interocclusal records (requirements)

- The recording material must <u>*not*</u> cause any movement of <u>*teeth or displacement of soft tissues.*</u>
- The recording material <u>*must fit casts*</u> as accurately as it fits the teeth intra-orally.
- The accuracy of the jaw relation <u>*record should be checked*</u> in the mouth and on the casts.

Bite Registration Materials

Characteristics of ideal registration material:

To be ideal bite registration material must have the following properties;

1) *Limited resistance before setting to avoid displacing teeth or mandible during closure.*
2) *Rigid after setting*
3) *Minimum dimensional change*
4) *Accurate record of incisal & occlusal surfaces*
5) *Easy to manipulate*
6) *No adverse effect on tissue*
7) *Records should be verifiable*

Bite Registration Materials:

1) Impression plaster (soluble plaster)

- Type 1 modified with addition of accelerators to decrease setting time & setting expansion
- Records are accurate , rigid after setting , do not distort with extended storage ,
- Difficult to handle, record is brittle.
- Not used now

2) Bite registration waxes

- Ease of manipulation.
- High coefficient of thermal expansion
- High resistance to closure.
- Distortion of wax during removal is also very common.
- Dimensionally Inaccurate , may interfere with active & passive movements

It has been classified as most inaccurate material among the interocclusal records studied. Therefore, zinc oxide eugenol or resin was added to wax impression in a very thin layer to improve poor detail transfer and displacement of wax.

4) Zinc oxide eugenol paste

- Fluidity before setting – is a critical factor because it ensures minimal interferences with mandibular closure during recording.
- Adhesion to carriers
- Rigid and inelastic after setting
- Accuracy in recording occlusal and incisal surfaces
- High degree of reproducibility
- Brittle(vital portion may be lost by breakage)
- Sticks to tissues
- Unless trimmed ,flash around the teeth may prevent accurate seating of casts

5) Acrylic Resin

The most frequent application of acrylic resins for interocclusal records is in the fabrication of single stop centric occlusion records. Acrylic resin is both accurate and rigid after setting.

Disadvantages:

- Dimensional instability due to polymerization shrinkage.
- Rigidity of the material can damage plaster cast and dies during mounting on the articulator.

6) Elastomers for IOR (luxabite):

- Least error among the materials studied. They are easy to manipulate and offer little or no resistance to closure.
- Set to a consistency that makes them easy to trim without distortion, and accurately reproduce tooth details. Furthermore, among the elastomers, addition silicones exhibit least amount of distortion.
- The excellent dimensional stability of addition silicones is attributed to the fact that it sets by addition polymerization reaction. Therefore, no by-products and no loss of volatiles occur in addition silicones.
- Dimensional stability, accuracy and elastic recovery, with short working time

OCCLUSION

The contact of the opposing surfaces of teeth of the two jaws". It is a relationship of the mandibular and maxillary teeth when closed or during side to side movements of the mandible; when the teeth of the mandibular arch come in contact with the teeth of the maxillary arch in any functional or parafunctional relationship.

DETERMINANTS OF OCCLUSION:

- ***Anterior Determinants of Occlusion***

The teeth of the maxillary and mandibular arches represent the Anterior Determinants of Occlusion, it involves;

1) *The anterior teeth: (canine to canine)*

- ❑ Determine the movement of the anterior portion of the mandible (guide the mandible in right and left lateral excursive movements and in protrusive movements).
- ❑ Anterior guidance is variable since it can be altered by: restorations, extractions, orthodontics, attrition, etc.

2) *The posterior teeth:*

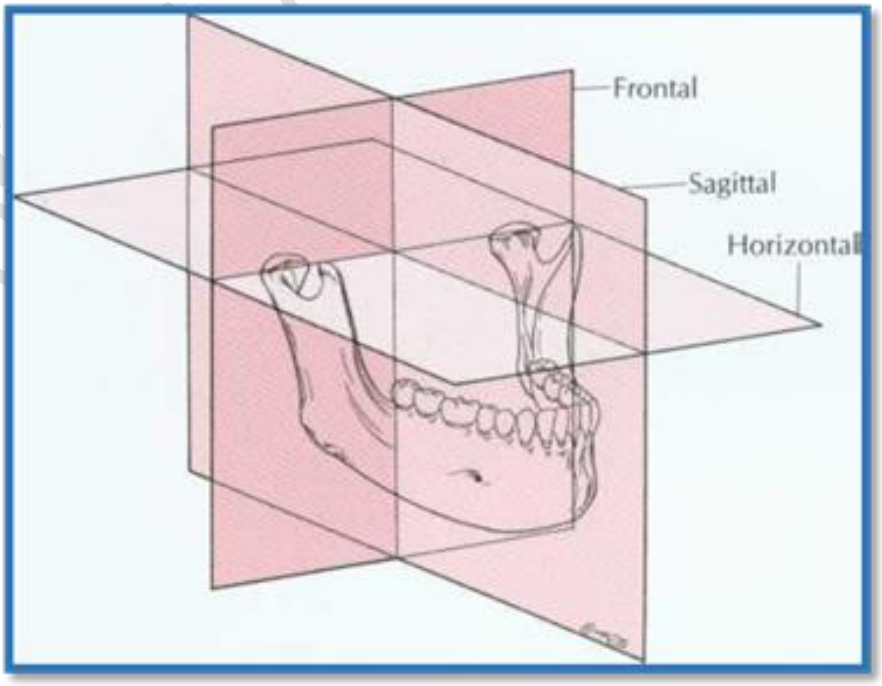
- ❑ Vertical stops for mandibular closure.
- ❑ Guide the mandible into the position of maximum intercuspation.

- ***Posterior Determinants of Occlusion***

Temporomandibular joint, right and left, represent the posterior determents of occlusion. Condylar guidance is a fixed factor, and the TMJs are the posterior controlling factor in mandibular movement.

MANDIBULAR MOVEMENT

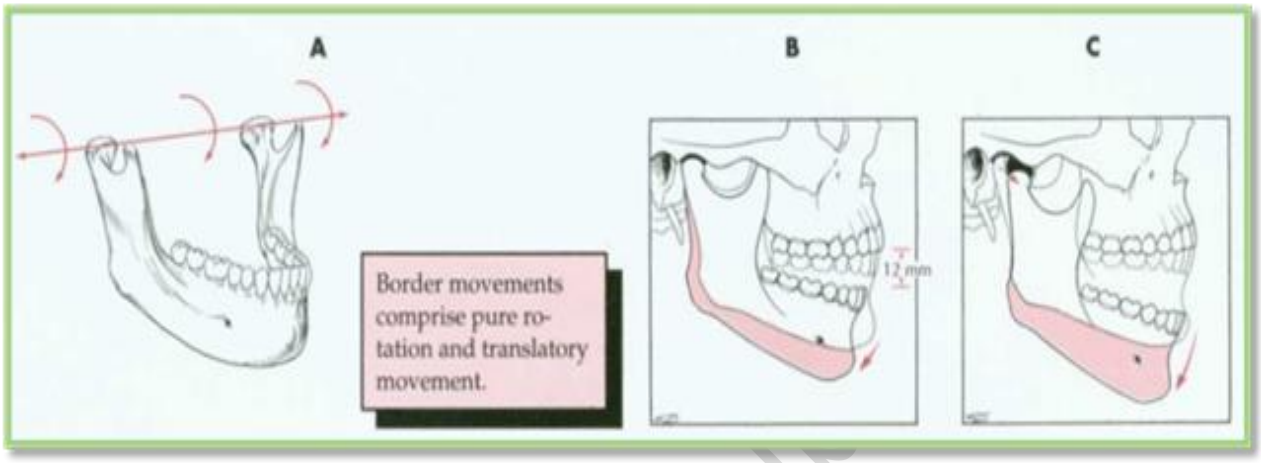
As for any other movement in space, complex three-dimensional mandibular movement can be broken down into two basic components: translation, when all points within a body have identical motion, and rotation, when the body is turning about an axis. Every possible three-dimensional movement can be described in terms of these two components, so, *It is easier to understand mandibular movement if we broke it into in three perpendicular planes: sagittal, horizontal, and frontal; or can be broken into series of motions that occurs around three axes*



Reference Plans of mandibular movements

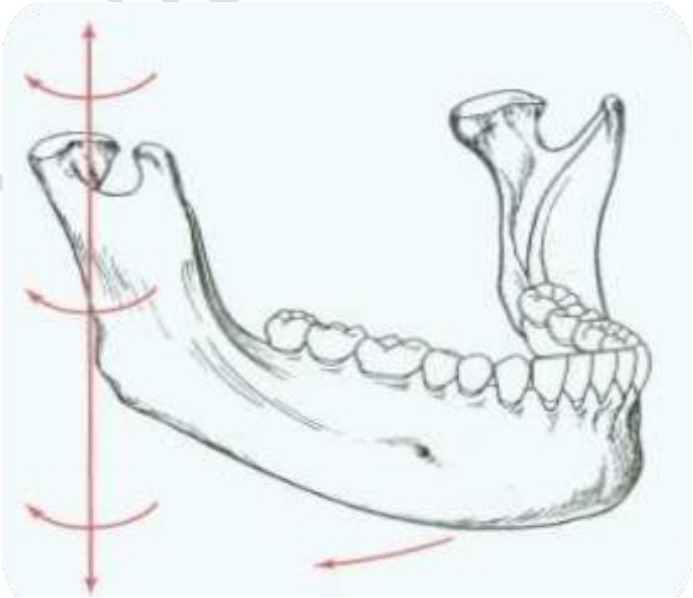
1) Sagittal Plane

In this plane, **the mandible is capable of a purely rotational movement as well as translation**. Rotation *occurs around the terminal hinge axis*; an imaginary horizontal line through the rotational centers of the left and right condylar processes. **The rotational movement** is limited to about **12 mm** of incisor separation **before the temperomandibular ligaments** structures anterior to the mastoid process **force the mandible to translate.** The initial rotation or hinging motion is between the condyle and the articular disk. During translation, the lateral pterygoid muscle contracts and moves the condyle-disk assembly forward along the posterior incline of the tubercle. Condylar movement is similar during protrusive mandibular movement.



2) Horizontal Plane

In the horizontal plane, the mandible is capable of rotation around several vertical axes. For example, lateral movement consists of rotation around an axis situated in the working (laterotrusive) condylar process with relatively little concurrent translation. The orbiting (nonworking) condyle travels forward and medially as limited by the medial aspect of the mandibular fossa and the temporomandibular ligament. Finally, the mandible can make a straight protrusive movement.



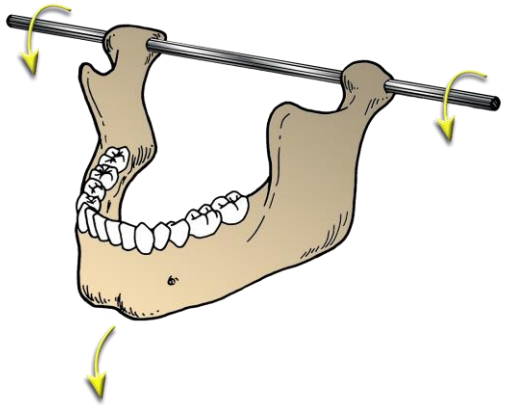
3) Frontal Plane

When observing a lateral movement in the frontal plane, the mediotrusive (or nonworking) condyle moves down and medially while the laterotrusive (or working) condyle rotates around the sagittal axis perpendicular to this plane.

According to the axes mandibular movements can broke into :-

1) Horizontal axis:

This movement, in the sagittal plane, happens when the mandible in centric relation makes a purely rotational opening and closing border movement around the transverse horizontal axis, which extend through both condyles.



The mandible moves around a horizontal axis,as seen in a hing axis opening

2) Vertical axis:

This movement occurs in the horizontal plane when the mandible moves into a lateral excursion. The center for this rotation is a vertical axis extending through the rotating or working side condyle .

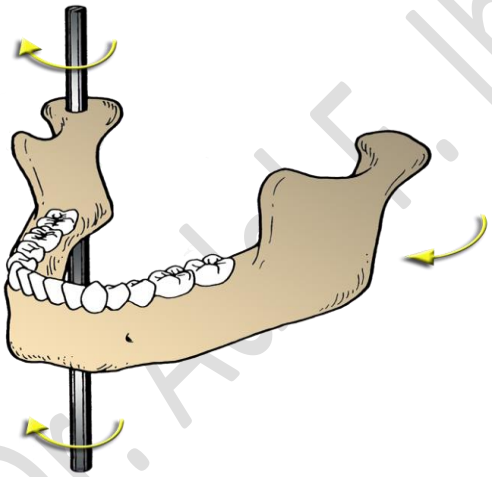


Fig. 17 The mandible moves around a vertical axis, during a lateral excursion.

3) Sagittal axis:

When the mandible moves to one side, the condyle on the side opposite from the direction of movement travel forward (Fig. 18). (Shillingburg et al, 1997)

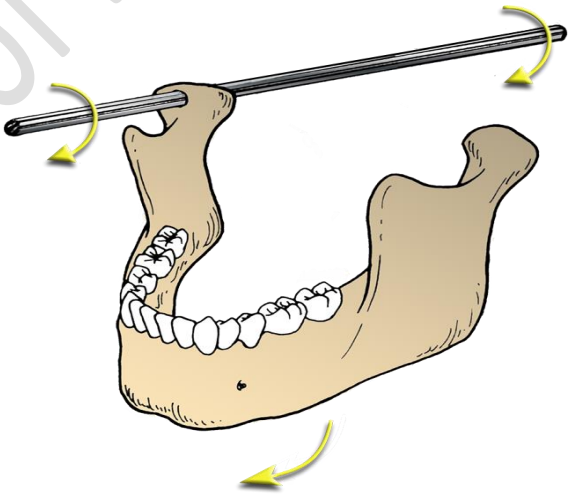


Fig. 18 The mandible also rotates around a sagittal axis, when one side drops down during a lateral excursion.

CLASSIFICATION OF OCCLUSION

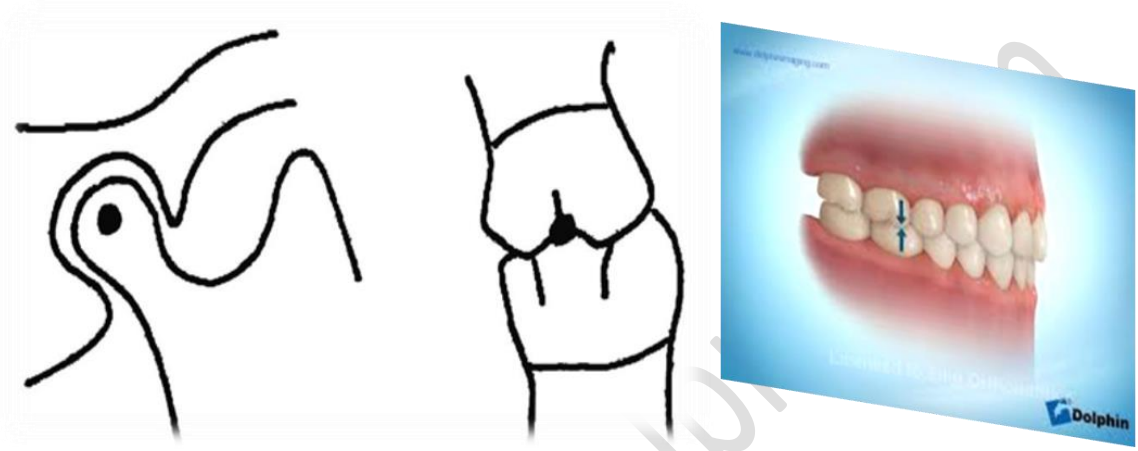
1. BASED ON MANDIBULAR POSITION

According to the position of mandible occlusion can be divided into two main subdivision centric and eccentric occlusion.

A. Centric Occlusion (CO):

The occlusion of teeth as the mandible closes in centric relation.

- It's a tooth-to-tooth relation.
- It is a reference point from which all other relations are eccentric.



Centric relation (CR)

Centric relation is a bone-to-bone relation. It is the relation between the maxilla and the mandible when the condyles are in the rear most upper most mid most in the glenoid fossae.

Maximum Intercuspation (MI):

It Is The Most Closed Complete Interdigitation Of Mandibular And Maxillary Teeth Irrespective Of Condylar Centricity. In Other Words, Maximum Intercuspation May or May Not Coincide With Centric Occlusion, Depending On the Position Of The Condyle.

If maximum intercuspation occurs with the condyles being out of centricity, then both positions would not coincide, with the maximum intercuspation in that case, referred to as the ***habitual or physiological occlusion or closure***, and is considered as an eccentric position. On other hand, low percentage of population have their maximum intercuspation coincide with centric occlusion (condyles centricity) such a case referred as ***ideal occlusion*****.**

You should keep in your mind the following points:

1) *Centric relation should not be confused with the centric occlusion.*
2) *Centric relation is not a relation about teeth. (The edentulous mandible is in centric relation if the condyle-disk assemblies are completely seated.)*
3) *Centric relation is not just a convenience position that is used because it is repeatable. It is the universally accepted jaw position because:* ***It is physiologically and biomechanically correct. Secondly it is the only jaw position that permits an interference-free occlusion.***

B. Eccentric Occlusion:

Occlusion other than centric occlusion refer to contact of teeth that occurs during movement of mandible.

Lateral occlusion: (working or functional side occlusion)

It is defined as the contact between opposing teeth (canines and posterior teeth) when the mandible is moved right or left of the midsagittal plane. The contacts occur on the sides towards which the mandible moves (working side).

PROTRUDED OCCLUSION

The occlusion of the teeth when the mandible is protruded (It includes eccentric contacts that occur when the mandible moves forward). The position of the mandible is anterior to centric relation. Ideally the six maxillary anterior teeth contact along the lingual inclines of the mandibular anterior teeth while the posteriors disocclude.

Balancing (nonfunctional) side occlusion

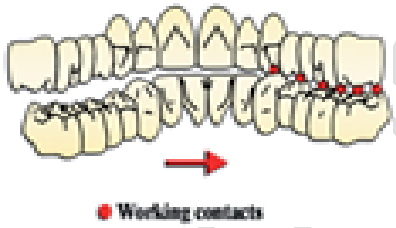
They are tooth contacts that occur in the segment away from which the mandible moves. For example if the mandible is moved to the left side, contact occur on right side.

2. BASED ON THE ORGANIZATION OF OCCLUSION

According to the pattern of occlusal relation of opposing teeth during lateral movement of mandible, occlusion can be divided into

A. Unilateral Balanced Occlusion:(Group Function)

Simultaneous contact of maxillary and mandibular teeth on working side as they glide over each other during lateral movement mandible movement from centric relation to the right or left side acting as a group to share & distribute forces ,however , teeth on the balancing side (non working) are free from any contact. It is widely accepted and used concept in fixed restorative dentistry



B. Bilateral Balanced Occlusion

The simultaneous contact of maxillary and mandibular teeth on working and balancing side as they glide over each other on the right and left , in anterior and posterior occlusal area when the mandible moved from centric relation to eccentric occlusal relations (balanced and equal contacts are maintained throughout the entire arch during all excursions of mandible). This type of occlusion rarely found in natural dentition, however, generally consider necessary for denture stability.

C. Canine guided (protected) Occlusion

During lateral mandibular movements, the opposing upper and lower canines of the working side contact there by causing disclusion of all posterior teeth on the working and balancing sides (The anterior teeth protecting the posterior teeth in all mandibular excursions and the posterior teeth protecting the anterior teeth at the intercuspal position). It is widely accepted, easy fabricated & greater tolerance by patients

3. Based on relationship of first maxillary permanent molar

a) **Class I : Neutro Occlusion**

Mesiobuccal cusps of the upper first permanent molar occludes with the mesiobuccal groove of the lower first permanent molar. This is called the key of occlusion

b) **Class II : Disto Occlusion**

Condition in which the mandibular first Permanent molar is placed posterior in relation to the normal class I condition

- *Division I*
- *Division II*

c) **Class III : Mesio Occlusion**

Condition in which the mandibular first Permanent molar is placed anterior in relation to the normal class I condition

Types of Interocclusal Records

Basically, there are three main categories of interocclusal registration:

- *Centric intercuspal records (centric occlusion or maximum intercuspation)*
- *Centric interocclual record (centric relation)*
- *Eccentric interocclusal records.*
  - *lateral inter occlusal records*
  - *protrusive inter occlusal records*

What we need to record in fixed prosthodontics? Centric relation CR or CO or IP ????

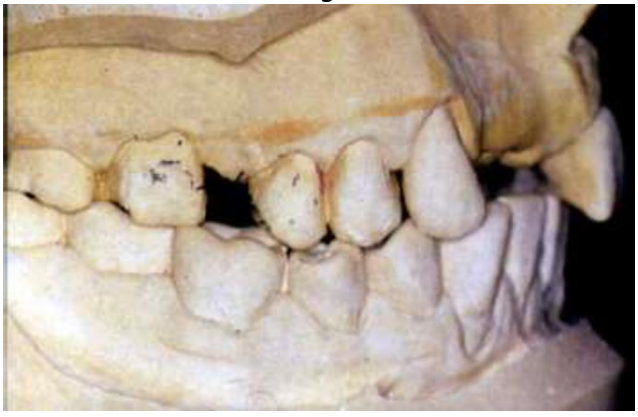
Most of time, in fixed prosthodontics, If the patient has a stable intercuspal position (weather it coincide with centric occlusion or not) and the treatment is restricted to the restoration area while all the remaining teeth didn't not involve in the treatment plan with no signs and symptoms of trauma to the occlusion, the goal of treatment should be directed toward maintaining pre-treatment intercuspation and occlusal vertical dimension (OVD) .

However In cases of occlusal reconstruction or complete mouth rehabelation treatment furthermore if the patient have un stable intercuspal position, with signs and symptoms of trauma from occlusion , the goal of treatment should be directed toward using centric relation as treatment position

Recording centric occlusion or maximum intercuspal position

If the patient has an adequate number of teeth and a stable intercuspal position, no signs and symptoms of trauma to the occlusion and the goal of treatment is to maintain pre-treatment intercuspation and occlusal vertical dimension (OVD). Most accurate method of articulation is to occlude opposing casts by hand, without intervening bite registration material.

Recording material placed between teeth in this case often prevents casts from maximal intercuspation and an interocclusal record is registered at an increased OVD.



Indications for Interocclusal Records

1) *When a segmental restorative is planned & remaining teeth are insufficient to produce hand articulation of the casts An interocclusal record is needed (as there is insufficient horizontal stability of the casts for hand articulation and mounting,for opposing casts to occlude accurately, a tripod of vertical support and horizontal stability must exist between the casts. The patient's pre-treatment maximum intercuspal position (MIP) is usually maintained.*

2) *When a unilateral fixed partial denture (FPD) involving terminal teeth is prepared, the dentist must fabricate an interocclusal record to recapture the lost leg and create a tripod of vertical support to mount casts accurately.*

3) *Interocclusal record is capture after construction of bit rim when fixed partial denture (FPD) planned for a patient have*

- *Missing poster teeth (Free end saddle) & need to restore the anterior teeth.*
- *Insufficient teeth to obtain accurate interocclusal record.*

Factors that influence inter occlusal record procedure;

- Amount and equalization of pressure, which depends on uniform consistency of recording material.
- Comfort of patient, which depends on stability & compatibility of record bases. Artificial teeth are more compatible to mandibular movements than occlusion rims.
- An inter occlusal record with multiple points of references made by styli or cusp tips is more satisfactory than with occluding surfaces of wax or non-cusp form teeth.

How TO Record

Whatever the material used to record the relation, you have to guide the mandible to the required relation (centric or eccentric). So ask the patient to close and guide him, put reference point (occlusion of the teeth opposite to the side of treatment), then put the record material and register the relation. *The recording material should place over the area between the prepared teeth only*. The most widely used material to record the occlusal relation is pink base plate wax or elastomer. The procedure is by softening the wax at first, then apply 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. In case of using elastomer you can ask the patient to close, then you can inject the material at the area of treatment. After complete setting remove the record from the patient mouth, trim the excess and attach it to the cast and transfer it to the articulator.

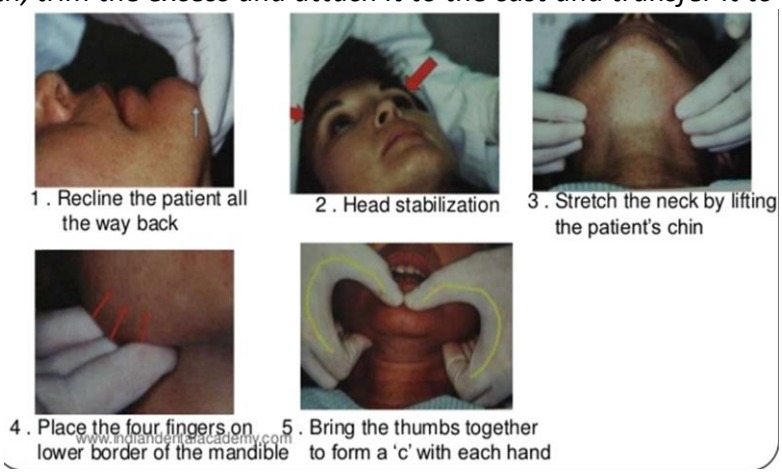
Recording centric relation

- **Dawson Technique *(Bimanual manipulation technique).***

He used bilateral manipulation to guide the mandible to centric relation and used following recording techniques:

How to record?

Dowson in 1914 suggest to place dental chair in reclined position and the patient s head fixed by dentist standing behind the patient with both thumbs on chin and the figures resting on the inferior border of the mandible *(Bimanual manipulation technique), then, by gentle downward pressure by thumbs and upward pressure by fingers, the patient mandible will bring into centric, ask the patient to bite on the bite registration material. After complete setting remove the record from the patient mouth, trim the excess and attach it to the cast and transfer it to the articulator.*



- **anterior- jig programmer**

Procedure for making an interocclusal record without the use of record bases. It involve Separation of the posterior teeth immediately prior to centric relation record fabrication using anterior- jig programmer, mostly Acrylic resin anterior stop, This results in the patient "forgetting" established protective reflexes that are reinforced each time the teeth come together, making mandibular hinge movements easier to reproduce. Acrylic resin anterior stop (anterior- jig programmer) is used to hold the desired vertical dimension of occlusion. Pink Base plate Wax or elastomer inter occlusal recording paste can be used then to record inter occlusal relation. If properly executed, use of a deprogramming device allows the patient to close into an operator-defined repeatable position unassisted.

How to record?

When the mandible is closed, the lower incisors strikes against a stop that is precisely fitted against the upper incisors. ***The stop should be thin enough so that the first point of tooth contact barely misses but under no circumstances should any posterior tooth be allowed to contact when the anterior stop is in place.*** *A firm setting bite registration paste is injected between the posterior teeth and allowed to set.*

Bite registrations for CAD/CAM procedures

Bite registration can be digitally recorded in the same way as that used for digital impression, both procedures are employed in conjunction with the computer-aided design/computer-aided manufacturing (CAD/CAM). Digital Bite registration are taken either:

- ❑ Indirectly using extra oral scanner (In lab).
- ❑ Directly in the mouth at chairside using an intraoral digital camera (In office).

In order to determine the occlusal relationship, for indirect scanning technique, an antagonist bite registration is required. Being able to directly capture images of this bite record with a scanning device or camera without having to apply a contrast medium, while for direct technique, in order to determine the occlusal relationship, the image of occlusal relation of opposing dental arch is capture directly from the inside of patient s mouth using intra oral digital camera without the need for of any material for bite registration record

Mounting of maxillary and mandibular arch

It is procedure of attaching the maxillary and mandibular casts to the articulator in their recorded jaw relation. The maxillary cast is first mount to the articulator using facebow record and then the mandibular cast is articulate (mount)after recording centric jaw relation.

FACEBOW

Dental instrument that used to records the relationship of the maxilla to the hinge axis of rotation axis rotation of the mandible and transfer it to the articulator. It allows the maxillary cast to be placed in an equivalent relationship on the articulator i.e. it aid in mounting maxillary cast on the articulator

In order to identify true hinge axis, hinge axis locator and hinge axis face bow are necessary. Facebow either kinematic (orient maxilla to actual hinge axis) or arbitrary (orient maxilla on arbitrary hinge axis).

Articulators

Articulator is a mechanical device which represents the temporomandibular joints and the jaw members to which maxillary and mandibular casts may be attached to simulate jaw movements.

PURPOSE OF AN ARTICULATORS

1) *To hold the maxillary and mandibular casts in a determined fixed relationship.*
2) *To simulate the jaw movements like opening and closing.*
3) *To produce border movements (extreme lateral and protrusive movements) and intra border movements (within the border movement) of the teeth similar to those in the mouth.*

USES OF AN ARTICULATOR

- *To diagnose the state of occlusion in both the natural and artificial dentition.*
- *To plan dental procedures based on the relationship between opposing natural and artificial teeth eg; evaluation of the possibility of balanced occlusion.*
- *To aid in fabrication of restorations and prosthodontic replacement.*
- *To correct and modify completed restoration.*
- *To arrange artificial teeth.*

TYPE OF ARTICULATORS;

1. **Nonadjustable articulator;**
   - *They can open and close in a fixed horizontal axis.*
   - *Have a fixed condylar path along which the condylar ball can be moved to simulate lateral and protrusive jaw movement.*
2. **Semi adjustable articulator**

   They have adjustable condylar path, adjustable lateral condylar paths, adjustable incisal guide tables and adjustable intercondylar distances.

   Semi adjustable articulator types:

   Arcon vs. Nonarcon
   - **Arcon:** *in this type the condylar element (condylar spheres) is attached to the lower member of the articulator and the condylar guidance (mechanical fossae) is attached to the upper member. This articulator resembles TMJ.*
   - **Nonarcon:** *in these, the articulators have the condylar guidance (mechanical fossae representing glenoid fossae) attached to the lower member, condylar element (condylar spheres) on the upper. This articulator is reverse of the TMJ.*
3. **Fully adjustable articulator**

   Capable of being adjusted to follow the mandible movement in all direction. These articulators have a number of readings which can be customized for each patient. They do not have condylar guidance, instead have receptacles in which acrylic dough can be contoured to form a customized condylar and incisal guidance.

Lecture: 10

SHADE SELECTION IN FIXED PROSTHODONTICS

Matching two objects that reflect similar color (wavelengths of electromagnetic spectrum)

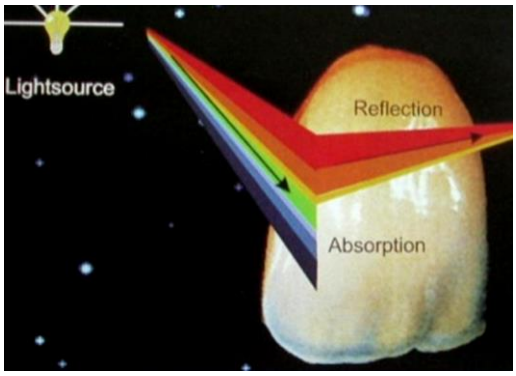
Shade Selection in fixed prosthodontics:

Process of replicating of the color of the adjacent teeth in an artificial prosthesis. The success of dental treatments as perceived by our patients is often evaluated on appearance, rather than long-term health, function and comfort. Everyone, it seems, is primarily interested in color, Color is light, modified by an object as perceived by an eye".

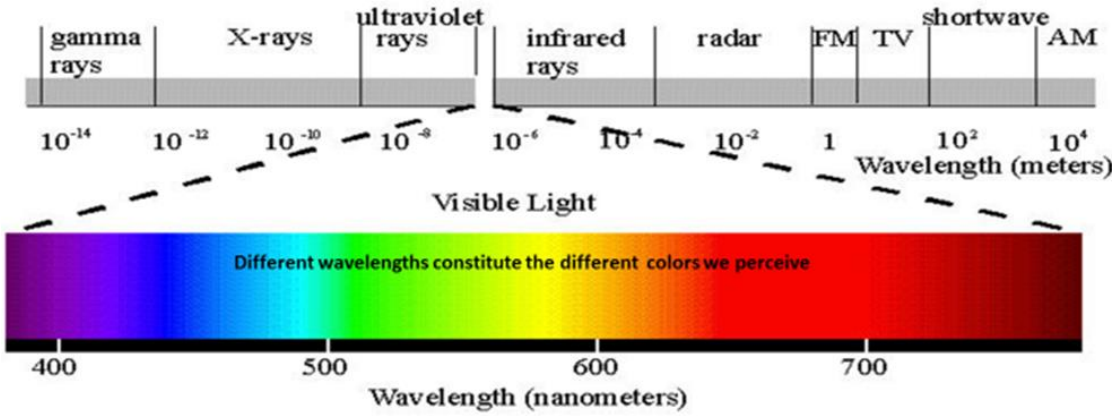
Color that is perceived is the result of a light source, the object that absorbs, transmits, reflects or scatters the light from the source, and the interpretation of the result by the human visual system. Without Light Color Does Not Exist

Color & Light

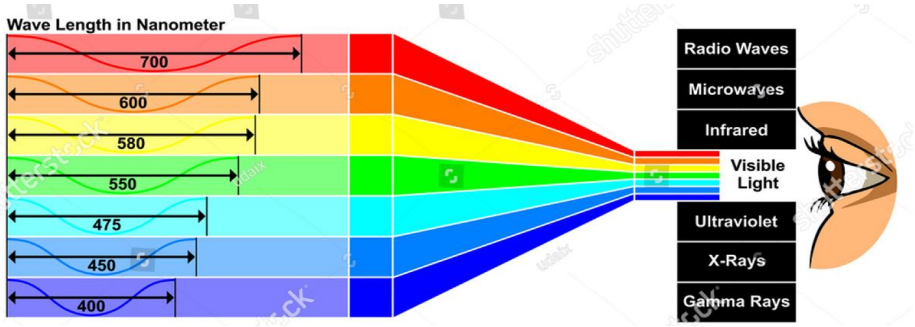
- **The color of an object is determined by the light that enters the human eye from that object**
- **What is commonly called "the color of a tooth" is actually the color of the reflected light.**



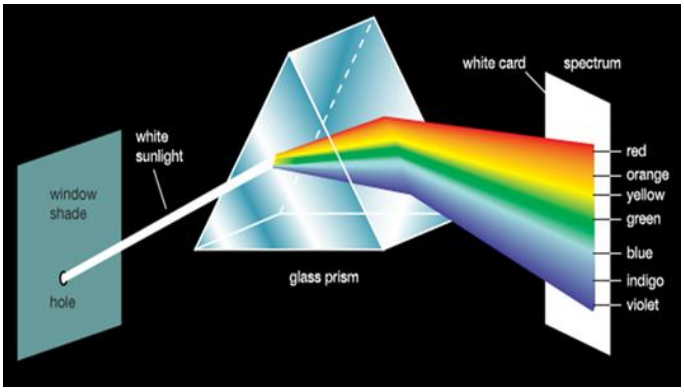
Light is a Form of visible energy that is part of the radiant energy spectrum. Radiant energy possesses specific wavelengths, which may be used to identify the type of energy. The eye is only sensitive to the visible portion of the spectrum (380 – 750nm) Different wavelengths constitute the different colors we perceive



Human eye is only sensitive to the visible portion of the radiant spectrum energy



When Pure White Light passed through a prism we see component colors of white light, Shorter wavelengths bend more than longer wavelengths



Color mixture

- **Primary colors**

Red, green, blue

- **Additive mixture system-**

Mixing of two of the light mixture primary colors produce a new color

Red + blue = magenta Red + green = yellow Green + blue = cyan

- **Pigment mixture system**

Yellow, cyan, magenta

How to describe color in words?

Albert Munsell, felt a need to describe the colors of his sketches in definite terms to his students. This led to the development of the Munsell Color System, which is presently a widely used visual color order system**.** He described **three dimensions** of color **as hue, chroma, and value**. It is possible to vary each of these qualities without disturbing the other. The ability to understand each of these dimensions and separate them from one another is fundamental to an understanding of color as it relates to dentistry

Munsell Color System (visual color order system)

Used to describe a definite color system in a visual order system.

Munsell define three dimension or qualities for color

1. Hue

Quality by which we **distinguish one color family from another** (variety of color). We have ten hue color families: **1.R-red 2.YR-yellowgreen 3.Y-yellow 4.GY-greenyellow 5.G-green 6.BG-bluegreen 7.B-blue 8.PB-purpleblue 9.P-purple 10.RP-redpurple.** Each of these ten hues is further subdivided into ten numbered segments. The middle red would thus be 5R

2. Chroma

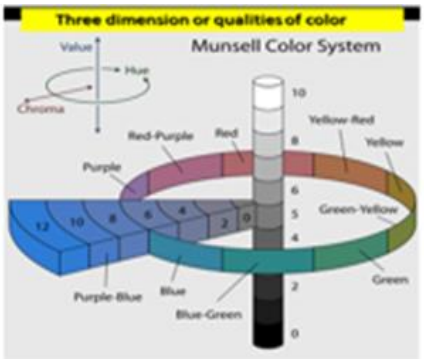
Quality of color by which we **distinguish a strong color from a weak one (the intensity or saturation of hue)**. The degree of departure of a color sensation from that of white or gray; the intensity of a distinctive hue, **color intensity _Range= 0 – 12**

3. Value

Quality by which we **distinguish a light color from a dark one or the relative brightness of object** (lightness or darkness), range from zero to ten, black is zero(0) and white is ten (10). The value of a color is determined by which one of the grays it matches on the scale. Colors with low value numbers are termed dark colors, and one with high value numbers are called light colors. A black-and-white television tube emits only a range of values 9.

Value is generally considered to be the most important of the three dimensions of color • One reason is that lightness and darkness differences are readily detected by individuals untrained in color perception • Another reason is that value differences are more easily detected at a variety of viewing distances (both close-up and at a distance), whereas differences in hue and chroma become more difficult to quantify as the viewing distance increases.

Munsell Color System
It compose of central core representing
Value (as you move from bottom to the top of the core value increase from 0 to 10)
Hue is represent by circle that surround the central core (it involve ten hues that is further subdivided into ten numbered segments. The middle red would thus be 5R and so on for other hue).
As you move from the central core to the outside Chroma increase (each colour intensity-Range= 0– 12



Color of Human Teeth

Dr. E. B. Clark was the first to accurately describe the color of teeth. In 1931, he reported his color data from a visual analysis of 6000 teeth from 1000 patients over an 8-year period

Hue range from 6 YR to 9.3 Y • Value range of 4 to 8 • Chroma range from 0 to 7

<u>Factors influence the apparent color of an object (teeth):</u>

1) **Nature of light**

We have three light source **Incandescent Light, Fluorescent Light and Natural Daylight**. Most dental offices are outfitted with incandescent and fluorescent lights. **Incandescent Light** Emits high concentration of yellow waves matching. while, **Fluorescent Light** emits high concentration of blue waves Both of two Not suitable for shade matching. **Chair light** not recommended for colour matching as it is over powering and interferes with fine discrimination of three dimensions of colour

Natural Daylight considered the **best Closest to emitting the full spectrum of white light Used as the standard by which to judge other light sources.** At Morning and evening light spectrum rich in yellow/orange, lacks blue/green because shorter wavelengths scatter before penetrating atmosphere, While. **At Mid-day time (Hours around noon) where Full spectrum of colors visible consider ideal time for color matching**

2) **Physical properties of object**

When light strikes an object, and according to the physical properties some wavelengths are **absorbed** by the object, while **other transfer** through it, the remaining is **reflected,** color of an object – light that is actually reflected by the object. True color characteristic and appearance of depth translucency in a natural tooth cannot be correctly perceived unless the tooth is free of

plaque and surface stains. With increasing opacity of teeth, the grey scale value decreases and the brightness (value) increases, **The Higher the brightness (values) the lower the transparency** becomes. The **more transparent a tooth the greyer it appears.**

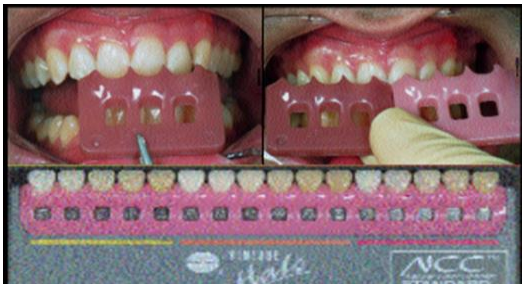
Opal Effect (Opalescence):

Fine particles in enamel (hydroxyapatite crystals) responsible for opal effect Fine particles reflect short wave lengths and allow longer wave lengths to pass through. Hence areas within a tooth or a restoration with higher translucency will have a lower value because light transilluminates through and away from the viewer. When evaluating enamel translucency, the observer will often focus on the opalescent blue areas that is why **Translucent areas of the teeth appear grey** while **opaque incisal edge appears white.** -hence tooth shows

•Bluish areas in reflected light

•Orange red areas in transmitted areas

Tooth must be kept moist during shade selection. The color environment surrounding an object influences our color perception of the tooth significantly (gum, lip color and color behind the object). **The Gumy gingival mask** (color contractor) was developed to neutralize the influence of the color environment on our color perception during visual shade selection.

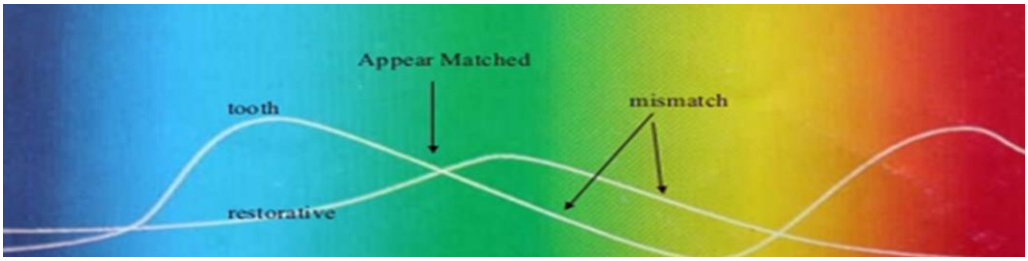


<u>Metemerism</u>

Phenomenon occurring when the color of the two objects appear to match under one lighting source but not under a different source.

Clinical significance of Metemerism

Tooth & crown restorative material of a differing shade may appear matched under certain light conditions, but may show discrepancy in day light, that is why shade selection must be evaluate under multiple light sources (different light sources)



3) Subjective assessment of observer

The light first penetrates a layer of nerve fibers, then passes through several layers of cells, and finally reaches the rods and cones, which are embedded underneath • The rods and cones of the retina form the chief component of the retinal receptor complex. The rods detect only lightness and darkness (value). The cones perceive the chromatic aspects of an object (hue and chroma). In Color - Deficient person which is Defect in color vision attack 8% males and 0.5% females. Several variations exist.

Achromatism – complete lack of hue sensitivity

Dichromatism – sensitivity to two primary hues

Anomalous Trichromatism – sensitivity to all three hues, with abnormality in retinal cones affecting one of primary pigments. **Dentists should have their color vision evaluated. If any deficiency is detected, a dentist should seek assistance when selecting tooth shades**

<u>Shade Selection Methods</u>

Traditional shade taking involves matching one or more selected colors from a range of shade tabs to the teeth adjacent or contralateral to the teeth to be restored. This serves as a guide to the lab technician fabricating the crown or the bridge. i.e it is Process of replicating of the color of the adjacent teeth in an artificial prosthesis, we have different methods for shade selection;

1) Visual shade matching.

Visual shade selection by comparison of a patient's tooth with a color standard (i.e. commercially available shade guide). **A Dental Shade Guide** is a set of simulated teeth used to select prosthetic teeth by color. Shade guide are Examples of various color combinations available from manufacturers of denture teeth, restorative resins and porcelains. These samples are compared with the natural teeth and the closest color match is determined, most commonly use shade guide in fixed prosthodontics;

a) Vita Classic Shade Guide

b) Vita-3D –Master shade guide

c) VITA Linearguide 3D-MASTER

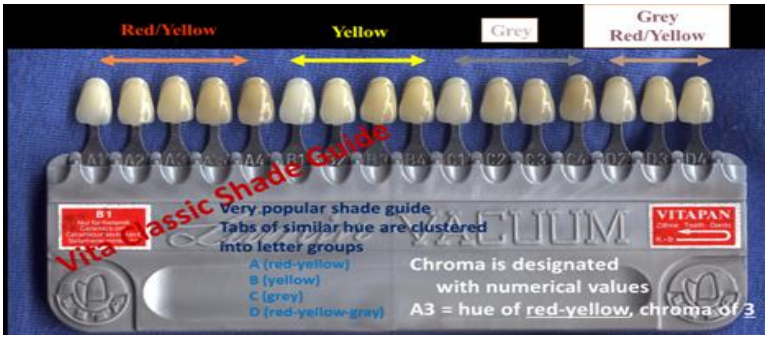
Principles of Shade Selection

1. Teeth to be matched must be clean & moist
2. Remove bright colors from field of view
   - makeup / tinted eye glasses
   - bright gloves
   - neutral operatory walls
3. View patient at eye level
4. Evaluate shade under multiple light sources
5. Make shade comparisons at beginning of appointment
6. Shade comparisons should be made quickly to avoid eye fatigue.
7. selection distance- a selection made at 3-6 feet from the oral cavity is often more useful, since it is representative of the conditions under which the patient teeth will most often be observed.
8. Use of color Contrastors: The color environment plays important role in our color perception of the grey tooth significantly
9. Shade tap position; Shade tab should be held above the mandibular tooth or below the max tooth to be match and aligned as close as possible to the plane of orientation of the facial surface of the tooth being matched. Holding the shade tab over the tooth can give a false impression of the color as the background of the tab is the tooth color rather than the oral

a) Vita Classic Shade Guide

Very popular shade guide, Tabs of similar hue are clustered into letter groups;

A (red-yellow) , B (yellow) , C (grey) , D (red-yellow-gray)



How to use Vita Classic Shade Guide

Manufacturer recommended sequence for shade matching as follow

1. Hue Selection 2. Chroma Selection

3. Value Selection: Because value level is not involved in this shade guide, the use of a second, value ordered shade guide is recommended (**Value oriented shade guide**)

Value oriented shade guide

B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, C4,

(bright >>>>>>>>>>>>decrease>>>>>>>>>>>>>>>>>>> dark)

4. Final Check / Revision

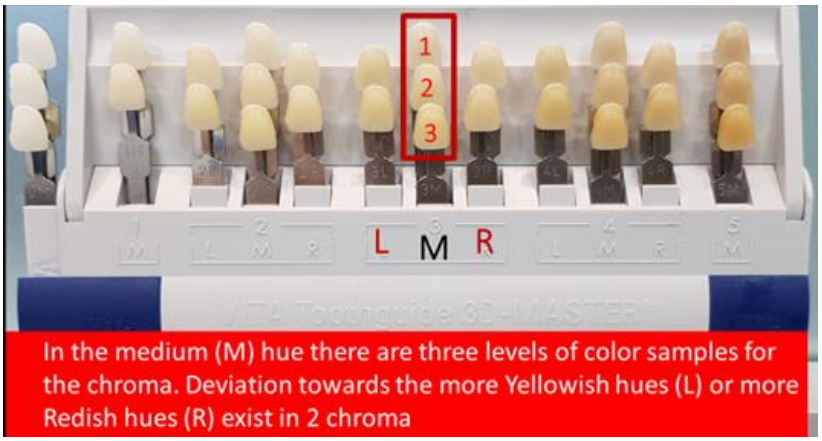
b) Vita-3D –Master shade guide

More precise shade guide, tooth color divided into 5 level of value, for each value group deviation from medium hue towards yellow or red. In the medium (M) hue there are three levels of color samples for the chroma, deviation toward more yellowish hues (L) or more reddish hue (R) exist in 2 chroma.

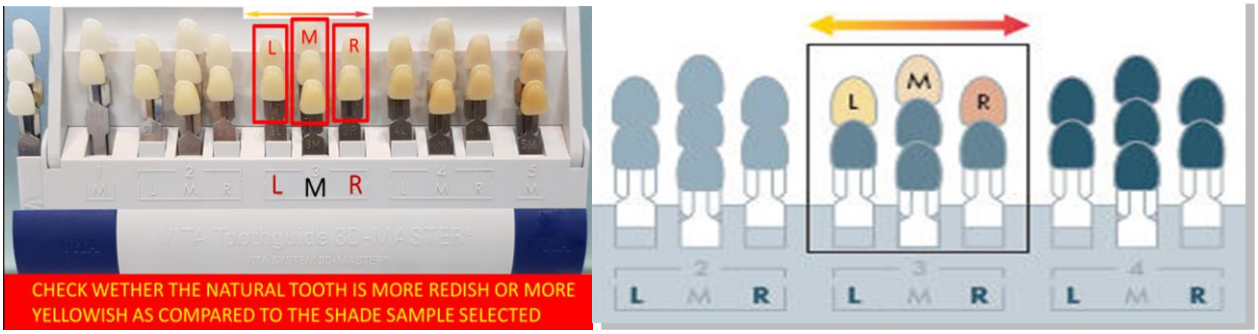
How to use Vita-3D –Master shade guide

Step 1 Determine the lightness level (value). Hold the shade guide to patient's mouth and start with darkest group moving to left. Select Value group 1, 2, 3, 4, or 5

Step 2 Select the chroma from your selected Value group, remove the middle tab (M) and spread the samples out like a fan Select one of the three shade samples to determine chroma.



Step 3 Determine the hue and Check whether the natural tooth is more yellowish or more reddish than the shade sample selected



c) VITA Linearguide 3D-MASTER SHADE GUIDE

The all-new VITA 3D-Master Linearguide enables the quick determination of precise tooth shades and uses the same scientific principles and 29 shades found in the popular VITA 3D-Master shade guide. The Linearguide features a sleeker, linear design that makes the process of precise shade determination even faster and easier. In two simple steps the final shade is achieved, first by selecting from five value tabs, then by choosing the proper mix of chroma and hue within the selected value range.

With the VITA Linearguide 3D-MASTER you can determine the correct tooth shade swiftly and accurately. The modern design and systematic structure of the VITA Linearguide enable the appropriate 3D-MASTER shade to be found quickly.

Shade taking in two steps:

Step 1: Remove the VITA Valueguide 3D-MASTER from the top of the Linearguide.

The correct degree of lightness can now be determined by removing the Valueguide. Make an initial choice using the Valueguide. In doing so, you determine the correct degree of lightness 0 to 5.

Step 2: Make a detailed choice within the determined degree of lightness from step 1 using the corresponding VITA Chroma/Hueguide.

Photography & shade matching

- Considered as an effective technique for shade matching
- Photography greatly simplifies the shade taking process, particularly for treatment in the aesthetic zone; providing the ceramist with a "palate" of shades rather than trying to match a single shade. (technicians need more information than just a single shade tab
- A shade tab with the shade that is closest to the shade of the tooth is placed next to the tooth in question and is photographed with the tooth.
- If needed, several photographs can be taken with different shade tabs.

2) Instrumental color analysis (Digital shade-scanning devices)

Digital devices are available that can be used to select the shade

- Tooth should be clean & free of debris
- Need to hold probe perpendicular to tooth
- There is variation in the color depending on where the probe is located
- Tip centered (1 – 2 mm from gingiva and incisal edge) or do 3 zones (gingival, middle, and incisal)

The advantages of a digital shade-matching system include objective readings and accuracy. There are two types of digital shade-matching devices commonly used in dentistry: the spectrophotometer and the colorimeter.

The spectrophotometer consistently and accurately measures natural tooth coloration in reference to any known specific color or can be based on any shading system. It measures the color characteristics of the natural tooth precisely and scientifically, indicating the deviations and gradations of value, chroma, and hue from a standard and provides all the information that is necessary to create an accurate restoration, or to modify an existing one such that it will accurately match the tooth. The spectrophotometer develops an accurate interpretation of the tooth shade on a given color system, which can then be related to an existing shade tab within dentistry or to a color that is interpolated between the shade tabs. In either case a lab technician

is given all the color clues to recreate a shade that is very natural in appearance and very close to the target coloration.

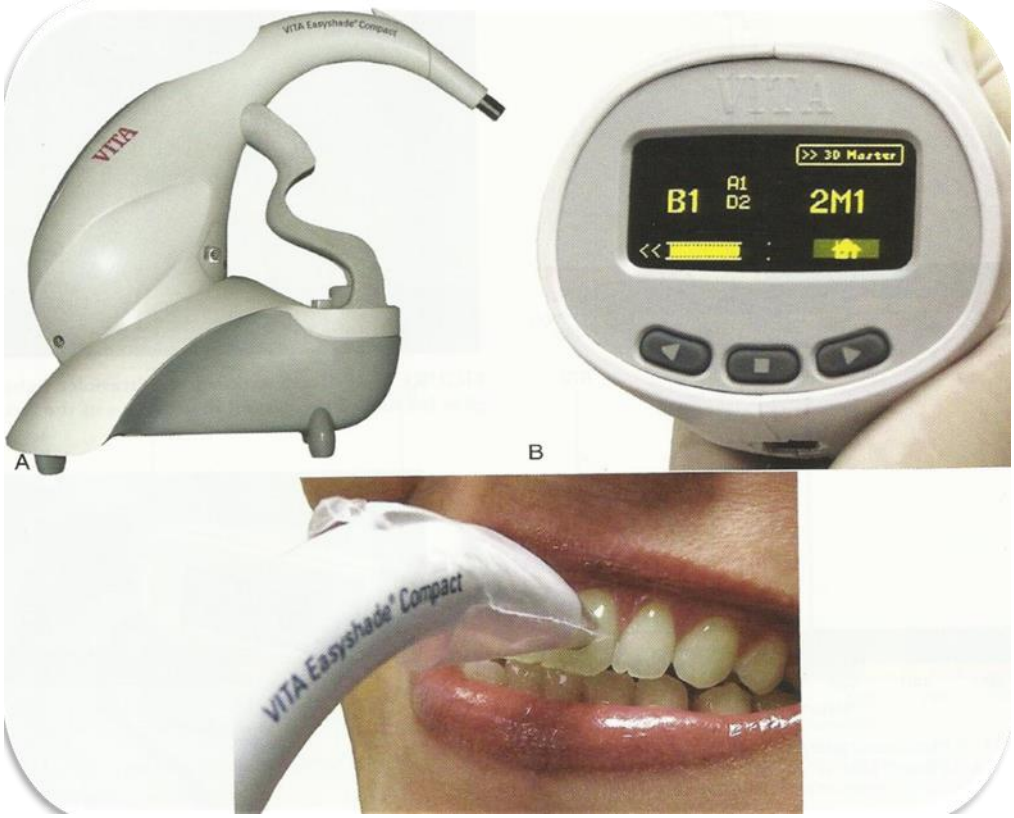
The colorimeter analyzes the tooth coloration based on preloaded data that is related to a shade system. It determines the shade tab that is closest to the actual color of the tooth. The colorimeter is typically less accurate than the spectrophotometer but may suffice in most dental situations.

Because both spectrophotometers and colorimeters tend to eliminate ambient light by standardizing the immediate environs of the target tooth, the shade can be taken in any operatory with any kind of lighting streaming in through the window. Digital shade taking therefore is far easier, far more practical, and far more accurate than shade taking using color tabs and the naked eye in a variable environment.

The current best approach to shade taking is the spectrophotometer. It provides the most accurate method for matching the coloration of the tooth. Some systems provide readings of translucence and reflectivity as well. Spectrophotometers provide consistent shade measurement regardless of the environment, lighting conditions, or other operatory variables including the dental team member who is conducting the shade-taking process. With some systems, a further comparative analysis can be undertaken on shade scans taken before and after treatment to provide the color difference between the two measurements. This is particularly useful for tooth-whitening procedures

An example of digital shade scanning devices

a) VITA EASYSHADE
b) VITA EASYSHADE COMPACT
c) MHT SPECTROSHADE SYSTEM



CYNOVAD SHADESCAN

The system is user friendly and is integrated with computed-aided design and manufacturing (CAD/CAM) technologies. The shade is measured by a handheld optical device from a single image of the whole tooth at the click of a button. The dentist can instantly obtain a shade map of the whole tooth with various established and popular shade systems.

Lecture: 10

Provisional Restorations

Between the time that the tooth is prepared and the final crown restoration is delivered, it is important that the patient should be comfortable and the tooth should be protected and stabilized with an adequate temporary restoration so Provisional (temporary) restoration in fixed prosthodontics can be defined as ;Crown or bridge restorations that are used in fixed prosthodontics during the interim between tooth preparation and final placement of definitive (permanent) crown or bridge restorations.

Why provisional restoration needed?

Provisional restoration is given for a period of time until a permanent arrangement can be made.

- To protect the prepared tooth and kept patient comfortable.
- By successful treatment with provisional restoration dentist can get the patient confidence which is an influencing factor for success in the final restoration.

Requirement of provisional restoration

A. Biological requirement

1. **Pulp Protection**: A provisional restoration must seal and insulate the prepared tooth surface from the oral environment to prevent sensitivity and further irritation to the pulp.
2. **Occlusal Compatibility and Tooth Position**: provisional restoration should establish or maintain proper contacts with adjacent and opposing teeth inadequate contacts allow over eruption and horizontal movement.
3. **Periodontal Health:** To facilitate plaque removal, a provisional restoration must have good marginal fit, proper contour and smooth surface.
4. **Prevention of Enamel Fracture:** provisional restoration should protect crown preparation margin. This is particularly true with partial-coverage designs in which the preparation margin is close to the occlusal surface of the tooth and could be damaged during chewing.

B. Mechanical Requirements

1. **Function:** The greatest stresses in a provisional restoration are likely to occur during chewing. Internal stresses will be similar to these in the definitive restoration. Fracture is not problem with complete crown due to adequately tooth reduction.
2. **Removal for reuse:** Provisional restorations often need to be reused and therefore should not be damaged when removed from teeth.

C. Esthetic Requirements

The appearance of a provisional restoration is particularly important for incisors, canines, and sometimes premolars.

❑ IDEAL REQUIRMENTS OF PROVISIONAL RETORATIVE MATERIAL

1. Adequate strength and wear resistance.
2. Biocompatible.
3. Good dimensional stability.
4. Easy to contour and polish.
5. Odourless and non-irritating.
6. Chemically compatible with luting cement.
7. Aesthetically acceptable.
8. Adequate working and setting time.
9. Easy to repair.

CLASSIFICATION

- ❖ <u>According to method of fabrication:</u>
  - ➢ Preformed
  - ➢ Custom made
- ❖ <u>According to material used:</u>
- ➢ Resin:
  - ✓ Preformed (Polycarbonate, Cellulose acetate)
  - ✓ Custom made (Acrylics, Bis-acryl composites)
- ➢ Metals:
  - ✓ Preformed (Aluminium, Tin silver, Nickel chromium)
  - ✓ Custom made (Cast metal alloy)
- ❖ <u>According to duration of use:</u>
  - ➢ Short term.
  - ➢ Long term.
- ❖ <u>According to technique of fabrication:</u>
  - ➢ Direct technique.
  - ➢ Indirect technique.

1. **Preformed Temporary Crowns.**

Generally, they consist of a shell of plastic or metal and may be cemented directly on the prepared tooth following adjustments or after lining them with of a resin material. They are indicated for single or multiple preparations. These include:

A- Metal temporary crowns:

Metal crowns are mainly used for posterior teeth. They are made of stainless steel, nickel chromium or aluminum. The most commonly used metal temporary crown is **aluminum temporary crown**, which is of two types;

1-Non Anatomical or Flat topped cylindrical AL. temporary crown.

2- Morphological or Anatomical AL. temporary crown.

B- Plastic Temporary Crowns:

They are mostly used for anterior teeth, the clinical procedure for their use is nearly the same as that for the metal T.C.

Types of Plastic temporary crowns:

1-Polycarbonate Temporary Crowns: made from polycarbonate plastic combined with micro-glass fibers, they are available for anterior and posterior teeth.

2-Acrylic Temporary Crowns: made from acrylic resin (tooth colored) & they are available in different sizes and colors, they used for anterior teeth.

In case we need to improve the fitness of the temporary crown or if there is no size which approximately fit the prepared tooth, we can reline the temporary crown with resin material to improve its fitness after selection of the most suitable size and shade of the crown and cutting its margin according to the finishing line. The procedure of relining could be done either directly on the prepared tooth in a similar manner to that of celluloid temporary crown or could be done indirectly on study cast of prepared tooth.

3-Celluloid Crown forms:

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

2. **Customized temporary crown and bridge:**

The fabrication of customized temporary crowns involves the construction of a mold or a matrix of the patient' teeth before they have been prepared, it may be obtained certain materials (such as elastic impression material), into which we place polymer resin material **(acrylic or composite)** which is held directly on the prepared tooth or teeth or indirectly against a model of prepared teeth.

Most Commonly Used Matrices (Mold) Material for Provisional Restorations are:

- **Impressions:**
  - Alginate: absorbs resin exotherm
  - Elastomers: reusable

  Advantages: simple, quick, inexpensive.
- **Vacuum formed thermoplastic:**
  - Clear vinyl sheet on stone duplicate of the wax up.
  - Used only in presence of number of adjacent locating teeth
  - Could be used with light cured resins.
- **Proprietary celluloid crown form**

MATERIALS USED FOR CONSTUCTION OF CUSTOMIZED PROVSIONAL RESTORATIONS:

1. **Acrylics**

- **Polymethyl Methacrylate's:**

Advantages:

low cost, good wear resistance, good esthetics, high polishability, good color stability.

Disadvantages:

significant amount of heat given off by exothermic reaction, high degree of shrinkage (about 8%), strong, objectionable odor, short working time, hard to repair, must be mixed, radiolucent.

- ***Poly-R' Methacrylate's (R' = ethyl, vinyl, isobutyl):***

Advantages:

Low cost, less heat given off during reaction than polymethyl methacrylates, less shrinkage than polymethylmethacrylates, extended working time.

Disadvantages:

Less esthetic than others, poor wear resistance, poor color stability, strong, objectionable odor, hard to repair, must be mixed, radiolucent.

2. **Bis-Acryl Composites:**

Advantages:

Less shrinkage than acrylics, minimal heat generated during setting reaction, relatively high strength, minimal odor, excellent esthetics, most products use automix delivery, can be repaired or characterized using resin composite, easy to trim, good color stability, radiopaque.

Disadvantages:

Greater cost than acrylics, some do not have a rubbery stage, viscosity cannot be altered, sticky surface layer present after polymerization, may be more brittle than acrylics.

3. **Epimines** (resin material)

Advantages

low exothermic heat reaction during polymerization, low residual monomer content and low volumetric shrinkage.

Disadvantages

-could not be altered or repaired.

-weak (low degree of hardness).

Provisional restoration might need some time to be reinforce, ethylene fiber or glass fiber or metal casting can be used to increase their strength. The indication for such reinforcement are the following:

1) Long poster span fixed partial denture long duration provisional restoration

2) Excessive occlusal force on the restoration

3) History of frequent breakage

4) masticatory muscles strength above average

Methods of construction of customized temporary crowns and bridge:

According to the type of material used for mold or matrix construction we have the following method:

1) Impression method.

2) Template method.

3) Polycarbonate matrix method.

4) Acrylic shell method.

TECHNIQUES FOR FABRICATION OF CUSTOMIZED PROVISIONAL RESTORATION

1) DIRECT TECHNIQUE
2) INDIRECT TECHNIQUE
3) DIRECT-INDIRECT TECHNIQUE

The most commonly used method is the **impression method.**

- **Alginate:** absorbs resin exotherm
- **Elastomers:** reusable

Advantages: simple, quick, inexpensive.

1) Clinical procedure for DIRECT TECHNIQUE

1- A preoperative over impression with alginate or silicon rubber base is made from the patient mouth or study model & carefully stored until complete teeth preparation (in case if you want to construct temporary bridge fill the missing tooth area with acrylic denture teeth and remove it after you complete preoperative over impression).

2- Complete the preparation of the teeth& Coat the prepared tooth with separation medium (saliva or Vaseline).

3- Mix tooth colored acrylic resin, the mixed acrylic is then place in the over impression at the area of the prepared tooth only. Seat over impression in it position over the dental arch

4- Remove the over impression from patient mouth and separate acrylic restoration from the prepared teeth before acrylic completely polymerized, otherwise, it cannot remove due to shrinkage of acrylic also to reduce the effect of heat of polymerization of acrylic on the prepared tooth (polymerization reaction of acrylic is exothermic reaction), leave the restoration a side until complete setting

5- Trim any excess material from the formed crown, the crown is then seated on the prepared tooth to check and adjust the occlusion, the crown is then smoothened.

6- Cement T.C. on the prepared tooth using temporary cement.

2) Clinical procedure for INDIRECT TECHNIQUE

1- A preoperative **over impression** with alginate or silicon rubber base is made from the patient mouth or study model & carefully stored until complete teeth preparation

2- Complete the preparation of the teeth. An alginate impression is then taken and pour with a fast setting plaster or stone, wait till stone is set, the cast were then separate from the impression

3- Coat the prepared tooth (on the cast) with separation medium (petroleum gully).

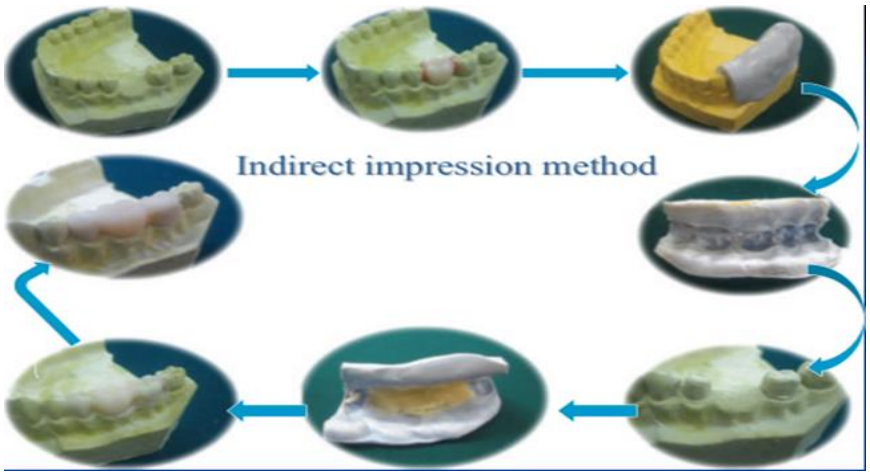
4- Mix tooth colored acrylic resin, mixed acrylic were then place in the **over impression** at the area of the prepared tooth only.

5- Seat the cast onto the over impression in upright position and maintain pressure (rubber band can be used for this respect) until acrylic is set completely, be sure that the cast correctly seat into the over impression.

6- After complete polymerization, separate the cast from the over impression , the formed crown were then removed from the prepared tooth(from the cast).

7- Trim any excess material from the formed crown, the crown were then seat on the prepared tooth , check and adjust occlusal, the crown were then smoothen

8- Cement T.C. on the prepared tooth using ZOE cement.



3) Clinical procedure for DIRECT-INDIRECT TECHNIQUE:

1. A preoperative over impression with alginate or silicon rubber base is made for the study model (fill the missing tooth area with acrylic denture teeth prior to impression taken)
2. Remove the acrylic tooth from the cast and start preparation of the abutment(s) on the diagnostic cast (more conservative than an actual preparation)
3. Mix tooth colored acrylic resin, mixed acrylic were then place in the over impression at the area of the prepared tooth and denture tooth only.
4. Seat the cast onto the over impression in upright position and maintain pressure (rubber band can be used for this respect) until acrylic is set completely, be sure that the cast is correctly seated in the over impression.
5. After complete polymerization, finish restoration
6. After complete the preparation of teeth in patient mouth, try and relined the preformed restoration, finally Cement T.C. on the prepared tooth

Advantages of indirect over direct technique:

1) There is no direct contact of free monomers with the prepared teeth or gingival tissue which might cause tissue damage or allergic reactions.
2) The procedure avoids subjecting a prepared tooth to the heat of polymerization of resin (acrylic exothermic polymerization reaction).
3) The marginal fitness of temporary restoration is significantly better (stone restricts resin polymerization shrinkage).
4) Save the clinician chair time.

Vacuum thermoplastic method (Vacuum-Formed Template):

- Stone models of both arches are used prior to mouth prep.
- used only in presence of number of adjacent locating teeth
- Constructed with the aid of a thermal vacuum machine that adapts a plastic sheet **(clear vinyl sheet)** over the entire stone cast
- Plastic sheet is trimmed around the teeth to be prepared
- Could be used with light cured resins.

Clinical procedure:

Prior to tooth preparation make a study model from alginate impression. In this technique, in state of using over impression as a mold or matrix for construction temporary restoration, we construct a plastic matrix (to be used later as a mold) from the study model using clear plastic vacuum made matrix (translucent coping material or transparent splint material that come as sheet 5 x 5 inch dimension & 0.025 inch thickness). By the aid of Thermal Vacuum forming machine, a sheet of clear plastic vacuum made template (matrix or mold) is adapt over the diagnostic cast covering the whole dental arch. In order that fits comfortably inside the patient mouth, after teeth preparation, cut any excess from plastic matrix that might interfere with accurate seating of template (matrix). If too much of matrix is removed it well makes the final placement of crown in the patient mouth

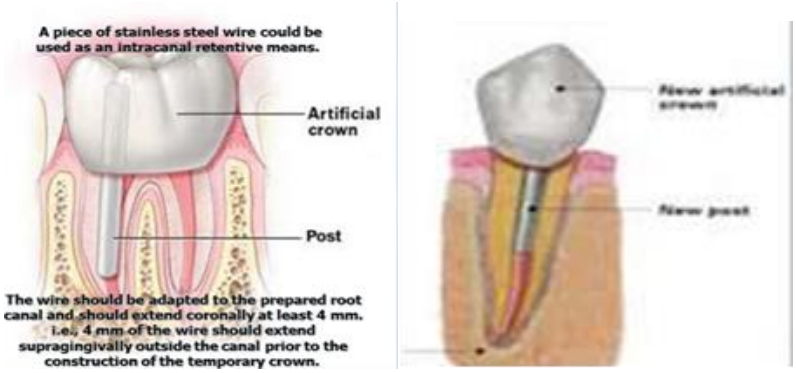
more difficult. **Quadrant matrix is the most comfortable.** Then follow the same steps discus in impression method

Direct versus Indirect

- Direct is faster for routine provisional restorations
- Indirect can save time with multiple units or complex fixed partial dentures
- Indirect Provisionals can be fabricated in advance of the tooth preparation appointment

Temporary restoration for tooth prepared to receive post crown

It is often difficult to fabricate T.C. for a tooth that has been prepared for post crown because there is so little of tooth structure left standing supragingivally that cannot give support to the temporary crown, so in such a case we need intra canal retentive mean to give retention for the T.C. A piece of stainless steel wire can be used intra canal retentive mean, it should be place and adapted to the prepared canal (the wire should extend coronally so that we will have at least 4mm. of the wire extend supragingivally outside the canal) prior to construction of the temporary crown. After that you can construct the T.C. in the normal way, as a result at the end the wire will be a part within the formed temporary crown.



Laboratory-made temporary restoration

We take a preoperative alginate impression and in lab do preparation on the cast after pouring and setting of stone and a temporary crown or bridges is done.

Digital interim fixed prosthesis

(CAD/CAM) production of restorations, definitive restorations can be fabricated the same day as tooth preparation, and interim crowns are not necessary. However, not all clinical situations are amenable to treatment with same-day CAD/CAM restorations, necessitating the use of interim restorations. Such situations include the need for large reconstructions, evaluating the effects of changes in occlusion in the presence of a temporomandibular -disorder, a planned change in occlusal vertical dimension, and the period of healing of pontic or implant site. In these situations, interim restoration can be extremely helpful. The patient can evaluate comfort, function, and appearance before the fabrication of the definitive restorations.

Interim restorations can be fabricated by means of a digital workflow.

The Tissue surface form (TSF) consists of three-dimensional virtual image of the prepared tooth.

The External surface from (ESF) consists of one of the following:

- **a three-dimensional virtual image of the intended tooth before preparation,**
- **a scan of a preoperative diagnostic waxing,**
- **a virtual shape proposal generated by computer**

The digital information is sent to a milling machine at the time of tooth preparation and the TSF and ESF are milled from solid blocks/disks of resin. Thus there is no need to have analog representations of the TSF and ESF or to then fill a mold cavity with material Resins available

Materials use for milling interim restorations include PMMA and composite.

The CAD/CAM process reduces the patient's exposure to chemicals dramatically, inasmuch as the commercially produced blanks from which interim restorations are milled contain only approximately 1% residual-free monomer. Therefore, the digital method of fabricating an interim crown is an entirely indirect method. The CAD/CAM interim restorations have been shown to be stronger and more accurate than traditional bis-acryl composite prostheses.

Another advantage of the digital production of interim restorations is that the data file can be used to mill the definitive restoration, if the tooth preparations (and tissue contours) have not been altered.

Advantages:

1. Efficient.
2. No laboratory work needed.
3. Easy on tissues.
4. Lowest residual monomer.
5. Generally more wear resistant.

6. No air-inhibited layer.
7. No polymerization shrinkage; some can be bonded to tooth structure.
8. Definitive restoration can be milled as an exact duplicate of interim.

Disadvantages:

1. Digital impression and in-office mill needed
2. Some blanks are monocolor.

CEMENTATION OF PROVISIONAL RESTORATION

- ***IDEAL PROPERTIES OF CEMENT***:
  - Ability to seal against leakage of oral fluid.
  - Strength consist with intentional removal.
  - Low solubility.
  - Chemical compatibility with provisional polymer.
  - Ease of eliminating excess.
  - Adequate working time and short setting time.
- **CEMENTS USED:**
  1) Zinc oxide eugenol.
  2) Reinforced zinc oxide eugenol: The liquid can be ethoxy benzoic acid, known as ZOEBA, making it stronger.
  3) Non- eugenol cements, do not soften resin (as in provisional restorations), they use carboxylic acids in place of eugenol.
  4) TempBond Clear is a translucent cement with Triclosan (an antibacterial & antifungal agent)

- Zinc oxide eugenol cement is the most commonly used cementing medium for T.C and bridge. This cement promote healing and allow easy removal of the temporary restoration Zinc phosphate, Zinc polycarboxylate, and Glass ionomer cements are not used because their comparatively high strength makes intentional removal difficult.

LIMITATIONS OF PROVISIONAL RESTORATION

- Lack of adequate strength—fracture of provisional is possible in long span FPDs, patient with bruxism and reduced inter-occlusal clearance.
- Inadequate marginal adaptation.
- Poor aesthetic in long term provisional restoration.
- Plaque accumulation due to poor surface characteristic.
- Compromised bonding characteristics.
- Mild to moderate tissue irritation

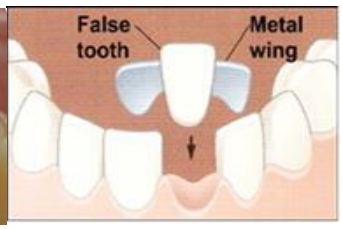
Crown and bridge Prosthodontics

Lecture 12

Adhesive bridge (Resin bonded bridge, acid etched bridge)

Fixed dental prosthesis that is luted to the unprepared or minimum preparation surface of abutment teeth permanently by acid etching of enamel with some type of resin bonding agent.

- It is alternative for the conventional bridge.
- It is involve attaching the pontic via a metal plate to the unprepared lingual surface of the abutment teeth.
- The attachment to the abutment is made by composite resin material after acid etch of the enamel.
- It is the most conservative methods.
- It is used when the abutment teeth have sufficient intact enamel, & usually used in younger patient.

Indications:

1) *Adolescents with single missing teeth (traumatic or congenital).*
2) *Caries- free abutment teeth and good oral hygiene.*
3) *Maxillary incisor replacements (most favorable prognosis) and Mandibular incisor replacements.*
4) *Periodontal splints.*
5) *Post orthodontic fixed retention*
6) *Short span edentulous areas(Single posterior tooth replacements).*

Contra Indications:

1) Small sized abutments – Peg Laterals
2) Extensive caries.
3) Heavily restored abutments.
4) Deep vertical overbite.
5) Mal-aligned abutments
6) Parafunctional habits
7) Long span edentulous area
8) Allergy to base metal alloys

Advantages:

1) *Conservative.*
2) *Saving clinical chairs time.*
3) *Not expensive.*
4) *Lab procedure is easy & short.*
5) *It can be re-cemented if failure occurs.*
6) *Good appearance.*

Disadvantages:

1) *Not strong as conventional bridge.*
2) *Limited use because abutment teeth should have sufficient enamel for etching.*
3) *Tendency to de-bond.*
4) *Increase thickness of tooth surface by the metal plate.*

Types:

1. **Direct:**

This type is made by using the crown of patient own tooth as a pontic, for example rapid replacement of a tooth that lost by traumatic injury. In order to increase the strength of the bridge (attachment) we add metal mesh or wire (temporary replacement).

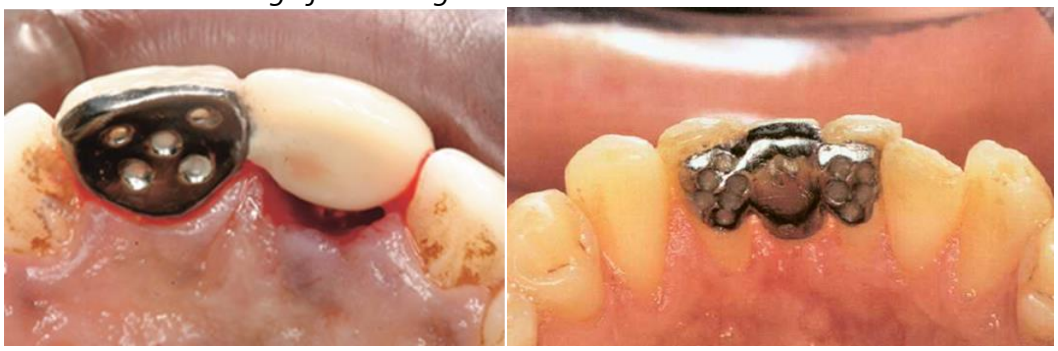
2. **Indirect adhesive bridge:**

According to the mean or way of retention of the metal frame work to the abutment teeth we have different types:

a) *Macro mechanical retention (Rochette).*
b) *Medium mechanical retention (Virginia).*
c) *Micro mechanical retentive (Maryland).*
d) *Chemically retention (Panavia).*

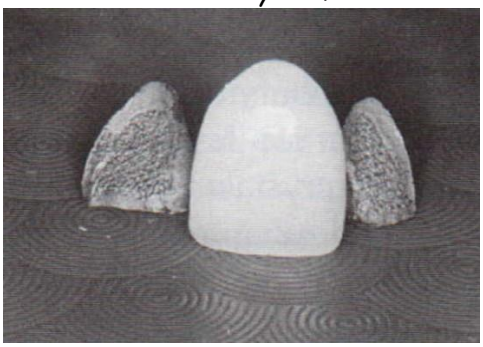
a. Macro mechanical retention (Rochette) :

In this types there is multiple funnel shaped undercut perforations in the cast metal frame of the retainer is used for retention & through which composite flow during cementation and make mechanical interlocking after setting



b. Medium mechanical retention (Virginia):

Retentive feature cast as a part of the metal frame work (non undercut lumps, mesh, on the fit surface of the retainer). The size of the retentive feature is intermediate between macro mechanical & micro mechanical retentive system



c. Micro mechanical retentive (Maryland):

In state of perforations, the tooth side of the frame work is electrolytically etched, with hydrofluoric acid , which produce a microscopic undercuts, the bridge attached with a resin luting agent that lock into the microscopic undercut of both the etched retainer & etched enamel.

d. Chemically retention (Panavia):

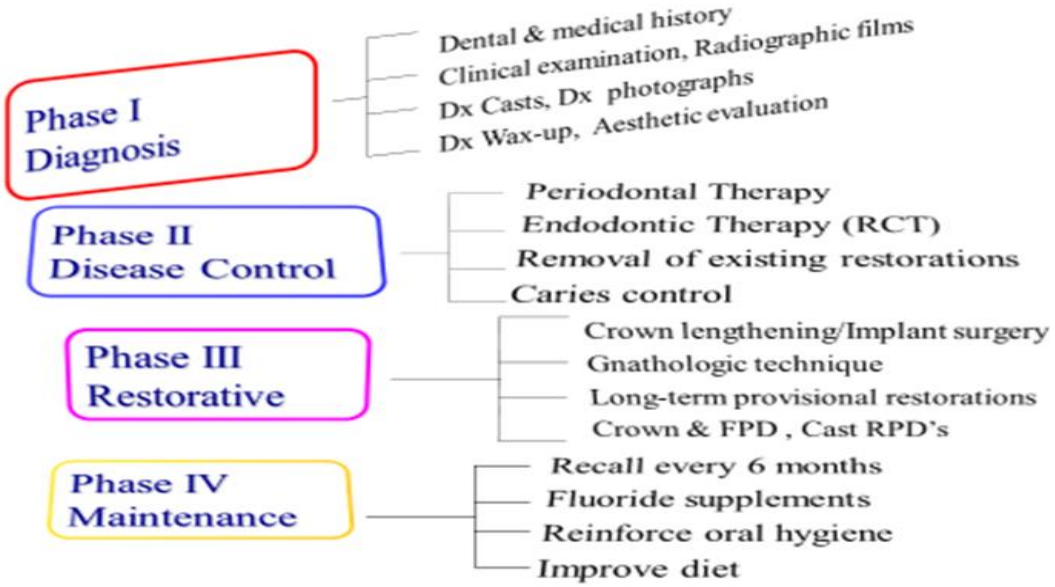
The resin adheres chemically to recently sand-blasted metal surface and is retained on the tooth by conventional acid etching of the enamel.

DIAGNOSIS AND TREATMENT PLANNING IN FIXED PROSTHODONTICS

Successful management of cases begin with a thorough assessment of the patient's physical and psychological condition and determining a treatment that will satisfy the realistic expectations of the patient

- **Diagnosis**
  - The determination of the nature of a disease.
- **Treatment plan**
  - The sequence of procedures planned for the treatment of a patient after diagnosis

Treatment Plan by Phases



FIVE ELEMENTS OF DIAGNOSIS

- **HISTORY**
- **Clinical examination**
  - **TMJ & EXTRAORAL EVALUATION**
  - **INTRA ORAL EXAMINATION**
- **DIAGNOSTIC CASTS**
- **RADIOGRAPHIC EXAMINATION**
- **Dx photographs, Dx Wax-up, Aesthetic evaluation**

DATA COLLECTION

1) Personal information
2) Dental History
3) Medical History

CHIEF COMPLAINT

The accuracy and significance of the patient's primary reason or reasons for seeking treatment should be analyzed first

FOUR CATEGORIES of chief complaint

- ***COMFORT*** (pain, sensitivity, swelling)
- ***FUNCTION*** (Difficulty in mastication or speech)
- ***SOCIAL*** (Bad taste or odor)
- ***APPEAREANCE*** (Fractured or unattractive teeth or restorations , discoloration)

CLINICAL EXAMINATION

consist of the clinician's use of sight, touch, and hearing to detect conditions outside the normal range.

General appearance:

- *Gait and weight are assessed.*
- *Skin color : Anemia or jaundice.*
- *Vital signs: Respiration, pulse, temperature and blood pressure are measured and recorded.*

EXTRAORAL EXAMINATION

- *FACIAL ASYMMETRY*
- *CERVICAL LYMPHNODES*
- *TMJ*
- *MUSCLS OF MASTICATION (palpated*

DIAGNOSTIC AIDS

- *RADIOGRAPHS*
- *VITALITY TEST*
- *DIAGNOSTIC CASTS*
- *PERIODONTAL PROBE*

Pulpal health must be measured before restorative treatment to

- *PERCUSSION and*
- *THERMAL STIMULATION*
- *VITALITY TESTS*

RADIOGRAPHIC EXAMINATION;

The radiograph should be examined carefully for *caries , presence of P.A lesion , the quality of the previous endodontic treatment , alveolar bone level, crown-root ratio , root configuration ,direction of root, Number can be examined ,also the presence of retained root in edentulous areas should be recorded*

Summary of supplement information, to clinical information, provides by radiographic examination, during this diagnosis phase, are

- *Extent of bone support*
- *Root morphology*
- *Peri apical pathology*

PANOROMIC RADIOGRAPHS

- *Presence or absence of teeth*
- *Assessing third molars impactions,*
- *Evaluating the bone before implant placement.*
- *Screening edentulous arches for buried root tips*.

Diagnostic Casts Examination;

They should be mounted on a semi adjustable articulator

Advantages;

1) *Allow an un obstructed view of the edentulous space*
2) *Allow accurate assessment of the span length and the curvature of the ridge or arch in the edentulous region*
3) *The shape and length of the abutment teeth can be measured to determine which preparation design will provide adequate retention and resistance.*
4) *Evaluate path of insertion (axial inclination of abutment) to determine the need for any modification.*

5) *No., size and location of wear can be evaluated.*
6) *Over erupted teeth can be easily spotted and the amount of correction needed can be determine.*
7) *Evaluate occlusion and Interocclusal space necessary to re-establish a proper occlusal plane.*
8) *Evaluate the need for any occlusal correction.*
9) *Used for diagnostic wax-up.*
10) *Construction of special try and provisional restoration.*

Diagnostic photographs

Even with radiographs, charting and mounted models, there is much diagnostic information to be gained by including photography to comprehensive treatment planning. It allows the practitioner to show the patient the photographs immediately, to co-diagnose, and to Patients understand their needs and complications much better when they can see a picture of their own pathology work with the patient chairside while showing his problem and discus the treatment.

What is an Ideal Treatment plan?

Treatment plan that achieves the best possible long-term outcomes for the patient, while addressing all patient concerns and active problems, with the minimum necessary intervention.

MOUTH PREPARATION

Mouth preparation refers to the dental procedure that need to be accomplished before fixed prosthodontics can be properly undertaken As a general plan , the following sequence of treatment procedures in advance of fixed prosthodontic should be adhered to;

1) Relief of symptoms (chief complaint)
2) Removal of etiological factors (eg; excavation of caries removal of deposits)
3) Repair of damage .
4) Maintenance of dental health.

The following list describes the sequence in the treatment of a patient with extensive dental disease including missing teeth , retained roots , caries and defective restorations.

- *Preliminary assessment*
- *Emergency treatment of presenting symptoms*
- *Oral surgery*
- *caries control and replacement of existing restorations*
- *Definitive periodontal treatment*
- *Orthodontic treatment*
- *Definitive occlusal treatment*
- *Fixed prosthodontics*
- *Removable prosthodontics*
- *Follow up care .*

SELECTION OF THE TYPE OF THE POSTHESIS

FACTORS CONSIDERED

- BIOMECHANICAL
- PERIODONTAL
- ESTHETIC
- FINANCIAL and PATIENTS WISHES.

Selection should not be less than optimum just because the patient cannot.
Sound alternative to the preferred treatment plan and not apply pressure.

SELECTION OF THE TYPE OF THE POSTHESIS

- **CONVENTIONAL TOOTH SUPPORTED FIXED PARTIAL DENTURE**
    1) *Abutment teeth are periodontally sound.*
    2) *Edentulous span is short and straight.*
    3) *Expected to provide a longlife of function for the patient.*
    4) *No gross soft tissue defect in the edentulous ridge.*
    5) *Reserved for patients who are both highly motivated and able to afford*
- ***RESIN BONDED TOOTH SUPPORTED FIXED PARTIAL DENTURE***
    1) *Defect free abutments where single missing tooth.*
    2) *A single molar (muscles are not well developed).*
    3) *Mesial and distal abutment are present.*
    4) *Moderate resorption and no gross soft tissue defects on edentulous ridges.*
    5) *Younger patients whose immature teeth with large pulps are poor risks for endodontic free abutment preparation.*
    6) *Tilted tooth can be accommodated only if there enough tooth structure to allow a change in the normal alignment of axial reduction.*
    7) *Periodontal splints*
- ***Removable partial denture abutment***
    1) *Edentulous spaces greater than two posterior teeth.*
    2) *Anterior space greater than four lncisors.*
    3) *Edentulous space with no distal abutment.*
    4) *Multiple edentulous spaces.*
    5) *Tipped teeth adjoining edentulous spaces and prospective abutments with divergent alignment*
- ***IMPLANT SUPPORTED FIXED PARTIAL DENTURE***
    1) *Insufficient number of abutments.*
    2) *Partial attitude and or a combination of intra oral factors make a removable partial denture or FPD a poor choice.*
    3) *No distal abutment.*
    4) *Alveolar bone with satisfactory density and thickness in a broad, flat ridges.*
    5) *Configuration that permit implant placement.*
    6) *Single tooth where defect free adjacent teeth.*
    7) *A span length of two or six teeth can be replaced by multiple implants.*
    8) *Pier in an edentulous span (three or more teeth long).*

It is not uncommon to combine two types in the same arch.

In cases where the choice between a fixed partial denture and a removable partial denture is not clear cut, two or more treatment options should be presented to the patients along with their advantages and disadvantages

The prosthodontist is the best person to evaluate the physical and biological factors present , while the patients feelings should carry considerable weight on matters of esthetics & finances ***NO PROSTHETIC TREATMENT ????!!!!!!!!!!!!!!***

1) *Long standing edentulous space into which there has been little or no drifting or elongation of the adjacent teeth.*
2) *If the patients perceives no functional, occlusal or esthetic impairment.*

FIXED PARTIAL DENTURES:

FPD is indicated where one or more teeth are missing or require removal. In this condition, these teeth are replaced by pontics that are designed to fulfill the functional and esthetic requirements of missing teeth. Pontics are connected to retainers, which are restorations on prepared abutment teeth. If FPD is designed in such a way that the forces are directed along the long axis of the teeth, the success rate of FPD is higher. The success of such FPD is further enhanced in patients maintaining oral hygiene.

REPLACEMENT OF SINGLE MISSING TEETH:

A single missing teeth can be replaced by a three unit FPD having one mesial and one distal abutment tooth. FPDs in which only one side of pontic is attached to a retainer are referred to as cantilevered. The long term prognosis of a single abutment cantilever is poor. Forces are best tolerated by periodontal supporting structures when directed in the long axis of the teeth. In such cases, a three unit FPD is used. A cantilever will induce lateral forces on the supporting tissues, which may harm & lead to tipping, rotation of the abutment. Clinical experience with resin retained FPDs have suggested that cantilever designs may be preferred, especially since readhesion after failure is greatly facilitated & often leads to predictable long term success. Cantilevers with implant supported prosthesis may be used successfully.

REPLACEMENT OF SEVERAL MISSING TEETH

To ensure a successful result, the prosthesis is planned by waxing the intended restorations on articulated diagnostic casts. This step is required for complex fixed prosthodontic treatments involving corrections of an irregular occlusal plane, alteration of the vertical dimension of occlusion, therefore implant supported prostheses is suggested in such cases.

REPLACING MULTIPLE ANTERIOR TEETH

Special considerations in this situation include problems associated with esthetics & requirement to resist tipping forces directed laterally. When maxillary incisors are being replaced ***forces directed against a maxillary incisors pontic will tend to tip the abutment teeth due to curvature of the arch (specially in cases of taper anterior arch curvature)****. Tipping forces must be resisted by means of two abutment teeth at each end of long span anterior FPD. Thus, when replacing four maxillary incisors, the clinician should generally use canines & first premolars as abutment teeth. The four mandibular incisors can usually be replaced by FPD with retainers on each canine. It is not usually necessary to include first premolars.*

REPLACING MULTIPLE POSTERIOR TEETH

When replacing multiple posterior teeth, it is advantageous to restore the posterior segments at the same time as this leads to the development of an efficient occlusal scheme. Treatment of all four posterior segments together might lead to complications and difficulties for the patient as well as the dentist. It is preferable to complete treatment of one side before starting treatment on the other side.

Lecture: 12

Clinical Try-In & Cementation

Clinical Try-In & Adjustment

After the lab. procedure has been completed, the crown restoration is now ready to be tried in (checked on the prepared tooth inside patient mouth) prior to final finishing & cementation. Try-in procedure involves three stages: firstly, pre-operative evaluation of crown or fixed bridge on its die, secondly seating on the tooth and finally evaluation of the seated restoration.

- **With or Without Anesthesia?**

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

Pre-operative evaluation of crown or bridge on its die

It is always worth checking the fit of the crown on the cast before trying it in the patient. In this way problems involving marginal fit, aesthetics and articulation can be anticipated prior to try in.

- Checking of the crown on the cast before trying it in the patient.
- Preferable with a good light and under magnification
- The restoration should have seated on the die without any pressure

Prior to Try in procedure, the inner surface of the restoration is inspected for:

- Nodules, bubbles might interfere with seating of the restoration on the die should be removed using a small round bur
- No contact should exist between the die and the internal surface of the restoration.
- A uniform space is necessary for the luting agent to spread evenly. Any contact(s) must be identified and relieved by selective grinding of the internal surface.

Seating The Restoration on the prepared tooth o(teeth)

1. Remove temporary restoration and clean the prepared tooth from any remnant of cement because it will interfere with seating of restoration. Instruments use to remove temporary restoration;

a. Backhaus towel clamp or
b. GC Pliers

2. Seat the restoration on the prepared tooth with pressure.

Evaluation Sequence of the seated crown

1. Proximal contacts
2. Marginal integrity
3. Retention & Stability
4. Occlusion
5. Polishing or Characterization and glazing

1. Proximal contacts

- ▶ The location, size, and tightness of a restoration's proximal contacts should resemble those of the natural teeth.
- ▶ Excessive contact prevents the complete seating of the restoration and cause marginal discrepancy
- ▶ Open contact lead to food impaction
- ▶ The use of unwaxed floss is a method to compare the contacts with others in the dentition
- ▶ The use of 0.05 mm shim stock (thin Mylar film) is probably a more reliable indicator of proximal contact.
- ▶ Satin finish helps to identify Excessive tightness in metal restoration, Shiny spot will appear where binding occurs Shiny spot will appear, where adjustment is necessary.

How to Examine the inter proximal contact area?

It should be tight as the other in the mouth. Dental floss is used to check the interproximal contact by passing it between the restoration and the adjacent natural teeth, it should have slight resistance otherwise we have either;

a) **Heavy resistance**: the dental floss can't pass through the contact, this indicate that the contact is heavy and it must be reduced.

b) **No resistance**: if the floss passes easily, it indicates that the contact area is under contoured (deficient contact).

How to correct

- ▶ A metal crown or retainer with a deficient proximal contact can usually either you have to repeat the restoration or to correct this defect by adding solder to that area.
- ▶ Porcelain restoration
- ❖ The area of contact can be identified with red pencil or thin marking tape.
- ❖ A tight proximal contact in unglazed porcelain is easily adjusted with a cylindrical stone.
- ❖ If adjustment of a glazed restoration is needed, it can be done with diamond-impregnated silicone points or diamond polishing paste

- ❖ A deficient proximal contact correct by adding porcelain (lab)

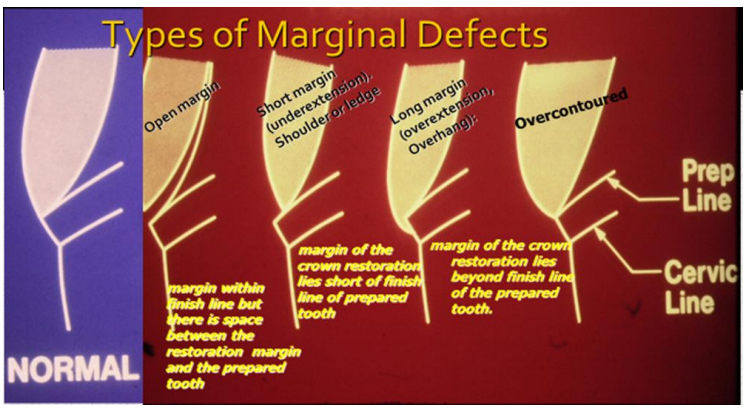
If the contact area is perfect and the crown is not seat completely this might mean that, there is interference from inside (metal bubbles or undercut) we use pressure indicating paste (special elastomeric detection pastes such as silicon wash) or spray to identify the interferences. We place it into the inner surface of the crown restoration, the crown is then seated on the prepared tooth with pressure, the restoration is then removed and inspected for any pressure (shiny) area which indicates an interference area that should relieved. Repeat this procedure till you achieve complete seating, if it fails refabricate the restoration.

2. Evaluating Complete Seating

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

Types of Marginal Defects

1. Short margin (under extension, Shoulder or ledge);
   Margin of the crown restoration lies short of finish line of prepared tooth
2. Long margin (overextension, Overhang);
   Margin of the crown restoration lies beyond finish line of the prepared tooth.
3. Open margin;
   Margin within finish line but there is space between the restoration margin and the prepared tooth
4. Overcontoured; Margin within finish line but the contour of gingival third show excessive bulk.



Poor fitting margins will lead to:

- ▶ Cement dissolution
- ▶ Plaque retention and affect the health of gingiva
- ▶ Recurrent caries

How to check?

To check the marginal integrity of the crown restoration

- **Visual**

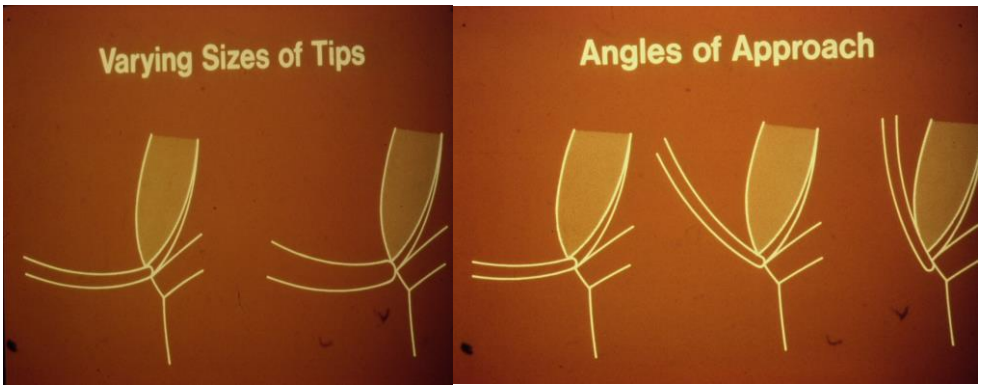
  This indicate especially for the supra gingival margin or margin that have easy access to evaluate by the operator eyes that might be:

  - Direct or indirect visual (mirror)
  - Use of Magnification apparatus such as eye loops or microscop.

- **Radiographic**
  - Use to detect Interproximal margins that cannot seen by eye
  - Angle of beam (parallel technique to detect interproximal margin)

- **Explorer**
  - Size of tip
  - Angle of approach

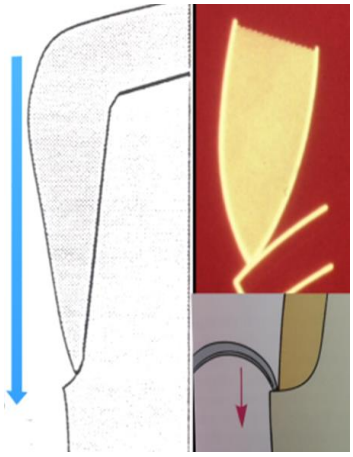
Probe can be used to check the marginal integrity of the crown restoration, especially subgingival margin, varying tip size probes should be used. Varying approaching angle should be applied during checking with probe.



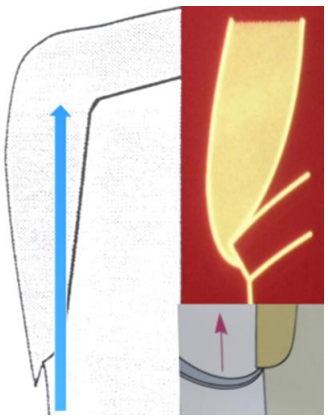
To check the marginal integrity of the crown restoration, sharp pointed probe (varying tip size) should be move in a two direction (varying approaching angle) , the direction of the movement and the angle of approach during checking with probe is very important .

How to check?

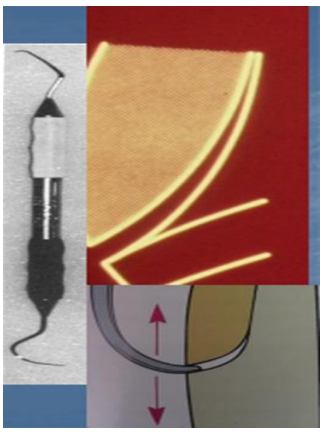
1) Move the probe from the restoration toward tooth surface, if it passed smoothly without any interpretation the margin is OKY however if there is any interpretation during this movement--- this indicate under extended margin.



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



3) If the probe passes smoothly in the two direction this mean the margin extension is correct.



4) if there is space between the restoration and tooth surface at area of f.l & probe can go in, this indicates an open margin.

3. Retention and stability

- The restoration should then be assessed for Stability on the prepared tooth. And it should not rock or rotate when force is applied. If instability is due to a small positive nodule it can usually be corrected, however. If instability due to distortion, remade will be necessary

4. Occlusion

- ▶ After complete seating, adjust the occlusal relationship in all mandible movements (centric and eccentric) using articulating paper.
- ▶ Any occlusal Prematurity should be relieved
- ▶ Occlusal adjustment can be done using high speed diamond burs
- ▶ For those that are out of occlusion, the treatment is remaking (metal) or refiring (Porcelain)

■ Now for metal crown(gold) restoration is ready for Margin finishing;

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

a) Sub gingival margin can be finish on the die using burnisher, no intra oral finishing is desirable because of the risk of damaging the tooth and the periodontal tissue.

b) Supra gingival margin can be finished directly on the tooth, margin adaptation can be improved by using burnisher or dull bur.

5. Polishing or Characterization and glazing

■ **Metal restoration.**

Purpose of Polishing;

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

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

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

■ **Porcelain in PFC and all ceramic crown restorations**

➢ **Contour & Shade of the restoration**

- the evaluation should be done before glazing
- Moistened with water or saliva (to reflect the light same to glazed restoration)

Verify shade & contour of the gingival third Excessive bulk might cause periodontal disease

- **Incisal edge**
  - On anterior teeth, establish the proper position and shape of the incisal edge.
  - This is important step in achieving good esthetics and function.
  - Ideally, the incisal edges of the maxillary anterior teeth will follow the curvature of the lower lip when it is relaxed.
- **Incisal embrasures**

  Proper incisal embrasures enhance good separation between restorations, whereas their absence draws attention to reveals its artificial nature
- **Surface Texture Characterization**
  - Should duplicate the surface detail & reproducing natural defects of the patient's natural teeth.
  - Avoid over characterizing restorations (lead to artificial appearance)

Glazing;

It is the application colorless glass powder to the fired crown or bridge surface produce a glossy surface & duplicate natural tooth surface luster and characterization.

Insufficient glazing will lead to:

- Rough surface may lead to abrasive wear of the opposing dentition
- Increase the rate of plaque accumulation.
- Inflammation of the soft tissues it contacts.
- Reduction in the strength of a ceramic restoration.

Polishing: An alternative to glazing is to polish the porcelain surfaces of the restoration.

- Provides precise degree of luster and distribution than glazing.
- Polishing dental ceramics as a way of restoring luster after adjustment by grinding.
- Polishing can be done using: silicone wheels or diamond polishing paste.

Cementation of crowns and bridges

Having successfully negotiated the planning, preparation, impression and prescription of your crown, the cementation stage represents the culmination of all your efforts. This stage is not difficult, but a successful outcome needs as much care as the preceding stages. Once a restoration is cemented there is no scope for modification or repeat.

Permanent Cementation

The mechanisms of holding a crown restoration on a prepared tooth using specific luting material (agent). It could be nonadhesive (mechanical luting and micromechanical bonding) or chemical adhesion (molecular adhesion). Dental cement doesn't contribute to the retention of the restoration.

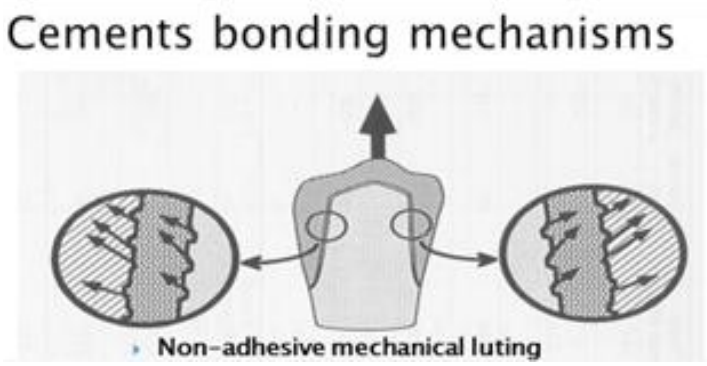
Luting Agent:

A material that acts as an adhesive to hold together the crown restoration to the tooth structure. Luting agents are designed to be either permanent or temporary.

Bonding Mechanisms

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

Involves filling of the macro-spaces between the tooth structure and the restoration with luting agent, when it sets (into the small irregularities between the opposing surfaces), it provides a mechanical bond (interlocking) that prevent the restoration from removal.

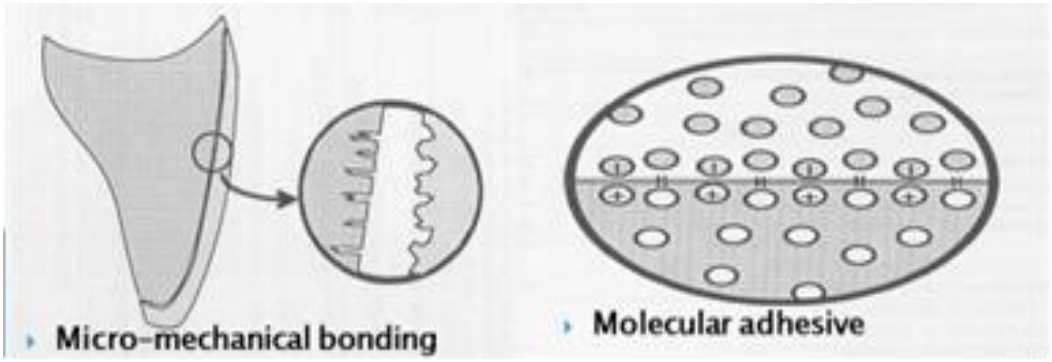


- **Micromechanical bonding**

Involves deep irregularities that can be produced on enamel surfaces by etching with phosphoric acid solution or gel; on ceramics, by etching with hydrofluoric acid; and on metal, by electrolytic / chemical etching, and sandblasting

- **Molecular adhesion**

Involves physical forces and chemical bonds between molecules of two different substances



Properties of ideal luting agent:

1) Low film thickness(≤25μm)

2) Adequate strength (minimum 70 MPA)

3) Low viscosity & solubility

4) Adequate working time

5) Reasonable setting time

6) Should provide good sealing. And must be non-toxic to the pulp (Biocompatible)

7) Radiopaque

8) Adhesion to tooth structure and restorative materials

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.

Factors affecting the retention of the cemented cast restoration

1. Geometrical relations of the preparation; retentive properties of the preparation (taper, height, surface area, …etc.).

2. Biophysical factors relating to the restoration such as accuracy of fit, metallurgical characters, inside surface texture of the casting restoration

3. Mechanical properties of the luting agent; such as compressive strength, tensile strength, shear strength, adhesive property and film thickness

4. Difference in the co efficient of thermal expansion between tooth, restoration and cement.

Dental Cementing (luting) Agents

Cements may be classified as soft or hard.

1) Soft cements can be used for provisional cementation of definitive crowns when a trial assessment period is needed, for example if the occlusion or aesthetics is being significantly altered.

2) Hard cements There are used for definitive (permanent) cementation. There are essentially three types of hard cement: conventional, resin or a hybrid of the two.

a) **Conventional cements**: rely on an acid-base reaction resulting in the formation of an insoluble salt (the cement) and water (e.g. zinc phosphate, zinc polycarboxylate and glass ionomer).

b) **Resin cements**, set by polymerization**.**

c) Hybrid **cements** relay on acid base reaction and polymerization

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 pulp (cavity varnish used to decrease that's effect) 14000-16000 PSI, with low PH at the time of cementing (about 3.5) which might irritate the pulp, come in two separate containers: powder and the liquid.

- **Oldest luting agent**
- **Little effect on the retention of the restoration**
- **Irritant to the**

Recommendations

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

Zinc silicophosphate cement

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

1. Mixture of zinc phosphate & silicate cement.
2. Film thickness, compressive strength & tensile strength in the range of ZPHC with slight lower solubility.
3. Anti-cariogenic property due to fluoride content.
4. Low PH & pulpal irritation, doesn't use now a day.

Poly-carboxylate cement

Adheres to enamel, dentine and stainless steel but not to gold alloy, high bond strength to enamel (1300 PSI), but its binding to dentine is considerably less (480 PSI). The pH before setting is (4.8), but attains a relatively neutral pH level after setting. Because of the large size of poly-acrylic acid molecules, it has less effect on the pulp. Its low film thickness optimizes fit and marginal integrity of the crowns.

Recommendations:

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

Glass ionomer cement

As for polycarboxylate cement but cement has similar acidity to zinc phosphate on mixing, has compressive strength of 18600 PSI (Low tensile strength), it bonds to enamel and dentine (to enamel more), it releases fluoride after setting which is indication of an ability to inhibit secondary caries. Sensitive to early moisture contamination. Has been accused of causing post-operative sensitivity but a controlled trial reports it is no worse than zinc phosphate

Recommendations:

- ☒ general prosthodontic use. Fluoride release may be beneficial for some patients. Avoid using glass ionomer with hypersensitive teeth.
- ☒ Used empirically for conventional crowns where patient has had a previously high caries rate.
- ☒ May be used as an alternative to zinc phosphate.

RESIN LUTING CEMENT

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

Advantages

1. chemical Bond to the tooth structure
2. High strength
3. Reduce fracture of ceramic restoration
4. Low solubility

Disadvantage

1. Difficult to remove excess after setting
2. High cost
3. Irritant to the pulp

Recommendations:

1. Must be used with or incorporate an effective dentine bonding agent.
2. Material of choice for porcelain veneers, ceramic crown & composite restoration and resin bonded ceramic crowns.
3. May be used to improve retention where preparation geometry sub-optimal.

Types

1) Adhesive Resin Cement

- ▶ Two component system - one bottle (self-etch), one syringe.
- ▶ Time-consuming, etching, bonding.
- ▶ Sensitive procedure

2) Self-adhesive resin cement

- ▶ One component type
- ▶ Time-saving, no etching, or bonding.
- ▶ Easy to use

Resin modified glass ionomer cements and compomers

Resin modified glass ionomer (RMGI) cements are a hybrid of traditional glassionomer cement with small additions of light curing resin and generally have the advantages of both, combine the strength and insolubility of resin with the fluoride release of GIC. They were introduced with the aim of overcoming the moisture sensitivity and the low strength of conventional glass ionomers.

Compomers are also composed of resin and glass ionomer but are more closely related to composites with the glass ionomer setting reaction occurring slowly as moisture is absorbed into the set resin matrix.

The use of RMGIs for luting purposes is becoming more popular because of their relatively high bond strength to dentine, and their ability to form a very thin film layer. RMGIs leach fluoride, but it is unclear how useful this is in preventing secondary caries formation.

- ▶ Sustained fluoride release.
- ▶ Moisture tolerant.
- ▶ Low solubility
- ▶ Low microleakage
- ▶ Less post cementation sensitivity

Recommendations:

1. Worth trying for metal or metal ceramic crowns especially where preparation retention is border line.
2. Currently unclear which RMGI cements can be used safely with ceramic crowns &post, delayed cement expansion might result in ceramic fracture or root fracture.

Delivery system

1) Hand mixing **2)** Applicap / maxicap capsule **3)** Auto mix (syringe or clicker dispenser)

The selection of cement for placement of crown restorations is not clear cut decision.

Factors affecting the selection of the type of cement

With the availability of different types of cements, the decision of choosing the suitable luting agent and method can be confusing for the practitioner. Especially with the wide use of contemporary restorative materials such as new generations of highly translucent zirconia as well as reinforced-composites, it is important to take into consideration that the properties of such materials differ highly from metal or earlier generations of zirconia. Subsequently the choice of the luting agent must be appropriate to achieve satisfying results and long-term success. The factors that determine cement type include:

1) **Restoration material of the crown and its Flexural strength**
2) **Translucency (optical properties) of the restorative material (esthetic demands)**
3) **ability to maintain a dry field**
4) **location of margin**
5) **chewing forces (anterior/posterior, bruxism)**
6) **tooth structure remaining**
7) **preparation design (retentive/no retentive)**

■ **Restoration Material Types**

Flexural strength and translucency of the restorative material are critical factors that influence the decision which luting agent to use. With the continuous introduction of new restorative materials to the dental market it is important to take into consideration the different mechanical properties of the various materials. The composition and the surface properties of the material have a decisive role in the ability to accomplish mechanical and/or chemical attachment to the restoration and therefore achieving required retention. Depending on the Flexural strength of the restoration, you can choose the type of cement material so;

- **Weak restorations (Ceramic with low Flexural strength under 350 MPa)** e.g. all porcelain (glass-ceramic, hybrid-ceramics) and all-composite crowns, inlays, onlays, and veneers must be adhesively bonded with strong cements. This increase in strength has been credited either to the ability of the cement to fill defects and prevent crack propagation in the ceramic or to the better mechanical properties of the resin cement (increased strength and lower water sorption).
- **High-strength ceramics with flexure strength of more than 350 MPa** (lithium disilicate and zirconia restoration) adhesive luting is highly recommended.
- **For metal restorations**, adhesive luting as well as conventional cementation can be used.

■ **Translucency (optical properties) of the restorative material:**

The choice of an opaque conventional cement for cementation of high-translucent restoration should not be recommended as it can negatively influence the final esthetic results. To meet the increasing esthetic demands

- For all translucent ceramic restorations, adhesive luting is highly recommended.
- For metal and opaque high-strength zirconia restorations, adhesive luting as well as conventional cementation can be used.

■ **Ability to maintain a dry field**

Adhesive bonding procedures are technique sensitive and intolerant to contaminations, therefore the luting process needs a dry oral environment avoiding any contamination, such as saliva or blood, preferably using rubber dam, as any contamination can compromise the bond strength.

Therefore, inability to maintain dry field as in case of subgingival preparation margins and posterior aspect of the mouth, particularly in the mandibular arch, is considered a contraindication for traditional full-adhesive bonding.

- **Preparation design**

- **Non-adhesive mechanical luting;** Zinc phosphate cement can be used

1) When tooth preparation provides high degree of mechanical retention

2) The pulp of the tooth is of no concern

3) Also we use it on endodontically treated teeth or teeth with heavy amalgam or composite filling.

However more biologically compatible cement is used **(polycarboxlate, GIC, Compomer);**

1. On teeth whose preparation possess in-adequate retentive features

2. When the depth of the preparation raises some concern about the vitality of pulp.

- Resin cements are suitable for bonding porcelain, cast ceramic, and composite restorations and recommended for teeth that have inadequate retention/resistance after preparation and non-retentive minimal-invasive restorations. The clinician's choice to bond a crown may depend on several clinical factors, such as the need for additional retention, the need to improve the strength of the crown, and whether adequate isolation can be achieved.
- Temporary Cements

Plain ZnOE Cements based on zinc oxide and eugenol are classical soft cements. The eugenol acts in a bacteriostatic or bactericidal function and arrest the production of toxin by the microorganism. **Eugenol limited application because it will inhibit the polymerization**. ZnOE is **not used for permanent cementation** because:

1. It has poor oral durability due to continuous eugenol loss.

2. It possesses low compressive strength, so we use it for temporary cementation.

Temporary cement zinc oxide non-eugenol

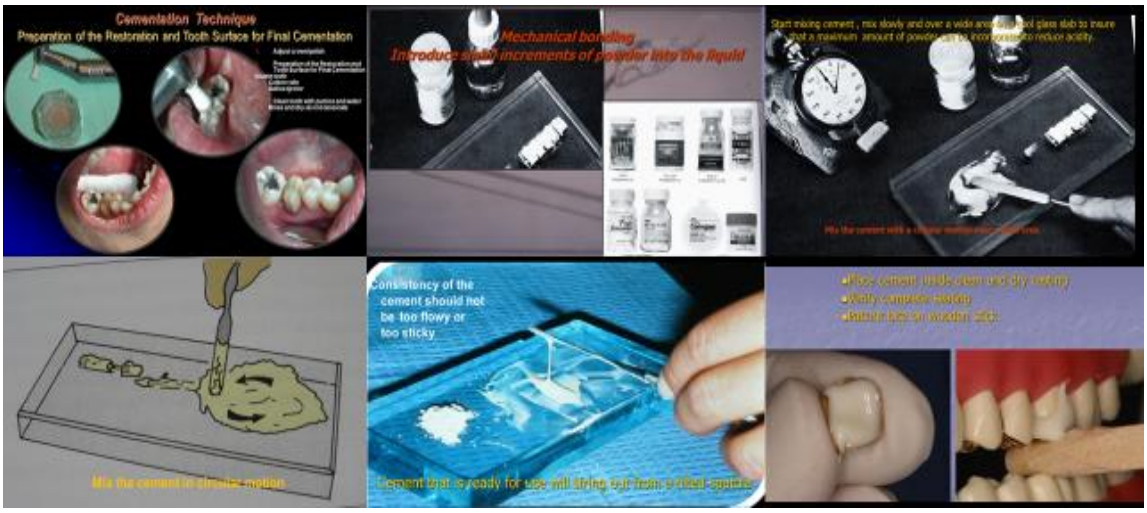
- Eugenol free for universal application because it will not inhibit the polymerization of resin
- Should have low film thickness help ensure an optimal fit
- Should have High adhesion to the tooth, to be removed easily for final cementation for time saving.

Cementation Technique

When ZPC is used as luting (for metal & PFM) (Mechanical bonding)

1. Remove the temporary crown, cleaning of the prepared tooth pumice and water from any residues of cement. Finally rinse and dry-do not desiccate

2. Isolate the prepared tooth or teeth with cotton roll (dry field of operation).
3. Partial protection of pulp can be provided by application of two layer of cavity varnish.
4. Start mixing cement, mix slowly and over a wide area on a cool glass slab to insure that a maximum amount of powder can be incorporated to reduce acidity.
5. Apply a coating of the cement to the inside of clean dry casting restoration, if there is any internal prep. Features such as grooves or boxes apply some cement on these areas of prep.
6. Seat the casting crown on the tooth with pressure and have the patient to apply force to the occlusal surface of the casting by biting on wooden stick or cotton roll for 3-4 minutes (to ensure complete seating).
7. After cement setting, remove any excess cement from the interproximal area, gingival cervical and underneath the bridge using dental probe and dental floss.
8. Check occlusion

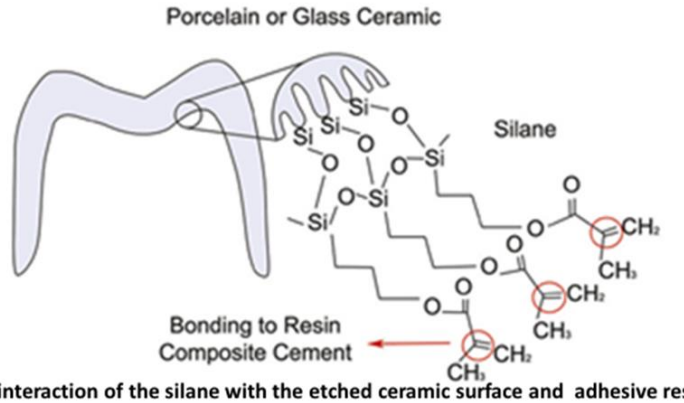


Cementation of all-ceramic crown and bridge (**Cementing or Bonding)**

Due to inherent brittleness, the behavior of ceramics in the oral cavity under functional stress is very different from metals. Excessive forces and surface damages may lead to fractures and cracks. Adhesive bonding with composite resins and proper treatment of the abutment tooth and the ceramic bonding surface increase fracture resistance of ceramic restorations, improve retention, and reduce microleakage. Clinical and laboratory bonding protocols must be follow depend on the type, composition, and properties of the ceramic. Ceramic restorations available today are either etchable or non-etchable based on the core material.

- Etch-able are the silica-based ceramics: feldspathic, Leucite-reinforced feldspathic porcelain (IPS Empress®), and lithium-disilicate glass-ceramic (IPS e-max®) should always be resin-bonded and treated with acid-etching and silane coupling-agent application.

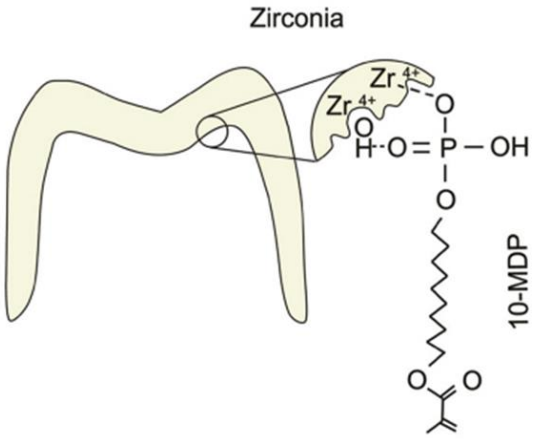
Etching is done **by using of 5% HFL gel** applied to the inner surface of the crown or bridge retainer for **20 seconds** and then copiously rinsed with water. **A primer** (silane coupling-agent) is applied for **60 seconds**.The primer allow bonding of resin cement to the restorative material. **Depending** on the **type** of **luting agent** used (self-etch adhesive resin/adhesive resin) the **tooth may or may not** need to be **pre-conditioned**.



Chemical interaction of the silane with the etched ceramic surface and adhesive resin. Note the formation of Si - O - Si bonds on the surface of the restoration. At the opposite end of the silane molecules, the methacrylate groups react with unreacted monomers in the resin composite cement by breaking of double bonds (circled in red).

- Non-etch able are the non-silica–based ceramics, High-strength, metal-oxide-based ceramics such as aluminum oxide (Procera® AllCeram) and zirconium oxide. Strong agreement state that a combined micromechanical and chemical pretreatment is necessary for long-term durable resin bonds to zirconia. Conventional or translucent zirconia restorations can be bonded without pretreatment, but a physical surface pretreatment prior to cementation is strongly recommended. The two most commonly used methods are based on grit-blasting, either using alumina powder or silica-coated alumina particles (tribochemical silica-coating). If no pretreatment or grit-blasting using alumina powder is used, an adhesive resin composite cement system that contains 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) should be used because conventional silane coupling agents cannot bond to metal-oxide ceramics. Air-particle abrasion with Al2O3 (grit-blasting using alumina powder) is both effective and practical to provide long-term durable bond strengths to high-strength ceramics. Adhesive resin composite cements or ceramic primers containing 10-MDP are indicated because 10-MDP, the most promising functional monomer, forms a relatively stable chemical bonding with the demineralized tooth (through reaction between the hydrophobic 10-MDP parts with collagen) and with zirconia (through reaction between the phosphate ester groups of 10-MDP with the hydroxyl groups on the passive zirconia surface). Alternatively, if tribochemical silica-coating (silica-coated alumina particles) is employed, creates an irregular silica layer on the ceramic surface when the special silica-coated alumina powder is blasted. It should be

followed by rinsing, air drying and the application of silane (silane coupling-agent), which enables chemical adhesion to any resin composite adhesive cement.



Chemical interaction of the 10-MDP monomer with the roughed zirconia surface obtained by grit-blasting. Ionic and hydrogen bonding may occur between 10-MDP and zirconia - here both possibilities are illustrated, but they may also occur separately.

Cementation procedure :(Adhesive Bonding)

1) Remove the temporary crown, cleaning of the prepared tooth pumice and water from any residues of cement. Finally rinse and dry

2) Isolate the prepared tooth or teeth (inability to maintain dry area is considered a contraindication for traditional full-adhesive bonding)

3) Treat the internal surface of the restoration as appropriate for its composition.

4) Apply bonding agent to the internal surface without curing, if this is specified by the manufacturer.

5) Etch the prepared teeth with 35% or 37% phosphoric acid (H3PO4) (15 s for dentin, 30 s for enamel). Tooth tissues do not possess any natural affinity to dental ceramics. This is why proper pretreatment and adhesive resin composite cements are vital when bonding ceramic materials to the tooth, so, by Application of phosphoric acid increases the surface energy of the dentin by removing the smear layer and promoting demineralization of the most superficial layer of hydroxyapatite crystals. The resin monomers infiltrate the water-filled spaces between collagen fibers, which results in a hybrid layer composed of collagen, resin, residual hydroxyapatite and traces of water

6) Gently wash and dry. Do not dehydrate the dentin.

7) Apply a thin layer of bonding agent on the cavity without curing.

8) Apply a coating of the resin cement to the insides (fitting surface) of crown restoration.

9) Insert the restoration into the prepared tooth (abutment teeth) and remove excess cement.

10) Apply light-curing for 10 s, and then remove excess resin cement from the proximal area (with dental floss).

11) Apply light-curing for 40–60 s per surface.

12) check occlusion. Adjust if necessary.

13) Finish and polish with fine diamonds and rubber points.

Factors that influence the completeness of seating after cementation

1) Viscosity of the cement.
2) Morphology of the restoration.
3) Vibration.
4) Seating force.
5) Venting.

Technique Tips

- Fluff powder before dispensing. Hold liquid bottle vertically, and release each drop slowly to ensure equal size drops.
- For any powder/liquid cement, incorporate the powder thoroughly. Insure mix is homogeneous.
- Load the crown evenly with cement.
- Place crown cement-side done on your palm for the dentist to pick up and seat on the tooth.
- As the cement loses its gloss and start to set, it will have a stringy, non-sticky consistency. Start removing excess cement before it hardens.
- After removal of excess, use a piece of knotted floss and run it through the interproximal areas to remove remnant cement.
- Instruct patients to wait 1 hour after cementation.

Crown And Bridge Prosthodontics

Lecture. 13

Failure in crown & bridge Prosthodontics

Failure in crowns and bridges should be regarded as a disadvantages and balanced against advantage, some bridges are failure from the day they inserted while others last over 40 years.

Manifestations of failure

Failure might manifested itself in one or more of following patient complaint;

- *Pain*
- *Inability to function*
- *Dissatisfaction with esthetics*
- *Broken teeth and/or restoration*
- *Inflammatory swelling*
- *Bad taste*
- *Bad breath*
- *Bleeding gums*
- *Anxiety*

Patient complaint might be Immediate or Delayed

Causes of fixed prosthesis failure

- Improper case selection
- Faulty diagnosis and treatment plan
- Inaccurate clinical or laboratory procedures
- Poor patient care and maintenance following insertion

For purpose of discussion the reasons for failure of fixed prosthesis may be divided into **biological, mechanical, esthetic and Maintenance problems.** while mechanical in general, are more directly under the control and influences of clinician the biological problems are not easily controlled and in some instances may be unrelated to the prosthesis, however it is true and many time that, the biological problems may be a consequence of the treatment procedure (pulpal) or of the restoration itself (periodontal or caries).

A) Biological problem

1. Caries;

It is the most common cause of failure of fixed restorations, its detection very difficult whether clinically or radiographically practically when complete coverage is used

Causes;

a) Open and over or under extended margin (short or long margin); her fluid seepage could occur lead to dissolution of cement that give an area for food debris impaction this defiantly result in caries.
b) Lose of retention as result of marginal seepage.
c) High risk patient (high caries index) because of poor oral hygiene.
d) Reduce salivary flow.
e) Perforation of restoration (structural durability)

2. Pulpal injury (problem)

Pulpal problem is not uncommon complication in bridge work.it might be the outcome of microbial, chemical, mechanical and thermal irritation. It should be always expected and most often associate with small teeth, in favor of structural duality and periodontal health a massive reduction is necessary so good evaluation is important. Teeth with questionable pulp go and do root canal treatment, anyhow, pulpal pain and discomfort should expected to last sometime to sex months. To verified pulpal pain vitality test should done

- *Full crown--------thermal*
- *Partial crown -------electrical*
- *Radio graphical-------to see periapical whether infected or not*

Causes of pulpal problem

I. Overheating and heat generation
- **a)** Lack of coolant.
- **b)** Very high speed
- **c)** Insufficient bure
- **d)** direct temporary crown

II. Improper or absence of temporary protection

III. Irritating cementing agent

IV. Over reduction ,insufficient tooth structure to protect pulp or microscopic pulpal exposure

V. Recurrent caries under full crown, microbial irritation.

VI. Traumatic occlusion.

3. Periodontal and soft tissue problems

Periodontal breakdown may lead to loss of abutment. ***Patient suffer from*;**

- *Mobility of abutment*
- *Periodontal pocket formation*
- *Periodontal abscess*
- *Pain which prevent mastication at the side of restoration*
- *Bad odor and taste*

The most common cause for periodontal problems are

I. Over contouring of crown.

II. Insufficient interproximal clearance, reduction or overcontour

III. Deficient interproximal contact

IV. Increased cervico occlusal length of connector

V. Improper tissue pontic relation---saddle design

VI. Overextended subgingival positioning of finish line

VII. Irregular or rough edges of crown that might cause irritation to the gingival tissue

VIII. Failure of contact ---food impaction

IX. Ill-fitting crown might cause irritation to gingival tissue

X. Presence of foreign body irritating soft tissue

XI. Improper pontic design (continuous food accumulation and soft tissue pressure

XII. Improper connector design

B) Mechanical problems

I. Looseness of crown or bridge (Cementation Failure):

Loss of retention is not a common cause of failure of individual crowns. However, because of the leverage forces on fixed–fixed bridges, one of the more common ways in which they fail is by one of the retainers becoming loose but the other remaining attached to the abutment tooth. The most common causes of Looseness are

a) Poor retention because of inadequate preparation or faulty preparation (converagence angle, length, surface area ,…….etc.)

b) Faulty cementation

The causes of Inadequate cementation might be

- Poor mixing of cement.
- Failure to have a dry field.
- Poor seating
- Type of cement

c) Faulty restoration

- Open or overhang margin
- Wear or perforation
- Deformation of restoration (structural durability)

d) Premature contact (torque)

e) Caries

f) Poor retainer design selecton such as ceramic crown in state of fused metal restoration.

II. Mechanical failure of crowns and bridges

a. *Porcelain fracture*

1. Ceramic crown……

- Faulty laboratory technique such as improper condensation , air bubbles, inadequate firing, ,faulty protocol for cad cam crown
- Faulty preparation

2. Porcelain fused to metal……

- Faulty technique…..poor coping design
- Metal framework flexing

b. *Distoration or fracture*

c. *Faulty structural durability of restoration*

d. *Occlusal wear or perforation*

e. *Failure of solder joint*

III. Restoration Failure

A-Retainer failure;

- Perforation
- Marginal discrepancy
- Veneering separation, fracture or wearing

B- Pontic failure;

- Pontic fracture (Porcelain) with unfavorable occlusal load
- Limited occluso cervical height due to over eruption

C- Connector failure;

- Improper designing of connector size and position
- Thin metal at the connector
- Incorrect selection of solder
- Porosity

IV. Marginal deficiencies of restoration

- ***a)*** *The cause might be*
- ***b)*** *Poor preparation (ill define finish line)*
- ***c)*** *Impression with Ill define margin (not clear) of preparation*
- ***d)*** *Technical faults*
- ***e)*** *Cementation errors*

V. Fracture of abutment tooth

Over reduction and tooth heath state might be the cause

VI. Design failure

A simple classification of these failures is as 'under-prescribed' and 'over-prescribed' bridges

- ***under prescribe bridge design***

These include designs that are unstable or have too few abutment teeth – for example a cantilever bridge carrying pontics that cover too long a span or a fixed–movable bridge where again the span is too long, or where abutment teeth with too little support have been selected. Another 'under-design' fault is to be too conservative in selecting retainers, for example intracoronal inlays for fixed–fixed bridges. With these design faults little can be done other than to remove the bridge and replace it with another design

- ***over prescribe bridge design***

Cautious dentists will sometimes include more abutment teeth than are necessary, and fate usually dictates that it is the unnecessary retainer that fails. The first lower premolar might be included as well as the second premolar and second molar in a bridge to replace the lower first molar, no doubt so that there will be equal numbers of roots each end of the bridge so as to comply with the redundant 'Ante's Law'. This is not necessary. The retainers themselves may be overprescribed, with complete crowns being used where partial crowns or intracoronal retainers would have been quite adequate; or metal– ceramic crowns might be used where all-metal crowns would have been sufficient. When the pulp dies in such a case, it is interesting to speculate whether this might not have occurred with a less drastic reduction of the crown of the natural tooth.

VII. Discomfort of the patient

a) Soft tissue irritation by pressure which might be from improper pontic design or food staff accumulation

b) Deficient interproximal contact that cause food impaction

c) Traumatic occlusion

- Faulty construction such as occlusal surface with high marginal ridge or deep incline plan
- Faulty diagnosis and treatment plan such as
- Use of teeth that lack of alveolar support
- Overloading of abutment
- Premature contact

d) Retention of food on occlusal surface (poor design)

e) Poor contouring of the retainer and pontic

- Overcontour.....overprotection and under stimulation
- Under contour.....over stimulation and under protection....gingival tissue trauma

f) Sensitive cervical margin to hot or cold application
- Long margin that might cause gingival recession
- Over displacement of gingiva
- Temporary restoration with long margin cemented for long period of time
- Retainer with short or open margin

g) Seating failure
- Too thick cement
- Insufficient pressure during cementation

C) Failure related to esthetic

One of the objective in replacing missing tooth is esthetic, definitely failure of this objective lead to failure of bridge. Shape, size, position and shade of restoration collectively play important role in esthetic value so factors that might cause faulty esthetic are;

a) *Improper shade selection*
b) *Poor harmony between restoration and natural teeth (improper contour might be the fault of dentist or lab technician)*
c) *Failure to mask metal color*
d) *Un necessary metal display*
e) *Improper cement selection*
f) *Irregular and rough surface .....discoloration*

D) Maintenance Failure

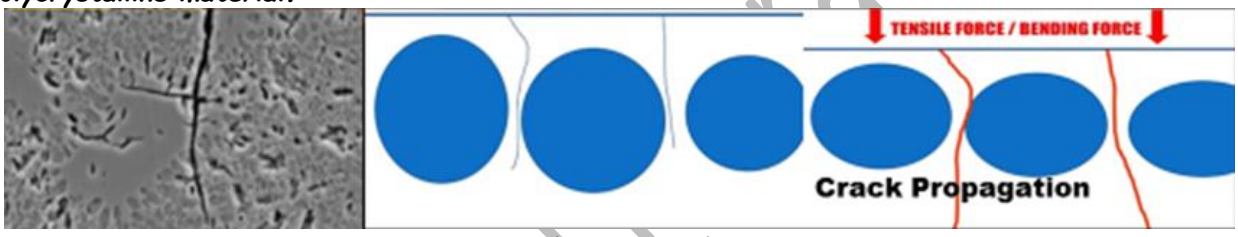
- *Poor oral hygiene and improper maintenance of a well done restoration may lead to failure of prosthesis.*
- *The patient must be fully informed about his responsibility in success or failure of restoration*
- *The dentist must recall the patient for periodic clinical and radiographic examination to detect early any harmful changes that might occur.*

Crown And Bridge Prosthodontics

Lecture. 14

Dental Ceramic

Ceramic is derived from GREEK word "KERAMI KOS" meaning Burnt earth. Generally, the word ceramic is used to name any material having both metallic and non-metallic ions (usually silicon, boron, oxygen) in its compositional formula which are obtained by the action of heat and whose final structure is partially or completely crystalline (example. Cements, gypsum, porcelain and glasses). Dental porcelain is the material from which the most esthetic restorations are made, it is compatible with the soft tissue. A ceramic material formed of infusible elements joined by lower fusing materials. Most dental porcelains are glasses and are used in fabrication of teeth for dentures, pontics & facings, crowns, inlays, onlays and other restorations. ***Dental porcelain in this domain is superior over polymers and reinforced polymers regarding tooth shade reproduction, translucency, biological compatibility, chemical stability and abrasion resistance****. Porcelain is very hard material but it is extremely* ***brittle, can fracture*** *easily. To compensate this weakness,* ***ceramics are usually supported by substructure, reinforced with particles, or made purely of polycrystalline material****.*



So in order to overcome this disadvantage (brittleness), porcelain fused to metal restoration is develops to combine the strength and the accuracy of cast metal with the esthetic of porcelain. ***P.F.M.*** *composed of* ***a metal copping casting (substructure) that fit over the tooth and porcelain fuse on to that copping****. This combination is* ***stronger*** *than porcelain alone. However, metal substrate can affect aesthetic by decreasing light transmission comparing to all ceramic crown, expose metal rim, and periodontal health. That's why, researches continue trying to develop new ceramic system (combine strength and esthetic) that can use without metal substructure. Development follow* ***2 path:***

1) Developing a high strength but not esthetic core, veneered with low strength esthetic ceramic.

2) Developing of ceramic that combine esthetic with high strength

Methods of strengthening ceramics

- ***Extrinsic*** *involve* ***Introducing or Development of Residual Compressive Stresses within the surface of the ceramic material*** *by using one of following techniques or methods:*

1) Ion exchange

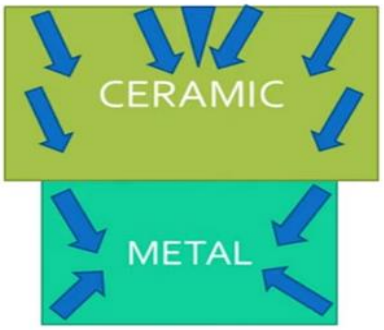
Involves exchange of large potassium ions for the smaller sodium ions .Sodium containing glass articles is placed in a bath of molten potassium nitrate. The potassium ion is 35% larger than sodium ion. Squeezing of the potassium ions into the place of sodium ions creates a large residual compressive stress.

2) *Thermal tempering.*

*Creating residual stresses by rapidly cooling (**quenching**) the surface of object (glass or ceramic) while it is hot and in the softened (molten) state to induce a state of compression in the surface. This rapid cooling produces a skin of rigid glass surrounding a soft molten core. As molten core solidifies it tends to shrink, creates residual tensile stresses within the outer surface. Thermal tempering is an attractive technique for strengthening dental ceramics because the technique can be easily performed in commercial dental laboratories and the material surfaces are not degraded as a result of the tempering treatment.*

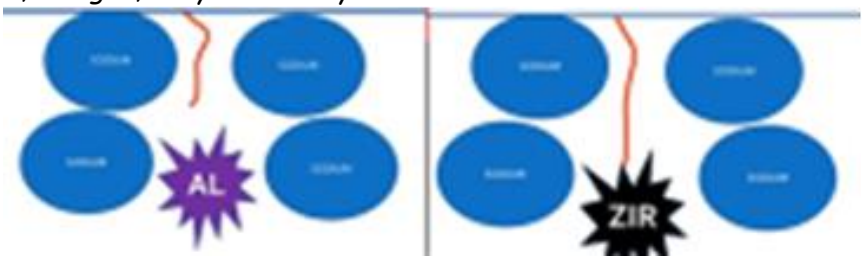
3) *Thermal compatibility*

The metal and the porcelain used in porcelain fused to metal restoration are designed with slight mismatch in their co-efficient of thermal expansion .The coefficient of thermal expansion for metals is more than porcelain thus the metal contacts more than the porcelain on cooling provides additional strength.



- ***Intrinsic involve Interruption of Crack Propagation by:***
  - ***Dispersion of Crystalline phase***

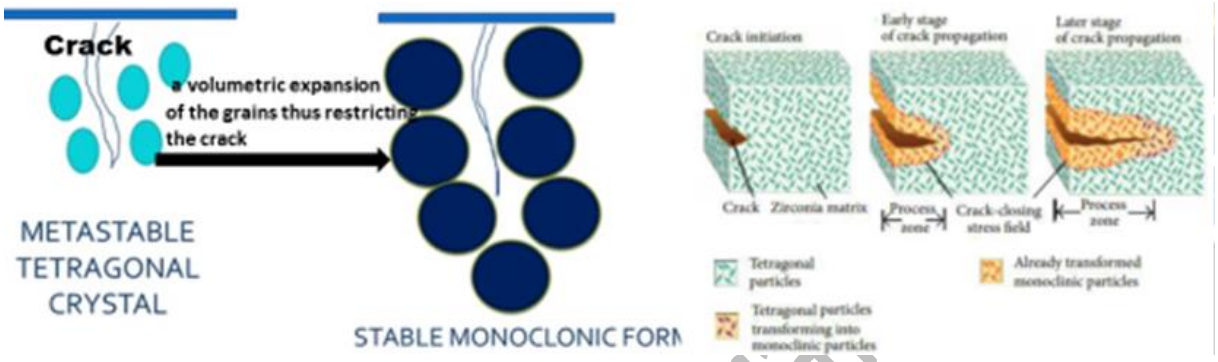
Involve adding Toughening particles AL2O3, MgO Crystals particles (zirconia) to a glass, the glass is toughened as the cracks cannot penetrate the alumina particles. Alumina have been added (40% Hi-Ceram) (In-Ceram 85%) to porcelain to increase its strengths enable it using alone (without metal substructure), also MgO Crystals and zirconium oxide have been added to porcelain to increase its strengths, enable it using alone as in all ceramic crowns, bridges, inlays and onlays.



  - ***Transformation Toughening***

New technique of strengthening glasses. *Toughness is ability of material to absorb energy to fracture.* ***Transformation Toughening ZIRCONIA (TTZ)*** *are often referred as ceramic steel because the strain or change in dimension, in response to stress behavior resemble that of steel in state of brittle ceramic. The energy required for the transformation is taken from the energy that allows to crack to propagate.*

(TTZ) *Involves* ***transformation*** *of* ***Zirconium oxide (ZrO2) grains from their TETRAGONAL phase to a MONOCLINIC phase*** *at the tips of cracks that are in the region of tensile stress. This transformation procedure accompanied by a volumetric expansion of the grains thus restricting the crack.* ***Since this expansion*** *is constrained by the surrounding material, the* ***net result is compressive stress on the surfaces of the crack****, which propagation is thus hindered, eventually preventing the failure of the zirconia restoration this is the reason why this phenomenon is called* ***phase transformation toughening****. Because of the strengthening and toughening mechanisms zirconium oxide was also referred to as "ceramic steel"*

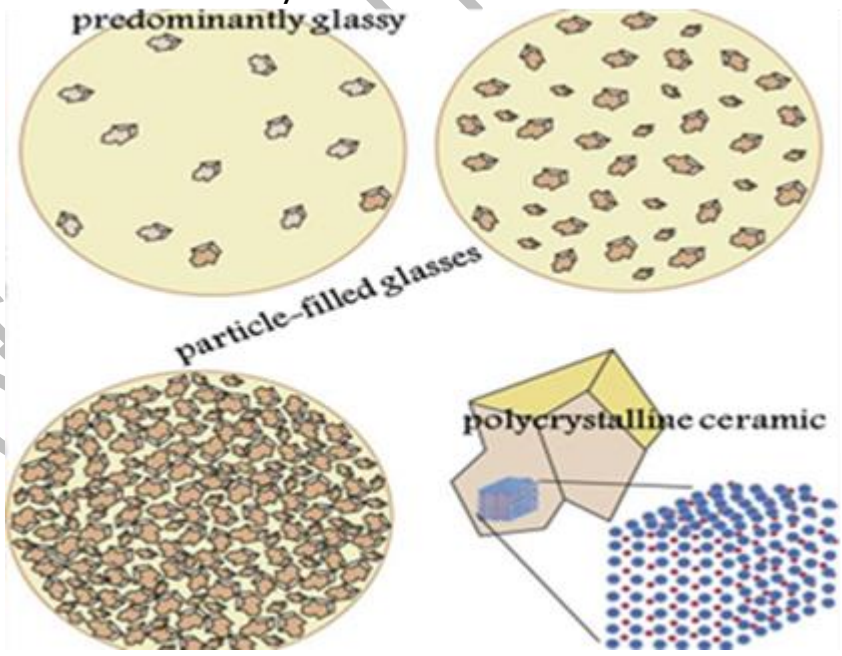


TYPES OF DENTAL CERAMICS

Kelly and Benetti, **classify ceramic according to their glass content** into three main divisions:

1) **Predominantly glassy materials,**
2) **Particle filled glasses---- Glass ceramics**
3) **Polycrystalline ceramics.**

Esthetic dental ceramics : Glassy
Substructure dental ceramics: Crystalline



1) **Predominantly glassy materials**

- *Best mimic the optical properties of enamel and dentine: Glassy material*
- *Glasses: 3D network of atoms having no regular pattern to the spacing between nearest atoms, thus they are amorphous or without form.*
- *Derived principally from a group of minerals called FELDSPAR: based on silica and alumina: Aluminosilicate glasses.*
- *Resistant to crystallization during firing, long firing ranges, biocompatible.*

2) Particle filled glasses---- Glass ceramics

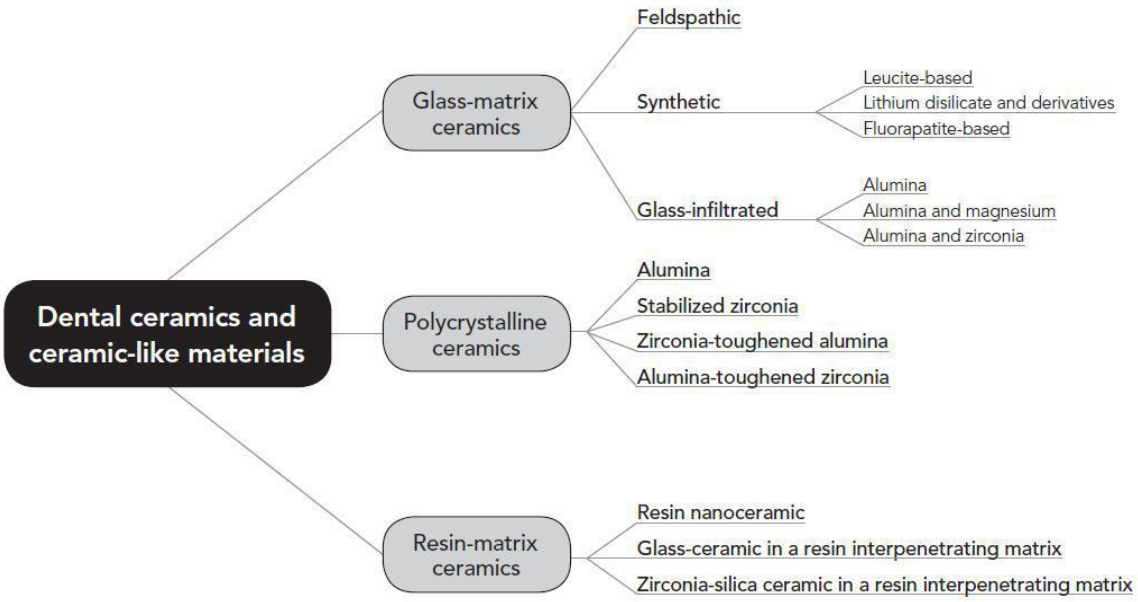
- *Filler particles are added to the base glass composition to improve mechanical properties and to control optical effects like Opalescence, Color, and opacity.*
- *This filler was added to create porcelains that could be successfully fired on metal substructure.*
- *Adding 17-25% Leucite filler (feldspar forms crystalline mineral Leucite, potassium-aluminum-silicate mineral with large coefficient of thermal expansion, when mixed with metal oxides & fired to high temperature) to base glass creates porcelains that are thermally compatible with dental alloys.*
- *Moderate strength increases can also be achieved with appropriate fillers added and uniformly dispersed: "Dispersion Strengthening"*

3) Polycrystalline ceramics

- *No glassy components, atoms are densely packed, regular network. Crack propagation difficult.*
- *Tougher and stronger than glassy ceramics.*
- *Difficult to process, CAD-CAM.*
- *Relatively opaque, core substructure.*
- *E.g. Aluminum oxide, partially stabilized Zirconia. (Procera, Cercon, Lava.)*

*The **increasing use** of **polycrystalline ceramics** (with no silicon in their composition), and the introduction of so-called **'hybrid' ceramics** (resin-matrix materials that are highly filled with ceramics) imposed the **need for a new classification system**, and, Since the existing classification systems does not include 'hybrid' ceramics, these are now available from various manufacturers and are recommended as esthetic alternative for a variety of clinical indications. In the light of this considerations a new classification system of ceramics was include. According to this classification system and **depending on the phase/phases present in their chemical composition**, all-ceramic and ceramic-like restorative materials can be **categorized into three groups:***

1. ***Glass-matrix ceramics:** nonmetallic inorganic ceramic materials that contain glass phase.*
2. ***Polycrystalline ceramics:** nonmetallic inorganic that do not contain any glass phase but only a crystalline phase.*
3. ***Resin-matrix ceramics:** polymer-matrices contain predominantly inorganic refractory compounds like porcelains, glass, ceramics and glass-ceramics.*



Composition (traditional porcelain – feldspathic porcelains)

1) **Kaolin 11—12%**
   - *It is a white clay like material (hydrated aluminum silicate).*
   - *Increases the ability of the porcelain mold before baking*
   - *Facilitates mixing with water while maintaining the form during drying and firing.*
   - *Make the material workable Reacts with the feldspar and gives rigidity*
   - *Being sticky in nature, bind the particles*
   - *Material can be carved*
   - *Give opacity to the fired porcelain*
2) **Feld Spar 70 – 90% (Alkaline aluminum potassium silicate)**
   - *It constitutes the bulk of dental porcelain*
   - *Translucent glossy matrix*
   - *Bind small particles of Kaolin and Quartz together*
   - *Alumina may replace silica –increase strength & opacity – use as core material under a regular translucent porcelain in all ceramic crown (jacket crown).*

Aluminous porcelain

The porcelain material contains 40-50% alumina crystals (Al_2O_3) in a low-fusing glass matrix (High-Ceram). The dispersed alumina particles are much stronger with higher modulus of elasticity and coefficient of thermal expansion than those of the glassy matrix. Presence of alumina makes the material opaque. (That is why it used only as coping or core beneath regular porcelain)

3) **Quartz**
   - *Form refractory skeleton about which the other material fuse and flow*
   - *A form of silica is used as filler*
   - *Form refractory skeleton about which the other material fuse and flow*
   - *Help the crown holding itself during firing*
   - *Increase the strength of the material*
   - *Tissue contacts appear as normal tooth*
   - *Constitutes the crystalline face*
   - *Hardening of the mass*
4) **Fluxes**
   - *Alkalies such as sodium, potassium and calcium*
   - *Increase fluidity*
   - *Lower firing temperature*
   - *Acting as glass modifier (called glass modifiers).*
5) **Pigments**
   - *Added to color the porcelain (to provide proper shade)*
   - *Involve metal oxide such as titanium oxide – yellowish brown, iron or nickel oxide – brown, copper oxide – green, manganese oxide (lavender), cobalt oxide (blue), etc*
   - *They are fused together with regular feldspar and then reground and blended to produce a variety of colors.*
6) **Opacifiers**

Since pure feldspathic porcelain is quite colorless, opacifiers are added to increase its opacity in order to simulate natural teeth. Oxides of zirconium, titanium and tin are commonly used opacifiers.

CHARACTERS OF DENTAL PORCELAIN

1. **Biological Properties:**
   - *Inert has no interaction with surrounding soft tissue (biocompatible)*
2. **Interfacial Properties:**
   - *Not adhere chemically to dental cements*
3. **Chemical properties:**
   - *Not soluble in oral fluids and resist acid attach*
   - *Both hydrofluoric acid and stannous fluoride can cause an increase in surface roughness*
4. **Mechanical Properties:**
   - *Brittle*
   - *Low Dimensional tensile strength and fracture toughness*
   - *Hard, can cause wearing of opposing dentition*

5. **Thermal Properties:**
   - *Low thermal diffusivity*
   - *Coefficient Of thermal expansion similar or slightly higher than to that of enamel and dentine, not exhibit micro leakage (acrylic 4 –6 more).*
6. **Esthetic properties:**
   - *porcelain exhibit the best (Excellent) esthetic quality, and color matching*
   - *Difficult to be stained*
   - *Differ from acrylic which is esthetically poor because of light absorbent).*
7. **Practicability:**
   - *Sensitive manipulation technique, Requiring skilled operator and Special equipment's*
   - *Firing shrinkage is always, so operator should build up the restoration to a bigger size that allows shrinkage*
8. **Color stability;**

Porcelain is the most stable tooth colored restorative material. Glaze porcelain provide smooth glassy non porous surface that is resistant to adherent of exogenous stain (acrylic is not stable due to water absorption and porosity).

Disadvantages of dental porcelain

1) *Abrasive to antagonists.*
2) *Complex techniques need (fabrication).*
3) *Difficult to adjust and polish intra-orally.*
4) *May degrade supporting structure.*
5) *Low fracture resistance.*

Techniques of firing

1. ***Pressure technique***
2. ***Diffusible gas technique***
3. ***Vacuum firing technique***

Vacuum firing is one of greatest practical value *to the dental ceramist* ***because***

1. *It is easy to manipulate*
2. *Porcelain of grater translucence is achieved (decrease in the No. of gas bubbles)*
3. *Strength qualities somewhat more*

❖ ***Porcelain reaction to firing (Phases of maturation)***

1. **Biscuit stag;**
   - *Little shrinkage in the body of porcelain*
   - *Appear like opaque whit mass with porous surface, no translucency*
   - *Contamination of porcelain at this stage is easy (oil and dust)*
2. **Maturity stage**
   - *It divides into low, medium and high*
   - *Maturation of porcelain is evident at this stag*
   - *The amount of translucency and color shin depend on the degree of maturation*
   - *At the end of maturation, it will appear non porous glaze where the surface reflects light and cluster*
3. **Coalescence stag**
   - *If we continue firing, we reach this stage in which we loss the form of porcelain*

Classification

- **According to fusing temperature**
  1) **High fusing porcelain 2350 – 2500 F** (>1,300°C)
     Usually used for manufacture of porcelain denture teeth and aluminous cores production
  2) **medium fusing porcelain 2000 – 2300 F (1,101°C to 1,300°C)**
     Usually used for FPD, porcelain jacket crown, porcelain inlay and onlay.
  3) **Low fusing porcelain 1600 – 2000 F (850°C to 1,100°C)**
     Usually used for building porcelain in porcelain fused to metal restoration
  4) **Ultra-low fusing less than 850 (used with titanium) (< 850°C)**
     Usually used for building porcelain in porcelain fused to titanium restoration

- **According to type of restoration**
  1) All ceramic crown
  2) Porcelain fused to metal crown
  3) Inlay
  4) Onlay
- **According to Microstructure**
  1) Glass
  2) Crystalline
  3) Crystal containing glass
- **According to composition**
  1) Glass-matrix ceramics.
  2) Polycrystalline ceramics.
  3) Resin-matrix ceramics.
- **According to porcelain Type**
  1) Feldspathic or conventional porcelain
  2) Aluminous porcelain
  3) Leucite reinforced
  4) porcelain Glass infiltrated alumina
  5) Glass infiltrated spinell
  6) Glass ceramic
- **According to Processing Method**
  1) Sintered porcelain
  2) Cast porcelain
  3) Machined porcelain.
- **According to their clinical applications**
  1) Core porcelain:
     Used to form the basal layer of jacket crown
  2) Dentine or Body porcelain:
     More translucent, used to build the body of crowns
  3) Enamel porcelain:
     The most translucent, used to form the incisal edges

Nature of Bond between Porcelain & Metal

1. Mechanical bond

- *Achieved by minute irregularities on the surface of the metal (rough surface)*
- *Mechanical interlocking occurs only when wetting is efficient*

2. Vander woals bond

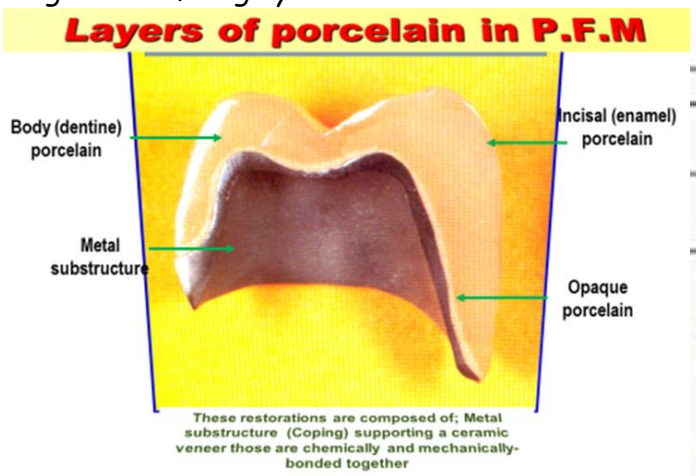
- *Represent attraction between atoms or molecules which are not primarily of same chemical nature*
- *It is more physical in nature*
- *It represents 1/3 of bonding*

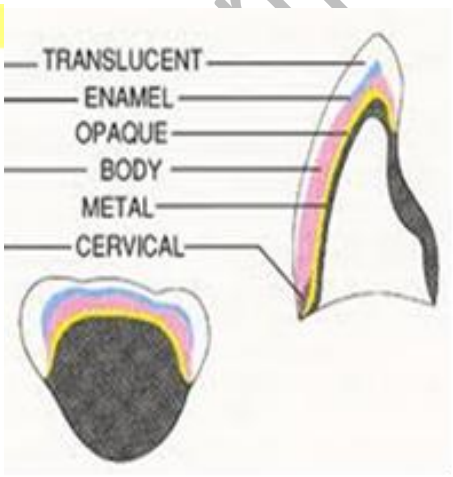
3. Chemical bond

- *It is either covalent or ionic bond*
- *It means formation of anew substance between metal and porcelain which is combination of both*
- *There will be direct electron transfer between the oxygen of the glass and the oxidizable metal in the copping alloy*
- *It depends on the ability of alloy to form oxide layer between the copping and porcelain (indium and tin established this potential)*

❖ ***Layers of porcelain in P.F.M***

1. ***Opaque porcelain:*** *It is applied as a first porcelain layer; it initiates the development of shade. it performs two major function: it masks the color of the alloy, and it play an important role in the development of the metal porcelain bond.*
2. ***Body porcelain (Dentin):*** *this is fired onto the opaque layer, make up the bulk of the restoration, providing the most of the color or shade of the final restoration. It provides some translucency. Body porcelains are available in a wide selection of shades, to match adjacent natural teeth.*
3. ***Incisal porcelain (Enamel):*** *A translucent, lightly – pigmented dental ceramic used on a base of dentine ceramic to simulate the natural tooth enamel*
4. ***Glaze:*** *Translucent, low fusing porcelain which may applied to the surface as final stage in the firing cycle*





❖ ***Layers of porcelain in All Ceramic Crown (traditional porcelain crown)***

1. *Core (high strength porcelain)*
2. *Body (dentine)*
3. *Incisal (enamel)*
4. *Glaze*

❖ ***Requirements of the alloys***

1. *The alloy should have high melting range point to withstand the porcelain firing temperature without melting or creep*
2. *The alloy should be sufficiently rigid and have high modulus of elasticity so that it resist deformation during firing veneer bonded to the metal or during masticatory function where occlusal force acting (to support a very brittle porcelain veneer) otherwise fractures 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 (capable of forming oxide layer).*
4. *The alloy should have a value of coefficient of thermal expansion similar to that for the porcelain to which it is bonded.*
5. *The alloy should have good castibility*
6. *The alloy should have fine grain structure to resist corrosion*

❖ ***available alloy for porcelain bonding***

- *Noble alloys (gold platinum alloy).*
- *Low noble alloys (gold palladium alloy).*
- *Silver-palladium alloys.*
- *Nickel-chromium alloys.*

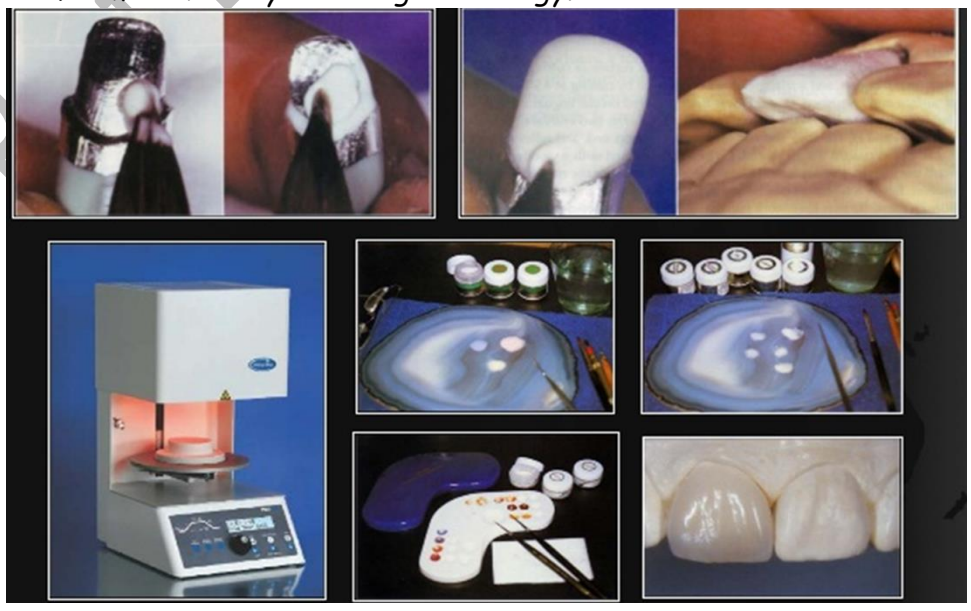
Families of all-ceramic restorations

In an all-ceramic restoration, the ceramic material may be ***monolithic (uni-layer)*** *and consist of a single ceramic material, or it may consist of a ceramic core material that is covered with a ceramic veneer and is known as* ***a bilayered all-ceramic restoration****.*

ALL CERAMIC SYSTEMS can classify According to fabrication technique into

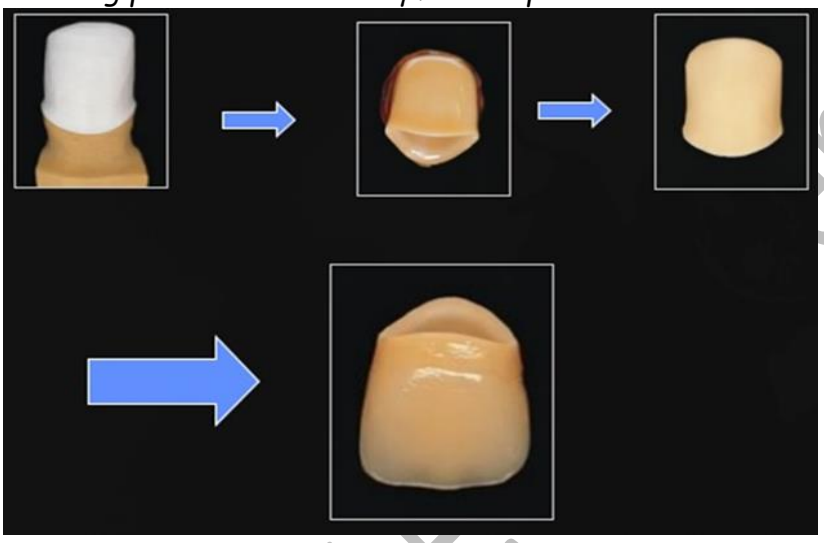
1. ***Powder-slurry (Sintering)ceramics (Conventional Ceramic Crown)***

The material presents as powder to be mixed with liquid (water) forming a slurry that is used to build the restoration up upon layer on the die of the prepared tooth to form the contour of the restoration. A slurry of densely packed ceramic particles was then sintered. ***Sintering is a process of heating closely packed particles to achieve interparticle bonding and sufficient diffusion to decrease the surface area or increase the density of the structure (heating a material to just below the melting point so that it forms on solid mass).*** *Veneers, inlays, and specific cases of crowns on anterior teeth are manufactured by sintering technology.*



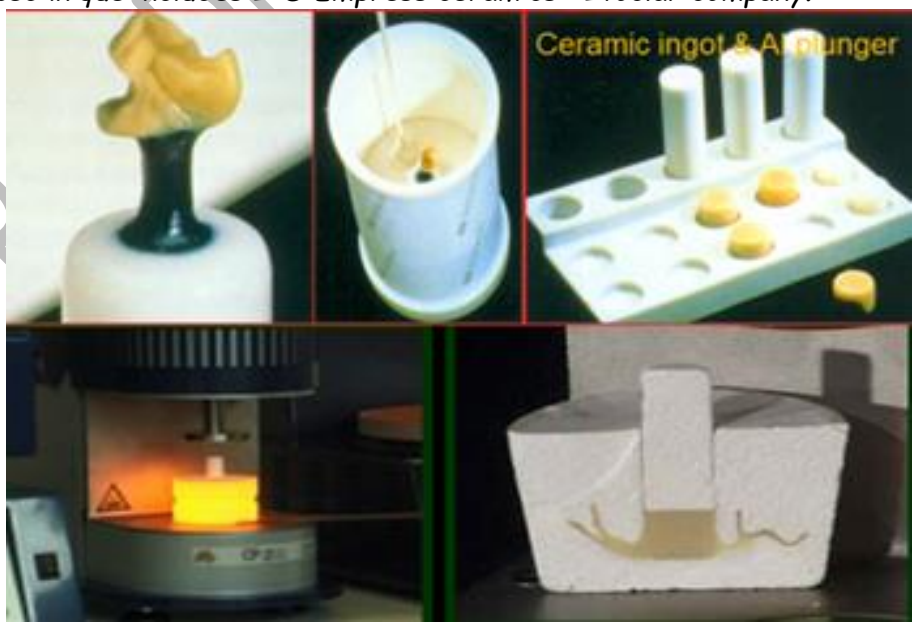
2. *Infiltrated ceramic (SLIP-CASTING TECHNIQUE)*

This technique involves the application of ceramic slurry to a porous refractory die which leads to compaction of the particles and creation of a porous infrastructure core by slip casting, which is sintered and then infiltrated with a lanthanum-based glass, producing two interpenetrating continuous networks: a glassy phase and a crystalline infrastructure (Powder is used to form a porous crystalline core by fusion of Metallic particles at high temperature, then, A Glass coat is then fused over the porous slip to infiltrate (at high temperature) into the pores (porous substrate) to give high strength restoration).Veneering porcelain is then required to provide the desired shade and contour



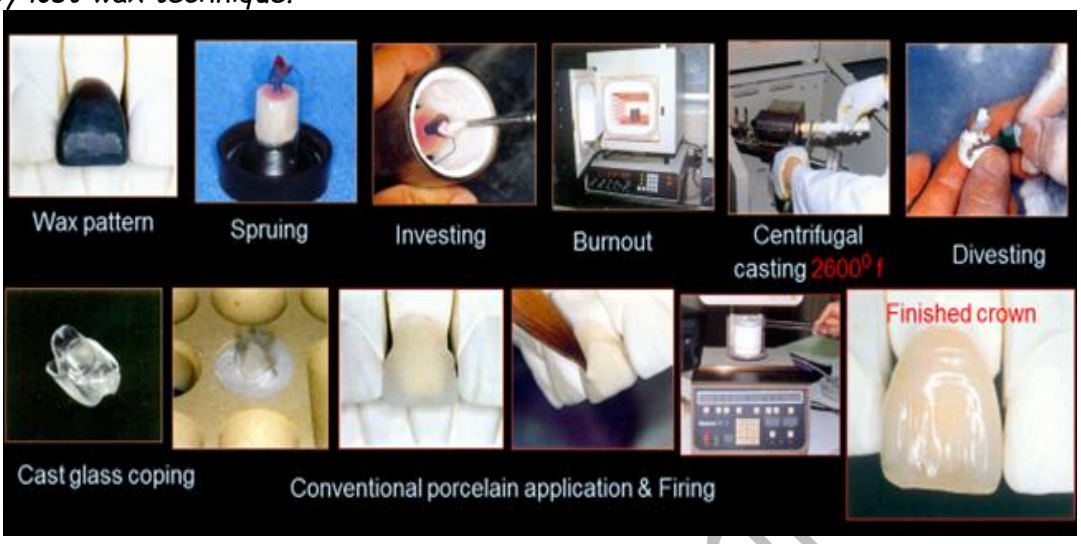
3. *Pressable ceramic (HOT-PRESSING TECHNIQUE)*

Because this method is based on the application of external pressure at high temperatures to produce the restoration, it is also known as the hot-pressing technique. The restoration fabricates by injection or pressing the molten ceramic material into a mold cavity made by lost wax technique (after waxing and investing). The first generation of heat-pressed dental ceramics contains leucite as reinforcing crystalline phase. The second generation is lithium disilicate-based. An example of the commercially available products used with the press technique includes IPS Empress ceramics—Ivoclar company.



4. *Castable ceramic*

The restoration fabricates by casting technique, to cast the molten ceramic material (the product supplied as a solid ceramic block) into previously prepared mold cavity that made by lost-wax technique.



5. Machinable ceramic

Mechanical processing (milling) of ceramic is a gradual removal of the material with rotating multi-bladed instruments (cutters or diamond heads), their cutting edges are in the interrupting contact with the processed material.

A. Copy milling technology

A resin pattern is directly fabricated on the prepared tooth or on the master die, scanner was then used to scan the pattern, the pattern was then used as a copping guide for the milling machine

B. CAD/CAM system (computer aid machine / computer aid design)

Computer aided design and computer aided manufacturing (CAD/ CAM) technologies. The prepared tooth is optically impressed (pictured using intra-oral camera). The restoration is design over that image by the aid of computer……Then Ceramic blocks are carved into restorations by the aid of computer-controlled milling machine