BIOLOGICAL AND TECHNICAL COMPLICATIONS IN TOOTH- AND IMPLANT-SUPPORTED FIXED AND HYBRID PROSTHESES: ETIOPATHOGENESIS, RISK FACTORS AND PREVENTIVE STRATEGIES – A NARRATIVE REVIEW

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ABSTRACT

Aim of the study: Fixed and hybrid prosthodontic restorations supported by natural teeth or dental implants are widely used in the rehabilitation of partially or completely edentulous patients. This narrative review aims to evaluate current evidence regarding biological and technical complications associated with these restorations, focusing on etiopathogenesis, risk factors, clinical implications, and preventive strategies.**Materials and methods:** A comprehensive search was conducted in PubMed, Scopus, Web of Science, and Google Scholar. Systematic reviews, randomized controlled trials, and high-quality observational studies were included to synthesize evidence on long-term complications of tooth- and implant-supported fixed and hybrid prostheses.**Results:** Biological complications include secondary caries, pulpal pathology, peri-implant mucositis, and peri-implantitis. Technical complications comprise restorative material fractures, loss of retention, wear of prosthetic components, screw loosening or fracture, and framework failures. The evidence indicates a multifactorial etiology involving prosthetic design, biomechanical loading, material characteristics, clinician-related factors, and patient-specific risk profiles.**Conclusions:** Biological and technical complications remain clinically relevant despite advances in materials and techniques. Their occurrence is influenced by multiple interacting factors, and a thorough understanding of their mechanisms is essential for improving treatment planning, optimizing prosthetic design, and establishing effective maintenance protocols.

Keywords: prosthodontics, fixed dental prostheses, implant-supported prostheses, hybrid prostheses, biological complications, technical complications, peri-implantitis, prosthetic maintenance, prosthesis survival, screw loosening.

INTRODUCTION

Fixed and hybrid prosthetic restorations supported by teeth and dental implants represent predictable treatment modalities for oral rehabilitation. Over the past few decades, significant advances in biomaterials, adhesive technologies, implant surface modifications, computer-aided design/computer-aided manufacturing (CAD/CAM) systems, and digital workflows have substantially improved the precision, durability, and overall success rates of prosthetic treatments [1-3].

Despite these technological and clinical developments, biological and technical complications continue to represent a major challenge in both tooth-supported and implant-supported rehabilitations [1,2,6]. While survival rates of fixed prostheses and dental implants remain high, long-term treatment success is

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increasingly recognized as being determined not only by prosthesis survival but also by the absence of complications, maintenance burden, patient comfort and preservation of supporting tissues [2,6,7]. Consequently, the management of prosthetic complications has become a central aspect of contemporary prosthodontic care.

Biological complications may affect the dental, periodontal, peri-implant, and peri-prosthetic tissues and can significantly compromise treatment outcomes if not identified and managed promptly [8-10]. Among the most frequently reported complications are secondary caries, pulpal pathology, periodontal inflammation, peri-implant mucositis, and peri-implantitis [8-12]. These conditions are typically associated with complex interactions between microbial biofilms, host susceptibility, prosthetic design characteristics, and patient-related behavioral factors. In severe cases, biological complications may result in loss of abutment teeth, progressive peri-implant bone destruction, or implant failure.

Technical complications remain equally relevant and may occur regardless of the type of prosthetic support. Commonly reported technical failures include loss of retention, veneering material fractures, ceramic chipping, screw loosening, screw fracture, framework fracture, and progressive wear of prosthetic components [6,13-15]. The incidence and severity of these complications are influenced by multiple variables, including prosthetic design, material properties, occlusal loading conditions, manufacturing accuracy, implant positioning, and clinician experience. Although many technical failures are not immediately catastrophic, they frequently increase treatment costs, maintenance requirements, and patient dissatisfaction.

Current evidence suggests that prosthetic complications are multifactorial phenomena resulting from the interaction of biological, biomechanical, prosthetic and patient-related factors [6,14,16]. However, despite the growing volume of literature addressing individual complications, available evidence remains fragmented, often focusing on specific prosthetic systems, materials, or clinical scenarios. Furthermore, the increasing adoption of implant-supported and hybrid rehabilitations has introduced new patterns of complications that differ substantially from those observed in conventional tooth-supported prostheses. As a result, clinicians are frequently required to integrate evidence derived from diverse sources when making treatment decisions and establishing maintenance protocols.

A comprehensive understanding of the etiopathogenic mechanisms, risk factors and preventive approaches associated with biological and technical complications is therefore essential for optimizing long-term treatment outcomes [7,15,16]. Identifying modifiable risk factors and implementing evidence-based preventive strategies may reduce complication rates, improve prosthesis longevity, and enhance patient satisfaction.

Therefore, the aim of this narrative review is to critically examine the current scientific evidence regarding biological and technical complications associated with tooth-supported, implant-supported fixed and hybrid fixed prosthetic restorations. Particular emphasis is placed on etiopathogenesis of these complications, their principal risk factors, clinical implications, and contemporary preventive strategies that may contribute

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to improved long-term prosthetic success.

MATHERIALS AND METHODS

This narrative review was conducted through a comprehensive search of PubMed, Web of Science, Scopus, and Google Scholar. The search focused on studies published in English addressing biological and technical complications associated with tooth- and implant-supported fixed and hybrid prosthetic restorations.

Keywords included: "prosthodontics", "fixed dental prosthesis", "implant-supported prosthesis", "hybrid prosthesis", "biological complications", "technical complications", "peri-implantitis", "secondary caries", "screw loosening" and "prosthetic failure. Priority was given to systematic reviews, meta-analyses, randomized clinical trials, prospective cohort studies, and landmark publications with significant relevance to contemporary prosthodontic practice. The selected literature was critically analyzed and synthesized to provide an updated overview of the etiopathogenesis, risk factors, prevention, and management of prosthetic complications.

RESULTS

I. BIOLOGICAL COMPLICATIONS

1. Secondary Caries

Secondary caries is a leading cause of failure in tooth-supported fixed prosthetic restorations [14,15]. It is defined as the development of a new carious lesion adjacent to the margins of an existing restoration and is frequently associated with marginal discrepancies, microleakage, inadequate oral hygiene, and plaque accumulation.

The etiopathogenesis of secondary caries is multifactorial, involving microleakage, poor oral hygiene, and caries risk [14,16]. Several studies have identified secondary caries as a major reason for the replacement or failure of fixed dental prostheses [15,16] The risk appears to increase with restoration age in patients presenting multiple caries risk factors. Clinically, undetected secondary caries may progress toward pulpal involvement, periodontal complications, and eventual loss of the abutment tooth.

Preventive stategies include meticulous tooth preparation, accurate marginal adaptation, appropriate material selection, regular professional maintenance, and individualized caries-risk assessment. Long-term success depends not only on prosthetic quality but also on patient adherence to preventive oral hygiene measures.

2. Periodontal Complications

Periodontal complications represent a significant biological challenge associated with fixed prosthetic restorations [16,17]. The periodontal response to prosthetic treatment is largely influenced by the design of the restoration, marginal location, contour profile, emergence profile and the patient's oral hygiene status.

Overcontured restorations, subgingival margins, inadequate emergence profiles, and poorly finished restorative surfaces may promote plaque accumulation and compromise effective biofilm control. Persistent plaque retention can initiate gingival inflammation, bleeding on probing, increased periodontal pocket depth, and progressive attachement loss [6,17].

The relationship between prosthetic restoration and periodontal health is complex and involves both local and systemic factors. Patients with a history of periodontitis, smoking habits, diabetes mellitus, or inadequate maintenance programs demostrate a higher susceptibility to periodontal deterioration following prosthetic treatment

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[16,17].

3. Pulpal Complications

Pulpal complications are associated with extensive tooth preparation, thermal preparation, thermal injury and microleakage [18,19]. Although advances in adhesive dentistry and minimally invasive protocols have reduced the overall incidence of pulpal injury, endodontic complications remain clinically relevant, especially in long-span fixed prostheses and restorations involving multiple abutment teeth [19].

Reduced dentin thickness increases pulpal sensitivity and the risk of necrosis due to increased permeability and diminished protective capacity of the dentin-pulp complex [19,20].

Post-cementation sensitivity is another frequently reported clinical manifestation, often associated with microleakage, polymerization shrinkage of resin-based luting agents, or hydraulic pressure generated during cementation procedures. In some cases, these symptoms may be transient; however, persistent inflammation can progress to irreversible pulpitis requiring endodontic treatment. Occlusal overload has also been identified as a contributing factor, particularly in cases of parafunctional habits such as bruxism. Excessive occlusal forces transmitted through fixed prostheses may exacerbate microcracks in dentin or compromise pulpal blood flow, further increasing the risk of pulpal degeneration [18-20].

Preventive strategies are primarily based on conservative tooth preparation techniques, adequate irrigation during preparation, use of desensitizing agents, and careful assessment of remaining dentin thickness. The application of adhesive protocols and immediate dentin sealing techniques has been shown to reduce postoperative sensitivity and improve pulpal prognosis [19].

4. Peri-implant Mucositis

Peri-implant mucositis is a reversible inflammatory condition affecting the soft tissues surrounding dental implants without evidence of progressive supporting bone loss. It is known to

be as the most prevalent biological complication associated with implant-support prosthetic restorations and is considered the precursor lesion of peri-implantitis [6,10].

The primary etiological factor involved in the development of peri-implant mucositis is the accumulation of bacterial biofilm at the implant-prosthesis interface [10,11]. It is characterized by bleeding on probing, erythema, swelling and increased probing depth, while radiographic examination generally reveals stable peri-implant bone levels.

Professional biofilm removal combined with improved patient oral hygiene can effectively resolve inflammation and restore peri-implant tissue health [11].

5. Peri-implantitis

Peri-implantitis is a biofilm-associated inflammatory characterized by inflammation of the peri-implant tissues accompanied by progressive loss of supporting bone. It represents one of the most significant biological complications affecting implant-supported prosthetic rehabilitations and is considered a major cause of implant failure in long-term clinical follow-up studies [8-10].

The pathogenesis of peri-implantitis involves a complex interaction between microbial colonization and host immune response [6,12]. Persistent biofilm accumulation induces chronic inflammation, resulting in the release of pro-inflammatory mediators, activation of osteoclasts, and subsequent peri-implant bone resorption. Several risk factors have been consistently associated with peri-implantitis. These include poor a history of periodontitis, poor plaque control, smoking, residual excess cement, prosthetic misfit, occlusal overload and irregular participation in maintenance

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programs [7-10] .

Clinically, peri-implantitis is characterized by bleeding and/or suppuration on probing, increased probing depths, mucosal inflammation, and radiographic evidence of progressive crestal bone loss. Early diagnosis is critical because advanced peri-implant lesions may ultimately compromise implant stability and result in implant loss. Current treatment strategies focus on infection control, biofilm disruption, surface decontamination, and correction of local contributing factors. Depending on disease severity, both non-surgical and surgical approaches may be indicated [11,16]. Table 1 summarizes the biological complications associated with tooth- and implant-supported fixed and hybrid prostheses reported in the literature.

Table 1. Biological complications associated with tooth-and implant-supported fixed and hybrid prosthetic restorations.

Complications	Main Etiological Factors	Clinical Consequences	Preventive Strategies
Secondary caries	Marginal discrepancies, microleakage, high caries risk, inadequate oral hygiene.	Tooth structure loss, pulpal involvement, abutment failure.	Accurate marginal adaptation, caries risk assessment, oral hygiene reinforcement, regular maintenance.
Periodontal complications	Overcontoured restorations, subgingival margins, inadequate emergence profile, plaque retention.	Gingival inflammation, attachment loss, periodontal disease progression.	Biologically oriented prosthetic design, supragingival margins when possible, supportive periodontal therapy.
Pulpal complications	Extensive tooth preparation, thermal trauma, dentin thickness, microleakage, occlusal overload.	Postoperative sensitivity, pulpitis, pulpal necrosis, need for endodontic treatment.	Conservative tooth preparation, adequate cooling, immediate dentin sealing, occlusal adjustment.
Peri-implant mucositis	Biofilm accumulation inadequate plaque control, residual cement, prosthetic overcontouring.	Reversible peri-implant soft tissue inflammation.	Professional biofilm removal, optimized prosthetic design, regular maintenance programs.
Peri-implantitis	Persistent biofilm, history of periodontis, smoking, excess cement, prosthetic	Reversible peri-implant bone loss, implant instability/loss.	Risk assessment, plaque control, maintenance therapy, early diagnosis and intervention.

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	misfit, poor maintenance compliance.		

II. TECHNICAL COMPLICATIONS

1. Loss of retention

Loss of retention represents one of the most frequently reported technical complications affecting both tooth-supported and implant-supported fixed prosthetic restorations [3,8]. It is characterized by the partial or complete dislodgement of the prosthesis from its supporting structure and may significantly compromise prosthetic function, patient comfort, and treatment longevity.

The etiology of retention loss is multifactorial and varies according to the type of prosthetic support. In tooth-supported restorations, inadequate preparation geometry, insufficient axial wall height, excessive taper, contamination during cementation procedures, and degradation of luting agents have been identified as major contributing factors [20,21]. Cement dissolution over time may further facilitate micro-movements at the tooth-restoration interface, increasing the risk of prosthesis decementation.

In implant-supported restorations, loss of retention may experience retention-related problems secondary to screw loosening or inadequate preload generation during prosthesis delivery [13,14,22].

Patient-related factors, including parafunctional habits, unfavorable occlusal schemes, and poor compliance with maintenance protocols, may further contribute to the development of retention failures. Although loss of retention is generally considered a reversible complication, repeated episodes may increase the risk of secondary biological complications, including caries, periodontal inflammation, and peri-implant disease [6,14].

Preventive strategies include meticulous treatment planning, appropriate preparation design, careful selection of luting materials, adherence to manufacturer-recommended cementation protocols, and regular maintenance visits. In implant-supported rehabilitations, proper torque application and verification of prosthetic fit are essential for minimizing retention-related complications [15,22-24].

2. Veneering material fracture and ceramic chipping

Fracture of veneering materials and ceramic chipping are among the most commonly reported technical complications in contemporary fixed prosthodontics, particularly in implant-supported and full-arch rehabilitations. Although these complications rarely result in complete prosthetic failure, they frequently compromised esthetics, function, and patient satisfaction while increasing maintenance requirements [20-21].

The etiopathogenesis of ceramic chipping is complex and involves interactions between material properties, prosthetic design, manufacturing procedures, and occlusal loading conditions. Inadequate framework support, non-uniform veneer thickness, residual stresses generated during fabrication, and material incompatibility between framework and veneering ceramic have all been implicated as contributing factors [23-26].

Biomechanical factors play a particularly important role in implant-supported prostheses. Because implants lack the shock-absorbing capacity of the periodontal ligament, occlusal forces may be transmitted

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more directly to the prosthetic components, increasing stress concentration with veneering materials. Patients presenting parafunctional habits such as bruxism demonstrate significantly higher rates of ceramic complications [24-27].

The introduction of monolithic restorative materials, including monolithic zirconia, has substantially reduced the incidence of veneering fractures compared to conventional restorations [15,26,28]. Preventive measures include appropriated framework design, optimizing of veneer thickness, careful occlusal adjustment, selection of high-strength restorative materials, and identification of patients with elevated functional risk. The use of occlusal splints may provide additional protection in patients exhibiting parafunctional activity [27,28].

3. Screw loosening

Screw loosening is considered the most prevalent technical complication associated with screw-retained implant-supported prosthetic restorations [24,27].

The stability of the implant-abutment connection depends primarily on preload, which is generated when the fixation screw is tightened according to the manufacturer's recommended torque values. Loss of preload may occur due to settling effects, cyclic mechanical loading, manufacturing inaccuracies, component misfit, or excessive occlusal forces. Once preload decreases below a critical threshold, micro-movements may develop at the implant-abutment interface, resulting in progressive screw loosening [24,27-28].

Risk factors associated with increased screw loosening incidence include non-passive prosthetic fit, cantilever extensions, unfavorable implant angulation, inadequate torque application, and parafunctional habits. Full-arch implant-supported rehabilitation may be particularly susceptible because of the complex distribution of occlusal forces across multiple implants [13,14,29].

Clinically, screw loosening may present as prosthetic mobility occlusal instability, food impaction, or patient-reported discomfort. If left untreated, repeated loosening episodes may lead to screw fracture, prosthetic component wear, bacterial leakage, and peri-implant tissue inflammation [22,29,30].

Preventive strategies focus on accurate prosthetic fabrication, passive framework adaptation, proper torque control, screw retightening protocols after initial insertion, and comprehensive occlusal management. Advances in implant connection design and screw metallurgy have contributed to reducing complication rates; however, screw loosening remains a relevant challenge in long-term implant prosthodontics [13,24,30].

4. Screw fracture

Screw fracture represents a less frequent but considerably more severe technical complication that screw loosening in implant-supported prosthetic rehabilitations. Although its reported prevalence remains relatively low, fracture of the prosthetic screw may result in complex clinical situations requiring component retrieval, prosthetic removal, or even implant replacement in advanced cases. Recent studies indicate that screw fractures account for a smaller proportion of technical complications compared to screw loosening; however, their clinical impact is substantially greater due to the difficulty of management [13,14,29-31].

The etiopathogenesis of screw fracture is primarily related to metal fatigue resulting from repetitive cyclic loading. In many cases, screw fracture is preceded by recurrent episodes of screw loosening, which generate micro-movements at the implant-abutment interface and increase stress concerning within the screw body. Over time, these repetitive stresses may initiate microscopic cracks that progressively propagate until catastrophic failure occurs [29,33].

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Several risk factors have been associated with an increased incidence of screw fracture, including inadequate preload, improper torque application, non-passive framework fit, cantilever extensions, implant malposition, unfavorable occlusal schemes, and parafunctional activity such as bruxism. Posterior restorations are particularly susceptible because of the higher occlusal loads generated during mastication [29].

Screw fracture presents with sudden prosthetic instability, loss of retention, or complete prosthesis mobility. Retrieval of fractured screw fragments can be challenging, especially when fracture occurs below the implant platform. Preventive strategies include precise torque control, optimization of prosthetic fit, reduction of cantilever length, careful occlusal adjustment, and routine maintenance protocols aimed at identifying early signs of mechanical instability before fatigue failure develops [29,33].

5. Framework fracture

Framework fracture is considered one of the most serious technical complications affecting fixed and hybrid prosthetic restorations. Although relatively uncommon in contemporary prosthodontics due to advances in material science and CAD/CAM manufacturing technologies, framework failure may compromise the structural integrity of the entire prosthesis and often requires extensive repair or complete prosthetic replacement [33-35]

The development of framework fractures is multifactorial and results from the interaction of biomechanical, material-related, and prosthetic factors. Inadequate framework design, insufficient connector dimensions, unsupported veneering materials, manufacturing defects, and repeated functional loading may generate stress concentrations within critical areas of the prosthesis. Over time, these stresses may initiate fatigue cracks that progressively propagate through the framework structure [31].

Historically, framework fractures were more frequently observed in cast metal and metal-ceramic prostheses. However, the widespread adoption of zirconia-based and CAD/CAM- fabricated restorations has altered the pattern of mechanical failures. Although monolithic zirconia frameworks demonstrate excellent fracture resistance, complications may still occur in extensive full-arch rehabilitations subjected to high occlusal loads or parafunctional activity [32,35].

Several risk factors have been consistently reported including long-span prostheses, excessive cantilever extensions, inadequate framework thickness, poor implant distribution, bruxism, and unfavorable occlusal loading, Framework fractures are often preceded by veneering material chipping, suggesting the presence of underlying biomechanical overload [34-36].

Prevention relies on prosthetically driven treatment planning, biomechanical optimization of framework design, adequate connector dimensions, use of high-strength materials, and careful occlusal management, Contemporary digital workflows and finite element analysis have further contributed to reducing the incidence of framework-related failures by allowing more precise stress distribution assessment during prosthesis design [30,35].

6. Prosthetic wear

Prosthetic wear represents a progressive technical complication affecting both tooth-supported and implant-supported restorations. Although often overlooked because of its gradual nature, cumulative war may significantly influence occlusal stability, esthetics prosthetic longevity and patient satisfaction over time [36-38].

Wear processes involve the gradual loss of restorative material as a consequence of mechanical contact, friction, abrasion, and

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fatigue phenomena occurring during mastication and parafunctional activity, The severity of wear is influenced by multiple factors, including restorative material properties, surface roughness, occlusal scheme, antagonist characteristics, and functional loading conditions [39, 40].

Composite resin restorations generally demonstrate grater wear susceptibility than ceramic materials, whereas high-strength ceramics such as monolithic zirconia exhibit excellent wear resistance [38]. Excessively rough zirconia surfaces may increase wear of the opposing dentition, highlighting the importance of appropriate finishing and polishing procedures [39,41].

Long-term wear may result in loss of occlusal anatomy, reduced vertical dimension, occlusal instability, food impaction, and increased stress on other prosthetic components, thereby indirectly predisposing to additional technical complications [39,42].

Continuous follow-up remains essential for identifying progressive wear before functional deterioration becomes clinically significant [41,42].

An overview of the technical complications is presented in Table 2.

Table 2. Technical complications associated with tooth- and implant-supported fixed and hybrid prosthetic restorations.

Complications	Principal Risk Factors	Clinical Impact	Preventive Strategies
Loss of retention	Inadequate preparation geometry, cement degradation, occlusal overload, improper cementation.	Prosthesis dislodgement, functional impairment.	Appropriate preparation design, suitable luting agents, maintenance protocols.
Veneering material fracture/ceramic chipping	Framework design deficiencies, non-uniform veneer thickness, parafunctional habits, occlusal overload.	Esthetical and functional compromise, repair requirements.	Monolithic materials, optimized framework support, occlusal management.
Screw loosening	Inadequate preload non-passive fit, cantilevers, excessive occlusal forces.	Prosthesis mobility discomfort, risk of secondary complications.	Proper torque application, passive fit verification, regular follow-ups.
Screw fracture	Repeated screw loosening, metal fatigue, implant malposition, bruxism.	Complex repairs, component replacement.	Early management of screw loosening, biomechanical optimization.

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Framework fracture	Long-span prostheses, inadequate framework thickness, parafunctional loading, manufacturing defects.	Major prosthetic failure, prosthesis replacement.	High-strength materials, CAD/CAM fabrication, biomechanical planning.
Prosthetic wear	Functional loading, material properties, parafunctional habits.	Occlusal instability, loss of anatomy, increased maintenance needs.	Material selection, occlusal monitoring, periodic adjustments.

DISCUSSION

Peri-implant diseases are strongly associated with biofilm accumulation, but their progression is influenced by systemic and local risk factors [6,7]. Similarly, technical complications are increasingly linked to biomechanical overload rather than material failure alone [20,22].

Technical complications continue to represent a substantial source of prosthetic maintenance.

Importantly, biological and technical complications are interrelated; mechanical failures may facilitate bacterial colonization, while biological inflammation may increase mechanical stress [8]. Regular maintenance therapy is essential for early detection and prevention of complications. Professional biofilm control, reinforcement of oral hygiene measures, evaluation of prosthetic integrity, and periodic occlusal assessment should be incorporated into individualized maintenance programs. Clinical and radiographic follow-up enables early diagnosis of biological and mechanical problems before extensive damage occurs [11].

The introduction of monolithic zirconia and CAD/CAM fabrication has significantly reduced the incidence of certain material-related failures. Framework design, passive fit, implant distribution, cantilever extension, occlusal loading, and parafunctional habits continue to influence long-term prosthetic performance [22-25].

This review has several limitations inherent to the narrative review methodology. The literature selection process was not performed according to a predefined systematic protocol, and heterogeneity among available studies regarding complication definitions, follow-up duration and reporting criteria limits direct comparison of findings. Consequently, the conclusions should be interpreted within the context of these methodological limitations.

Overall, modern fixed and hybrid prosthetic rehabilitations demonstrate high survival rates and predictable clinical outcomes. Nevertheless, biological and technical complications remain common and should be considered an expected aspect of long-term prosthetic therapy.

Comprehensive risk assessment, evidence-based treatment planning and structured maintenance protocols remain essential for maximizing prosthetic longevity and preserving oral health.

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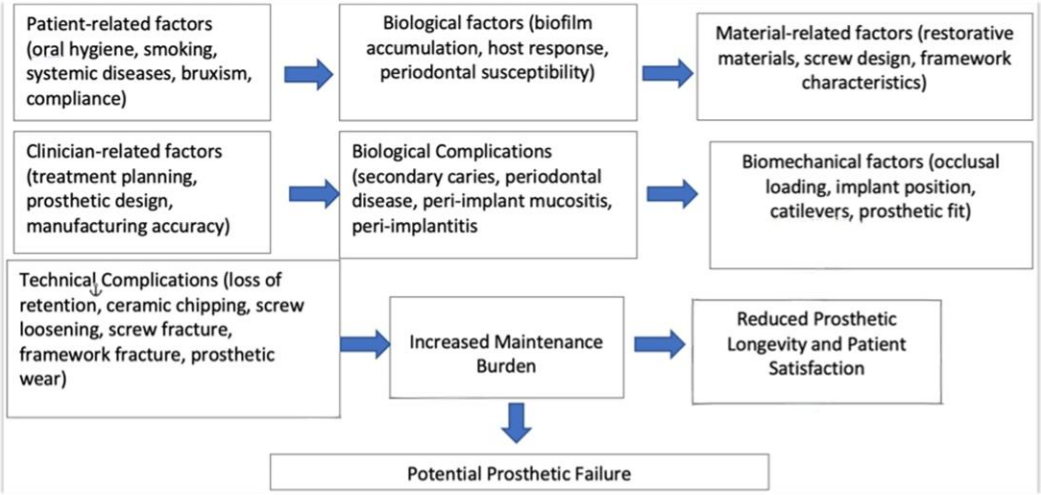

Figure 1. Conceptual model illustrating the multifactorial pathways involved in biological and technical complication.

CLINICAL IMPLICATIONS

The findings of the present review have important clinical implications for both treatment planning and long-term maintenance of fixed and hybrid prosthetic restorations. Given the multifactorial nature of biological and technical complications, successful prosthodontic rehabilitation requires a comprehensive approach that integrates biological, mechanical, and patient-related considerations throughout all phases of treatment.

A fundamental aspect of complication prevention is thorough patient assessment prior to treatment initiation. Identification of individual risk factors, including poor oral hygiene, history of periodontal disease, smoking, systemic conditions, parafunctional habits, and unfavorable occlusal patterns, allows clinicians to develop personalized treatment strategies and realistic maintenance protocols. Risk assessment should therefore be considered an essential component of contemporary prosthodontic care rather than a supplementary procedure.

From a biological perspective, prosthetic designs should facilitate effective plaque control and support the maintenance of healthy periodontal and peri-implant tissues. Careful attention should be paid to restoration contours, emergence profiles, marginal adaptation, and accessibility for placement and avoidance of plaque-retentive areas may contribute significantly to reducing the risk of peri-implant diseases.

The prevention of technical complications requires particular emphasis on biomechanical principles. Appropriate material selection, passive prosthetic fit, adequate framework design, proper torque application, and careful occlusal adjustment remain essential for minimizing mechanical failures. Special attention should be given to patients presenting parafunctional habits, as excessive functional loading has been consistently associated with increased rates of prosthetic complications. In such cases, occlusal splint therapy may provide additional protection and improve long-term prosthetic stability.

Regular maintenance programs represent

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one of the most effective strategies for reducing complication rates. Periodic clinical and radiographic evaluations facilitate the early detection of biological and technical problems before significant damage occurs. Professional biofilm control, reinforcement of oral hygiene measures, assessment of prosthetic integrity, and monitoring of occlusal relationships should form part of a structured recall protocol tailored to the patient's risk profile. Finally, advances in digital technologies offer valuable opportunities from improving treatment accuracy and prosthetic precision. However, successful outcomes continue to depend on sound clinical judgement, evidence-based decision-making, and adherence to established biological and biomechanical principles. Consequently, long-term prosthetic success should be views as the result of a continuous interaction between appropriate treatment planning, high-quality prosthetic execution, patient compliance, and effective maintenance care.

CONCLUSIONS

1. Fixed and hybrid prosthetic restorations supported by natural teeth and dental implants represent highly predictable treatment modalities for the rehabilitation of partially and completely edentulous patients. Despite the substantial advances achived in biomaterials, digital technologiesm and clinical protocols, biologica land technical complications continue to affect long-term treatment outcomes and remain an important challenge in contemporary prosthodontic practice.

2. The evidence reviwed in this study indicates that complications such as secondary caries, periodontal and pulpal pathology, peri-implant mucositis, peri-implantities, loss of retention, ceramic chipping, screw loosening, screw fracture, framework failure, and prosthetic wear are multifactorial phenomena resulting from the interaction of biological biomechanical, prosthetic, and patient-related factors.

3. A recurring finding throughput the literature is the central role of preventive strategies in reducing complications rates and improving long-term prosthetic success. 5. 5.

4.Comprehensive patient assessment, individualized risk evaluation, biologically and mechanically optimized prosthetic design, appropriate material selection, and structured maintenance programs are essential components of successful rehabilitation. Furthermore, the integration of digital technologies can enhance treatment precision and workflow efficiency, however, long-term outcomes remain dependent on adherence to established biological and biomechanical principles.

5. Given the increasing complexity of contemporary prosthetic rehabilitation and the growing prevalence of implant-supported treatments, clinicians should adopt a comprehensive and patient-centered approach focused not only on prosthesis survival but also on complication prevention and long-term tissue preservation. Future research should prioritize standardized reporting of prosthetic complications and long-term prospective studies aimed at identifying predictive factors and optimizing preventive protocols. Such efforts may contribute to improving the longevity, predictability, and overall quality of fixed and hybrid prosthetic treatments.

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