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Review Article

Clinical failures in fixed partial denture treatment options and their relative management

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ABSTRACT:
Fixed partial prosthodontics encompasses a wide range of treatment options that are based on both prosthodontic and restorative principles. Patients expectations with fixed partial denture (FPD) treatment are generally high; therefore, failures are not well received by them. Complications in any treatment are inevitable but can be prevented by having thorough knowledge of procedures, materials, and patients conditions. This review was prepared after evaluation of literature related to FPD treatment of recent and past times on multiple databases. Failures in FPD treatment, their causes, prevention, and management have been described under biologic, mechanical, and aesthetic headings. All possible angles starting from diagnosis to follow-up have been related to each treatment option. The main causes and their prevention have been stressed. The review provides a novel insight to the practitioner, who can apply it in his daily practice to enhance treatment compliance from his patients.
Key words: partial denture fixed, post core, foundation restoration, secondary caries, tooth fracture

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INTRODUCTION

An additional health issue that arises as a result of an existing one is known as a complication. Postoperative complications are linked to increased short-term costs, with studies showing a two-to-three-fold increase in costs during hospital admission.[1] In Europe, patients with complications experienced up to five times more in-patient care costs.[2] The increased postsurgical healthcare use is significantly higher in patients with selected complications. While the first six months of most dental treatments is associated mostly with improvements, the effects may not persist throughout the follow-up. This points to a heavier cumulative demand on resources over time. Although problems might mean clinical failure has happened, that usually isn't the case. Subpar treatment could also be a contributing factor to problems.[3] But this is seldom the case, to reiterate. Issues or complications typically develop during or after properly executed fixed partial denture (FPD) prosthodontic treatment procedures.From more conventional manufacturing processes like lost wax casting to more modern ones like milling and additive manufacturing (3D printing), the laboratory fabrication of restorations has also been digitalised to overcome laboratory induced errors.[4] Before deciding that an existing restoration is flawed and needs fixing or replacing, it is important to conduct an impartial assessment of it. Minor failures are subjective and may be left alone for the time being; obvious failures, on the other hand, require immediate attention to prevent additional damage to the dentition. The periodontium plays a key role in preventing damage to teeth from occlusal stresses, bacterial invasion, and trauma.[5]Anything can go wrong at any moment. As a result, you should know the process that is required to recall the scenario and be alert to both overt and covert signs of prosthesis failure. The midline denture fracture caused by flexural fatigue failure can be caused by low-level repetitive stress induced by the improper patient use,[6]

while the blame may go on the dentist. Inadequate, improper or unprofessional clinician- technician communication and/or lack of seeking clarification regarding planned restoration is often overlooked at teaching/ practitioners levels.[7] Between treatment success and failures, there are wide range of decisions that can lead to a clinical failure in fixed prosthodontic treatment options. This review presents an indepth analysis of various factors that contribute to both sides of the spectrum. The review is based on a search of 4 medical databases (medline, pubmed, google scholar, scopus) related to clinical failures in fixed prosthodontics, yeilding more than 177 research articles of various study designs. The study objective being to bring to light the reasons associated with clinical failures in fixed prosthodontic treatment. While catastrophic mechanical failures like fractures get all the attention, it's important to keep in mind that failures can also have biologic or aesthetic causes.

Biologic Failures: Among biologic failures, secondary caries surrounding a restoration is the most prevalent. There are a few ways in which caries can impact a FPD: directly, at the retainer margins; indirectly, after cementation failure; or, thirdly, from somewhere on the tooth and spreading to the casting's fit surfaces.[8-10] Detection methods include visual inspection, probing restoration margins with a sharp explorer, and radiographs for interproximal caries.[9] Defective margins, loose retainers, incomplete caries removal, poor design, food accumulation, and patient diet change are common causes of tooth decay.Regular oral hygiene is crucial for patients with high caries index and a history of restoration carious lesions, and fluoride-containing dentifrices and mouthwashes can help prevent this issue.[5] The management of carious lesions involves conservative operative procedures, using good seal for marginal caries, and amalgam for long-term marginal seal. Resin materials or GIC may be used in aesthetic areas. Prosthesis removal is necessary for access, and preparation can be extended for small lesion cases. Large amalgam restoration may be required before prosthesis fabrication as fundation restorations. When lesions have become large under a failing retainer, the strength of the tooth can be enhanced by cast foundation restorations.[11]Pulp degeneration is characterized by persistent postinsertion sensitivity in abutment teeth, intense pain, or periapical abnormalities detected radiographically.[12] Excess heat generation during preparation, tooth reduction, potential pin point exposure, occlusal trauma, and the presence of cement can cause this issue.[5] The use of varnish or dentin bonding agent serves as a protective barrier, shielding the underlying pulp from the harmful effects of cement and core materials. Access to the pulp requires a hole in the prosthesis for treatment. Perforation can be restored with gold foil or amalgam.[13] If the retainer casting becomes loose or fractures during access cavity preparation, endodontic treatment should assess tooth structure for support and retention. If tooth structure decreases, reinforcement may be needed. If root-filled teeth cause trouble, apicectomy is the solution.[7]Tooth preparation should not shorten the abutment tooth too much. The recommendation is against indirect pulp capping as its failure could potentially endanger the existing prosthesis.

Periodontal breakdown, characterized by chronic diseases [pocket, mobility, furcation, recession], can be a generalized issue or restricted to the bridge or implant abutment.[14,15]Prosthesis hygiene issues can be caused by inadequate patient instructions, poor oral hygiene, poor marginal adaptation, overcontouring, large connectors, large edentulous ridges, rough surfaces, traumatic occlusion, and insufficient abutment selection.[7.8] Prevention involves following proper oral hygiene instructions and reviewing appointments.[5] Preparation design involves flat axial contours for easy maintenance and plaque control.[10] Treatment options include flap reflection surgeries, grafting, and correct occlusion for less severe scaling. If the abutment tooth prognosis decreases, the restoration may need to be removed.

When there is an issue with occlusal contact [centric or eccentric], it might interfere with the alignment of the teeth, leading to excessive tooth mobility. Early detection can remove these without permanent damage. However, traumatic occlusion or long-term interferences can develop tooth mobility that cannot be reversed.[16] Prosthesis removal and bilateral braced teeth may be necessary, and abutment tooth extraction may be necessary. Patients with bruxism may need guards/splints, while anterior flat ramp is better for clenchers.[17]To avoid prosthesis failure due to improper occlusion, it is recommended to selectively reshape faulty contacts and restore or replace teeth in a more favourable position to house occlusal forces. Improperly positioned pins in restorations can cause tooth perforations. It is viable to extend the tooth's preparation to wrap a perforation that is occlusal to the pulp depth. Periodontal surgery can be done to restore the perforated area or smooth off the protruding pin if it reaches into the periodontal ligament or the biologic width. Tooth extraction might be in order if getting to the location isn't an option.

MECHANICAL FAILURES

Abutment teeth deteriorate quickly when retainers are loose because of unequal occlusal loads and leverage especially in cantilever extensions,[18] which in turn accelerates the breakdown of teeth caused by saliva, plaque, and pumping action. It is important to differentiate this symptom from others that the patient may feel, including as looseness, sensitivity to heat or sugar, and a persistent foul taste or smell, which might be caused by periodontal disease or inadequate dental care. The patient might feel the bridge shifting, and to find out why, a dentist would examine it by pressing it up and down, not drying the teeth, and then using a curved explorer to search for tiny saliva bubbles at the retainer boundaries.[19] It becomes extremely

challenging, if not impossible, to identify a single loose retainer when there are numerous abutment teeth involved. It is necessary to remove the prosthesis in order to examine the abutment teeth in the event that the retainer becomes loose. The restoration can be recemented if it can be removed without causing harm or cavities. It can be due to moisture contamination or an increase in cement space, both of which are examples of improper cementation processes.[20] Modifying the teeth to increase retention and resistance shape is necessary if the prosthesis exhibits loss of retention. Cross pinning, grooves, boxes, or extra abutment can be used to achieve increased retention.[21] Core build-up or crown exposure surgery are options for severely damaged teeth. This is followed by the fabrication of a new prosthesis. If the span length is too long or the occlusal forces are too strong, FPD may still come loose, no matter how much preparation you do. One possible and only viable option is a removable partial denture (RPD). Without a cover, teeth are less likely to sustain damage or retain plaque, thus it's preferable than with a loose one. To avoid solder joint or connector failure, check that the joint's width and depth are adequate to withstand occlusal force, and that there is enough gold mass. The connector dimensions are especially important when designing restorations and FPD with all ceramics,[22] which use digital fabrication.[23] MLZ processing causes volumetric changes of 15%-30%, requiring larger materials for sintering.[23] These errors result in high occlusion and bulky contact points. Other materials used as substructures include glass, ceramics, crystallized porcelains, and CADCAM ceramics. Occlusal load, which puts too much pressure on the abutment teeth, can lead to connector failure. From the beginning, zirconia reinforced ceramics were only supposed to be used for short span fixed partial dentures or single crowns in fixed prosthodontics.[24]If there is an issue with the solder, the junction is too small, or the prosthesis fails to adhere to the metal surface, it is recommended to remove and replace it. There should be at least 0.25 mm of space between the joining pieces to prevent improper metal flow.[25] Because they can't move, abutment teeth make it hard to find fracture connectors.[26] The FPD components are separated by inserting wedges under the connector; occasionally, a metal inlay is made to span the fracture site and stabilise the prosthesis. Removing pontics and inserting a temporary RPD can help preserve space and improve aesthetics if a remake is not an option. To increase the surface area and durability of the porcelain covering, it is advised to solder link several unit bridges in the centre of the pontics prior to adding porcelain. One must be well-versed in the stomatognathic system in order to do occlusal restorations, but the most crucial aspect is using material science principles when selecting an interocclusal recording material (IRM).[27]Research has shown that all ceramic three-unit FPDs can benefit from an occlusal embrasure design that increases fracture resistance, as long as the gingival embrasure has a higher curvature ratio.

The rate of occlusal wear on a prosthesis can be accelerated by habits such as clenching, bruxism, or forceful chewing.[28] Gingival recession or inflammation, polished facets on retainers or pontics, and attrition of neighbouring teeth are some of the clinical symptoms. Perforations in gold crowns can cause leakage and caries, which can lead to prosthesis failure after 2-3 years of wear.[5,8] Inadequate occlusal clearance for metal is another major cause, as is wear on the occlusal surfaces of posterior teeth. If perforation detection is done early, restorations made of gold or amalgam can be placed. Cobalt-chrome or cobalt-chrome alloys are cost-effective base metals that offer an advantage over traditional materials with increased resistance to fatigue, biocompatibility (hypoallergenicity), thermal conductivity, and adaptation.[29]Otherwise, resin, composite, or GIC can be used. Ignore treatment and keep an eye on the perforation if it extends over the amalgam core. Fabricating a new prosthesis is necessary if the metal surrounding the perforation is thin. Ceramic wear is not an issue when occlusal surfaces are covered in porcelain, but enamel wear can be seen on opposing natural teeth due to grinding, clenching, or bruxism. Metal should be placed over occluding surfaces in mouths where occlusal wear is expected in order to minimise wear and preserve the integrity of the natural teeth.

TOOTH FRACTURE

Damage from coronal fractures can range from negligible to catastrophic, leading to tooth loss in extreme cases. Excessive tooth preparation, inadequate tooth structure, loose restorative material, occlusal contact interference, heavy loads, improper prosthesis or bridge seating, and so on can lead to cavities in the teeth that support the abutment.[8,12] Amalgam, gold foil, or resin can fix minor flaws for a few more years. A new prosthesis should be made to cover the damaged area of the tooth if the stability of the remaining tooth structure is in question. To support large coronal fractures, a separate pin-retained restoration is necessary in addition to full-coverage restorations. Endodontic treatment, including preparation of post and core abutments, may be required if pulp exposure occurs as a result of a fracture. It is common for full coverage restorations to cause horizontal cracks at the finish line, which in turn necessitate endodontic treatment and removal of the prosthesis.[21] Factors that can lead to root fractures include trauma, improper fitting posts, forceful seating of posts, and endodontic treatment.[30] Their extraction and subsequent prosthesis fabrication is necessary because they are situated beneath the alveolar bone. It is possible to expose the fracture site for prosthesis fabrication during periodontal surgery if the fracture ends at or slightly below the alveolar

bone. Fractures aren't always easy to see at first, but they usually become obvious with time. Because of the risk of pontic failure from insufficient strength, no porcelain occlusal pontic should be used unless the bite is perfectly aligned. In order to prevent cementation failure or porcelain facing fracture, the gold framework must be extremely rigid. An occlusion problem is a common reason, especially in cases of lateral excursions. The contacting area should be slight and convex to avoid tissue contact, which is a leading cause of failure. It is recommended to keep the gingival, lingual, distal, and mesial embrasures open so that they can be easily cleaned.[15] Because of inadequate tooth preparation or excessive occlusal forces, all ceramic restorations frequently break.[15]

Metal-Ceramic porcelain failure may result from multiple factors, including framework design, which can lead to crack propagation and ceramic fracture. Acute angles or uneven regions on the veneering surface can lead to stress concentration, whereas excessively thin metal castings may fail to sufficiently support porcelain, resulting in flexure and fracture.[21] In PFM restoration, occlusal contact in centric relation at or near the metal-ceramic interface may result in premature porcelain fracture. Intense occlusal forces or habits such as clenching and bruxism may result in prosthesis failure, potentially due to centrifugal or eccentric interferences or unaddressed occlusal slides, leading to deflective contact with opposing teeth. Inadequate management of alloy during porcelain casting, finishing, or application may result in metal contamination, leading to bubbles at the metal-ceramic interfaces, stress, or fractures. Excessive oxide layers on base metal alloys can cause significant contamination, resulting in the detachment of porcelain from the metal.[31] Preparation with minor undercuts or distorted impressions may result in prosthesis binding, causing fractures. This issue may remain undetected until a post-insertion failure occurs. Thin metal may protrude beyond the termination of tooth reduction, resulting in a fracture of the overlying porcelain.

In rare cases, alloys and porcelain may be fundamentally incompatible, rendering bonding without veneer loss or fracture unfeasible. Fractured metal-ceramic restorations can be repaired with resin materials that provide effective colour matching. Nonetheless, these materials exhibit disadvantages, including limited durability and colour degradation. They are also prone to mechanical interlocking, resulting in frequent repair failures post-insertion. The procedure entails the extraction of residual porcelain, drilling pin holes to a depth of 2mm, fabricating a pin-retained metal casting, fusing porcelain to the casting, and securing the casting in position with cement.[22] To mitigate the risk of flexing in the pontic area, porcelain should extend to the lingual side to enhance rigidity.[8] When a substantial amount of porcelain is compromised on a retainer or pontic's labial/incisal surface, the entire unit may be repaired or replaced. The porcelain veneer is excised along with a portion of the underlying metal from the labial surface and the incisal third of the palatal surface.[32] This procedure is straightforward for pontic units, but necessitates consideration of the underlying pulp. A frequent error is insufficient removal of porcelain and metal. While it is possible to successfully restore incisors with the right preparation for all ceramic restorations, occlusal force makes fractures more likely when placing restorations on canines and posterior teeth.[7] Tooth preparation quality and occlusal load magnitude are clinical success or failure factors. Preventative dentistry entails reducing the tooth to a size that can hold a restoration in place. Light cure composites, GIC, and resin are used for short-term repairs in management. It is advised to get a new crown if the chip is very severe.[16] Metal ceramics should be seriously considered if failure happens early and there are no defects.[12]

The marginal area of the jacket crown is more closely adapted to the tooth in vertical fractures, and sharp areas like lines and incisal angles produce high stress in restorations.[12,21] This type of ceramic fracture can occur in a number of ways. Vertical fractures can also occur in a round preparation form if it is not resistant to rotational forces enough. Fractures of the cervical third typically manifest with short tooth preparations and are semilunar in shape. When the occlusion is near the cingulum of the preparation, shear forces on the porcelain, insufficient reduction of the teeth, and heavy occlusal forces cause less than 1mm of porcelain to be present, therefore lingual fracture occurs.[20] Inadequate mechanical retention, improper technique, wrong material choice, mixing instructions ignored, use of expired or polluted stock, improper prosthesis insertion, isolation, and venting are some of the many causes of cementation failure.[19-21] The most retentive cements are resinous ones, but they have one major flaw: water seepage through the pores creates an internal hydraulic chamber that eventually causes the cement to fail.[33] A restoration's inability to counter forces while interfering with the arc of rotation can be caused by the taper of the preparation, which can lead to design failure. How well axial unseating forces are retained is dependent on the taper or angle between the two walls.[19] Cement cannot be extruded from the crown duringluting, leading to an excess of cement thickness, making parallel preparation impractical. Failure due to loss of retention becomes common when the taper surpasses 30 degrees.[21] For optimal retention, a taper of 7 degrees with little cement in the middle is ideal.[5,17,21] Important in clinical crowns is the length-to-taper relationship. If a crown is too short for retention, it can be surgically or internally lengthened using a core. Shorter crowns necessitate more parallel walls. Along with lowering the insertion angle, these techniques can withstand crown loss from all angles.Teeth with irregular contours are more resistant to forces exerted when the tooth is tilted or twisted. To prevent restorations from coming loose,

grooves can be carved into teeth that are too round, too short, or have been over-taped. Using boxes instead of grooves increases resistance to faciolingual dislodging forces and is recommended when there is enough tooth structure, especially in the proximal areas. Boxes and grooves are essential components of any partial veneer crown.[22,34] When restoring tilted teeth in particular, it is important that the mesiodistal inclination follow a straight line parallel to the contact areas of neighbouring teeth to avoid holding the restoration in place at the proximal contact areas and locking it out.[10] There are two extremes in the complexity spectrum when it comes to bridge design: underprescribed and overprescribed. Both categories necessitate a great deal of expertise, experience, and judgement.Cantilever and fixed-movable bridges are examples of underprescribed bridges because of their flimsy construction and lack of abutment teeth.[35] Additionally, retainers might be overprescribed in cases where partial or intracoronal crowns would have sufficed, or when all metal crowns would have been adequate, in the case of complete crowns.Dental restorations, such as positive ledges (overhangs) or negative ledges, can develop marginal deficiencies.[23] Crowns made of porcelain are more likely to have positive ledges, which are edges that extend beyond the preparation margin. Just a little on-site grinding and polishing will fix these. The preparation margin is visible with negative ledges because there is insufficient crown material, but there are no significant spaces between the tooth and the crown. The try-in process makes it difficult to fix this common problem with metal margins. The tooth surface may be amenable to adjustment if the crown margin is either just above or below the gingival margin.

FAILURES OF DOWEL

Root canal post loss can happen if the post is too tapered or doesn't fit the canal walls properly.[36] It might also be inserted through a hole in the alveolar bone or be excessively brief. Radiographs taken from the root's opposite side may reveal a different position for the post if bleeding is present. Placing a probe into the post hole and gently pushing the tooth apart can confirm a longitudinal or oblique root fracture. The crack usually shows signs of blood. Post fractures, usually at the gingival margin, can happen for a variety of reasons, including cast posts' small diameter, soft alloy, porosity, or extraordinary occlusal forces; pre-formed posts' corrosion, or thin post selection.[36] Metal fatigue can occur in posts that do not have enough stress resistance. Root splitting, insufficiently sealed root filling, a lateral canal, too thick or partially set cement, screw posts touching the hole end, or a perforation letting cement into the periodontal membrane are all potential causes of post-cementation pain. Crown loss can occur as a result of a thick core, particularly on the palate, or a short or conical core preparation. If there was no space between the core and opposing tooth, wear facets, or a short clinical height, then a bonded crown would have been a better choice than a porcelain jacket crown.The therapy can fail due to reinfection if there is a surface or marginal gap within treated canal (inner dentine surface and sealer). Consequently, it is vital to attach the sealer closely to the dentine before initiating it removal for post placement.[37]

ESTHETIC FAILURE

Ceramic restorations frequently fall short in terms of aesthetics when it comes to colour matching. This can happen for a variety of reasons, such as when the patient's natural teeth don't match the available porcelain colour, when the shade selection is inadequate, when metamerism is present, when there isn't enough tooth reduction, when the form or framework design is incorrect, or when the patient's teeth undergo colour changes that porcelain does not.[21,25] Furthermore, a prosthesis's marginal fit or cervical shape might encourage plaque buildup, gingival inflammation, and an unnatural appearance of soft tissues, rendering it aesthetically undesirable.

REMOVING OF FAILED CROWN AND BRIDGES

It is critical to plan for the protection of the airway and think about the possibility of a temporary crown before removal. Crowns, particularly those with inlays, are more likely to inspire because of their diminutive size.[21] Inertia forces, reciprocal forces, and retainer division are some of the methods used to remove previous bridges. In order to keep the dislodging force from slewing the bridge and locking it even tighter on the loose retainer, which could lead to damage, it is essential to support the loose end of the bridge with firm finger pressure when it is loose.

PATIENT EDUCATION

Crowns and bridges only last as long as the patient practices excellent dental hygiene. Patients need to know how to properly care for their teeth, including brushing and flossing, and how to maintain the space between their bridge's retainer and pontic. Dietary recommendations and fluoride rinses should be administered to patients with a high decay rate or reduced salivary flow.[12] Athletes and patients who brux should be given a guard appliance that is appropriate for their needs. It is important to have the patient come back for a review if they experience any changes, such as symptoms, mobility, or difficulty with the restoration after cemented. This guarantees that the restoration will last for a very long time.Every six months, you should schedule a review appointment to go over your caries rate and oral hygiene standards. Occlusion, tooth mobility, and restoration exams are crucial. Assessments of the gums, bleeding, recession of the gum line, and attachment loss all point to active disease that requires treatment. Patients with a high caries index must

undergo periodic radiographs. Patients with unusual tooth anatomy or position in the arch should be given individual considerations before planning their prosthesis.[38]

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