

# Prosthodontics (Crown & Bridge)



Lecture  
Crown construction

# Purposes of crown construction

- 1. To restore the grossly damaged tooth, fractured tooth or a tooth with a heavy filling (amalgam or composite).
- 2. To restore the masticatory function and speech.
- 3. To restore the esthetic (hypoplastic condition whether heredity defect or acquired defect).
- 4. To maintain the periodontal health by re-contouring the occlusion and prevents food impaction.
- 5. To alter the occlusion (occlusal relationship) as a part of occlusal reconstruction to solve occlusal problems or to improve function.
- 6. As a retainer for the bridge.

# Steps in the crown construction

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

# Steps in the crown construction

- Note: Steps (1-4, and 11) are clinical steps, while steps (5-10) are laboratory steps carried out in the lab by the laboratory technician.
- Note: The steps mentioned above concern the fabrication of cast restorations which are restorations made entirely from metal or a combination of metal and plastic material. All ceramic restorations are fabricated using other laboratory procedures such as CAD/CAM (Computer Aided Design / Computer Aided Manufacturing).

# 1. Diagnosis

- The first step should be the diagnosis of the case whether it is indicated for crown and bridge work or not. This is decided after a thorough examination of the tooth and surrounding structures, which includes:
- **(a) Periodontal Examination:** The patient should have proper oral hygiene to ensure that no plaque accumulation would occur on the crown margins which might lead, if left, to caries.
- **b) Dental examination:** which includes:
- *-Visual examination:* we should examine the occlusion of the patient, the presence of crowding, spacing, rotation of teeth, tilting (drifting) and supra-eruption of the abutment tooth (or teeth).

# 1. Diagnosis

- **(b) Dental examination:** which includes:
  - Meanwhile, the condition of the remaining tooth structure, the presence of caries and the quality of existing old fillings in the abutment tooth (or teeth) all should be checked.
  - *-Radiographic examination:* The radiograph reveals the shape and number of the roots, the condition of the surrounding structures, and the bone support of the tooth (crown/root ratio). The ideal crown/root ratio of a tooth to be used as an abutment for fixed partial denture is 1:2.
  - The radiograph also reveals the presence of a lesion in the bone, root canal treatment, fracture in the tooth or root, bone loss, un-erupted teeth, etc...These information will affect the prognosis of the treatment.

## 2. Tooth Preparation

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

# Objectives of tooth preparation

The main objectives of tooth preparation in fixed prosthodontics include:

- 1-To eliminate undercuts from the axial surfaces of the tooth.
- Note: The axial surfaces are the facial (labial or buccal), proximal (mesial and distal), and palatal (lingual).
- 2-To provide enough space for the crown restoration to withstand the force of mastication. This space depends on the material used; metal needs little space, while plastic materials need more space.
- 3-Not to enlarge the size of the tooth.
- 4-To provide good esthetic.



# Disadvantages of crowns

- 1. Heat generation during the cutting procedure of the teeth might affect the health of the pulp; therefore, water coolant must be used during the preparation procedure.
- 2. Over preparation can cause pulp irritation or even pulp exposure which might lead to death of the pulp. Excessive tooth preparation can also weaken the tooth structure.
- 3. Periodontal problems: food impaction with subsequent gingivitis and periodontal pocket formation and secondary caries might develop.

# Finishing line of the preparation (FL)

- Finishing line of the preparation is a line that separates between the prepared and the unprepared tooth portions. It represents the end margin of our preparation. It should be smoothly continuous from one surface to the other; otherwise, it will interfere with seating of the crown if it is poorly done.
- Requirements of FL
  - 1. It must be clear, smooth and well defined.
  - 2. It must be continuous from one surface to the other.
  - 3. It must lie on sound tooth structure.

# Finishing line of the preparation (FL)

## Finishing line types (configuration)

- 1. Feather edge (knife edge).
- 2. Chamfer.
- 3. Heavy chamfer.
- 4. Shoulder (Butt shoulder).
- 5. Shoulder with bevel.
- 6. Radial shoulder.

The selection of certain type of finishing line depends on:

- 1. The materials used to construct the restoration.
- 2. The position of the tooth.
- 3. The tooth aspect to be prepared.

# Finishing line of the preparation (FL)

## Position of finishing line

- **1. With the level of free gingival margin.**
- **2. Supra gingival finishing line:** it's better to place the finishing line supra-gingivally for the following reasons:
  - A. Easy to be prepared and finished by dentist without trauma to the soft tissues.
  - B. Patient can keep it clean easily.
  - C. Impression is easily made and can be removed without tearing or deficiency.
- **3. Sub-gingival finishing line:** indicated in
  - A. Esthetic.
  - B. Caries or filling at the area of finishing line.
  - C. To increase retention of short teeth.

# Finishing line of the preparation (FL)

## 1. Feather edge (knife edge)

- A pointed end tapered fissure bur (long needle diamond fissure bur) is used to provide this type of margin design.
- It forms  $>135^\circ$  cavo-surface line angle.
- In this type, all convexities coronal to the gingival margin are removed only.
- It is the least acceptable type, but it was advocated already before the development of high speed cutting instruments and improvement of impression materials and techniques.

# Finishing line of the preparation (FL)

## 1. Feather edge (knife edge)

### • Advantages of knife edge finishing line:

- 1. It is the most conservative type of finishing line, since the least amount of tooth structure is removed.
- 2. It provides the best marginal seal.
- 3. It is easy to prepare.
- 4. It is a burnishable type of finishing line. i.e. it provides a burnishable margin. Burnishing is the further adaptation of the margin of metal restoration to the tooth structure.

# Finishing line of the preparation (FL)

## 1. Feather edge (knife edge)

- **Disadvantages of knife edge finishing line:**
  - 1. Difficult to be identified by the laboratory technician (difficult to locate on the cast).
  - 2. It provides a thin margin that is difficult to accurately fabricate wax pattern and cast.
  - 3. The margin of the restoration is susceptible to distortion, since this type of margin design does not provide enough thickness for the material (this margin type is weak, it lacks strength).

# Finishing line of the preparation (FL)

## 1. Feather edge (knife edge)

- **Indications of knife edge finishing line:** It is mainly used for:
  - 1. Full metal crown (all the surfaces).
  - 2. The lingual and proximal surfaces of full veneer crown, three-quarter crown and post crown.



# Finishing line of the preparation (FL)

## 2. Chamfer finishing line:

- This type is prepared with a tapered round-ended fissure diamond bur.
- It is a well-defined finishing line somewhat like knife edge finishing line, except that the cut is made deeper. It forms a  $130-160^\circ$  cavo-surface line angle.
- It is regarded as the line of choice for most veneer cast metal restorations and lingual margins of porcelain fused to metal restoration.
- It has been shown to exhibit the least stress.

# Finishing line of the preparation (FL)

## 2. Chamfer finishing line:

- It provides adequate space at the cervical region, so it can make the contour of the crown restoration within the contour of natural tooth without over-contouring of the final restoration. However, the restoration margin obtained with this type of finishing line is thick, so it is unburnishable.
- This type of finishing line is indicated for areas to be covered by metal only as the knife edge finishing line, so it is mainly used for:
  - 1. Full metal crown (all the surfaces).
  - 2. The lingual and proximal surfaces of full veneer crown, three- quarter crown and post crown.

# Finishing line of the preparation (FL)

## 3. Heavy chamfer finishing line

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

# Finishing line of the preparation (FL)

## 4. Shoulder finishing line (Butt shoulder):

- This finishing line is prepared with flat-end tapered diamond fissure bur.
- It is very well defined finishing line, so it is easily detected on the cast.
- In the "butt" type of shoulder finishing line, the axial walls meet the finishing line at a right angle.
- The wide ledge provides resistance to occlusal forces and minimizes stresses that might lead to fracture of the restoration.

# Finishing line of the preparation (FL)

## 4. Shoulder finishing line (Butt shoulder):

- It is the least conservative type due to the excessive amount of tooth structure removed to obtain this type of finishing line. So, it is regarded as the best choice for jacket crowns.
- This type of finishing line is used when bulk is required for strength or esthetic. That is why it is almost used with jacket crown, since jacket crown is made of either porcelain or acrylic resin, which are brittle materials and require enough thickness to withstand the occlusal forces without fracture. On the other hand, the increased thickness provides better shade of the material, so better esthetics.

# Finishing line of the preparation (FL)

## 5. Shoulder with bevel:

- It is a modification of the shoulder finishing line by adding a bevel to the shoulder. The bevel is at  $45^\circ$  angle.
- In this type, we create a bevel on the end margin of unprepared tooth structure, this lies between the prepared and unprepared tooth structure and it is very critical area.

# Finishing line of the preparation (FL)

## 5. Shoulder with bevel:

### • Objectives of shoulder with bevel finishing line

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

### • Indications of shoulder with bevel finishing line

- 1. It is indicated when we use a combination of metal with facing material (acrylic or porcelain) as in full cast veneer crown, where it is used for the labial or buccal surface.
- 2. Shoulder with bevel is recommended for extremely short walls, since the axial walls of this type are nearly parallel to each other which enhances the retention.

# Finishing line of the preparation (FL)

## 6. Radial shoulder finishing line

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



# Biomechanical principles of tooth preparations

The designs and preparations of a tooth for a cast metal or porcelain restorations are limited by five principles:

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

# Biomechanical principles of tooth preparations

## 1. Preservation of the tooth structure

The preparation of the tooth must be conservative, the minimal amount of the tooth structure must be removed. Excessive removal of the tooth structure has many harmful effects:

- Excessive reduction lead to thermal hypersensitivity, pulpal inflammation and necrosis may result from approaching to the pulp closely.
- The tooth might be over tapered or shortened and this might affect the retention and resistance of the prepared tooth.

# Biomechanical principles of tooth preparations

- **2. Retention and resistance form**
- **Retention:** is the ability of the preparation to resist the crown restoration removal or dislodgment along its path of insertion.
- **Resistance:** is the ability of the preparation to resist the dislodgment of the restoration by forces directed obliquely or horizontally to the restoration.
- **Path of insertion:** An imaginary line along which the restoration can be inserted and removed without causing lateral force on the abutment.

# Biomechanical principles of tooth preparations

- The crown restoration should have a single path of insertion to be retentive. Most of the time the path of insertion of crown restorations is parallel to the long axis of the tooth except in  $\frac{3}{4}$  crown for anterior teeth where the path of insertion should be parallel to the incisal  $\frac{2}{3}$  of the tooth crown (not to the long axis). By limiting the path of withdrawal, retention is improved. A preparation with unlimited freedom of displacement is much less retentive.

# Biomechanical principles of tooth preparations

## Factors affecting retention and resistance:

- a- Taper of the preparation.
- b- Surface area of the preparation,
- c- Length and height of the preparation.
- d- Diameter of the tooth (tooth width).
- e- Texture of the preparation.
- f- Accessory mean.

# Biomechanical principles of tooth preparations

- **a- Taper of the preparation**
- Convergence angle is the angle that is formed between each two opposing axial walls of a tooth prepared to receive a crown restoration. It determines the convergence (taper) of the prepared tooth.
- The magnitude of retention depends on the degree of this angle, the greater the taper the less the retention. The degree of the convergence angle is one of the factors that determine the amount of axial and non-axial forces which can be tolerated without leading to loss of the crown restoration.

# Biomechanical principles of tooth preparations

- **a- Taper of the preparation**
- The more nearly parallel the opposing walls of preparation the greater will be the retention, but parallel walls is difficult to be obtained in the patient mouth without undercuts. Also parallel walls might lead to difficulty in seating of the crown restoration.
- Therefore, (5-6) degree convergence angle is mostly used to provide the needed retention.
- The more parallel the axial walls the more will be the resistance of crown restoration. The walls of a short wide preparation must be kept nearly parallel to achieve adequate resistance from.

# Biomechanical principles of tooth preparations

- **b- Surface area of the preparation:**
- Increasing the surface area increase retention. Factors that influence surface area are:
  - - Size of the tooth: The larger the size of the tooth the more will be the surface area of the preparation, the more will be the retention. For example, full metal crown on molar tooth definitely more retentive than that on premolar tooth.
  - - Extend of coverage by restoration: The more the area that will be covered by the crown restoration, the more will be the retention. For example, full metal crown on molar is more retentive than 3/4 crown on the same tooth.
  - - Accessory feature such as grooves and pin holes, and boxes.



# Biomechanical principles of tooth preparations

- **c. Length (height) of the preparation:** Increasing the length increase retention and resistance and vice versa.
- **d. Diameter of the tooth (tooth width):** Under some circumstances, crown on narrow tooth can have greater resistance to tipping than a crown on a wider tooth, this occur because the crown on the narrower tooth has shorter radius for rotation resulting in a lower tangent line and a larger resisting area.
- **e. Texture of the preparation:** Depending on the type of luting agent, texture of the preparation might effect on the retention of cast crown. Smooth surfaces are less retentive than rough surface (mechanical interlocking).
- **f. Extra retention means:** The retention of a preparation can be greatly enhanced by the addition of grooves, pin holes or boxes.

# Biomechanical principles of tooth preparations

- **3- Structural Durability (SD):**
- The preparation must be designed so that it provide SD to the restoration, i.e. the crown restoration must be rigid enough to not flex, perforate (metal) or even fracture (plastic).
- For a restoration to be rigid it need bulk, so to provide enough bulk to the crown restoration, sufficient tooth structure must be removed from the prepared tooth to create enough space. By doing so the restoration allowed to withstand the forces of occlusion, prevent wearing holes in the gold and allow proper contouring and carving of the restoration.

# Biomechanical principles of tooth preparations

- **Preparation features related to structural durability**
- **a- Occlusal reduction.**
- Enough tooth structure must be removed from occlusal surface, so that the restoration can be built back to ideal occlusion and thick enough to prevent wearing or distortion (1-1.5mm).
- **Occlusal clearance:** is the space between the occlusal surface of the prepared tooth and that of opposing tooth. It should be evaluated in centric and eccentric relation.

# Biomechanical principles of tooth preparations

- **Functional cusps:** The cusps that give centric stops of occlusion. (Palatal of upper posterior teeth and buccal of lower posterior teeth).
- Occlusal reduction must reflect the geometric inclined planes of occlusal surface, the so called "planar occlusal reduction" or "anatomical occlusal reduction".
- Avoid creating steep planes with sharp angles, because it lead to stress.
- Flat occlusal reduction lead to thin metal, this will lead to perforation of the crown restoration in future.

# Biomechanical principles of tooth preparations

- Lowering the entire occlusal surface in attempt to providing sufficient space might lead to tooth structure destruction (non-conservative preparation) which interferes with the first principle of tooth preparation which is the conservation of tooth structure. In addition, it will shorten the axial walls of the prepared tooth which definitely will affect the retention-resistance features of the preparation.

# Biomechanical principles of tooth preparations

- **Functional cusp bevel (FCB)**
- Wide bevel should be placed on the functional cusps of posterior teeth to provide structural durability (it allow adequate thickness of restoration at this critical area without structure destruction).
- If FCB is omitted, the restoration is likely to be thin in this stress bearing area. If the restoration thickness is achieved by over tapering, this will compromise the retention.
- In the absence of FCB, the technician will overbuild the crown restoration in attempt to provide structural durability for the restoration this will lead to super-occlusion or premature contact with the opposing tooth.

# Biomechanical principles of tooth preparations

- **2- Axial reduction.**
- Sufficient reduction is important to provide sufficient space, so that the restoration can be built with sufficient thickness, this will prevent flexing of the crown restoration when occlusal force act on.

# Biomechanical principles of tooth preparations

## 4. Preservation of the periodontium

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

- (a) Whenever possible, the margin of the preparation should be placed supra-gingivally.
- (b) The crown restoration should have proper contact, embrasure form, occlusion and a healthy occluso-gingival contour.



# Biomechanical principles of tooth preparations

- The finishing line of the preparation can be placed either supra-gingivally, sub-gingivally, or equ-gingivally (with the level of the gingiva). Placing the margin of the preparation above the gingival tissue offers the following advantages:
- a- Can be easily prepared and finished by the operator.
- b- To provide good vision for the operator during preparation.
- c- The impression can be easily made.
- d- The patient can keep the area clean more easily.
- e- Most of the time such a position is situated on hard enamel.
- f- Less destructive.

# Biomechanical principles of tooth preparations

- So, it is better to place the margin of the preparation supra-gingivally whenever possible. However, there are some situations which require sub-gingival placement of the finishing line as listed below:
- a- For esthetic.
- b- When we need extra retention as in teeth with short crowns.
- c- When there is caries or filling at the area of finish line (the preparation margin should be placed on sound tooth structure).

# Biomechanical principles of tooth preparations

## 5. Marginal Integrity

- The restoration can survive in the biological environment of the oral cavity only, if the margin is closely adapted to the preparation margin. The configuration of the finishing line determines the shape and bulk of the restoration margin that will affect both marginal adaptation and the degree of seating of the restoration. The restoration margin should have the following requirements:
- (a) It must fit as closely as possible against the finishing line of preparation.
- (b) It must have sufficient strength.
- (c) Whenever possible, it should be placed in an area where the dentist can finish easily and the patient can clean properly.



Thank you