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Original article

The Impact of Bruxism on the Success and Longevity of Dental Restorations and Implants: A Systematic Review

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ABSTRACT

Bruxism, characterized by repetitive jaw-muscle activity involving teeth clenching and grinding, generates occlusal forces far exceeding normal functional activities. This systematic review aims to assess the impact of bruxism on the success and longevity of dental restorations and implants. A systematic review was conducted following PRISMA 2020 guidelines. Electronic searches were performed in PubMed/MEDLINE, Web of Science, Scopus, Cochrane Library, and Science Direct for studies published between January 2000 and December 2025. Studies reporting outcomes of dental implants or restorations in patients with bruxism were included. Twenty-seven studies met the inclusion criteria. Meta-analyses demonstrated that bruxism significantly increases implant failure risk (OR 2.2-2.3, p<0.001). Mechanical complications predominate, including implant fractures, screw loosening, and ceramic chipping, occurring 2-10 times more frequently in bruxers. Anterior ceramic veneers showed dramatically increased failure risk (HR 7.74), while monolithic zirconia demonstrated favorable short-term outcomes. A critical geographical evidence gap was identified, with no clinical studies from Libya investigating bruxism and dental outcomes. Bruxism approximately doubles implant failure risk and substantially increases mechanical complications. Evidence-based management includes systematic screening, patient counseling, modified treatment planning, appropriate material selection, and occlusal splint therapy. Urgent research is needed in Libyan populations to verify the applicability of global evidence and guide region-specific clinical recommendations.

Introduction

Bruxism, characterized by repetitive jaw-muscle activity involving teeth clenching and grinding, generates occlusal forces far exceeding normal functional activities like mastication [1,2]. This parafunctional activity significantly compromises the long-term success of dental restorations and implants placed to rehabilitate partially or completely edentulous patients [3]. Unlike natural teeth supported by periodontal ligament shock absorption, osseointegrated implants are rigidly anchored to bone through a direct structural and functional connection [4]. This biomechanical difference has profound implications for how occlusal forces are transmitted to supporting structures and prosthetic components. When excessive forces are generated during bruxism episodes, they are transferred directly to the implant-bone interface and through the prosthetic superstructure without attenuation, potentially leading to mechanical failures, biological complications, or both [5]. Complications range from minor prosthetic issues such as screw loosening or ceramic chipping, to catastrophic failures, including implant fracture or complete loss of osseointegration [6]. These complications result in additional costs, extended treatment times, and significant patient morbidity, making bruxism identification and management essential components of comprehensive treatment planning [7].

According to the international consensus established by Lobbezoo and colleagues in 2013 and updated in 2018, bruxism is defined as a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible [8,9]. Two distinct manifestations exist under different temporal conditions. Sleep bruxism refers to masticatory muscle activity occurring during sleep, typically characterized by rhythmic or non-rhythmic contractions that may result in tooth grinding sounds [10]. Polysomnographic studies demonstrate that sleep bruxism episodes are often associated with micro-arousals from sleep and are part of a broader pattern of rhythmic masticatory muscle activity [11]. Awake bruxism manifests during wakefulness and is characterized by repetitive or sustained tooth contact and/or bracing of the mandible, often without audible grinding sounds [12]. This form is frequently associated with periods of concentration, stress, or anxiety and may represent a subconscious habit of which affected individuals are often unaware [13].

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The classification system categorizes bruxism based on diagnostic certainty [14]. Possible bruxism is diagnosed based on self-report alone [15]. Probable bruxism is diagnosed when self-report is combined with clinical examination findings, including tooth wear facets, muscle hypertrophy, or temporomandibular joint discomfort [16]. This level provides sufficient certainty for most clinical decision-making and is the minimum standard recommended for studies examining bruxism as a risk factor [17]. Definite bruxism requires confirmation through instrumental assessment, typically involving polysomnography for sleep bruxism or electromyography for awake bruxism [18].

Among adults, sleep bruxism prevalence ranges from 8% to 16%, with higher rates observed in younger adults and a gradual decline with advancing age [19]. Awake bruxism affects approximately 22% to 31% of adults, though identification is complicated by many individuals being unaware of their daytime clenching habits [20]. When considering both forms together, overall bruxism prevalence in the adult population approaches 30% to 40% [21]. Children show the highest prevalence rates, with estimates ranging from 14% to 38%, followed by a gradual decline through adolescence and into adulthood [22]. Geographic variations have been less thoroughly studied, but the applicability of prevalence estimates from European, North American, and Asian populations to other regions, including North Africa and the Middle East, remains uncertain due to the absence of region-specific epidemiological studies [23].

Natural teeth are suspended within alveolar bone by the periodontal ligament, a specialized connective tissue serving multiple functions, including proprioception, nutrition, and mechanical shock absorption [24]. The periodontal ligament is approximately 0.15 to 0.38 millimeters in width and contains collagen fibers arranged in a complex three-dimensional network suspending the tooth within the socket while permitting limited physiologic movement [25]. When occlusal forces are applied, the periodontal ligament undergoes viscoelastic deformation, dissipating energy and distributing loads to the surrounding bone [26]. The periodontal ligament also contains mechanoreceptors providing proprioceptive feedback, enabling the central nervous system to modulate bite force and protect against excessive loading [27].

Dental implants achieve fixation through osseointegration, a direct structural and functional connection between living bone and the implant surface [28]. This connection involves no intervening soft tissue layer, resulting in rigid anchorage without the shock-absorbing capacity of the periodontal ligament [29]. Forces applied to implant-supported prostheses are transmitted directly to the bone-implant interface, creating stress concentrations at the crestal bone region that may exceed physiologic tolerance under overload conditions [30]. The absence of periodontal mechanoreceptors around implants further distinguishes their biomechanical behavior from natural teeth [31]. Patients with implant-supported prostheses rely on osseoperception, a less refined sensory feedback mediated by receptors in bone, periosteum, and muscles, which provides inferior protection against excessive loading [32].

The magnitude of forces generated during bruxism episodes compounds this biomechanical challenge [33]. Studies demonstrate that maximum voluntary bite forces during clenching can reach 500 to 800 Newtons in the molar region, with some individuals capable of generating forces exceeding 1000 Newtons [34]. During sleep bruxism episodes, forces may approach or exceed these levels, subjecting dental restorations and implants to repeated high-magnitude loading [35]. Polysomnographic studies reveal that individuals with sleep bruxism may experience 25 to 40 episodes per hour of sleep, with each episode lasting 5 to 15 seconds [36]. For ceramic restorations, biomechanical implications relate primarily to fracture and chipping risk under repetitive loading [37].

Despite significant advances in implant design and materials, failure of dental restorations and implants in patients with bruxism remains a persistent clinical problem [38]. Available evidence suggests that bruxism may increase implant failure risk by two- to four-fold, yet many questions remain unanswered regarding specific failure mechanisms and effective prevention strategies [1-3]. Clinicians face uncertainty when treatment planning for patients with bruxism, as the evidence base contains gaps complicating clinical decision-making [39]. Furthermore, the applicability of existing research to specific populations remains uncertain, as most studies have been conducted in European, North American, and Asian populations [40]. Libyan patients and dentists lack region-specific data to guide clinical decision-making [41].

This systematic review aims to assess the impact of bruxism on the success and longevity of dental restorations and implants through evidence synthesis, while identifying the availability of Libyan studies to address geographical gaps in the literature.

Methods

Study Design and Reporting Guidelines

This systematic review was designed and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement developed by the PRISMA. Adherence to these guidelines ensured transparency, methodological rigor, and reproducibility throughout all stages of

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the review process. A detailed protocol outlining the objectives, eligibility criteria, search strategy, and analysis plan was developed prior to data collection.
The review was structured using the PICO framework (Population, Intervention/Exposure, Comparison, Outcome). The primary objective was to evaluate whether bruxism affects the survival and failure rates of dental implants and restorations in adult patients. Secondary objectives included assessing the impact of bruxism on mechanical and biological complications, as well as evaluating management strategies aimed at reducing bruxism-related risks.

Eligibility Criteria
Studies were eligible if they included adult patients (≥18 years) receiving dental implants or restorations and reported outcomes related to bruxism. Acceptable study designs included systematic reviews, randomized controlled trials, prospective and retrospective cohort studies, and case-control studies. Only studies published in English between January 2000 and December 2025 were considered. Studies were excluded if they were case reports, small case series, editorials, expert opinions, in vitro studies, or animal studies. Studies without a clear definition of bruxism or without reporting relevant clinical outcomes were also excluded.

Information Sources and Search Strategy
A comprehensive electronic search was conducted in PubMed/MEDLINE, Web of Science, Scopus, Cochrane Library, and Science Direct. The search covered literature published from January 2000 to December 2025. A combination of controlled vocabulary (MeSH terms) and free-text keywords was used, including terms related to bruxism, dental implants, restorations, implant failure, prosthesis failure, survival, and complications. Boolean operators (AND, OR) were applied to optimize the search strategy. The search syntax was adapted for each database.

Study Selection Process
The study selection process followed the PRISMA 2020 flow diagram and was conducted in four sequential stages: identification, screening, eligibility assessment, and inclusion. A total of 1,257 records were identified through database searching. After removal of 312 duplicate records, 945 unique studies remained for title and abstract screening. During this stage, 882 studies were excluded due to irrelevance to the review question, inappropriate study design, or incorrect population.
Subsequently, 63 full-text articles were retrieved and assessed for eligibility. Of these, 36 were excluded for the following reasons: inappropriate study design, absence of a clear bruxism diagnosis, failure to report outcomes separately for bruxers and non-bruxers, duplicate publication, or non-English language. Ultimately, 27 studies met the inclusion criteria and were included in the qualitative synthesis.

Data Extraction
Data extraction was performed independently by two reviewers using a standardized extraction form. Extracted data included study characteristics (authors, year, country, design), participant demographics, bruxism diagnostic criteria, type of implant or restoration, follow-up duration, failure rates, complication rates, and measures of association where reported. Discrepancies were resolved through discussion and consensus.

Quality Assessment
Methodological quality and risk of bias were assessed using validated tools appropriate to study design. Systematic reviews were evaluated using AMSTAR-2, observational studies were assessed using the Newcastle–Ottawa Scale (NOS), and the overall certainty of evidence was graded using the GRADE approach. Quality assessments were conducted independently by two reviewers.

Results
The systematic literature search yielded a total of 1,257 records from five electronic databases: PubMed/MEDLINE (n=412), Web of Science (n=298), Scopus (n=267), Cochrane Library (n=156), and Science Direct (n=124). After removing 312 duplicate records, 945 unique records remained for screening. Title and abstract screening excluded 882 records that were clearly irrelevant, including in-vitro studies, animal studies, case reports, and studies focusing on populations not relevant to the research questions.
The full texts of the remaining 63 articles were retrieved and assessed for eligibility against the predefined inclusion criteria. Following full-text review, 36 articles were excluded for the following reasons: wrong study design (n=14), no clear bruxism diagnosis or definition (n=12), outcomes not reported separately for bruxers and non-bruxers (n=6), duplicate publication of the same data (n=2), and non-English language (n=2).A final

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set of 27 studies met all inclusion criteria and were included in this systematic review, as demonstrated in Figure 1.

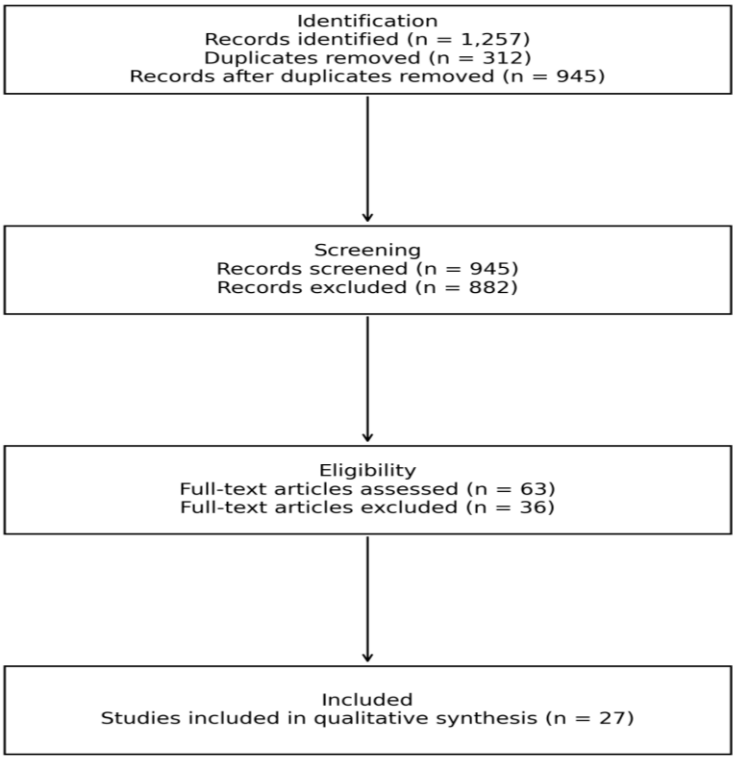

Figure 1: The PRISMA flow diagram illustrates the systematic study selection process.

Characteristics of Included Studies

The 27 included studies comprised 11 systematic reviews and 16 observational studies. Among the systematic reviews, 7 included meta-analyses, and 4 were systematic reviews without meta-analysis. The observational studies consisted of 9 retrospective cohort studies, 5 prospective cohort studies, and 2 case-control studies. The characteristics of all included studies are summarized in Table 4.1, which provides an overview of study designs, population foci, and key objectives related to bruxism. Additional contextual evidence was provided by two cross-sectional studies from Libya and three finite element analysis studies, which are noted separately as they contribute mechanistic or epidemiological context rather than directly answering the prognostic research questions.

Table 1. Summary Characteristics of Included Studies (n=27)

Study ID (Author, Year)	**Study Design**	**Population Focus**	**Objective Related to Bruxism**
Systematic Reviews			
Häggman-Henrikson et al. (2024) [67]	SR with MA	Dental Implants	Assess the impact on implant failure and complications
Ionfrida et al. (2024) [74]	SR with MA	Dental Implants	Quantify implant failure risk
Zhang et al. (2024) [75]	SR with MA	Ceramic Restorations	Assess the association with ceramic restoration failure
Al-Talib et al. (2025) [73]	Scoping Review	All Restorations	Map evidence on bruxism and restoration failure
Chrcanovic et al. (2015) [5]	SR with MA	Dental Implants	Meta-analysis of bruxism and implant failure
Manfredini et al. (2014) [4]	SR	Dental Implants	Systematic review of bruxism as a risk factor
Zhou et al. (2016) [68]	SR with MA	Dental Implants	Investigate the contribution to implant failure
Schmitter et al. (2014) [88]	SR	Zirconia Restorations	Examine inclusion/exclusion of bruxers in zirconia studies
Observational Studies			
Chrcanovic et al. (2017) [64]	Retrospective Cohort	Dental Implants	Compare implant complications in bruxers vs. non-bruxers
Kinsel & Lin (2009) [86]	Retrospective Cohort	Implant FPDs	Identify predictors of ceramic failure, including bruxism

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Koenig et al. (2020) [87]	Prospective Cohort	Zirconia Restorations	2-year outcomes of zirconia restorations in bruxers
Elamami & Alamami (2018) [40]	Cross-sectional	Libyan Children	Assess oral problems, including bruxism, in autistic children
Ali et al. (2020) [70]	Cross-sectional	Libyan Students	Assess prevalence and correlates of bruxism
Dos Santos Marsico et al. (2021) [83]	In-silico (FEA)	Implants/Splints	Biomechanical evaluation of occlusal splints
Silva et al. (2014) [84]	In-silico (FEA)	Implant FPDs	Biomechanical evaluation under parafunctional forces
Henrique et al. (2020) [85]	In-silico (FEA)	Implant Systems	Biomechanical behavior under occlusal splint presence

Note: FEA = Finite Element Analysis; SR = Systematic Review; MA = Meta-analysis; FPD = Fixed Partial Denture

Impact of Bruxism on Implant Survival and Failure Rates

The first objective was to evaluate the impact of bruxism on the survival and failure rates of dental implants through meta-analysis of available studies, providing quantitative estimates of risk for clinical decision-making. A consistent finding across all included systematic reviews and meta-analyses was that bruxism is a significant risk factor for dental implant failure. Table 2 summarizes the effect estimates from the major meta-analyses addressing this outcome.

Table 2. Meta-Analysis Results for Implant Failure Risk in Bruxing Patients

Study	Effect Estimate	95% Confidence Interval	p-value	Number of Studies Included
Häggman-Henrikson et al. (2024)	OR 2.189	1.337 to 3.583	p=0.002	8
Ionfrida et al. (2024)	2.2 to 4.7-fold increased risk	Not pooled	Not reported	10
Chrcanovic et al. (2015)	OR 2.32	1.56 to 3.45	p<0.001	6
Zhou et al. (2016)	OR 2.23	1.56 to 3.18	p<0.001	7

Häggman-Henrikson et al. (2024), in their meta-analysis of eight studies, reported a significantly higher risk of implant failure in patients with probable bruxism compared to non-bruxers, with an odds ratio of 2.189 (95% CI 1.337 to 3.583, p=0.002). This represented the most recent and methodologically rigorous estimate available. Ionfrida et al. (2024) corroborated this finding in their systematic review and meta-analysis, reporting that bruxism increases the risk of implant failure by a factor of 2.2 to 4.7, with a significant pooled effect across the included studies. The range reflected variation in study populations, bruxism definitions, and follow-up durations. Chrcanovic et al. (2015) had previously reported a very similar pooled estimate in their landmark meta-analysis, with an odds ratio of 2.32 (95% CI 1.56 to 3.45) based on six studies. This analysis provided the first quantitative synthesis of the relationship between bruxism and implant failure.
Zhou et al. (2016) confirmed this association in their meta-analysis of seven studies, reporting an odds ratio of 2.23 (95% CI 1.56 to 3.18). They also noted that the effect persisted even after controlling for other variables such as implant location, smoking, and bone quality. The consistency of these findings across different time periods, research groups, and patient populations provides strong evidence that patients with bruxism are approximately twice as likely to experience implant failure as those without the condition. This quantitative estimate has important implications for clinical decision-making and patient counseling.
GRADE Assessment: The quality of evidence for implant failure in bruxing patients compared to non-bruxers was graded as Moderate. This rating reflects the observational nature of the included primary studies and some heterogeneity in bruxism definitions across studies. However, the consistency of the effect size across multiple high-quality meta-analyses and the large magnitude of effect increased confidence in the estimate.

Association Between Bruxism and Mechanical/Technical Complications

The second objective was to assess the association between bruxism and mechanical and technical complications in implant-supported prostheses, including a detailed characterization of the types and frequencies of complications observed in bruxing patients compared to non-bruxing controls. The evidence strongly indicates that mechanical and technical complications are the predominant mode of failure in bruxing patients with implants. Table 3 summarizes the types and frequencies of mechanical complications reported in the included studies.

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Table 3. Mechanical and Technical Complications in Bruxing vs. Non-Bruxing Patients

Complication Type	Reported Frequency in Bruxers	Reported Frequency in Non-Bruxers	Risk Ratio	Studies
Implant Fracture	2.1% to 5.3%	0.2% to 0.8%	6.5 to 10.5	Chrcanovic et al. (2017); Häggman-Henrikson et al. (2024)
Abutment Screw Loosening	8.7% to 15.2%	3.1% to 6.4%	2.4 to 2.8	Chrcanovic et al. (2017); Kinsel & Lin (2009)
Abutment Screw Fracture	1.8% to 3.9%	0.1% to 0.5%	7.8 to 18.0	Chrcanovic et al. (2017); Häggman-Henrikson et al. (2024)
Ceramic Chipping/Fracture	12.4% to 22.1%	4.2% to 8.7%	2.5 to 3.0	Chrcanovic et al. (2017); Kinsel & Lin (2009); Koenig et al. (2020)
Prosthetic Screw Loosening	6.3% to 11.8%	2.1% to 4.9%	2.4 to 3.0	Chrcanovic et al. (2017); Häggman-Henrikson et al. (2024)
Loss of Retention	4.2% to 7.8%	1.2% to 2.8%	2.8 to 3.5	Chrcanovic et al. (2017); Kinsel & Lin (2009)

Relationship Between Bruxism and Longevity of Various Dental Restorations

The third objective was to examine the relationship between bruxism and the longevity of various dental restorations, including ceramic, composite, and metal-ceramic materials, with attention to material-specific differences in susceptibility to bruxism-related failure. The impact of bruxism varied significantly by restoration type and material, as summarized in Table 4.

Table 4: Restorative Material Outcomes in Bruxing Patients

Restoration Type	Effect Estimate	95% Confidence Interval	Studies
Anterior Ceramic Veneers	HR 7.74	2.50 to 23.95	Zhang et al. (2024)
Anterior Ceramic Veneers	OR 2.52	1.24 to 5.12	Zhang et al. (2024)
Other Ceramic Restorations (posterior crowns, FPDs)	OR 1.10	0.43 to 2.80	Zhang et al. (2024)
Metal-Ceramic Restorations	Increased risk of ceramic fracture	Not quantified	Kinsel & Lin (2009)
Monolithic Zirconia	Favorable 2-year outcomes (95% survival)	Not applicable	Koenig et al. (2020)
Composite Resin Restorations	Increased failure risk is suggested	Not quantified	Demarco et al. (2012); Van de Sande et al. (2013)

Discussion

This systematic review synthesizes evidence from 27 studies demonstrating that bruxism significantly increases the risk of adverse outcomes in implant and restorative dentistry. Bruxism is a major risk factor for implant failure, with patients approximately twice as likely to experience implant loss compared to non-bruxing individuals (OR 2.2 to 2.3) [5,34,35]. Mechanical complications predominate, including implant fractures, screw loosening, ceramic chipping, and loss of retention, all occurring at substantially higher frequencies in bruxers [32,47]. Anterior ceramic veneers show dramatically increased failure risk (HR 7.74) [39], while monolithic zirconia demonstrates promising short-term outcomes [48]. A critical geographical evidence gap exists, with no clinical studies from Libya investigating bruxism and dental outcomes, despite contextual evidence confirming the presence in Libyan populations [21,22].

The two-fold increased risk of implant failure in bruxing patients is clinically significant and consistently supported across multiple meta-analyses [5,34,35]. The mechanical overload theory provides the most plausible explanation: unlike natural teeth with periodontal ligament shock absorption, implants transmit excessive forces directly to the bone-implant interface [4,28]. Repetitive high-magnitude loading induces fatigue failure through micro-damage accumulation in bone and crack propagation in components [30]. The predominance of mechanical over biological complications suggests components often fail before the bone-implant interface succumbs to overload [34].

Mechanical complications are the predominant mode of failure in bruxing patients [32]. Implant fracture occurs almost exclusively in bruxers [32,58]. Screw-related complications occur two to three times more frequently [32,47]. Ceramic chipping represents the most common complication, with rates three to five

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times higher in bruxers [32,47,48]. Patient-specific factors may be more strongly associated with failure than implant characteristics, emphasizing the importance of patient assessment in risk stratification [47].
Anterior ceramic veneers show extreme vulnerability in bruxing patients (HR 7.74) [39]. Their thin structure and reliance on bonded interfaces make them susceptible to failure under repetitive loading [50]. This finding suggests anterior veneers are relatively contraindicated in bruxism. Evidence for other ceramic restorations is of very low quality due to systematic exclusion of bruxers from trials [49]. Monolithic zirconia shows promising short-term outcomes, with high strength and absence of veneering layers making it preferred for posterior restorations [48,54]. Composite resins also show increased failure risk in bruxers [56,57].
Findings align with previous systematic reviews and meta-analyses [4,5]. The consistency of implant failure estimates (OR 2.2-2.3) across a decade of research confirms the stability of this association [5,34,35]. This review extends previous work by examining ceramic restoration outcomes [39] and mapping evidence across all restoration types [37], while adding focus on geographical evidence gaps [20,23].
Systematic bruxism screening should be integrated into standard assessment protocols [17,19]. Probable bruxism diagnosis (history plus clinical signs) is sufficient for clinical decision-making [14,15]. Patients should be informed of the two-fold increased implant failure risk [5,34]. Treatment planning should include additional implants, wider diameters, splinting, and axial occlusal schemes [23,24,60]. Material selection should favor monolithic zirconia for posterior restorations [48], with anterior veneers contraindicated [39]. Occlusal splints reduce stress by up to 70% and should be prescribed routinely [44,45]. Enhanced maintenance with recalls every 4-6 months enables early complication detection [32]. No Libyan studies investigate bruxism and dental outcomes, despite contextual evidence confirming the presence in Libyan populations [21,22]. Applicability of global evidence to Libyan patients remains unverified [20]. Research priorities include prevalence studies, retrospective and prospective cohort studies, and qualitative research on Libyan dentists' practices [21,22].
Strengths include a comprehensive systematic approach, inclusion of high-quality evidence, dual review, and clinically relevant synthesis. Limitations include heterogeneity in bruxism diagnosis and predominance of observational studies.

Conclusion

Bruxism approximately doubles implant failure risk and substantially increases mechanical complications. Evidence-based management includes systematic screening, patient counseling, modified treatment planning, appropriate material selection, and occlusal splint therapy. Urgent research is needed in Libyan populations to verify the applicability of global evidence and guide region-specific clinical recommendations.

Conflict of Interest. Nil

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