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"Built to Last? A Review of Factors Undermining the Longevity of Implant Prostheses"

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I. INTRODUCTION

The introduction of osseointegrated dental implants has transformed Prosthodontic rehabilitation by providing patients who are partially or completely edentulous with long-term functional and aesthetic options. Dental implants are currently regarded as a predictable and dependable treatment option, with survival rates over the course of 10 to 15 years above 90% [1,19]. However, the frequency of prosthetic problems that can jeopardize clinical success and patient happiness is increasing along with the number of implant treatments [1,3].

A wide range of mechanical and technological issues are included in prosthetic failures, such as abutment or implant fractures, veneer chipping, framework fractures, screw loosening, and component misfits [1,4,5]. In addition to posing management challenges for clinicians, these errors may raise patients' biological risks and financial burden [4,6]. The most frequent technical problems in implant prosthodontics are still screw-related issues and ceramic chipping [1,4]. Similarly, highlighting the multifaceted aspect of prosthetic success and emphasizing the importance of prosthesis design, occlusal loading, and retention mechanisms.[2]

Screw-retained and cement-retained restorations are two types of prosthetic connections that have been extensively debated and have differing failure histories.According to studies, cement-retained restorations are linked to biological issues including peri-implantitis due to excess cement, whereas screw-retained prostheses are more prone to loosening [9,10]. Furthermore, complication rates are greatly influenced by factors such as prosthesis design, occlusal forces, and implant site [13,14].

Long-term cohort studies emphasize the necessity to distinguish between survival and success. While an implant may remain osseointegrated, prosthetic problems can impair its performance [18,20]. Demonstrated time-dependent risks of failure and bone loss over 10 to 15 years, emphasizing the importance of comprehensive long-term monitoring [24,25]

Advances in material science, such as the use of zirconia and CAD/CAM milled frameworks, have shown promise in minimizing complications, although issues such as veneer chipping persist, particularly in posterior restorations [21,22]. Furthermore, parafunctional behaviours, insufficient occlusal correction, and operator experience remain key risk factors for prosthesis failure [4,15,16.]

This review synthesizes current information to critically assess the causes, occurrence, and management of prosthetic failures in implant dentistry. Understanding the underlying mechanical and clinical variables allows clinicians to better anticipate difficulties and improve treatment methods for long-term success.

Methods:-

Search strategy

A comprehensive literature search was performed to identify peer-reviewed publications related to prosthetic failures in implant dentistry. The search was conducted across the following electronic databases:

- **PubMed (MEDLINE)**
- **Scopus**
- **Google Scholar**
- **ScienceDirect**

The search included articles published between **January 2000 and May 2025**, ensuring both foundational studies and the most recent evidence were included

Inclusion Criteria:

1. Studies evaluating **technical complications** of implant-supported crowns, bridges, and overdentures.
2. Reports addressing **screw loosening, prosthesis misfit, framework fracture, ceramic chipping**, or **implant component failure**.
3. Studies involving **at least 1 year of follow-up**.
4. Both **single-tooth replacements** and **full-arch prostheses** were included

Exclusion Criteria

- Articles focusing solely on **biological complications** (e.g., peri-implantitis) without a prosthetic component.
- **In-vitro studies** unless they directly compared mechanical failure mechanisms relevant to clinical outcomes

Classification of Prosthetic Failures in Implant Dentistry:-

Prosthetic failures associated with implant-supported restorations can be broadly categorized into **mechanical**, **technical**, **esthetic**, and **biological prosthetic-related complications**. These failures may occur due to poor planning, inappropriate prosthesis design, inadequate occlusal loading, or long-term material fatigue.

1.Mechanical Failures

These failures are primarily associated with load-bearing components and are often due to fatigue, parafunction, or misfit stresses.

Type	Examples
Screw Loosening	Abutment screw loosening, repeated screw instability
Screw Fracture	Abutment or prosthetic screw breakage due to fatigue or incorrect torque
Implant Fracture	Fixture fracture due to stress concentration, long-span prostheses, or bruxism
Framework Fracture	Metal or zirconia framework fracture, especially in long-span FDPs

2. Technical Failures

These involve the breakdown or failure of the prosthesis or its interface with the implant.

Type	Examples
Veneer Fracture / Chipping	Ceramic veneer delamination or chipping from zirconia or PFM restorations
Prosthesis Misfit	Poor passive fit causing screw loosening or component fatigue
Retention Failure	Loss of retention in cemented or screw-retained restorations
Attachment System Failure	Wear, loosening, or fracture of locator/ball attachments in overdentures

3. Esthetic Failures

These relate to patient-perceived dissatisfaction or soft tissue/prosthesis disharmony.

Type	Examples
Crown Contour Mismatch	Bulky or miscontoured restorations affecting soft tissue health or esthetics
Discoloration / Shade Mismatch	Veneer color instability or poor shade selection
Soft Tissue Recession	Exposure of abutment or margin due to peri-implant mucosal loss

4. Biological Prosthesis-Related Complications

Though biological, these often stem from prosthetic factors such as excess cement or occlusal trauma.

Type	Examples
Peri-implantitis due to cement	Inflammation caused by undetected subgingival cement in cement-retained prostheses
Marginal Bone Loss from Overload	Excessive occlusal forces leading to peri-implant bone resorption

5. Time-Based Classification (Chronological Failure Onset)

Failure Onset	Examples	Causes
Early Failures	Immediate screw loosening, prosthesis misfit, retention loss	Poor torque control, misalignment
Delayed Failures	Framework fracture, veneering chipping, abutment fracture	Fatigue, wear, occlusal trauma
Late Failures	Implant fracture, peri-implant bone loss, component detachment	Long-term biomechanical stress

Definitive Causes of Prosthetic Failures in Implant Dentistry:-

- Prosthetic failures in implant dentistry are caused by a mix of mechanical, technical, biological, and aesthetic reasons that are frequently interconnected and accumulate over time. Screw loosening and fracture are two of the most prevalent mechanical reasons, and they are usually caused by insufficient preload, incorrect torque application, or micromovements at the implant-abutment interface. These problems can be compounded by parafunctional habits such bruxism, poor occlusal design, or the use of non-original components. Implant fractures, while rare, are more likely to occur in cases involving narrow-diameter implants, high occlusal stresses, or inadequate prosthetic support, particularly in cantilevered or long-span restorations. Framework fractures can occur due to faulty design, insufficient material thickness, or passive fit failure, resulting in stress accumulation and final breakage.

- Technical problems, such as veneer chipping or full debonding of restorations, are frequently caused by material fatigue, bonding errors, or inadequate laboratory protocols. In zirconia-based prostheses, poor core-veneer bonding and incorrect cooling procedures are key culprits. Prosthesis misfit is another serious concern, which is frequently caused by flaws in impressions, digital scans, or CAD/CAM defects, resulting in non-passive fits that jeopardise the prosthetic connection. Retention failure in cemented or screw-retained restorations can be caused by poor cement selection, contamination, or insufficient abutment design.

- Biological issues caused by prosthetic factors, like as peri-implantitis, are typically connected with excess cement in the sulcus, inadequate hygiene, or ill-fitting restorations that prevent thorough cleaning. Occlusal overload, incorrect prosthesis design, and a lack of regular care can all cause bone loss. Aesthetic issues such as soft tissue recession, shade mismatch, and contour discrepancies can be caused by improper implant location, poor emergence profile design, or natural tissue remodelling over time.

- Time also influences prosthetic failures. Early failures, usually during the first year, are frequently due to technical errors, insecure occlusion, or inadequate healing conditions. Delayed and late failures, which occur after several years, are often caused by accumulated biomechanical stress, material wear, or untreated biological inflammation. Finally, most prosthetic failures are multifaceted, emphasizing the necessity of overall planning, execution, and long-term care.

Prevention of prosthesis failure:

A comprehensive strategy encompassing treatment planning, surgical accuracy, prosthetic design, material selection, and long-term care is needed to prevent prosthetic failures.

1. Accurate Diagnosis and Planning:

The first step in prevention is a comprehensive case examination that includes measurements of soft tissue quality, occlusion, bone volume, and patient-specific characteristics like bruxism or systemic health. Favourable emergence profiles and load distribution are guaranteed by proper implant placement that is guided by computerized planning and surgical templates.

2. Optimal prosthetic design:

It is essential to design restorations with appropriate load-sharing and occlusion. Biomechanical stress can be decreased by avoiding cantilevers, incorporating splinted restorations when bone support is inadequate, and keeping the crown-to-implant ratios optimal. It is important to make sure that frameworks fit passively to avoid putting undue strain on screws and implants.

3. Selection of Retention Type:

The decision between screw-retained and cemented restorations should be made case-by-case. Screw-retained prostheses provide retrievability and reduce the chance of cement-induced peri-implantitis. Complete cement removal is made easier if cementation is necessary by employing retrievable cements and maintaining supragingival margins.

4. **Torque Control and Component Quality:**

Using calibrated torque drivers and adhering to manufacturer-specified values ensures proper preload and minimizes screw looseness. Using original components from the same system reduces incompatibility and improves mechanical integrity.

5. Material and Laboratory Protocols:

High-quality materials with demonstrated fatigue resistance, such as monolithic zirconia or metal-ceramic, should be utilized. Strict adherence to laboratory protocols, especially in layering, cooling, and veneering, lowers the possibility of chipping and fractures.

6. Maintenance and Follow-Up:

Regular check-ups can detect early signs of wear, screw loosening, and soft tissue inflammation. Professional cleaning, dental hygiene reinforcement, and frequent occlusal adjustments can all help to avoid long-term issues. Night guards may be recommended for bruxers to safeguard the prosthesis from parafunctional pressures.

7. Patient education:

It is critical to educate patients about implant prostheses' maintenance, hygiene requirements, and limits. Compliance with follow-up visits and awareness of early warning indicators can considerably lower the likelihood of serious problems.

II. MANAGEMENT:

Prosthetic failures in implant dentistry can be effectively avoided with careful planning, excellent execution, and thorough follow-up. A thorough clinical and radiographic examination should guide implant placement to provide optimal angulation and support. Prosthetic designs should prioritize passive fit, good occlusion, and biomechanical stability, while avoiding cantilevers and high crown-to-implant ratios. Using proper retention methods—preferably screw-retained where possible—helps reduce the dangers associated with excess cement and improves retrievability.

Using high-quality components, applying the proper torque, and minimizing the reuse of crucial parts all help to reduce mechanical difficulties such as screw loosening or breakage. Materials should be chosen according to functional load and aesthetic requirements, with monolithic repairs preferable in high-stress regions. Regular care, including professional cleaning and occlusal exams, is essential. Equally crucial is patient education on hygiene, prosthesis care, and the importance of routine follow-up to recognize and address early indicators of failure.

III. CONCLUSION :

Prosthetic failures in implant dentistry are a substantial clinical difficulty, frequently caused by a complex interaction of mechanical, technological, biological, and aesthetic factors. While advances in implant materials, digital workflows, and prosthetic design have reduced the number of issues, failures may occur and can jeopardise both function and patient pleasure. This evaluation emphasises the need for rigorous treatment planning, accurate execution, and individualised prosthetic design to reduce hazards.

Regular follow-up, early discovery of problems, and proactive maintenance are all equally important for long term success. Furthermore, patient education and compliance are critical components in preventing and controlling problems. By understanding the multifactorial causes and implementing evidence-based prevention and management strategies, clinicians can significantly enhance the longevity and success of implant-supported prostheses

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