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Review Article

A brief review on clinical failures associated with fixed dental prostheses and their relative management

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ABSTRACT:
Fixed partial dentures (FPD) in the form of single crowns or various types of bridges or implant-supported restorations are one of the most common treatments delivered to dental patients whose teeth are affected by caries or who have lost them to the diseases. From dental ceramics to alloys and plastics, fixed partial dentures can be fabricated from any of these materials or a combination of them. In the past two decades, dentistry has evolved from traditional manual to digital and computerized dentistry, which has been witnessed with the reduction of material and human-induced errors. Fixed partial dentures in the present era are more technically and biologically accurate. However, they still are vulnerable to complicating the oral environment and still have the tendency to damage tooth and adjacent tooth structures. This review presents insight into the clinical failures associated with traditional FPD and summarizes their clinical management in the wake of recent evidence. The review also allows dental practitioners to take preventive measures so as to reduce the occurrence of these complications.

Key words: dental implant, dental bridge, fixed partial denture, spring cantilever, dowel crown.

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INTRODUCTION

Complications in fixed prosthodontics are secondary diseases developing during or after fixed prosthodontic treatment procedures, often not indicative of clinical failure or substandard care. An objective evaluation of an existing restoration is necessary to determine if it is defective and requires replacement or repair.[1] A failure in prosthesis can be biological, mechanical, or aesthetic. Minor failures are subjective and can be repaired or replaced. Failure can occur at any time, so it's crucial to be aware of signs and procedures. Failures can be biologic or esthetic, depending on the situation. Regular review appointments should be made every 6 months, assessing caries rate and oral hygiene. Restoration examinations, occlusion checks, periodontal evaluations, and radiography are essential for patients with a high caries index and active disease.[2] A treatment failure may occur even before one starts treating a patient for a fixed partial denture. Exploring all treatment options should be mandatory in any tooth-supported prosthodontic treatment. There is a wide array of prosthodontic treatment options that are not generally practiced by specialists for example, immediate overdentures or spring cantilever fixed partial denture design.[3] In conservative principles, extraction of the natural tooth should be the last option. Even a hopeless tooth can be extruded using orthodontic procedures and then used as a root to support either a fixed or a removable partial denture.[2,4] or various types of bridges or implant-supported restorations are one of the most common treatments delivered to dental patients whose teeth are affected by caries or who have lost them to the diseases. From dental ceramics to alloys and plastics, fixed partial dentures can be fabricated from any of these materials or a combination of them. In the past two decades, dentistry has evolved from traditional manual to digital and computerized dentistry, which has been witnessed with the reduction of material and human-induced errors. Fixed partial dentures in the present era are more technically and biologically accurate. However, they still are vulnerable to complicating the oral environment and still have the

tendency to damage tooth and adjacent tooth structures. This review presents insight into the clinical failures associated with traditional FPD and summarizes their clinical management in the wake of recent evidence. The review also allows dental practitioners to take preventive measures so as to reduce the occurrence of these complications.

Biologic failures: Caries or secondary caries under FPD is the most common biologic failure, affecting bridges directly or indirectly.[5] Detection involves visual inspection, probing margins, and radiographs, especially those that are digital and more based on artificial intelligence.[6] Causes include defective margins, loose retainers, incomplete removal, poor design, and patient diet changes.[5] Prevention involves routine oral hygiene, fluoride-containing dentifrices, and mouthwashes for patients with high caries index.[7] The management of carious lesions involves conservative operative procedures, using good foil for marginal caries, amalgam for long-term marginal seal, and resin materials or GIC for aesthetic areas.[2,4] Prosthesis removal is necessary for access, and large amalgam restoration may be required.[4,6] Pulp degeneration is a clinical condition characterized by persistent post-insertion pain and periapical abnormalities caused by excessive heat generation, tooth reduction, pinpoint exposure, occlusal trauma, and cement-related issues, which can be prevented by following principles of biomechanical tooth preparation and can be somewhat managed to a lesser extent with varnish or dentin bonding agents.[8-11] Access to the pulp requires a hole in the prosthesis for treatment. Perforation can be restored with gold foil or amalgam. If retainer casting becomes loose or fractures occur, the prosthesis should be remade.[4,8] Endodontic treatment should assess tooth structure for support and retention.[12] Apicectomy is recommended for root-filled teeth, but indirect pulp capping is generally not recommended. Periodontal breakdown, characterized by gingival recession, furcation, pocket formation, and mobility of abutment, can be caused by inadequate prosthesis hygiene instructions, poor patient implementation, hindering oral hygiene, poor marginal adaptation, over-contouring, large connectors, large occlusions, rough surfaces, and traumatic occlusion.[7,10] Prevention involves proper oral hygiene instructions, review appointments, and proper axial contours.[4, 5, 7] Treatment options include less severe scaling, increased severity, and correct occlusion, and if abutment teeth's prognosis decreases, tooth removal may be necessary.[11] Occlusal problems can cause mobility, tenderness, and perforation in teeth. Early detection can eliminate interferences without permanent damage. However, traumatic occlusion or long-term interferences can lead to mobility that cannot be reduced.[13] Proper anterior guidance components are necessary to avoid occlusal-related complications. FPD is contraindicated in deep bite since it causes trauma to existing occlusion, which may later culminate in temporomandibular joint problems. Prosthesis removal and/or extraction of abutment teeth may be necessary in extremely complicated cases. Night guards or occlusal splints may be given if FPD is the source of muscular or temporomandibular joint imbalance. Improper occlusion can cause neuromuscular discomfort and prosthesis failure, necessitating selective reshaping of defective contacts and tooth restoration to accommodate occlusal forces.[14,15] Pinholes in pin-retained restorations can cause tooth perforation laterally.

Mechanical failures: Loose retainers cause rapid tooth destruction due to leverage and uneven occlusal loads.[2,8] Patients may experience looseness, sensitivity to temperature or sweets, and recurring bad taste or odor.[4] Detection involves examining the bridge without drying the teeth, pressing it up and down, and using a curved explorer.[7,8] In prosthetics with multiple abutment teeth, a single loose retainer may be difficult to detect. The management of loose prosthesis involves removing the retainer to evaluate the abutment teeth. If the restoration can be dislodged without damage, it can be recemented due to improper cementation procedures.[16] If the prosthesis shows loss of retention, teeth should be modified to improve retention and resistance. If teeth are severely destructed, core build-up or surgical exposure of the crown can be done.[17] Sometimes, FPD comes loose due to excessive span length or heavy occlusal forces.[18] To avoid solder joint failure, ensure the joint has adequate width and depth to resist occlusal stress and a sufficient bulk of gold. Causes include connector failure under occlusal load, flaws in the solder, failure to bond to metal surface, not being large enough for the condition, and improper metal flow.[19] Fracture connectors in abutment teeth are difficult to detect, so wedges can be placed beneath them to confirm the diagnosis for looseness. If a remake isn't possible, pontics can be removed and a provisional RPD inserted. Occlusal embrasure design can increase fracture resistance in all-ceramic 3-unit FPDs. Heavy chewing forces, clenching, or bruxism can accelerate occlusal wear of prosthetics, leading to attrition of opposing teeth, polished facets on retainers/pontics, gingival recession, or inflammation.[5,8,11] Causes include inadequate occlusal clearance for metal, wear down of posterior teeth, and gold crowns with 0.5 mm or more of gold occlusally. Perforations can cause leakage and caries, leading to prosthesis failure. If detected early, gold or amalgam restorations can be placed. If the metal surrounding the perforation is enormously thin, a new prosthesis should be fabricated. If porcelain covers occlusal surfaces, enamel wear is not problematic, but heavy chewing forces, clenching, or bruxism can exacerbate this issue. Tooth fractures can be major or minor, depending on the cause.[5,11] Causes include caries of abutment teeth, excessive tooth preparation,

interfering occlusal contacts, or improperly fitting prosthesis. If the defect is small, it can be restored with amalgam, gold foil, or resin.[20] If the fracture is large, full coverage restorations may be fabricated. If the fracture exposes pulp, endodontic treatment is necessary, and abutment preparation should involve placing bevels to increase resistance. Root fractures are often due to trauma, forceful seating of a post during endodontic treatment, or an improperly fitting post.[21] They are located below the alveolar bone and must be extracted and replaced with a new prosthesis. Pontic fractures can occur due to inadequate strength, and all porcelain occlusal pontics should never be used unless the occlusion is favorable.[5] The gold framework must be of adequate rigidity, and even slight flexion can cause cementation failure or fracture of the porcelain facing.[7] A faulty occlusion, particularly in lateral excursions, is a common cause of pontic failure. An acrylic facing can wear and discolor rapidly, and tissue contact is a major cause of failure.

Porcelain fractures can occur in both metal-ceramic and all-ceramic crown restorations, with most failures due to improper design characteristics of the metal framework or problems related to occlusion.[22] In PFM restorations, framework design that allows centric occlusal contact on or immediately next to the metal-ceramic junction, or when the angle between the veneering surface and the non-veneered aspect of the casting is less than 90°, can lead to premature porcelain fracture.[23] Heavy occlusal forces, habits, or uncorrected occlusal slides can also lead to failure.[5, 24] Improper handling of alloy during casting, finishing, or application of the porcelain can lead to metal contamination, bubbles, severe contamination, and excessive oxide layer on metal.[15] Preparation, impression, and inserting with slight undercuts, slightly distorted impressions, or teeth with feather-edge finish lines can also cause cracks.[2,4] In rare instances, an alloy and porcelain may be truly incompatible, making bonding without loss of veneer or cracking impossible.[23] Fractured metal ceramic restorations can be repaired using resin materials, which offer good color matching but lack longevity and discoloration.[24] However, they may fail in areas with heavy occlusal forces due to mechanical interlocking. To repair more permanently, remove remaining porcelain, drill pinholes, create a pin-retained metal casting, fuse porcelain to the casting, and cement the casting in place.[23] If pontic area flexing is a concern, porcelain should be carried on to stiffen them further. Porcelain loss from a retainer or pontic can be repaired by removing the porcelain facing and underlying metal from the labial and incisal/occlusal surfaces. Occlusal feldspathic porcelain should be avoided since porcelain occlusal contacts are never patient-specific due to the thermal shrinkage during processing.[22] Porcelain jacket crowns have a limited lifespan, but they can be successful on incisors with proper preparation.[5,11] Fractures are more common on posterior teeth and canines due to occlusal force.[22] Factors determining success include quality of tooth preparation and occlusal load. Preventative measures include adequate tooth preparation and tooth reduction. Management involves short-term repairs with GIC, resin, and light-cure composites; replacing chipped crowns with new ones; considering metal ceramics for early failures; and replacing fractures due to trauma.[5,11,22] Ceramic fractures can occur in various ways, including vertical fractures due to the marginal area of the jacket crown, sharp areas on the tooth, and round preparation forms.[11,25] Facial cervical fractures occur when opposing tooth contact is located incisally to the prepared tooth, leading to tipping forces.[7] Lingual fractures occur when occlusion is located cervically to the cingulum of the preparation, with shear forces on the porcelain, inadequate tooth reduction, and heavy occlusal forces. [25] Cementation failure can occur due to inadequate mechanical retention, poor cementation technique, incorrect material choice, improper mixing, old or contaminated stock, inadequate P/L ratio, improper prosthesis insertion, and inadequate venting. Resinous cements are retentive but have H_2O percolation, leading to hydraulic chamber failure.[26]

Design failures: Abutment preparation design is crucial for successful restorations. Factors affecting dislodgement include taper of preparation, length of preparation, circumferential irregularities, and occlusal irregularities.[11] Taper reduces the restoration's ability to resist occlusally directed forces and interfere with the arc of rotation.[5] The ideal taper varies with the tooth position and inclination, but it can cause undercuts or damage adjacent teeth. The length of preparation depends on the nature of occlusal forces, number of teeth, and whether the crown will be subjected to withdrawing forces from an FPD. Shorter clinical crowns require more parallel walls, while irregularities like boxes and grooves can help resist tipping and twisting forces.[12] Irregular reduction according to the occlusal plane also aids in resistance to dislodging forces, while flat reduction provides little interference and unnecessarily reduces the length of preparation. Supragingival margins are preferred for oral hygiene maintenance and reduce pulpal sensitivity.[9] Smooth and even margins are preferred, as rough or irregular ones can increase plaque formation and gingival inflammation. The path of insertion should be parallel to the tooth's long axis, with a facially inclined path causing over-contouring. The path should also parallel adjacent teeth's contact areas. Structural durability is crucial, with a minimum of 1.5 mm for functional cusps and 1.0 mm for non-functional cusps. A bevel should be given at an angle of 45 degrees to provide space for metal in heavy occlusal contact. Over-contoured restorations can lead to deflective occlusal contacts, which can only be eliminated by reducing opposing

teeth. Choice of FPD design is essential for each clinical situation. Many situations can have simple designs, like in spring or cantilever prostheses, while some situations, like pier abutments, require complex FPD designs.[27, 28]

Bridge design is a complex process that requires years of knowledge, experience, and judgment. It can be classified into under-prescribed and overprescribed bridges. Under-prescribed bridges are unstable or conservative in selecting abutment teeth, leading to failure. Overprescribed bridges may include more abutment teeth than necessary, resulting in failure.[9,13] If a large bridge unit fails, it can be sectioned and remade as an individual restoration. Retainers may also be overprescribed, using complete crowns or metal ceramics. Marginal deficiencies can occur in dental restorations, including positive ledges (overhangs) and negative ledges (excessive crown material protruding beyond the preparation margin).[5,19] Positive ledges are more common with porcelain and can be corrected with grinding and polishing. Negative ledges are more common with metal margins but difficult to correct at the try-in stage.[22] Adjusting the tooth surface may be possible with supragingival or subgingival margins but may cause gingival damage.

Dowel or post core design: Dowel design should be equal to crown length or 2/3 root length, with 4 mm of gutta-percha remaining to prevent dislodgement and leakage.[29] Post failure can occur due to various factors, including loss of post from root canal, post too short, longitudinal or oblique fracture of root, fracture of post at the gingival margin, pain on cementation of post, loss of crown, or fracture of crown.[30-33] Post failure can be caused by factors such as diameter being too small, alloy too soft, porosity, corrosion, or selection of a thin post.[31] Crown failure can be caused by a poorly sealed root filling, lateral canal, or perforation, and a bonded crown should have been used instead of a porcelain jacket crown.[29,33]

Esthetic failures: Poor color match in dental labs can occur due to various factors such as inability to match natural teeth with porcelain, inadequate shade selection, metamerism, inadequate tooth reduction, incorrect form design, natural tooth color changes, and marginal fit, which can lead to unnatural soft tissue color or form.[2,4,5,9,13]

Prevention and Maintenance: The removal of crowns and bridges involves several methods, including inertia forces, reciprocal forces, and retainer division.[2,22,31] It is important to remember the need for a temporary crown, particularly inlays. If possible, try to remove the prosthesis intact, but if not possible, cut until the prepared tooth is exposed and then remove it. Preparing the slot lingually is advantageous, as the material bulk on the lingual side is comparatively less and therefore easily removed. Old FPDs can be removed using various methods, such as using a wire, an inertia bridge remover, or a straight chisel. Inertia forces (pneumatic crown remover) involve threading a loop of soft stainless-steel wire or brass under the connectors and holding a bar or instrument handle to support the loose end. Reciprocal forces involve using orthodontic band-removing pliers or an inlay remover made of hard tool steel. Both devices act reciprocally without causing force on the periodontium. Retainer division can be done by making a burr cut on the buccal or lingual surface of a full veneer retainer, either by placing a chisel in the slot and twisting to separate each part or by placing the chisel in the groove to separate each part away from the tooth.[19,33] Gold is easier to bend than alloy with bonded porcelain, and bulky retainers may have to be divided on both buccal and lingual to effect loosening. Division of a connector is sometimes indicated, such as extracting the first molar or dividing the bridge at the connector between the pontic and the molar.[4] A diamond disc in a disc guard with water can do this rapidly, but it should be confined to the peripheral part of the disc to avoid jamming in the metal.[25] Direct temporary bridge replacement may be worth taking before starting to remove an old bridge that may disintegrate. Richwill crown removal is a green sticky tube that is softened in hot water and placed over the crown, allowing the patient to bite and hold for a few seconds before opening the mouth quickly to remove the crown.[33] Maintaining a high standard of oral hygiene is crucial for the longevity of a crown or bridge. Patients should be instructed on the necessary cleaning procedures, such as burnishing and flossing, and the use of a floss threader or super-floss. In cases of high decay rate or decreased salivary flow, dietary advice and fluoride rinses should be given. A suitable guard appliance should be provided for athletes and patients with brux tendencies. Patients should be asked to return for review if symptoms develop, mobility is felt, or the restoration feels difficult from when it was cemented.

Implant-supported single or multiple fixed prostheses: The failures in implants can begin right at diagnosis and most commonly involve those where infection control and asepsis are not maintained during any of the surgical protocol.[34] Osseointegration can be significantly affected if the surgical environment around the implant fixture is contaminated; therefore, all guidelines regarding asepsis need to be followed at surgical stages.[35, 36] Most of the failures observed in studies on the long-term survival of implants are those due to surgical failures.[37] These are observed irrespective of the choice of prosthetic option (removable or fixed).[38] Once the implant is loaded, failures mostly arise due to improper occlusion or wrong implant placements in terms of orientation. Crestal bone loss is the early sign of the failing implant, and the threshold of bone

loss at the crest acts as a warning sign of the implant being improperly stressed.[39] Since the implant fixtures are placed by a surgeon who is being guided by the prosthesis fabricated by a prosthodontist, there are times when both have to innovate after observing the clinical situation. Improper alignment of the implant fixture can be overcome by varying conventional techniques for either placing the abutment or the prosthesis.[40]

CONCLUSION

FPD is neither desirable nor advisable since it involves sacrificing healthy abutments for the sake of replacing a missing tooth. But at present, since technology allows us these options, one has to be content; however, it is also true that one needs to be careful or extra careful while delivering an FPD. Most of the complications can be avoided through strict oral hygiene maintenance and regular follow-ups of the patient. FPD in any of its forms still remains to be the choice of treatment if the involved or surrounding teeth are affected by caries or have an existing restoration.

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