SYSTEMIC DISEASE AS A PREDICTOR OF PROSTHETIC REHABILITATION OUTCOMES IN PARTIAL EDENTULISM

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Abstract

Objectives. The aim of this narrative review was to evaluate the current evidence on the predictability of success and failure in prosthetic and implant-prosthetic rehabilitation of edentulous patients in relation to systemic pathology. **Materials and Methods.** A structured literature search was conducted in PubMed/MEDLINE, PubMed Central, Scopus, and Web of Science. Systematic reviews, meta-analyses, randomized controlled trials, and cohort studies published between 2000 and 2025 were included. Outcomes of interest were implant survival rate, implant success rate, marginal bone loss, peri-implantitis prevalence, and prosthetic complication rates. Data were synthesized narratively due to heterogeneity across included studies. **Results**. Partial edentulism clusters strongly with diabetes, cardiovascular disease, and obesity. Systemic conditions — including diabetes mellitus, cardiovascular disease, rheumatoid arthritis, SLE, and osteoporosis — amplify periodontal dysbiosis, impair immune competence and microvascular integrity, and accelerate alveolar bone destruction, thereby compromising the prognosis of both tooth-supported and implant-supported prosthetic rehabilitations. The conceptual framework has shifted from categorical contraindication toward individualized risk stratification, with most systemic conditions representing relative rather than absolute contraindications, and treatment predictability being primarily determined by disease control status rather than diagnosis alone. **Conclusions.** Systemic comorbidities represent predominantly relative rather than absolute contraindications for prosthetic and implant-prosthetic rehabilitation. Long-term treatment predictability is modulated by disease control status rather than the mere presence of a systemic condition, underscoring the need for individualized risk stratification and multidisciplinary management prior to and during prosthetic rehabilitation.

Keywords: *prosthetic rehabilitation; risk factors; systemic disease; medically compromised patients.*

1. INTRODUCTION

Partial edentulism remains one of the most prevalent oral health conditions worldwide, with considerable functional, aesthetic, psychological, and systemic repercussions. Partial edentulism cluster strongly with the presence of diabetes, cardiovascular disease, and obesity [1]. Prosthetic rehabilitation, encompassing both conventional removable and fixed implant-supported solutions, represents the standard of care for restoring masticatory function and quality of life in edentulous patients [2]. The long-term success of such rehabilitations is shaped by a complex interplay of local, biomechanical, behavioral, and systemic factors [3-8].

Periodontal diseases are initiated and perpetuated by a dysbiotic subgingival microbiota — dominated by keystone

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pathogens such as *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola* — which trigger a chronic inflammatory cascade leading to progressive destruction of the alveolar bone and periodontal ligament. This pathological process is substantially amplified by systemic conditions that alter immune competence, microvascular integrity, and the qualitative composition of the oral biofilm, including diabetes mellitus, cardiovascular disease, rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), and osteoporosis [9-14].

Understanding which systemic conditions confer measurable risk — and under what thresholds of disease control those risks become clinically relevant — is central to treatment planning, informed consent, and outcome prediction.

The resulting loss of periodontal support, reduction in residual bone volume, and persistence of a pro-inflammatory peri-oral environment directly compromise the prognosis of both tooth-supported— undermining abutment tooth stability, and ultimately reducing the long-term predictability of rehabilitation outcomes in patients whose systemic comorbidities remain inadequately controlled [15, 16]. For conventional removable prostheses, success encompasses adaptation, masticatory efficiency, mucosal health, and absence of prosthesis-induced stomatitis — all of which can be adversely modulated by systemic pathology [17].

Comorbidities such as diabetes, osteoporosis, cardiovascular diseases, as well as the intake of certain medications categories can influence peri-implant bone metabolism, immune response, and soft tissue homeostasis can increase the risk of the failure of a dental implant [18-20]. Surveys of patients eligible for dental implants in Korea and Europe reveal that 44% are diagnosed with two or more systemic diseases [21]. The concept of "medically compromised patients" has evolved from a short list of absolute contraindications (recent myocardial infarction, intravenous bisphosphonate therapy, active cancer treatment) to a risk-stratification framework in which most systemic conditions represent relative rather than absolute contraindications [22].

The review aims to discuss the relationships between systemic comorbidities and the success/failure of prosthetic and implant-prosthetic rehabilitation in edentulous patients, with particular focus on the most clinically prevalent conditions: diabetes mellitus, cardiovascular disease, osteoporosis, and autoimmune/immunosuppressive states.

MATERIALS AND METHODS

Search Strategy

The identification of relevant studies was carried out by consulting the electronic databases PubMed/MEDLINE, PubMed Central (PMC), Scopus, and Web of Science. The literature search was performed using combinations of keywords and MeSH terms such as: "dental implants", "implant survival rate", "implant success rate", "implant failure", "prosthetic rehabilitation", "edentulism", "osseointegration", "peri-implantitis", "marginal bone loss", "systemic disease", "comorbidity", "medically compromised patients", "diabetes mellitus", "glycemic control", "HbA1c", "cardiovascular disease", "hypertension", "osteoporosis", "antiresorptive therapy", "bisphosphonates", "MRONJ", "autoimmune disease", "rheumatoid

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arthritis", "immunocompromised", "obesity", "removable partial denture", "complete denture", "implant-supported overdenture", and "fixed dental prosthesis". Search terms were used both individually and in Boolean combinations (AND/OR) to maximize retrieval of relevant records. Priority was given to studies available in full text via PMC Open Access, in order to ensure complete data extraction.

Selection Criteria

The following study types were included: original manuscripts (randomized controlled trials, prospective and retrospective observational studies) comparing prosthetic and implant-prosthetic outcomes in patients with systemic diseases versus systemically healthy controls; systematic reviews and meta-analyses addressing the clinical performance of dental implants or prosthetic restorations in medically compromised populations; narrative reviews from recognized reference works in implantology and prosthodontics; and studies reporting quantitative outcomes including implant survival rates, prosthetic component complication rates, marginal bone loss values, peri-implant clinical parameters (probing depth, bleeding on probing, suppuration), and incidence rates over defined follow-up periods. The exclusion criteria included: non-human studies; articles published before the year 2000; papers without direct relevance to prosthetic or implant-prosthetic outcomes in the context of systemic disease; studies focused exclusively on implant biomaterials or implant surface topography without clinical outcome data in systemically compromised patients; and publications not available in English for which a validated translation could not be obtained.

Data Extraction and Quality Assessment

Data were extracted independently and systematically from each selected article. The following variables were recorded for each included study: study design and level of evidence; sample size (number of patients and implants); patient characteristics (age, sex, type and severity of systemic condition, disease control status, and pharmacological treatment); type of prosthetic rehabilitation performed; follow-up period; outcome measures reported (implant survival rate [ISR]; implant success rate; marginal bone loss [MBL]; peri-implant clinical parameters; prosthetic complication rates); and statistical measures (odds ratios, relative risks, and mean differences with 95% confidence intervals).

LITERATURE REVIEW

1.General Context

Contemporary implantology reports consistently high survival rates for implant-supported restorations across diverse populations. A comprehensive review of implant-supported single crowns demonstrated an overall 10-year survival rate of 95.2%, while the survival of the prosthetic crowns themselves was slightly lower at 89.4% at 10 years, with material choice influencing outcomes: metal-ceramic crowns achieved a 5-year survival of 98.3%, whereas monolithic lithium disilicate and hybrid resin-matrix ceramic restorations showed notably lower figures (91% and 67%, respectively) [2]. For implant-supported fixed complete prostheses, 5-year survival rates range from 97.1% for fixed dental prostheses to 95–

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100% for implant-retained overdentures; however, these figures mask a substantial burden of prosthetic complications — screw loosening remains the most frequent technical complication of single implant crowns, with a cumulative 5-year rate of 8.8%, and veneering ceramic fracture/chipping dominates multi-unit restorations [2]. A five-year retrospective cohort study of 161 implants in 143 patients found an overall implant survival rate of 92.5%, with statistically significant associations identified for patient sex (female patients had higher survival, p=0.01), smoking status (non-smokers had higher survival), and systemic conditions including diabetes and cardiovascular disease [23]. Early implant failure — defined as failure before prosthetic loading — has been reported at approximately 4% in large retrospective series, with systemic disease present in 36.6% of cases experiencing early failure [24]. A scoping review mapping 388 studies published between 1983 and 2025 identified peri-implantitis as the most frequently reported biological aetiology of implant failure, and singled out diabetes, osteoporosis, and drug-related bone metabolism changes as key systemic influences, alongside prosthetic misfit and parafunction as major mechanical triggers [25]. For conventional removable prosthetic rehabilitation, a systematic review comparing fixed and removable modalities in fully edentulous patients confirmed that implant-supported fixed prostheses demonstrate superior masticatory efficiency and occlusal stability, while survival rates of implant-supported overdentures are high and patient satisfaction is generally favorable; however, direct comparisons remain difficult due to heterogeneous outcome criteria and follow-up periods across studies [26, 27]. A landmark population-based analysis using NHANES data (17,109 adults, mortality follow-up through 2019) demonstrated that dental implant rehabilitation significantly mitigated the increased all-cause mortality risk associated with posterior tooth loss, with implant-supported prostheses showing the strongest protective effect compared to removable or tooth-supported fixed alternatives — findings that underscore the systemic health implications of prosthetic rehabilitation quality [1].

2.Diabetes Mellitus

Systemic conditions affecting bone healing and osseointegration have attracted much interest over the past decades, with diabetes mellitus (DM) being one of the most studied. Important advances characterized by a nuanced glycemia-dependent risk model have now emerged. A large meta-analysis combining 89 studies — 5,510 implants placed in diabetic patients against 62,780 in non-diabetic controls — found implant failure rates to be 77.7% higher in the diabetic group (OR 1.777; $p<0.001$). Type 1 diabetes carried a substantially greater burden of risk than type 2 (OR 4.477; p=0.032), and the pattern of failure showed a clear anatomical predilection: differences reached statistical significance in the maxilla but not in the mandible. Bone loss figures told a similar story — mean marginal bone loss (MBL) was 0.776 mm greater in diabetic patients (p=0.027), and this gap widened progressively, with an estimated additional 0.032 mm lost per month of follow-up [28]. What these numbers make plain is that the implant-tissue interface in a diabetic patient is not simply at higher risk at placement —

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it continues to deteriorate at a measurably faster rate over time.

The picture becomes more nuanced, however, when glycemic control is brought into the equation. A systematic review focused specifically on type 2 DM established that patients with well-controlled glycemia (HbA1c <8%) achieved implant survival rates in the range of 96.1–97.3% at one year and 87.3–96.1% at five years — figures that sit comfortably alongside those reported for non-diabetic populations. By contrast, poorly controlled diabetes (HbA1c >8%) consistently degraded peri-implant health parameters across the board: marginal bone loss deepened, probing depths increased, and bleeding on probing worsened. HbA1c thus functions not merely as a metabolic marker but as a clinically actionable threshold for patient selection and risk stratification [29].The association between glycemia and peri-implant outcomes has also been reinforced through advanced modelling indicating a dose-response effect, with consistently worse outcomes associated with higher HbA1c levels. A separate meta-analysis of immediately loaded implants in patients with type 2 diabetes yielded similar findings, reporting no difference in implant survival compared to matched non-diabetic controls (RR=1.00; 95% CI 0.96–1.04), even amongst diabetics with poor glycemic control (RR=1.08; 95% CI 0.87–1.33; p=0.48) — supporting the contention that immediate loading protocols may not impose additional risk when appropriate case selection is employed [30]. Biological mechanisms underlying DM-associated implant complications include neutrophil dysfunction, altered collagen synthesis and angiogenesis, modified osteoblast/osteoclast dynamics, and predisposition to bacterial colonization — together, these abnormalities impair osseointegration quality and peri-implant tissue homeostasis [31, 32].

3 Cardiovascular Disease and Hypertension

Cardiovascular disease (CVD) and hypertension have long been approached with caution in implant planning — the theoretical concerns are not unreasonable: compromised peripheral perfusion, reduced bone oxygenation, and heightened infection susceptibility in a chronically hypoxic tissue environment all suggest a less-than-ideal biological substrate for osseointegration. In practice, however, the clinical evidence has proved considerably more reassuring than the theoretical framework would suggest. A narrative review drawing on 70 studies indexed across PubMed, Web of Science, and Scopus found that the published literature almost unanimously reported no association between hypertension and increased peri-implant biological complication risk, across both retrospective and cross-sectional study designs [20]. Hypertension, cardiac disease, and diabetes mellitus — considered individually — did not generate statistically significant implant failure rates [22].

The CVD category is nonetheless not homogeneous. Patients with established cardiovascular pathology remain physiologically vulnerable — chronic hypoxia impairs macrophage function and blunts the local immune response, which may predispose the peri-implant compartment to infection. Cardiac disease has historically been listed as a relative contraindication partly on account of infective endocarditis risk in susceptible

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individuals. What the evidence suggests, however, is that with appropriate pre-surgical cardiovascular risk stratification and targeted antibiotic prophylaxis where indicated, implant therapy is both feasible and capable of delivering outcomes comparable to those seen in healthy controls across most CVD subcategories. True absolute contraindications are narrow and well-defined: recent myocardial infarction within the preceding six months, recent cerebrovascular accident, and uncontrolled coagulopathy [18]. Edentulism and periodontal disease are independently associated with elevated cardiovascular risk, mediated through chronic low-grade systemic inflammation. Prosthetic rehabilitation that restores masticatory function and reduces the periodontal inflammatory burden may therefore carry cardiovascular implications that extend well beyond the oral cavity [1].

4 Osteoporosis and Antiresorptive Therapy

Osteoporosis presents a particularly nuanced challenge in implant-prosthetic planning, as reduced bone mineral density theoretically compromises primary stability and osseointegration quality. A 2025 systematic review and meta-analysis (PRISMA-compliant, PROSPERO-registered) comparing implant outcomes in osteoporotic versus non-osteoporotic patients concluded that osteoporosis alone does not compromise dental implant outcomes, supporting safe and predictable implant therapy in older adults when guided by careful individual assessment [31]. This finding aligns with a broader systematic review of clinical studies through October 2024, which similarly concluded that osteoporosis does not constitute a contraindication for implant placement and that satisfactory survival rates are achievable in osteoporotic patients. Notably, systemic diseases such as neurologic disorders, HIV, hypothyroidism, and cardiovascular diseases, as well as drugs such as beta-blockers, antihypertensives, or diuretics, do not show a decreased rate of implant osseointegration according to the available evidence [19]. A point of ongoing clinical concern is the concomitant use of antiresorptive medications — bisphosphonates and denosumab — prescribed to manage osteoporosis. These agents reduce bone turnover and have been associated with medication-related osteonecrosis of the jaw (MRONJ) in a small proportion of users. A comprehensive systematic review and International Osteoporosis Foundation Taskforce consensus statement concluded that current evidence does not suggest an association between antiresorptive therapy for osteoporosis and dental implant failure; implants may be safely placed without cessation of bisphosphonate or denosumab therapy. However, long-term bisphosphonate use is associated with a small but measurable increase in MRONJ risk (approximately 3 cases per 1,000 patients; adjusted hazard ratio 4.09, 95% CI 2.75–6.09) [30].

5 Autoimmune Diseases and Immunocompromised States

Autoimmune connective tissue diseases (CTDs) — including rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), Sjögren's syndrome, and scleroderma — represent a heterogeneous group with shared characteristics of chronic systemic

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inflammation, bone metabolism dysregulation, and immunosuppressive pharmacotherapy. A systematic review specifically examining survival and success of dental implants in patients with autoimmune diseases reported high implant survival rates exceeding 95% after 5–10 years in this population, extending the indications for implant therapy to include patients with various systemic autoimmune conditions [33]. For patients with RA specifically, a longitudinal retrospective study found that patients with and without RA demonstrated similar implant survival rates and no significant difference in marginal bone loss at comparable follow-up periods; however, RA patients showed more pronounced soft-tissue vulnerability as reflected by higher bleeding indices — consistent with the pro-inflammatory milieu of the disease [34, 35]. Interestingly, studies specifically analyzing RA reported implant survival rates of 100% in some series, while patients with RA combined with other CTDs showed increased bone resorption and more vulnerable soft-tissue conditions [36]. The potential pathobiochemical similarity between RA and periodontitis — both characterized by cytokine-mediated bone resorption and osteoclast dominance — may explain the increased susceptibility to peri-implant complications observed in some RA cohorts [37]. For broader immunocompromised states, a systematic review and meta-analysis covering HIV infection, chemotherapy, transplantation, and autoimmune disease found that for follow-up periods of 24 months or longer, mean implant survival rates were 93.1% in HIV patients, 98.8% post-chemotherapy, 88.75% in autoimmune disease patients, and 100% following organ transplantation — with no statistically significant overall effect of immunocompromised conditions on implant survival [38]. The authors concluded that implant-based therapy in immunocompromised patients should not aggravate general morbidity when carefully planned, but that a rigorous risk stratification prior to implant therapy is fundamental. Crohn's disease was a notable exception, showing a significant effect on early implant failure in this review. The AO/AAP 2024 consensus on peri-implant diseases established that key systemic and behavioral risk factors for peri-implantitis development include history of periodontitis, smoking, uncontrolled diabetes, poor microbial biofilm control, and obesity — while implant malposition, unfavorable prosthetic factors, and suboptimal peri-implant soft tissue phenotype are relevant site-related determinants [39]. Obesity as an independent risk factor has received increasing attention: a narrative review found that "almost all studies investigating obesity as a risk factor for implant rehabilitation found a positive association between the two" — a finding not replicated for diabetes, CVD, hypertension, or osteoporosis considered individually — making obesity a particularly significant modifiable risk factor for biological implant complications [20].

6. Prosthetic Outcomes in Geriatric Patients

With advancing patient age, the issue of multimorbidity — the coexistence of two or more chronic conditions — becomes central to prosthetic planning. Advanced periodontal disease associated with extensive marginal bone loss in patients with osteoporosis are common in

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geriatric patients [40]. A prospective clinical study of implant overdentures in patients with a mean age of 67.55 years found that 70% patients carried more than two systemic diseases. Despite this systemic burden, implant survival rate was 96.6% over a mean follow-up of 39.05 months. No statistically significant differences in implant survival were found according to sex, age, implant diameter, or systemic disease burden. Mandibular implants and those opposed by removable prostheses showed lower marginal bone loss — a prosthetic variable outweighing systemic factors in this cohort [21]. These results support the conclusion that favorable clinical outcomes can be achieved in elderly patients when adequate healing periods are ensured and maintenance protocols are rigorously followed. The question of removable prosthetic rehabilitation in edentulous patients with systemic diseases encompasses not only implant-specific considerations but also the interaction between acrylic dentures, mucosal integrity, and systemic health. A retrospective study of patients using removable prostheses for a minimum of five years identified hypertension as the most prevalent systemic disease in the cohort (58%), and observed that patients with systemic diseases did not necessarily present with clinically manifest oral mycosis despite potentially compromised immune surveillance — underscoring the complex and non-linear relationship between systemic morbidity and prosthesis-associated oral pathology. While individual systemic conditions are variably associated with implant outcomes, the cumulative evidence calls for an individualized, risk-stratified approach to implant treatment planning in medically compromised patients. The review underscored that most systemic conditions are relative rather than absolute contraindications, and that treatment outcomes are heavily modulated by disease control status rather than the mere presence of a condition [17].

CONCLUSIONS

Systemic comorbidities exert a measurable but condition-specific and dose-dependent influence on the outcomes of prosthetic and implant-prosthetic rehabilitation in edentulous patients. The paradigm shift from categorical contraindication to individualized risk stratification represents the most important conceptual contribution of the current evidence base. Treatment predictability in medically compromised patients is determined, above all, by the degree of disease control at the time of intervention, the quality of the interdisciplinary treatment plan, and the rigor of long-term maintenance — not by the systemic diagnosis alone. Future research should prioritize standardized outcome reporting, longer follow-up periods, and prospective studies in multimorbid populations, in order to refine risk stratification models and evidence-based protocols for prosthetic rehabilitation in this growing patient segment.

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