Prosthodontics (Crown & Bridge)

Lecture

Failures in crown and bridge

Failures in crown and bridges

- Failure in crowns and bridges should be regarded as a disadvantages and balanced against their advantages. Some bridges are failed from the day they inserted, while others last over 40 years. So, Patient complaint might be immediate or delayed.
- Every dentist would like to be able to answer the patient questions: how long will the crown or bridge last?
- Because crown and bridge are a custom-made device of a daily use and perform their service in a hostile biological environment submerge in water (saliva), so the failures are more liable to occur.
- For purpose of discussion the reasons for failure of fixed prosthesis may be divided into biological and mechanical problems.
- In general, the mechanical are more directly under the control and influences of clinician, while the biological problems are not easily controlled and in some instances may be unrelated to the prosthesis.
- However, it is true and in many time, the biological problems may be a consequence of the treatment procedure (pulpal) or of the restoration itself (periodontal or caries).

Failures in crown and bridges

- **Manifestations of failure**
- Failure might manifested itself in one or more of following patient complaint:
- 1. Pain.
- 2. Inability to function.
- 3. Dissatisfaction with esthetic.
- 4. Broken teeth and/or restoration.
- 5. Inflammatory swelling.
- 6. Bad taste.
- 7. Bad breath.
- 8. Bleeding gums.
- 9. Anxiety.

Failures in crown and bridges

- **Causes of failure**
  - 1. Improper case selection.
  - 2. Faulty diagnosis and treatment plan.
  - 3. Inaccurate clinical or laboratory procedures.
  - 4. Poor patient care and maintenance following insertion.
- **Classification of Failure according to the stage:**
  - 1. Before preparation.
  - 2. During teeth preparation.
  - 3. During construction.
  - 4. During cementation.
  - 5. After cementation.
- **Classification of failure according to the problem:**
  - A) Biological problem.
  - B) Mechanical problem.

A) Biological problem

- **I. Caries or recurrent caries problem:**
- It is the most common cause of failure of fixed restorations.
- Its detection is very difficult whether clinically or radiographically particularly with complete coverage crown.
- The caries is often detected only after irreversible pulp involvement had resulted.
- Disease may rapidly progress to the point, where tooth loss or the fabrication of a new prosthesis becomes inevitable.
- The cause of the problem should be identified, dealt with before repair or replacement is started.
- **Causes**:
- 1- Open and over or under extended margin (short or long margin). In this situation, fluid seepage could occur here which leads to dissolution of cement that give an area for food debris impaction this definitely results in caries.

A) Biological problem

- **I. Caries or recurrent caries problem:**
  - a- Over extension of the margin, will cause plaque formation and periodontal problem due to resorption of the cement which closes the space between the cast and teeth.
  - b- Short casting will leave rough cementum or dentin which cause collection of debris.
  - c- Open margin will allow the saliva and cariogenic organisms to enter between the tooth and the restoration.
- 2- Perforation of restoration (structural durability). Wear of the cast will cause resorption of the cement, exposure of the tooth surface which cause caries later on.
- 3- Looseness of one of the retainers. Loss of retention as a result of marginal seepage.
- 4- Using a wrong type of retainer.
- 5- High risk patient (high caries index), because of poor oral hygiene of the patient.
- 6- Reduced salivary flow.

A) Biological problem

- **II. Pulpal injury problem**
- Pulpal problem is not uncommon complication in bridge work.
- Great care is needed to prevent pulp injuries during fixed prosthodontic procedures .
- It might be the outcome of microbial, chemical, mechanical and thermal irritation.
- It should be always expected that it is most often associated with small teeth. In favor of structural durability and periodontal health a massive reduction is necessary, so good evaluation is important.
- In teeth with questionable pulp, it is preferred to do root canal treatment for them, in these teeth pulpal pain and discomfort should expected to last sometime to six months.
- To verify pulpal pain vitality test should done.
  - 1. Full crown--------thermal.
  - 2. Partial crown -------electrical.
  - 3. Radio graphical-------to see periapical whether infected or not.

A) Biological problem

- **II. Pulpal injury problem**
- **Causes:**
- **1**- Overheating and heat generation (temperature during tooth preparation).
  - **a)** Lack of coolant.
  - **b)** Very high speed.
  - **c)** Insufficient bur.
  - **d)** direct temporary crown.
- **2**- Improper or absence of temporary protection (temporary cement).
- **3**- Irritating cementing agent (chemical irritation by dental material).
- 4- Traumatic occlusion (mechanical irritation).
- 5- Recurrent caries (microorganisms). Recurrent caries under full crown (microbial irritation).
- 6- Over reduction, insufficient tooth structure to protect pulp or microscopic pulpal exposure. More reduction of tooth structure without provisional restoration.
- So, every one of the above can cause irreversible pulpits.

A) Biological problem

- **III. Periodontal and soft tissue problems**
- Periodontal disease may be generalized, or its progress may be accelerated locally in a poorly designed, made or maintained restoration.
- If the loss of periodontal attachment is diagnosed early enough and the cause removed, so usually no further treatment is necessary.
- However, if the disease has progressed to the point where the prognosis of the tooth significantly reduced then the crown or bridge, or the tooth itself may have to be removed.
- Periodontal breakdown may lead to loss of abutment. Patient suffer from:
  - 1- Mobility of abutment.
  - 2- Periodontal pocket formation.
  - 3- Periodontal abscess.
  - 4- Pain which prevent mastication at the side of restoration.
  - 5- Bad odor and taste.

A) Biological problem

- **III. Periodontal and soft tissue problems**
- **Causes:**

- 1- Over contouring of crown (over margin which lead to a pressure on the gingiva).
- 2- Insufficient interproximal clearance, reduction or over-contour (deficient interproximal contact). Failure of contact can lead to food impaction.
- 3- Irregular or rough edges of crown might cause irritation to the gingival tissue. (coarse or rough margins, not smooth). Thick margins with poor seating of the restoration and poor axial contour that will ultimately cause periodontal problem.
- 4- Improper connector design (increased cervico-occlusal length of connector).
- 5- Improper tissue pontic relation (saddle design). Improper pontic design can lead to continuous food accumulation and soft tissue pressure.
- 6- Position of the crown margin (overextended sub-gingival positioning of finish line). sub-gingival margin may have better appearance initially, but will often have a degree of gingival inflammation which may lead to more serious periodontal disease.
- 7- Ill-fitting crown might cause irritation to gingival tissue.
- 8- Presence of foreign body irritating soft tissue.
- 9- Remnants of excessive cementing material.

A) Biological problem

- **IV. Fracture of the abutment tooth (prepared natural crown or root)**
- **Causes:**
- 1- Trauma.
- 2- Recurrent caries.
- 3- Removing the prosthesis intact with using large force.
- 4- Tooth structure is thin, especially with pulpless teeth (so the post core is necessary).
- 5- Over reduction and tooth heath state might be the cause.

A) Biological problem

- **V. Discomfort of the patient, pain or sensitivity.**
  - **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)** Retention of food on occlusal surface (poor design).
  - **d)** Traumatic occlusion.
    - 1. Faulty construction such as:
      - occlusal surface with high marginal ridge .
      - or deep incline plan.
    - 2. Faulty diagnosis and treatment plan such as:
      - Use of teeth that lack of alveolar support.
      - Overloading of abutment.
      - Premature contact.

A) Biological problem

- **V. Discomfort of the patient, pain or sensitivity.**
  - **e)** Poor contouring of the retainer and pontic.
    - 1. Over-contour will lead to over -protection and under stimulation.
    - 2. Under-contour will lead to under -protection and over stimulation and will lead to gingival tissue trauma.
  - **f)** Sensitive cervical margin to hot or cold application.
    - 1. Long margin that might cause gingival recession.
    - 2. Over displacement of gingiva.
    - 3. Temporary restoration with long margin cemented for long period of time.
    - 4. Retainer with short or open margin.
  - **g)** Seating failure.
    - 1. Too thick cement.
    - 2. Insufficient pressure during cementation.

B) Mechanical problem

- **I- Loss of retention (looseness of crown or bridge)**
- When only one retainer becomes loose (without a cement seal), so plaque forms in the space between the retainer and the abutment tooth. So, caries develops rapidly across the whole of the dentine surface of the preparation.
- A good diagnostic test for a loose retainer is to examine the bridge carefully without drying the teeth, pressing the bridge up and down and looking for small bubbles in the saliva at the margin of the retainers.
- **Causes:**
- 1- Inadequate tooth preparation. Poor retention because of inadequate preparation or faulty preparation (for example, convergence angle, length and surface area).
- 2- Solubility of the cement due to open margin or perforation in the bridge.
- 3- Too much spacer materials on the die.
- 4- Faulty cementation (bad technique of cementation). The causes of inadequate cementation might be due to:

B) Mechanical problem

- **I- Loss of retention (looseness of crown or bridge)**
  - a. Poor mixing of cement or using improper ratio.
  - b. Failure to have a dry field (inadequate isolation).
  - c. Poor seating.
  - d. Type of cement.
  - e. Not removing any remnants that interfere with retention.
  - f. Movement of the patient during cementation.
- 5- Faulty restoration
  - a. Open or overhang margin.
  - b. Wear or perforation.
- 6- Deformation of restoration (structural durability). Deformation of the metal cast on the abutment teeth.
- 7- Premature contact (torque).
- 8- Caries (caries which cause leakage at the margin).
- 9- Poor retainer design selection such as ceramic crown in state of fused metal restoration.

B) Mechanical problem

- **II– Failures of crown and bridge components:**
- Typical mechanical failures are:
- 1- Porcelain fracture. 2- Distortion or fracture (Faulty structural durability of restoration). 3- Occlusal wear and perforation. 4- Failure of solder joints. 5- Lost facings. 6. Marginal deficiencies of restoration. 7. Design failure. 8. Inadequate clinical or laboratory technique.

B) Mechanical problem

- **II–Failures of crown and bridge components:**
- **1. Porcelain fracture**
  - **a.** Ceramic crown……
    - 1. Faulty laboratory technique such as improper condensation , air bubbles, inadequate firing, faulty protocol for cad cam crown.
    - 2. Faulty preparation.
  - **b.** Porcelain fused to metal……
    - 1. Faulty technique (poor coping design).
    - 2. Metal framework flexing.

B) Mechanical problem

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

B) Mechanical problem

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

B) Mechanical problem

- **2. Distortion or fracture.**
- Distortion of all metal bridges may occur. For example, hygienic pontics are made too thin, or if a bridge removed using too much force. When, this happens, the bridge has to be remade.
- In metal-ceramic bridges distortion of the framework can occur during function, or as result of trauma. This is likely if the framework is too small in cross section, the length of span, and the material used.
  - **a-Retainer failure:**
    - 1. Perforation.
    - 2. Marginal discrepancy.
    - 3. Veneering separation, fracture or wearing.
  - **b- Pontic failure:**
    - 1. Pontic fracture (porcelain) with unfavorable occlusal load.
    - 2. Limited occluso-cervical height due to over eruption.

B) Mechanical problem

- **3. Occlusal wear and perforation.**
  - a) Insufficient occlusal preparation lead to less thickness of the metal and this may lead to perforation, which may occur in the finishing and polishing.
  - b) Even with normal attrition, the occlusal surfaces of teeth wear down substantially over a lifetime.
- If perforation has been the result of normal wear and it is spotted before caries has developed, it may be repaired with an appropriate restoration.

B) Mechanical problem

- **4- Failure of solder joints**
- Occasionally a solder joint that appears to be sound fails under occlusal loading, this may be due to:
  - a. A flaw or inclusion in the solder itself.
  - b. Incorrect selection of solder.
  - c. Failure to bond to surface of the metal.
  - d. Improper designing of connector size and position. The solder joint not being sufficiently large for the conditions in which it is placed. Thin metal at the connector.
  - e. Porosity.
- A problem, particularly with metal-ceramic bridge work, is that too much restriction of the solder connectors, buccally, gingivally and incisally can lead to inadequate area of solder joint.
- It is better to join multiple unit bridges by solder joints in the middle of pontics before the porcelain is added, strengthened by porcelain covering.
- There are no satisfactory intraoral repair methods, and it is not possible to re-solder. So, the whole bridge has to be remade.

B) Mechanical problem

- **5- Lost facings.**
- Laboratory made ceramic or acrylic facing may be entirely lost.
- With acrylic facing, wear and discoloration are also common.
- Causes:
  - a. Poor retention.
  - b. The facing is not protected by the metal completely.
  - c. Heavy occlusion on the facing.

B) Mechanical problem

- **6. Marginal deficiencies of restoration**
- **Causes:**
  - a) Poor preparation (ill-defined finishing line).
  - b) Impression with ill-defined margin of preparation (not clear).
  - c) Technical faults.
  - d) Cementation errors.
- **7. Design failure**
- a. In-adequate abutment preparation design.
- b. In-adequate bridge design.
  - 1. Under prescribed bridge design.
  - 2. Over prescribed bridge design.

B) Mechanical problem

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

B) Mechanical problem

- b. In-adequate bridge design.
- Designing bridges is difficult, it is neither a precise science nor a creative form of art. It needs knowledge and experience judgment which take years to accumulate. Simple classification of these failures are:
- 1. Under prescribed bridge design.
- This includes designs that are unstable or have too few abutment teeth. For example, a cantilever bridge carrying pontics that cover too long span, or a fixed-movable bridge where again the span is too long, or where abutment teeth with too little support has selected.

B) Mechanical problem

- b. In-adequate bridge design.
- 2. Over prescribed bridge design.
- The dentists sometimes include more abutment teeth than necessary which may fail. For example:
  - The 1st lower premolar might be included as well as the 2nd premolar with the 2nd molar in a bridge to replace the lower 1st molar. This is not necessary.
  - Upper canines and both premolars on each side are replacing the four incisors. This is destructive, or it gives rise to unnecessary practical difficulties in making bridge.
  - The retainers themselves may be over prescribed with complete crowns being used, where partial crowns or intra-coronal retainers would have been quite adequate. Metal-ceramic crowns might be used where all metal crowns would have been sufficient.

B) Mechanical problem

- **8. In-adequate clinical or laboratory technique**
- It is helpfully to allocate problems in the construction of crowns and bridges to one of three groups: Minor problems to be noted and monitored, but where on action is needed, the type of inadequacies that can be corrected in site, and those that can not.
- a- Marginal deficiencies:
- 1- Positive ledge (overhang): A positive ledge is an excess of crown material protruding beyond the margin of the preparation. These are more common with porcelain than any other margins. This easy to recognize and correct before the crown cemented other-wise disturbing the restoration.

B) Mechanical problem

- 2-Negative ledge:
- This is deficiency of crown material that leaves the margin of the preparation exposed, but with no major gaps between the crown and the teeth. It is a fairly common fault, particularly with metal margins, but that is difficult or impossible to correct at the try in stage.
- **Causes:**
  - 1- The impression did not give a clear enough indication of the margin of the preparation.
  - 2- The die was over-trimmed, resulting in under-extension of the retainer.
  - 3- The die is not separated.
- Supra-gingival margin or just at the margin. It is possible to adjust the tooth surface of the crown.
- Sub-gingival margin can be adjusted with a pointed stone, although this will cause gingival damage. However, the best solution is to remade the restoration.

B) Mechanical problem

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

Failures in crown and bridges

- c - Poor shape or color (esthetic problems):
- 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:
  - 1. Improper shade selection (inaccurate shade selection).
  - 2. A common mistake in preparing upper incisors for crowns is to remove insufficient material (insufficient tooth reduction) from the buccal\ incisal third of the preparation. These result in either a crown that is too thin, so that the opaque core material shows through, or in a bulbous crown.
  - 3. Too much adjustment is done, the incisal shade of porcelain will be ground away and the esthetic effect spoiled.

B) Mechanical problem

- c - Poor shape or color (esthetic problems):
  - 4. The stone should be held perpendicular to the junction otherwise the metal particles may contaminate the porcelain.
  - 5. Poor harmony between restoration and natural adjucent teeth (improper contour might be the fault of dentist or lab technician).
  - 6. Failure to mask metal color or insufficient thickness of porcelain.
  - 7. Absence of the embrasures will recognize the teeth as artificial.
  - 8. Excessive glazed anterior teeth will look un-natural.
  - 9. Irregular and rough surface will lead to discoloration.
  - 10. Un necessary metal display.
  - 10. Improper cement selection.

B) Mechanical problem

- c- Poor shape or color (esthetic problems):
- Any problem in the waxing may create a problem on the final restoration such as:
  - 1. When the wax pattern left on the die lead to distortion, because stresses occur in the wax as a result of the heating and manipulation of the wax during fabrication.
  - 2. Wax pattern should be over sized slightly mesiodistally, finished and polished without creating an open contact in the finished restoration.
  - 3. Most common error relating to axial contour is the creation of bulge or excessive convexity leading to accumulation of food debris plaque causing gingival inflammation, which is encouraged rather than prevented.
  - 4. During the margin finishing, don't approach the finishing line on the die with sharp instrument that can remove die material causing the final restoration will not fit on the prepared tooth. The margin is a critical area of any wax pattern.
  - 5. Any roughness in the wax near the margin lead to plague, irritation and inflammation of adjacent gingival tissues.

B) Mechanical problem

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

B) Mechanical problem

- e. Defects in the casting:
- 1- Nodules: bubbles of gas trapped between the wax pattern and the investment produce nodules on the casting surface. When they are large or situated in a margin, the restoration should be remade.
- 2- Fins: are caused by cracks in the investment that have been filled with molten metal. These cracks can result from:
  - a. Weak mix of investment (high water\ powder ratio)
  - b. Excessive casting force.
  - c. Steam generated from the rapid heating.
  - d. Reheating invested pattern.
  - e. Improperly situated pattern (too close to the periphery of the casting ring).
  - f. Premature rough handling of the ring after investing.

B) Mechanical problem

- e. Defects in the casting:
- 3- In-completeness:
  - a- If an area of wax is too thin (less than 0.3 mm) in-complete casting may result (veneering surface of a metal ceramic restoration).
  - b- In-adequate heating of the metal.
  - c- In-complete wax elimination.
  - d- Excessive cooling (freezing) of the mold.
  - e- Insufficient casting force.
  - f- Not enough metal, or metal spillage.

B) Mechanical problem

- f- Voids or porosity
- Voids may be caused by debris trapped in the mold, commonly a particle of the investment. A well waxed small sprue will help prevent them.
- Porosity resulting from:
  - 1. Solidification shrinkage occurs, if the metal in the sprue solidifies before that in the mold, as may happen when a sprue is too narrow, too long, or incorrectly located or a large casting is made in absence a chill vent.
  - 2. Gases may dissolve in the molten alloy during melting leave porosity defects.
  - 3. Back pressure porosity may be caused by air pressure in the mold as the molten metal enters.

B) Mechanical problem

- **III. Maintenance Failure**
- 1. Poor oral hygiene and improper maintenance of a well done restoration may lead to failure of prosthesis.
- The patient should be instructed bout the maintenance which is important for success or failure. So, the patient must be fully informed about his responsibility in success or failure of restoration.
- 3. The dentist must recall the patient for periodic clinical and radiographic examination to early detect any harmful changes that might occur.

Failures in crown and bridges

- Failures can also be classified or grouped into 6 categories, with severity increasing from Class I to Class VI:
- Class I: Cause of failure is correctable without replacing restoration.
- Class II: Cause of failure is correctable without replacing restoration; however, supporting tooth structure or foundation requires repair or reconstruction.
- Class III: Failure requiring restoration replacement only. Supporting tooth structure and/or foundation acceptable.
- Class IV: Failure requiring restoration replacement in addition to repair or reconstruction of supporting tooth structure and/or foundation.
- Class V: Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Fixed prosthodontic replacement remains possible (restoration replacement) through use of other or additional support for redesigned restoration.
- Class VI: Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Conventional fixed prosthodontic replacement (restoration replacement) is not possible.

Thank you