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Failures In Fixed Partial Denture

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Abstract:
The broad category of fixed partial prosthodontics includes treatment solutions based on both prosthodontic and restorative principles. Patients typically have high expectations for fixed partial denture (FPD) therapy, so they rarely welcome failures. The situations that arise during or following properly executed fixed prosthodontic therapy operations are known as failures. There are three categories of reasons why fixed prosthodontics fail: biological, mechanical, and aesthetic. Loss of retention, bridge fractures, coronal tooth fractures, porcelain fractures, and occlusal wear are major causes of mechanical failures in FPD. Common biological failures include food lodgement, periapical disease, abutment movement, and cavities. Technical abilities, clinical condition evaluation, and appropriate diagnosis knowledge are vital when working with failed or deteriorating fixed restorations. This article's objective is to evaluate the biological, mechanical, and aesthetic reasons why fixed partial dentures fail.

Keywords: Prosthesis failure, fixed partial denture failure, Biological failure, Mechanical failure, Esthetic Failure

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I. Introduction:

The process of restoring and replacing teeth through fixed partial dentures (FPDs) is a crucial treatment approach in dentistry, largely because of the ongoing high incidence of caries and periodontal diseases in both adult and geriatric demographics.(1).
They are applicable for treating severely decayed teeth as well as for replacing absent teeth.(2).

The causes of failures can be categorized into biological, mechanical, and aesthetic failures. Mechanical failures are more directly influenced by the clinicians' actions. In contrast, biological issues are often less manageable and may, in certain cases, be unrelated to the treatment or prosthesis. Common failures observed in fixed bridge prosthodontics include loose retainer, fractures of soldered joints, porcelain fractures, fractures of the abutment teeth, or the presence of voids in retainer or ponitcs. (3).

And the failure may encompass caries, restorations lacking cement, over-contoured restorations, a deficient occlusal plane, periodontal conditions, periapical complications, unsuccessful post retained crowns, inadequate aesthetics, crown perforation, and flawed margins of restorations. (1).

The unsuccessful outcome of these restorations might also cause recurrent caries or the loss of abutment teeth. (3).

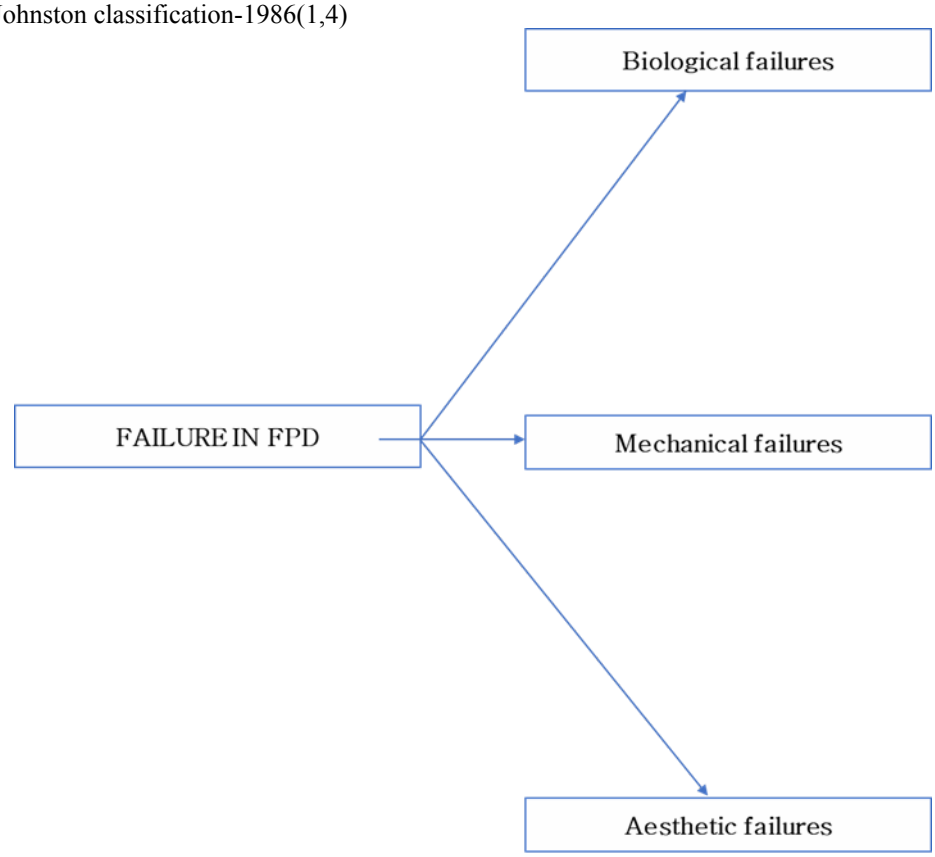
These failures can be noted during the placement of the prosthesis or following its application. Consequently, in our investigation, we assessed the failure rates of the FPDs. (2).

Failures In FPD

The success of fixed partial dentures (FPDs) relies on careful diagnosis, meticulous treatment planning, precise execution, and patient compliance. However, failures are still frequently encountered in clinical practice due to biological, mechanical, or esthetic complications. These failures not only compromise the function and longevity of the prosthesis but may also negatively impact the supporting structures and overall oral health. A comprehensive understanding of the etiology, classification, and prevention of FPD failures is therefore essential for enhancing treatment outcomes and ensuring long-term success.[1]

Classification For Failures of Fixed Partial Dentures

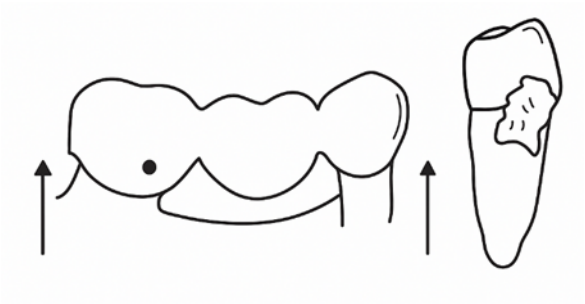
a) John. F. Johnston classification-1986(1,4)



Biological failures:

Caries:

Caries is the most common biological failure in fixed partial dentures. It can be identified through discoloration around the margins during visual examination, probing for marginal defects, and radiographic assessment for interproximal lesions.



Root Caries

Root caries primarily develops in areas of gingival recession where root surfaces are exposed. This is especially common in patients with a high caries risk or reduced salivary flow.

Periodontal Disease

Periodontal disease is characterized by gingival recession, furcation involvement, pocket formation, and, in more advanced cases, mobility of the abutment teeth.

Occlusal Problems

Occlusal problems present as large wear facets, tooth mobility, tenderness upon percussion, open contacts, cusp fractures, and tenderness of masticatory muscles. Radiographic signs may also include widening of the periodontal ligament space.

Gingival Irritation

Gingival irritation occurs due to poorly adapted margins, overhangs, or rough restoration surfaces, leading to localized inflammation.

Gingival Recession

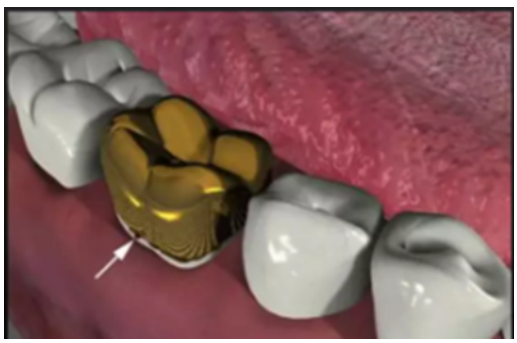
Gingival recession is often associated with periodontal disease, over-preparation of teeth, or faulty prosthesis design, resulting in the exposure of the tooth root surface.

Pulp and Periapical Health

Pulp degeneration can manifest as pulpal sensitivity, intense pain, and periapical radiolucency, indicating inflammation or infection of the pulp and surrounding tissues.

Tooth Perforation

Tooth perforation may occur above or below the periodontal ligament level. These defects are often unnoticed at the time of prosthesis placement and become apparent later during service.



Mechanical Failures

Retention

Loss of retention is caused by leverage forces or unequal occlusal loading on different parts of the bridge, which can lead to loosening of retainers and subsequent rapid destruction of the abutment core.

Cementation failures

It can occur due to inadequate cementation techniques, poor cement selection, or improper preparation design, compromising the bond between the prosthesis and the tooth structure.

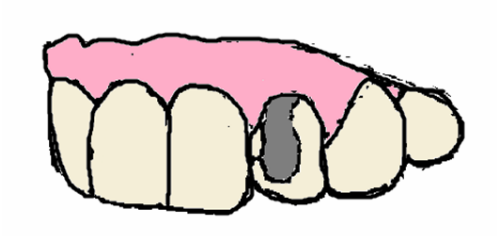
Acrylic Veneer Wear or Loss
Acrylic facing can wear down or detach due to occlusal forces, impact, or material fatigue over time.

Porcelain Fracture
Porcelain fractures can be seen in both metal-ceramic and all-ceramic restorations. In metal-ceramic cases, fractures are often related to inadequate metal framework design or occlusal discrepancies. In all-ceramic restorations, heavy occlusal loads or insufficient preparation are common causes.

Metal-Ceramic Porcelain Failures
These failures arise from poor metal-ceramic bonding, improper oxide layer formation, or structural weaknesses in the framework.

Porcelain Jacket Crown Failures
Porcelain jacket crowns are highly susceptible to fracture under heavy occlusal loads or when the tooth preparation is inadequate to provide support.

Aesthetic Failures



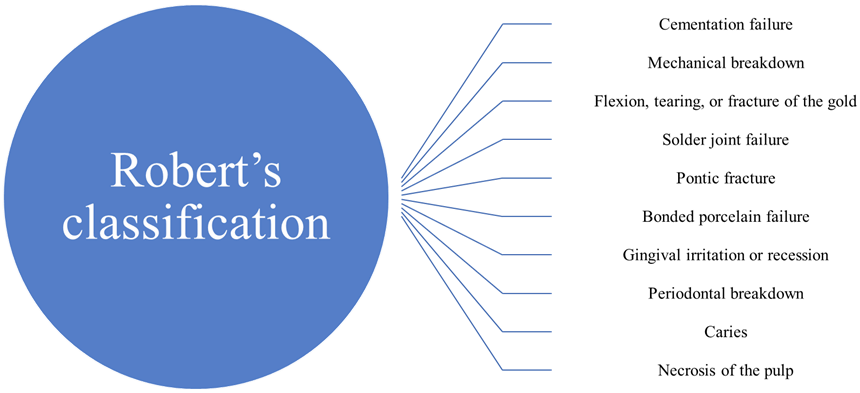
Improper shade selection can lead to a noticeable mismatch between the prosthesis and adjacent natural teeth.
Excessive metal thickness and exposure occur when the metal coping is overbuilt or exposed at the margins, particularly compromising appearance in the anterior region.
An overly thick opaque layer application and over-glazing can reduce translucency, giving the restoration an unnatural look.
A dark space in the cervical third appears due to improper contouring, gingival recession, or shadowing from the underlying metal.
Discoloration of the facing can be caused by staining, rough surface texture, or aging of the veneering materials.

Facing Failures
Facing failures refer to the detachment or fracture of the veneering material from the underlying framework.

Failures of Translucency
These failures occur when opaque layers are excessively thick or when ceramic layering techniques are poorly executed, leading to a flat, lifeless appearance.

Improper Contouring
Improper contouring can compromise aesthetics due to inaccurate shape or surface form, which can also adversely affect gingival health.[1][17]

b) Robert's Classification:(1,4)



1. Cementation Failure

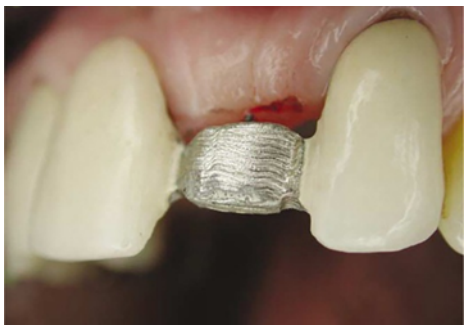
Loss of retention due to compromised integrity of the luting agent, which may result from inadequate abutment preparation geometry, improper isolation during cementation, or dissolution of the cement under oral fluids. This can precipitate microleakage, recurrent caries, or dislodgement of the prosthesis.

2. Mechanical Breakdown

Structural compromise of the prosthesis secondary to fatigue failure under cyclic masticatory loading. This may involve deformation or fracture of the metallic substructure or framework components.

3. Solder Joint Failure

Fracture at soldered connectors, often due to improper joint design, insufficient solder bulk, or incomplete metallurgical bonding. Thermal stresses and functional loading exacerbate the defect.



4. Pontic Fracture

Structural failure of the pontic, either in the veneering porcelain (cohesive fracture) or at the metal-ceramic interface (adhesive fracture), commonly caused by occlusal overload, inadequate metal support, or parafunctional activity.

5. Bonded Porcelain Failure

Loss of veneering porcelain integrity through cohesive fracture within the ceramic mass or adhesive debonding at the porcelain–metal interface. Etiological factors include thermal coefficient mismatch, insufficient porcelain support, and non-uniform thickness distribution.

6. Gingival Irritation or Recession

Localized inflammatory changes or apical migration of the gingival margin resulting from violation of the biological width, over-contoured restorations, or pontic designs that impede plaque control and promote biofilm accumulation.

7. Periodontal Breakdown

Loss of periodontal attachment and alveolar bone support around abutment teeth due to chronic plaque-induced inflammation exacerbated by prosthesis design that compromises access for plaque control.

8. Caries

Secondary caries at the restoration–tooth interface caused by marginal discrepancies, cement dissolution, or persistent microleakage, leading to compromised abutment integrity.

9. Necrosis of the Pulp

Loss of pulpal vitality in abutment teeth due to excessive reduction of coronal tooth structure, thermal trauma from high-speed instrumentation without adequate coolant, or postoperative bacterial ingress through marginal gaps.

c) Barreto classification:(5)

Aesthetics	-shapes -contours -surface characteristics
Biophysical	-physical properties -chemical composition of porcelain and metal
Biomechanical	-faulty designs -misplaced finish lines -rough or sharp surface -undercuts on the bonding surface cause porcelain to be dislodged

d)Bennard G. N. Smith: (6).

1**.Mechanical failures of crown or bridge components**:

-Porcelain Fracture
-Failures Of Solder Joints
-Distortion
-Occlusal Wear And Perforation
-Lost Facings

2.Changes In the Abutment Tooth:

-Periodontal Disease
-Problems With the Pulp
-Caries
-Fracture Of the Prepared Natural Crown
-Movement Of the Tooth

3.Design Failures

-Under Prescribed FPDs
-Over Prescribed FPDs

4.Inadequate Clinical Or Laboratory Techniques

-Positive Ledge
-Negative Ledge
-Defect
-Poor Shape And Colour

5.Loss of retention

6.Occlusal problems

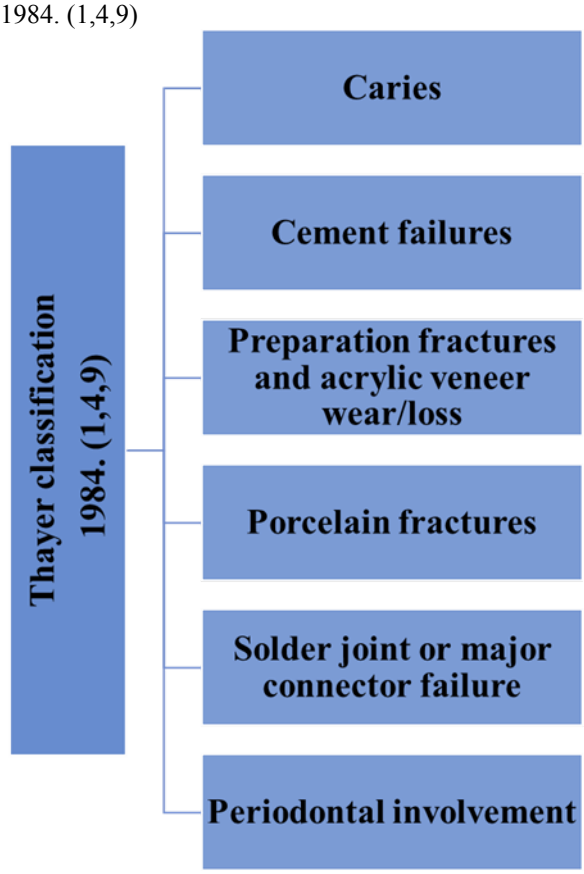
e) Wise classification – 1999 (1,4)

- General pathosis
- Periodontal problems
- Caries

- Pulpal changes
- Erosion
- Cracked teeth
- Sub-pontic inflammation
-Temporomandibular joint disorders
- Occlusal problem

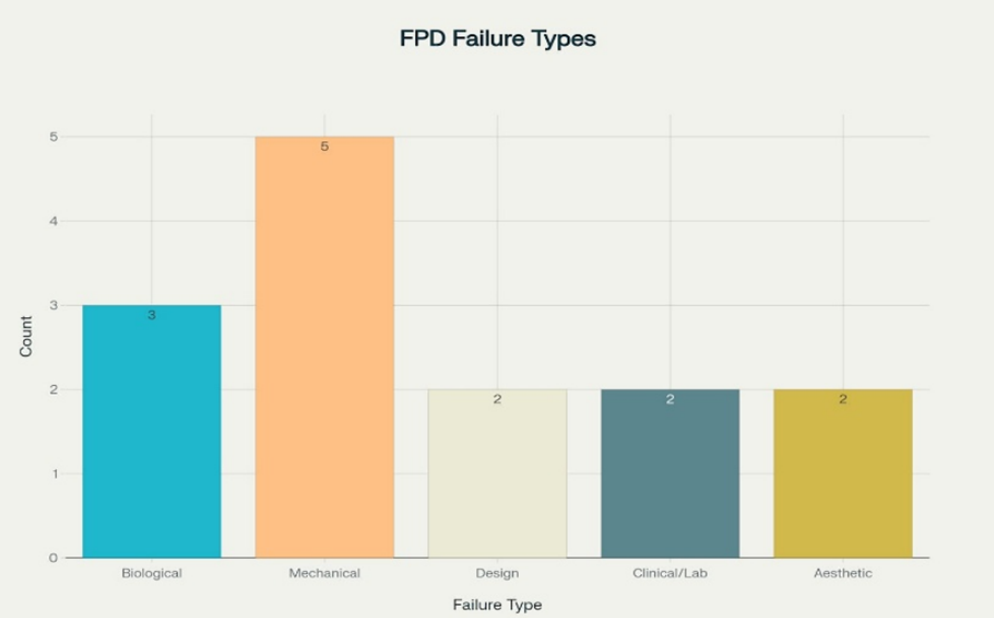
f) Selby classification – 1984 (1,4,9)
-Biologic
- Caries
- Periodontal disease
- Endodontic or periapical problems
-Mechanical
-Loss of retention
- Fracture or loss of porcelain
-Wear or loss of acrylic veneer
-Wear or perforation of gold
-Fracture of metal framework
- Fracture of solder joints
- Fracture of abutment tooth or root
-Defective margins
-Poor contour
- Poor aesthetics

g) Thayer classification – 1984. (1,4,9)



h) Manappallil classification – 2008. (1,4)
-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 through the 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 is not possible.



Common Types Of Failure In FPD:

Biological Failures*:*

Dental Caries:

The most prevalent biological failure. Overextending the margin excessively can cause the cement that fills the space between the cast teeth to be absorbed. This absorption leads to a buildup of plaque, which can result in various periodontal issues. It is crucial to maintain an appropriate margin to prevent these complications from arising. (4).

Treatment:

1. Careful oral hygiene is particularly important for patients with a high caries index.
2. The use of fluoride mouth rinses, toothpaste, professionally administered topical fluoride, and dietary counselling is recommended.
3. Antibacterial cements such as zinc phosphate and antimicrobial agents ought to be utilized to reduce the incidence of caries. (1).

Pulp Degeneration:

Every phase of the thorough crown preparation process involves certain risks that could threaten the health of the dental pulp. Typically, this damage may arise from factors like excessive heat, dehydration, or contact with harmful chemicals. Injuries to the pulp can lead to conditions such as pulpitis, which is the inflammation of the pulp, or in more serious instances, result in necrosis, where the pulp tissue dies. It is essential to recognize these risks to preserve the integrity of the pulp during the procedure. (7).
Marginal leakage is an additional element that has been proposed to contribute to pulp pathology. (8).

Treatment:

Access to the tooth is initially obtained through the retainer, which is then followed by the performance of endodontic treatment to address any underlying issues within the tooth's pulp. (10).

Mechanical Failures:

Loss Of Retention:

Failures in dental crowns often stem from inadequate design or construction processes. However, the loss of retention is not commonly a significant factor in the failure of individual crowns. Rather, a major contributor to these failures is the leverage forces exerted on the bridge. One of the most common modes of failure is the loosening of a retainer from the abutment tooth, which can compromise the stability and effectiveness of the entire structure. (11).

The subsequent factors should be taken into account when determining if the retention is sufficient for a specific fixed restoration. These factors encompass:

1. The magnitude of the dislodging force
2. The geometry of the tooth preparation
3. The taper
4. The surface area
5. The stress concentrations.
6. The type of preparation
7. The roughness of the fitting surfaces of the restorations
8. The materials that are being cemented. (12).

Treatment:

1. Prostheses need to be completely removed or extracted using alternative methods. If the problem is linked to the cementation process and the prosthesis itself is still in good condition, it can be recemented.
2. However, if the loss of retention is due to the design of the tooth preparation, it is necessary to modify the teeth to improve both retention and resistance form. After making these adjustments, a new prosthesis should be created to ensure proper fit and function. (10).

Connector Failure:

1. A connector serves the purpose of linking an abutment retainer to a pontic, or it can connect two pontics together. However, this connector is susceptible to failure when subjected to biting forces. Instances of failure have been documented in both cast and soldered connections. These failures are frequently attributed to internal porosity within the metal, which compromises its structural integrity and strength. (13).
2. Porcelain or acrylic resin can fracture if not properly protected or if incompatible metals are used, creating weaknesses that increase damage risk and compromise durability. (14).

Treatment:

1. Redesign the connector in a replacement prosthesis
   - Increase connector cross-sectional area (make it larger bulk) so that it can resist higher loads.
   - Ensure sufficient height of the connector in the direction of loading (occluso-gingival dimension). (21).
2. Use stronger materials
   - Materials with higher fracture toughness (e.g. zirconia vs weaker ceramics). (22).
3. Choose appropriate cementation
   - Cement type can influence stress distribution and bond strength which may affect connector survival. (20) .

➢ **Aesthetic Failures:**

1. A key goal of dental restoration is to achieve patient satisfaction. The restoration should fulfil the requirements for effective chewing function, appropriate shape, resistance to staining and wear, among other features. In the end, the chosen shade should correspond to the patient's age-related appearance and blend seamlessly with the colour of their natural teeth. (11).
2. Delayed aesthetic failure;

These failures appear after a period following cementation due to:

- Recession of the gums
- Shrinkage of tissue beneath the pontic after extraction – if healing time is insufficient post-extraction, the tissue may shrink after cementation, creating a gap between the pontic and the ridge, which can be especially unappealing in the front areas.
- After periodontal surgery – if adequate healing time is not provided after any surgical procedure, the margins may become exposed due to gum recession. (10).

Aesthetic Ceramic Repair Kit:

In dentistry, ceramic restorations (veneers, crowns, porcelain-fused-to-metal, all-ceramic crowns, etc.) sometimes undergo chipping, cracking, or delamination. Rather than remaking the restoration, a more conservative option is to repair it intraorally using a "ceramic repair kit" (also called a porcelain/ceramic repair system)

Such kits typically contain;

- Surface conditioners / etchants (e.g. hydrofluoric acid, or other acid gels)
- Silane coupling agent
- Bonding agents / adhesives
- Opaque materials (to mask underlying metal or dark substrate)
- Resin-based composite restorative materials in various shades
- Finishing & polishing instruments

These kits allow clinicians to restore small defects, chips, or fractures in ceramic surfaces, improving esthetics and function without fully removing the restoration. (18)

How a repair is done using a ceramic repair kit

The steps can vary depending on the type and extent of failure (chip, craze line, full fracture, delamination). Below is a generalized protocol, which aligns with what a "repair kit" would support:

1. Diagnosis & planning

2. Remove unsupported / loose ceramic
   - Gently remove any loose porcelain fragments to create a stable margin.

3. Surface cleaning / preparation
   - Clean the area, remove contamination (saliva, debris, previous cement).
   - Rinse, dry, and ensure a clean surface.

4. Apply silane coupling agent
   - The silane molecule bonds to the ceramic and provides chemical linkage to the resin adhesive.
   - Allow required reaction time (e.g. 1 minute) and drying.

5. Apply bonding agent / adhesive resin
   - A low-viscosity adhesive resin is applied to promote penetration and wetting, then light-cured (if the system is light-cured).
   - This enhances adhesion between ceramic and composite.

6. Use of opaquing / masking layer (if needed)
   - If the underlying substrate (metal, dark tooth) is exposed, an opaque material may be required to mask its appearance.

7. Apply composite resin in shades
   - Use a compatible resin composite (shade-matched) to rebuild the defect, layering as needed.

8. Finishing & polishing
   - After curing, the restoration is contoured, trimmed, finished with fine diamond burs, and polished to a gloss to match the surrounding ceramic surface.

9. Evaluate and adjust
   - Check occlusion, margins, and esthetics. Adjust if necessary. (19).

Aesthetic Ceramic Failure Kit

Management:
Effective treatment planning relies on accurately identifying patient needs.
Treatment is necessary to accomplish one or more of the following goals:

- Rectification of current ailments
- Prevention of potential diseases
- Restoration of functionality
- Enhancement of aesthetic appearance (15).

The following radiographs are recommended based on the clinical situation:
1. Periapical radiographs - This radiograph provides valuable information about the bone quality at the implant site and is crucial for monitoring the preservation of crestal bone after implant placement.
2. Digital radiographs/radiovisiography (RVG) - These are especially useful during the surgical placement phase, enabling the step-by-step confirmation of the implant's position relative to important anatomical features.
3. Occlusal radiograph - This type of radiograph offers insights into the bone's width and density.
4. Lateral cephalogram - This imaging method provides details about the amount and angle of bone in the anterior areas, as well as the alignment of the skeletal arch.
5. Orthopantomogram (OPG) - This is the most commonly used radiograph, offering information about the height of the available bone, its relationship to essential structures, and the quality of the bone, etc. (16).

II. Conclusion:

The procedure of substituting teeth with crowns and bridges is commonly carried out by dental practitioners. Even with careful design and execution, a restoration that is cemented but subsequently ignored can be susceptible to failure. After the active treatment phase, several common complications may occur, such as cavities, gum problems, failures in root canal treatments, loose retainers, fractures in porcelain, and root fractures. Fixed prosthetics can achieve the desired functionality, appearance, and cost efficiency, as long as they are properly planned and implemented. The majority of failures are distinct and pose different challenges to the dental professional. Significant satisfaction can be attained by addressing a situation and resolving it in an efficient and cost-effective way.

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