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TERAPIA COM IMPLANTES DENTÁRIOS EM PACIENTES COM DOENÇA RENAL CRÔNICA: CONSIDERAÇÕES CLÍNICAS, MOMENTO IDEAL E SEGURANÇA

DENTAL IMPLANT THERAPY IN PATIENTS WITH CHRONIC KIDNEY DISEASE: CLINICAL CONSIDERATIONS, TIMING, AND SAFETY

TERAPIA CON IMPLANTES DENTALES EN PACIENTES CON ENFERMEDAD RENAL CRÓNICA: CONSIDERACIONES CLÍNICAS, MOMENTO ADECUADO Y SEGURIDAD

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ABSTRACT

Background: Chronic kidney disease (CKD) is associated with systemic alterations that may affect bone metabolism, wound healing, bleeding risk, and susceptibility to infection. These factors may influence the biological and clinical outcomes of dental implant therapy, particularly in patients with advanced disease or receiving renal replacement therapy. **Objective:** This critical narrative review aimed to analyze the current evidence regarding dental implant therapy in patients with CKD, with emphasis on biological mechanisms, implant outcomes, clinical timing, dialysis, kidney transplantation, and individualized treatment planning. **Methods:** A structured literature search was conducted in PubMed, Scopus, and Web of Science. Priority was given to systematic reviews, clinical studies, clinical guidelines, and publications addressing dental implants, osseointegration, renal replacement therapy, and kidney transplantation. The selected evidence was critically appraised and narratively synthesized according to its clinical applicability. **Results:** Current evidence does not support considering CKD an absolute contraindication to dental implant therapy. Implant placement has been reported as technically feasible in selected patients with advanced CKD, dialysis dependence, and stable kidney transplantation. However, the available evidence is limited and heterogeneous, and

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recent evidence in patients with end-stage renal disease indicates that early implant loss and marginal bone changes may occur despite technically feasible implant placement. CKD-related mineral and bone abnormalities, anemia, bleeding risk, systemic instability, immunosuppressive therapy, and treatment-related factors may modify clinical outcomes. Evidence is particularly limited for peritoneal dialysis and for defining standardized timing around kidney transplantation. **Conclusion:** Dental implant therapy may be feasible in carefully selected and medically stable patients with CKD, although the certainty of evidence regarding long-term safety and predictability remains limited. Treatment decisions should integrate systemic stability, renal treatment modality, CKD-related mineral and bone abnormalities, hematological and pharmacological factors, oral health, surgical complexity, and the patient's ability to maintain long-term peri-implant care.

Keywords: Chronic Kidney Disease; Renal Insufficiency, Chronic; Dental Implants; Osseointegration; Renal Dialysis.

RESUMO

Introdução: A doença renal crônica (DRC) está associada a alterações sistêmicas capazes de afetar o metabolismo ósseo, a cicatrização, o risco de sangramento e a suscetibilidade a infecções. Esses fatores podem influenciar os resultados biológicos e clínicos da terapia com implantes dentários, particularmente em pacientes com doença avançada ou submetidos à terapia renal substitutiva. **Objetivo:** Esta revisão narrativa crítica teve como objetivo analisar as evidências atuais sobre a terapia com implantes dentários em pacientes com DRC, com ênfase nos mecanismos biológicos, resultados clínicos dos implantes, momento adequado para o tratamento, diálise, transplante renal e planejamento terapêutico individualizado. **Métodos:** Foi realizada uma busca estruturada da literatura nas bases PubMed, Scopus e Web of Science. Foram priorizadas revisões sistemáticas, estudos clínicos, diretrizes clínicas e publicações relacionadas a implantes dentários, osseointegração, terapia renal substitutiva e transplante renal. As evidências selecionadas foram criticamente avaliadas e sintetizadas de forma narrativa, de acordo com sua aplicabilidade clínica. **Resultados:** As evidências atuais não sustentam considerar a DRC uma contraindicação absoluta à terapia com implantes dentários. A instalação de implantes foi descrita como tecnicamente viável em pacientes selecionados com DRC avançada, dependência de diálise e transplante renal estável. Entretanto, as evidências disponíveis são limitadas e heterogêneas, e dados recentes em pacientes com doença renal terminal indicam que perda precoce de implantes e alterações ósseas marginais podem ocorrer mesmo quando a instalação é tecnicamente viável. Alterações do metabolismo mineral e ósseo relacionadas à DRC, anemia, risco de sangramento, instabilidade sistêmica, terapia imunossupressora e fatores relacionados ao tratamento podem modificar os resultados clínicos. As evidências são particularmente limitadas para pacientes em diálise peritoneal e para a definição de protocolos padronizados de momento terapêutico em torno do transplante renal. **Conclusão:** A terapia com implantes dentários pode ser viável em pacientes cuidadosamente selecionados e clinicamente estáveis com DRC, embora a certeza das evidências quanto à segurança e à previsibilidade em longo prazo permaneça limitada. A decisão terapêutica deve integrar estabilidade sistêmica, modalidade de tratamento renal, alterações mineral e óssea relacionadas à DRC, fatores hematológicos e farmacológicos, condição de saúde bucal, complexidade cirúrgica e capacidade do paciente de manter cuidados peri-implantares em longo prazo.

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RESUMEN

Antecedentes: La enfermedad renal crónica (ERC) se asocia con alteraciones sistémicas que pueden afectar el metabolismo óseo, la cicatrización, el riesgo de sangrado y la susceptibilidad a las infecciones. Estos factores pueden influir en los resultados biológicos y clínicos del tratamiento con implantes dentales, particularmente en pacientes con enfermedad avanzada o que reciben terapia de reemplazo renal. **Objetivo:** Esta revisión narrativa crítica tuvo como objetivo analizar la evidencia actual sobre el tratamiento con implantes dentales en pacientes con ERC, con énfasis en los mecanismos biológicos, los resultados de los implantes, el momento clínico del tratamiento, la diálisis, el trasplante renal y la planificación terapéutica individualizada. **Métodos:** Se realizó una búsqueda bibliográfica estructurada en PubMed, Scopus y Web of Science. Se dio prioridad a revisiones sistemáticas, estudios clínicos, guías clínicas y publicaciones relacionadas con implantes dentales, osteointegración, terapia de reemplazo renal y trasplante renal. La evidencia seleccionada fue evaluada críticamente y sintetizada de forma narrativa de acuerdo con su aplicabilidad clínica. **Resultados:** La evidencia actual no respalda considerar la ERC como una contraindicación absoluta para el tratamiento con implantes dentales. La colocación de implantes ha sido descrita como técnicamente viable en pacientes seleccionados con ERC avanzada, dependencia de diálisis y trasplante renal estable. Sin embargo, la evidencia disponible es limitada y heterogénea, y estudios recientes en pacientes con enfermedad renal terminal indican que pueden producirse pérdidas tempranas de implantes y cambios en el hueso marginal a pesar de que la colocación del implante sea técnicamente viable. Las alteraciones del metabolismo mineral y óseo relacionadas con la ERC, la anemia, el riesgo de sangrado, la inestabilidad sistémica, la terapia inmunosupresora y otros factores relacionados con el tratamiento pueden modificar los resultados clínicos. La evidencia es particularmente limitada en pacientes sometidos a diálisis peritoneal y para establecer protocolos estandarizados sobre el momento adecuado para la colocación de implantes en relación con el trasplante renal. **Conclusión:** El tratamiento con implantes dentales puede ser viable en pacientes cuidadosamente seleccionados y clínicamente estables con ERC, aunque la certeza de la evidencia sobre la seguridad y la predictibilidad a largo plazo sigue siendo limitada. Las decisiones terapéuticas deben integrar la estabilidad sistémica, la modalidad de tratamiento renal, las alteraciones del metabolismo mineral y óseo relacionadas con la ERC, los factores hematológicos y farmacológicos, la salud bucal, la complejidad quirúrgica y la capacidad del paciente para mantener un cuidado periimplantario a largo plazo.

Palabras clave: Enfermedad Renal Crónica; Insuficiencia Renal Crónica; Implantes Dentales; Osteointegración; Diálisis Renal.

INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition characterized by persistent abnormalities in kidney structure or function and is associated with

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systemic alterations that may affect multiple physiological processes. As kidney function declines, disturbances in mineral and bone metabolism, hematological and immune function, nutritional status, and tissue repair may become increasingly relevant, particularly in advanced disease. The growing number of individuals living with CKD and receiving long-term renal replacement or transplant care has consequently increased the number of medically complex patients requiring oral rehabilitation and implant-supported treatment (KIDNEY DISEASE: IMPROVING GLOBAL OUTCOMES [KDIGO] CKD WORK GROUP, 2024; ZAIMI, 2024).

Oral health is an important component of overall care in patients with CKD. Periodontal disease, dental caries, tooth loss, and other oral conditions may compromise oral function and quality of life, while the systemic consequences of advanced renal disease may further complicate dental management. Implant-supported rehabilitation may therefore represent a therapeutic option for selected patients; however, alterations associated with CKD raise relevant questions regarding bone healing, osseointegration, infection risk, bleeding, and long-term implant stability (SCARANO et al., 2024; ALLA et al., 2023).

One of the principal biological considerations in implant therapy for patients with CKD is chronic kidney disease-mineral and bone disorder (CKD-MBD). Alterations in calcium and phosphate homeostasis, vitamin D metabolism, parathyroid hormone (PTH) regulation, and bone turnover may influence skeletal quality and remodeling. These changes may be particularly relevant to implant therapy because successful osseointegration requires an adequate biological response at the bone–implant interface. Experimental evidence has suggested impaired peri-implant bone healing under conditions of renal dysfunction, although the extent to which these findings translate into clinically meaningful differences in human implant outcomes remains uncertain (KANJEVAC et al., 2018; ZOU et al., 2013; ZAIMI, 2024).

Clinical evidence regarding dental implant therapy in patients with CKD remains limited and heterogeneous. A systematic review and case report published by ALLA et al. (2023) identified a relatively limited body of clinical evidence and highlighted the need for further investigation of implant survival in patients with CKD. More recently, SCARANO et al. (2024), in a scoping review addressing oral surgery and dental implants in patients with CKD, emphasized the complexity of oral rehabilitation in this population and the influence of renal disease, dialysis, bone metabolism, and systemic conditions on clinical management. These findings support an individualized approach rather than considering CKD either as an absolute contraindication or as a condition without relevant implications for implant therapy.

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The clinical context of implant therapy may vary substantially according to the stage and treatment modality of kidney disease. Patients undergoing hemodialysis may present additional considerations related to dialysis-associated anticoagulation, anemia, fluctuations in systemic condition, and CKD-MBD. Patients receiving peritoneal dialysis represent a distinct population for which implant-specific evidence remains particularly limited. Similarly, patients awaiting kidney transplantation face uncertainty regarding the timing of elective rehabilitation, whereas transplant recipients require consideration of immunosuppressive therapy, infection susceptibility, graft function, and long-term maintenance. These differences illustrate that the term “CKD patient” encompasses clinically heterogeneous populations that should not be approached using a single therapeutic algorithm (YUAN et al., 2017; HERNÁNDEZ et al., 2019; BERTON et al., 2024).

Recent evidence in kidney transplant recipients has reported favorable implant outcomes in appropriately selected and monitored patients. Prospective studies have suggested that long-term immunosuppressive therapy does not necessarily preclude successful implant rehabilitation in stable renal transplant recipients (HERNÁNDEZ et al., 2019; BERTON et al., 2024). Evidence from broader solid-organ transplant populations has also reported high implant survival; however, such findings should be interpreted cautiously when applied specifically to kidney transplant recipients because different transplanted organs and clinical contexts may involve different risk profiles (CHEN; TANG; LIAO, 2025).

Conversely, recent evidence from patients with end-stage renal disease (ESRD) highlights the uncertainty surrounding implant predictability in advanced renal disease. In a case series of 15 patients receiving 27 implants, SALOMÃO et al. (2025) reported seven implant failures and accelerated marginal bone loss during the first 6 months of follow-up. Although the study demonstrates the technical feasibility of implant placement in selected patients with ESRD, its findings also raise concerns regarding early implant loss and biological stability. Importantly, the study did not demonstrate a significant association between PTH levels and implant loss or primary stability, reinforcing the need to avoid isolated laboratory thresholds when evaluating implant candidacy (SALOMÃO et al., 2025).

These findings indicate that implant therapy in CKD should be considered within a broader framework of individualized risk assessment. Renal disease severity, dialysis or transplant status, CKD-MBD, hematological and pharmacological factors, oral inflammatory conditions, surgical complexity, and the patient's ability to maintain long-term peri-implant health may all influence treatment planning. Consequently, the

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distinction between technical feasibility, clinical predictability, and safety is particularly important when interpreting the available evidence.

Despite growing interest in implant rehabilitation for medically complex patients, important clinical questions remain insufficiently answered. What clinical conditions should be present before implant therapy is considered in patients with CKD? How should treatment timing be adapted to hemodialysis, peritoneal dialysis, or kidney transplantation? Which systemic and local factors are most relevant to implant stability and long-term maintenance? Addressing these questions requires integration of the available evidence on implant outcomes with a careful understanding of renal disease, CKD-MBD, systemic stability, treatment modality, and individual treatment goals.

Accordingly, this critical review aims to analyze the current evidence regarding dental implant therapy in patients with chronic kidney disease, with particular emphasis on biological mechanisms relevant to osseointegration, implant survival, clinical timing, safety considerations, dialysis, kidney transplantation, and strategies for individualized treatment planning.

METHODS

Study design

This study was designed as a critical narrative review with a structured literature search addressing dental implant therapy in patients with chronic kidney disease (CKD). The review focused on clinically relevant evidence concerning biological mechanisms that may influence osseointegration, implant outcomes, surgical timing, bleeding and infection risks, dialysis, kidney transplantation, and individualized treatment planning.

Literature search

A structured literature search was conducted in PubMed and Scopus on September 5, 2026. The search strategies were designed to identify publications addressing CKD and dental implant therapy, including evidence related to advanced renal disease, dialysis, kidney transplantation, osseointegration, implant survival, and treatment-related complications.

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In PubMed, the search combined Medical Subject Headings (MeSH) and title/abstract terms related to kidney disease and dental implant therapy. In Scopus, the search was conducted within article titles, abstracts, and keywords using the terms “chronic kidney disease” and “dental implant.”

The PubMed search retrieved 70 records, whereas the Scopus search retrieved 28 records, resulting in 98 records identified before duplicate removal. The complete search strategies are presented in Supplementary Table 1.

Eligibility and study selection

Publications were considered eligible when they addressed dental implant therapy or outcomes relevant to implant treatment in patients with CKD, renal replacement therapy, or kidney transplantation. Publications addressing biological mechanisms relevant to osseointegration and clinical factors affecting implant treatment planning were also considered when directly applicable to the review objectives.

Systematic reviews, meta-analyses, clinical guidelines, prospective and retrospective clinical studies, case series, case reports, and clinically relevant narrative reviews were considered according to their contribution to the clinical questions addressed in this review.

Publications were excluded when they were unrelated to dental implant therapy or did not provide clinically applicable information concerning CKD, renal replacement therapy, kidney transplantation, implant outcomes, or factors directly relevant to implant treatment planning.

Reference lists of selected publications were manually screened to identify additional relevant publications.

Evidence appraisal and synthesis

The selected publications were critically analyzed according to study design, patient population, CKD status, renal replacement modality, transplant status, implant-related outcomes, and clinical applicability.

Greater weight was given to systematic reviews, prospective clinical studies, and kidney-specific clinical evidence when formulating clinical considerations. Case reports and case series were interpreted primarily as evidence of clinical feasibility

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and hypothesis generation rather than as evidence establishing treatment safety or predictable long-term outcomes.

Evidence derived from broader solid-organ transplant populations was considered indirect when extrapolating findings specifically to kidney transplant recipients.

The evidence was narratively synthesized according to the following clinical domains: biological mechanisms and CKD-related mineral and bone disorder; implant survival and complications; hemodialysis; peritoneal dialysis; patients awaiting kidney transplantation; stable kidney transplant recipients; bleeding and infection considerations; and individualized treatment planning.

Because of the limited number and substantial heterogeneity of studies specifically evaluating dental implant therapy in patients with CKD, quantitative synthesis was not performed. The complete search strategies are presented in Supplementary Table 1.

Chronic kidney disease and biological mechanisms relevant to implant therapy

Chronic kidney disease is associated with a complex spectrum of systemic alterations that may be relevant to dental implant therapy. Among these, disturbances in mineral and bone metabolism are particularly important because osseointegration depends on coordinated bone healing and remodeling at the implant–bone interface. As renal function declines, abnormalities involving phosphate retention, calcium homeostasis, vitamin D metabolism, parathyroid hormone (PTH) regulation, and bone turnover may progressively develop as components of chronic kidney disease-mineral and bone disorder (CKD-MBD) (KIDNEY DISEASE: IMPROVING GLOBAL OUTCOMES [KDIGO] CKD WORK GROUP, 2024; ZAIMI, 2024).

CKD-MBD does not represent a uniform skeletal condition. Depending on the stage of disease and the underlying metabolic abnormalities, patients may present different patterns of bone turnover and mineralization. Secondary hyperparathyroidism, altered vitamin D activation, hyperphosphatemia, and disturbances in calcium balance may contribute to changes in bone architecture and mechanical properties. These alterations may affect not only the axial and appendicular skeleton but also the jaws and alveolar bone, potentially influencing the biological environment in which dental implants are placed (KANJEVAC et al., 2018; ZAIMI, 2024).

The potential impact of CKD on osseointegration has also been supported by

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experimental evidence. Zou et al. (2013) demonstrated impaired healing around titanium implants in an experimental model of chronic kidney disease, suggesting that renal dysfunction may interfere with peri-implant bone formation. Although experimental findings cannot be directly extrapolated to human clinical outcomes, they provide a biologically plausible explanation for concerns regarding delayed or impaired osseointegration in patients with advanced renal disease. Bone remodeling is a dynamic process involving the coordinated activity of osteoblasts and osteoclasts. Successful implant osseointegration requires adequate vascularization, cellular activity, bone formation, and subsequent remodeling in response to mechanical loading. In patients with CKD, systemic inflammation, metabolic disturbances, anemia, nutritional deficiencies, and alterations in bone turnover may interact and potentially compromise these processes. However, the presence of CKD does not necessarily imply that osseointegration will fail, as the clinical consequences of these biological alterations may vary substantially among individuals (ALLA et al., 2023; SCARANO et al., 2024).

The clinical relevance of PTH deserves particular attention in implant dentistry. Elevated or markedly altered PTH levels may indicate disturbances in bone turnover, although a single laboratory value cannot independently determine implant eligibility or prognosis. The interpretation of PTH should therefore be integrated with the patient's overall renal status and other markers of mineral and bone metabolism. Recent clinical observations in patients with end-stage renal disease have reinforced the importance of considering metabolic bone status when evaluating implant outcomes; however, available clinical data do not support the use of PTH as an isolated eligibility or prognostic threshold (SALOMÃO et al., 2025; ZAIMI, 2024).

Another relevant consideration is that CKD-related skeletal alterations may not be adequately reflected by conventional assessments of bone quantity alone. Radiographic bone availability may appear sufficient for implant placement while underlying abnormalities in bone turnover or mineralization remain present. Consequently, implant planning in patients with CKD should not rely exclusively on local radiographic findings but should also consider the systemic context, particularly in patients with advanced disease, dialysis dependence, or evidence of CKD-MBD (KANJEVAC et al., 2018; KIDNEY DISEASE: IMPROVING GLOBAL OUTCOMES [KDIGO] CKD WORK GROUP, 2024).

Importantly, the current evidence does not support the assumption that all patients with CKD have an intrinsically poor capacity for implant osseointegration. The available clinical literature remains limited, heterogeneous, and largely based on small samples. Therefore, CKD should be understood as a potential modifier of biological risk rather than an automatic predictor of implant failure. The degree of renal dysfunction, metabolic stability, dialysis status, bone metabolism, and overall

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systemic condition are likely to be more clinically relevant than the diagnosis of CKD alone (ALLA et al., 2023; SCARANO et al., 2024).

What does the current evidence say about implant survival in patients with chronic kidney disease?

The available evidence regarding dental implant survival in patients with chronic kidney disease remains limited but generally suggests that implant treatment may be technically feasible in carefully selected individuals, although long-term predictability remains uncertain. Importantly, the current literature does not support considering CKD an absolute contraindication to implant therapy. However, the small number of studies, heterogeneous patient populations, and differences in renal disease severity make it difficult to establish a single predictable survival rate for all patients with CKD (ALLA et al., 2023; SCARANO et al., 2024).

A systematic review by Scarano et al. (2023) evaluated the available literature on implant therapy in patients with CKD and highlighted the scarcity of high-quality clinical evidence. The included studies involved patients with different degrees of renal dysfunction and distinct treatment modalities, including dialysis and kidney transplantation. Although favorable implant outcomes were reported, the limited sample sizes and methodological heterogeneity prevented definitive conclusions regarding the influence of CKD on long-term implant survival.

More recent clinical evidence has contributed additional information regarding patients with advanced renal disease. Salomão et al. (2025), in a case series involving patients with end-stage renal disease, reported that implant placement was technically feasible in this population. Nevertheless, the occurrence of implant loss and peri-implant bone changes in some patients reinforces that outcomes may be influenced by factors extending beyond the surgical procedure itself, including systemic disease severity and alterations in mineral and bone metabolism.

The interpretation of implant survival in CKD should therefore extend beyond a simple comparison between successful and failed implants. Marginal bone loss, delayed healing, peri-implant tissue stability, and the duration of follow-up are also clinically relevant outcomes. A patient may initially achieve successful implant osseointegration but subsequently experience biological complications related to inadequate oral hygiene, periodontal susceptibility, systemic instability, or changes in bone metabolism. Consequently, short-term implant survival alone may overestimate the predictability of treatment in medically complex populations (ALLA et al., 2023; SCARANO et al., 2024).

Evidence from patients receiving renal replacement therapy deserves particular attention. The clinical environment associated with hemodialysis may

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introduce additional variables, including fluctuations in systemic condition, exposure to anticoagulation, anemia, nutritional compromise, and CKD-MBD. Despite these concerns, implant placement has been reported as feasible in selected dialysis-dependent patients, suggesting that dialysis itself should not automatically preclude treatment. Instead, the timing of surgery and the patient's overall metabolic and medical stability appear to be central considerations (YUAN et al., 2017; SCARANO et al., 2024).

Patients awaiting kidney transplantation represent another particularly complex group. Implant therapy performed before transplantation may offer the advantage of completing oral rehabilitation before the initiation or intensification of post-transplant immunosuppressive therapy. Conversely, in patients with a stable clinical condition and no foreseeable short-term transplantation, implant rehabilitation may be considered when the expected benefits outweigh the risks and adequate follow-up can be ensured (ALLA et al., 2023; SALOMÃO et al., 2025). Available evidence in this population remains insufficient to establish universal recommendations, and decisions should therefore be individualized according to the expected transplant timeline, oral condition, and likelihood of achieving stable osseointegration before transplantation (ALLA et al., 2023).
The evidence available for renal transplant recipients is comparatively more encouraging. Prospective studies have reported favorable implant survival in appropriately selected patients receiving long-term immunosuppressive therapy (HERNÁNDEZ et al., 2019; BERTON et al., 2024). Similarly, a recent systematic review and meta-analysis involving solid organ transplant recipients suggested that implant therapy can achieve high survival rates in this medically complex population (CHEN; TANG; LIAO, 2025). Nevertheless, these findings should not be interpreted as evidence that transplantation eliminates implant-related risks, as infection susceptibility, medication effects, and individual systemic stability remain important determinants of treatment outcomes.

Overall, the current literature suggests that implant therapy may be feasible in selected patients across different stages of renal disease, including advanced CKD, dialysis, and post-transplantation. However, the certainty of the available evidence remains low because most studies involve small cohorts, case series, or observational designs. The most clinically defensible conclusion is therefore that CKD modifies implant-related risk but does not, by itself, determine treatment failure. Implant prognosis appears to depend on the interaction between renal disease severity, metabolic bone status, systemic stability, oral conditions, and the quality of long-term maintenance.

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When may implant therapy be considered in patients with CKD?

The safety of implant therapy in patients with chronic kidney disease cannot be determined solely by the presence or stage of renal disease. Instead, the decision should result from an individualized assessment integrating renal function, systemic stability, mineral and bone metabolism, current medical treatment, oral health status, and the invasiveness of the planned procedure. Current evidence therefore supports a risk-based approach rather than the automatic exclusion of patients with CKD from implant rehabilitation (ALLA et al., 2023; SCARANO et al., 2024).

A fundamental prerequisite for considering implant therapy is clinical stability. Patients with acute systemic deterioration, uncontrolled complications of advanced CKD, severe metabolic disturbances, or active infection should not undergo elective implant surgery until their condition has been appropriately evaluated and stabilized. Because implant placement is generally an elective procedure, the potential benefits of treatment should always be weighed against the patient's current systemic condition and the possibility that postponement may reduce avoidable surgical risk (KIDNEY DISEASE: IMPROVING GLOBAL OUTCOMES [KDIGO] CKD WORK GROUP, 2024; YUAN et al., 2017).

Assessment of renal status should extend beyond the simple identification of CKD. Whenever clinically relevant, the dental team should have access to information regarding the degree of renal dysfunction, underlying renal disease, dialysis status, current medications, and major systemic complications. In patients with advanced CKD, communication with the nephrologist may be particularly important when extensive surgery is planned or when there are concerns regarding bleeding, anemia, mineral and bone disorder, blood pressure instability, or drug prescription (YUAN et al., 2017).

The presence of CKD-MBD should also be considered when evaluating implant candidacy. However, abnormal biochemical parameters should not be interpreted in isolation as automatic predictors of implant failure. Rather than establishing a single laboratory threshold for implant placement, clinicians should evaluate whether the patient presents evidence of clinically significant disturbances in bone metabolism and whether these abnormalities are being appropriately monitored and managed. When substantial metabolic instability is suspected, elective implant treatment may reasonably be postponed until the systemic condition has been clarified (ZAIMI, 2024; SCARANO et al., 2024).

Local oral conditions remain equally important. Active periodontal disease, untreated dental infection, extensive plaque accumulation, and inadequate oral hygiene should be addressed before implant placement. This principle is particularly relevant in patients with CKD because systemic vulnerability may coexist with an

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increased burden of oral disease. Implant therapy should therefore be incorporated into a broader rehabilitation plan rather than used as an isolated response to tooth loss (YUAN et al., 2017; SCARANO et al., 2024).

Bleeding risk requires individualized interpretation. CKD itself does not necessarily predict clinically significant postoperative hemorrhage in every patient, but advanced renal dysfunction may be associated with uremic platelet dysfunction and anemia. Additional factors, including antiplatelet or anticoagulant therapy and anticoagulation associated with hemodialysis, may further modify procedural risk. Therefore, the decision to perform implant surgery should consider the patient's complete hematological and pharmacological profile and, when indicated, should involve medical consultation rather than relying on CKD stage alone (YUAN et al., 2017).

Patients receiving hemodialysis require particular attention regarding surgical timing. Existing clinical recommendations generally favor performing invasive dental procedures on non-dialysis days, commonly on the day after a dialysis session, to avoid the immediate effects of dialysis-associated anticoagulation. However, this recommendation is based largely on clinical guidance and experience rather than robust comparative evidence and should not be treated as a universal rule. The dialysis schedule, anticoagulation regimen, post-dialysis condition, vascular access, surgical complexity, and recommendations of the nephrology team should all be considered (YUAN et al., 2017).

From a surgical perspective, treatment complexity should be proportional to the patient's overall risk. When implant therapy is considered appropriate, careful planning aimed at minimizing surgical trauma, operative time, and postoperative morbidity may be preferable, particularly in medically complex patients. The available literature does not provide sufficient evidence to define a universally superior implant protocol for all patients with CKD. Consequently, decisions regarding the number of implants, grafting procedures, loading protocols, and healing periods should be individualized rather than automatically applying protocols developed for healthy populations (ALLA et al., 2023; YUAN et al., 2017). Importantly, implant therapy should not be considered appropriate merely because the surgical procedure can technically be performed. Long-term maintenance must also be feasible. The patient should demonstrate an ability to maintain adequate oral hygiene and attend periodic follow-up appointments, as peri-implant health depends on continuous monitoring and control of local risk factors. This consideration may be particularly important for patients with advanced CKD who already face frequent medical appointments and a substantial treatment burden (YUAN et al., 2017; SCARANO et al., 2024).

Overall, implant therapy may be considered in selected patients when the

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patient's renal disease is clinically stable, major systemic complications are appropriately managed, active oral infection has been eliminated, bleeding risk has been assessed, and adequate postoperative follow-up can be ensured. Conversely, elective treatment should generally be reconsidered or postponed when significant systemic instability, uncontrolled metabolic disturbances, active infection, or unresolved medical concerns are present. The available evidence supports individualized decision-making rather than rigid contraindications based exclusively on the diagnosis of CKD.

Implant therapy in patients undergoing dialysis

Patients undergoing renal replacement therapy represent a particularly complex subgroup within the CKD population. However, dialysis dependence should not be interpreted as an absolute contraindication to implant therapy. Instead, the modality of dialysis, the patient's clinical stability, associated complications, and the timing of the surgical procedure should be incorporated into individualized treatment planning (YUAN et al., 2017; SCARANO et al., 2024).

Hemodialysis

Hemodialysis introduces specific considerations that may influence implant surgery. Patients may experience fluctuations in intravascular volume and blood pressure, anemia, metabolic disturbances, and exposure to anticoagulants during dialysis sessions. In addition, advanced CKD may be associated with platelet dysfunction, potentially increasing the complexity of bleeding control during invasive procedures. Therefore, implant surgery should be planned in close consideration of the patient's dialysis schedule and overall medical status (YUAN et al., 2017).

A commonly recommended approach is to schedule invasive dental procedures on a non-dialysis day, frequently on the day following hemodialysis. This timing aims to avoid the immediate effects of anticoagulation used during the dialysis session while allowing the patient to undergo treatment after fluid and metabolic correction. Nevertheless, this recommendation should be interpreted as a clinical principle rather than an inflexible rule, since individual dialysis protocols, anticoagulation strategies, and medical conditions may vary considerably among patients (YUAN et al., 2017).

Preoperative assessment should include careful review of the patient's dialysis schedule, current medications, blood pressure, hematological status, and relevant complications of advanced CKD. When extensive implant surgery, bone grafting, or other complex procedures are planned, communication with the nephrology team

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may be particularly valuable. The objective is not simply to obtain medical clearance, but to identify modifiable factors that may influence surgical safety and postoperative healing (YUAN et al., 2017).

The presence of an arteriovenous fistula or graft should also be recognized as an important aspect of patient management. Blood pressure measurement and vascular procedures should generally avoid the extremity containing the vascular access, and the dental team should be aware of the patient's overall vascular status during treatment. In addition, prolonged or highly stressful procedures may require modifications aimed at reducing physiological burden and improving patient comfort. Bleeding management should be based on the patient's individual risk profile rather than dialysis dependence alone. Uremic platelet dysfunction, anemia, antiplatelet therapy, systemic anticoagulation, and the anticoagulant regimen used during dialysis may interact to influence bleeding risk. When an increased risk is anticipated, a preoperative hemostatic strategy and appropriate local measures should be planned before surgery (YUAN et al., 2017).

From a surgical perspective, minimizing tissue trauma and avoiding unnecessary procedural complexity may be particularly appropriate in medically vulnerable patients. The use of a carefully planned surgical approach, adequate primary stability, and meticulous postoperative monitoring may be more relevant than adopting a universally modified implant protocol. Current evidence remains insufficient to determine whether specific implant designs or loading strategies provide superior outcomes in patients undergoing hemodialysis (ALLA et al., 2023; YUAN et al., 2017).

Peritoneal dialysis

Evidence specifically addressing dental implant therapy in patients undergoing peritoneal dialysis is considerably more limited than that available for hemodialysis. Consequently, recommendations cannot simply be transferred from hemodialysis protocols without considering the important physiological and therapeutic differences between these modalities.

Unlike hemodialysis, peritoneal dialysis does not usually involve the same intermittent systemic anticoagulation associated with a dialysis session. Therefore, the recommendation to schedule implant surgery according to a post-dialysis interval does not apply in the same manner to patients receiving peritoneal dialysis. Instead, treatment planning should focus on the patient's overall metabolic stability, nutritional condition, infection status, medication use, and the presence of complications associated with advanced CKD.

In patients undergoing peritoneal dialysis, particular attention should be given

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to the risk of infection. Because these patients depend on a permanent peritoneal catheter and remain vulnerable to infectious complications, active oral infections should be eliminated before elective implant surgery. However, the current implant-specific literature does not provide sufficient evidence to support a universal protocol regarding prophylactic antibiotics or a specific interval between dialysis exchanges and implant placement.

For this reason, implant therapy in patients undergoing peritoneal dialysis should be approached through individualized interdisciplinary planning. The absence of robust implant-specific evidence means that treatment decisions should prioritize systemic stability and close communication with the nephrology team rather than relying on extrapolated protocols.

Clinical implications

Overall, dialysis should be considered a modifier of implant treatment planning rather than an absolute contraindication. For patients undergoing hemodialysis, the timing of surgery in relation to dialysis sessions and anticoagulation exposure is particularly relevant. For patients undergoing peritoneal dialysis, the emphasis shifts toward systemic stability, infection prevention, and individualized medical assessment.

The most defensible approach is therefore not to ask whether a patient “on dialysis can receive implants,” but rather:
Is this individual patient clinically stable, adequately monitored, free from uncontrolled oral infection, and able to undergo surgery and long-term maintenance safely?

Patients awaiting kidney transplantation and kidney transplant recipients

Patients awaiting kidney transplantation represent a particularly challenging group for implant treatment planning. On one hand, completing necessary dental care before transplantation is generally encouraged to eliminate potential sources of oral infection before the initiation of intensive immunosuppressive therapy. On the other hand, implant therapy is an elective procedure that requires adequate healing and a period of osseointegration, which may be difficult to reconcile with the unpredictable timing of organ availability (ALBAGIEH et al., 2024; SCARANO et al., 2024).

The decision to place implants before kidney transplantation should therefore not be based solely on the assumption that treatment is necessarily safer before immunosuppression. The anticipated time to transplantation, the patient's systemic stability, the need for additional surgical procedures, and the expected healing period should all be considered. When transplantation is expected imminently, initiating

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elective implant therapy may be difficult to justify if osseointegration and early healing cannot be adequately monitored before transplantation. Conversely, in patients with a stable clinical condition and no foreseeable short-term transplantation, implant rehabilitation may be considered when the expected benefits outweigh the risks and adequate follow-up can be ensured (ALLA et al., 2023; SALOMÃO et al., 2025).

Importantly, pre-transplant dental care should prioritize the elimination or stabilization of active oral disease. Although comprehensive dental evaluation and treatment are important components of transplant preparation, the evidence specifically supporting standardized implant timing before kidney transplantation remains limited. From an implant perspective, elimination of infectious foci and establishment of periodontal stability should take priority over elective rehabilitation when treatment time is restricted (ALBAGIEH et al., 2024).

Kidney transplantation introduces a different set of considerations. During the early post-transplant period, immunosuppressive therapy is typically most intensive, and susceptibility to infection and impaired wound healing may be increased. For this reason, elective invasive dental procedures are generally deferred during the initial period following transplantation, with urgent care taking priority when necessary. However, the exact duration of postponement varies among clinical protocols and should not be presented as a universal evidence-based threshold (ALBAGIEH et al., 2024).

After the patient has achieved systemic stability and entered a maintenance phase of immunosuppressive therapy, implant treatment may become a reasonable option. Prospective evidence has demonstrated that implant-supported rehabilitation can be successful in appropriately selected renal transplant recipients receiving long-term immunosuppressive therapy. Berton et al. (2024) reported favorable long-term outcomes and concluded that implant rehabilitation is feasible when patients are adequately maintained and followed. Similarly, previous prospective evidence has suggested that immunosuppression alone does not necessarily preclude successful osseointegration (HERNÁNDEZ et al., 2019; BERTON et al., 2024).

Nevertheless, favorable implant survival in transplant recipients should not be interpreted as evidence that all post-transplant patients can undergo implant surgery without additional precautions. The type and intensity of immunosuppressive therapy, history of graft complications, current renal function, susceptibility to infection, periodontal status, and general systemic condition remain clinically relevant. Communication with the transplant and nephrology teams is particularly important when invasive procedures are being considered in medically complex recipients (ALBAGIEH et al., 2024).

A clinically relevant distinction should therefore be made between the early post-transplant period, when elective implant therapy is generally postponed, and the

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stable long-term post-transplant phase, when treatment may be considered following individualized medical and dental assessment. Current literature supports this cautious approach, although robust evidence establishing an exact universally safe interval for implant placement after kidney transplantation remains unavailable. Overall, the timing of implant therapy around kidney transplantation should be guided by a central principle: the optimal moment is not necessarily before or after transplantation, but when the patient's systemic condition, oral environment, and expected period of healing provide the greatest likelihood of safe and stable treatment. This individualized perspective is particularly important given the heterogeneity of transplant timelines and immunosuppressive regimens.

To facilitate clinical decision-making, Table 1 summarizes the main clinical scenarios involving patients with CKD and outlines the key concerns, recommended approaches, and supporting evidence for implant therapy.

Clinical scenario	Can implant therapy be considered?	Main concerns	Recommended approach	Main supporting evidence
Stable CKD without renal replacement therapy	**May be considered after individualized assessment**	CKD-MBD, systemic comorbidities, bone metabolism	Individual assessment of renal and systemic stability; control oral disease before implant placement	ALLA et al., 2023; Scarano et al. (2024); KDIGO (2024)
Advanced CKD	**Case-by-case**	CKD-MBD, anemia, altered bone turnover, systemic instability	Assess overall metabolic status and relevant complications; consider medical consultation before elective surgery	Scarano et al. (2024); Zaimi (2024); KDIGO (2024)

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Hemodialysis	**May be considered with individualized precautions**	Dialysis-associated anticoagulation, bleeding risk, anemia, systemic fluctuations	Plan surgery according to the dialysis schedule, commonly on a non-dialysis day; minimize surgical trauma and coordinate with the nephrology team	Yuan et al. (2017); Scarano et al. (2024)
Peritoneal dialysis	**May be considered only after individualized interdisciplinary assessment**	Limited implant-specific evidence, infection risk, systemic and nutritional status	Prioritize systemic stability and infection control; no standardized implant-specific surgical timing protocol can currently be recommended from available evidence	Evidence gap; Scarano et al. (2024)
Awaiting kidney transplantation	**Case-by-case**	Unpredictable transplant timing and limited time for osseointegration	Prioritize elimination of oral infection; consider implant therapy only when adequate healing and follow-up are expected before transplantation	ALLA et al., 2023; Salomão et al. (2025)

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Early post-transplant period	**Generally postpone elective implant therapy**	Intensive immunosuppression, infection susceptibility, wound healing	Defer elective invasive procedures until systemic stability is established in coordination with the transplant team	ALBAGIEH et al. (2024); Scarano et al. (2024)
Stable renal transplant recipient	**May be considered after individualized assessment**	Immunosuppressive therapy, infection risk, periodontal maintenance	Individual risk assessment, medical stability confirmation, strict periodontal and peri-implant maintenance	Hernández et al. (2019); Berton et al. (2024); Chen et al. (2025)
Evidence of uncontrolled oral infection or poor plaque control	**Elective implant placement should be deferred**	Peri-implant infection and impaired long-term maintenance	Treat active periodontal/endodontic disease and establish adequate oral hygiene before implant therapy	Yuan et al. (2017); Scarano et al. (2024)
Marked systemic or metabolic instability	**Elective treatment should be postponed**	Increased perioperative risk and uncertain healing	Stabilize systemic condition and reassess implant indication after appropriate medical management	KDIGO (2024); Scarano et al. (2024)

Figure 1. Decision framework proposed by this review

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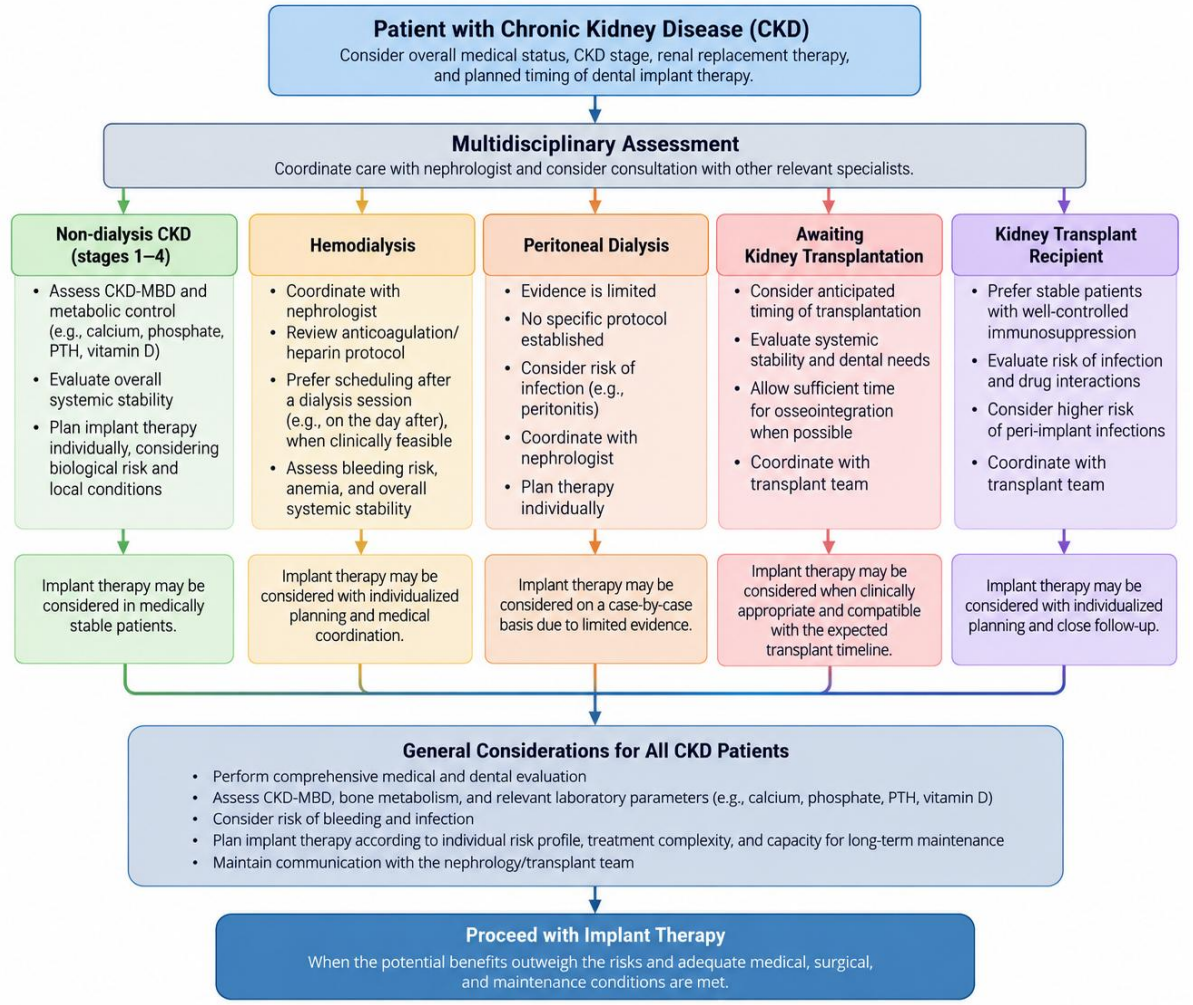


Figure 1. Proposed framework for dental implant therapy in patients with chronic kidney disease (CKD).
Note: This figure represents a framework based on the available evidence and clinical considerations discussed in this review.
It is not a validated clinical algorithm, and individual patient management should be tailored to each clinical situation in consultation with the nephrology/transplant team.

Figure 1. Evidence-informed clinical decision framework for dental implant therapy in patients with chronic kidney disease (CKD). Implant therapy should be based on individualized assessment of systemic stability, renal treatment modality, oral health status, surgical risk, and the patient's capacity for long-term maintenance. CKD-MBD: chronic kidney disease-mineral and bone disorder.

DISCUSSION

The present review indicates that chronic kidney disease should not be regarded as an automatic contraindication to dental implant therapy; however, the

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available evidence is insufficient to establish equivalent safety or predictability across the different stages and treatment modalities of CKD. Implant placement may be technically feasible in carefully selected patients, but feasibility should be distinguished from predictable long-term clinical outcomes. This distinction is particularly important in advanced CKD and end-stage renal disease (ESRD), in which the available evidence remains limited and heterogeneous (ALLA et al., 2023; SCARANO et al., 2024).

A central finding of this review is that the diagnosis of CKD alone provides insufficient information for implant decision-making. Patients classified within the same broad CKD category may present substantially different risks depending on renal function, dialysis dependence, metabolic control, hematological status, nutritional condition, comorbidities, medication use, and overall systemic stability. This heterogeneity may partly explain the inconsistent findings across the available clinical literature. Consequently, CKD should not be interpreted as a homogeneous clinical condition when assessing implant-related risk. Future studies should characterize renal disease severity and relevant systemic variables more precisely rather than treating CKD as a single clinical exposure (ALLA et al., 2023; KIDNEY DISEASE: IMPROVING GLOBAL OUTCOMES [KDIGO] CKD WORK GROUP, 2024).

The biological rationale for concern regarding implant healing in CKD is supported by experimental and clinical observations. CKD-related disturbances in mineral and bone metabolism may alter bone turnover and mineralization, while systemic inflammation, anemia, nutritional abnormalities, and other complications of advanced renal disease may additionally influence tissue repair. Experimental evidence has demonstrated impaired peri-implant bone healing under conditions of renal dysfunction, providing biological plausibility for concerns regarding osseointegration (ZOU et al., 2013). Nevertheless, experimental findings cannot be directly extrapolated to clinical implant survival. Clinical evidence remains insufficient to determine the magnitude of the effect of these biological alterations on human implant outcomes (ZAIMI, 2024). Thus, a plausible biological mechanism should not automatically be interpreted as proof of clinically relevant implant failure.

The available clinical evidence requires particularly cautious interpretation. Small cohorts, case series, heterogeneous follow-up periods, and differences in patient selection limit the generalizability of reported outcomes. In addition, patients selected for implant therapy may already represent a healthier and more medically stable subgroup of the CKD population. This potential selection bias may contribute to more favorable outcomes than would be expected in an unselected population with

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advanced renal disease. The evidence synthesized by SCARANO et al. (2023) and SCARANO et al. (2024) therefore supports the interpretation that implant therapy may be feasible in selected patients, while remaining insufficient to establish universal long-term predictability.

Recent evidence in patients with ESRD further reinforces this distinction. In a case series involving 15 patients and 27 dental implants, SALOMÃO et al. (2025) reported seven implant failures, corresponding to approximately 26% of the implants evaluated. The authors also described accelerated marginal bone loss during the first 6 months after implant placement. These findings demonstrate that implant placement can be technically performed in selected patients with ESRD, but the occurrence of early failures and marginal bone changes raises concerns regarding biological stability. Therefore, the findings of SALOMÃO et al. (2025) should be interpreted primarily as evidence of technical feasibility accompanied by clinically relevant concerns, rather than as evidence of predictably safe implant therapy in ESRD.

The findings reported by SALOMÃO et al. (2025) are also relevant to the interpretation of PTH in implant planning. Although PTH concentrations varied substantially among the patients evaluated, ranging from 105.1 to 1965 pg/mL, no significant association was observed between PTH levels and either primary implant stability or implant loss. These findings do not support the use of PTH as an isolated laboratory threshold for determining implant eligibility or prognosis. Rather, CKD-MBD should be interpreted as a heterogeneous clinical condition involving alterations in bone turnover, mineralization, biochemical control, and treatment status. Accordingly, laboratory findings should be integrated with the patient's systemic condition, bone status, renal treatment modality, and other relevant clinical variables (SALOMÃO et al., 2025; ZAIMI, 2024).

The distinction between feasibility and predictability is particularly important when considering patients receiving dialysis. Hemodialysis introduces additional clinical variables, including intermittent anticoagulation, anemia, blood pressure fluctuations, changes in intravascular volume, and complications associated with advanced CKD-MBD. YUAN et al. (2017) proposed clinical considerations for dental implant treatment in dialysis patients, including attention to the timing of invasive procedures in relation to dialysis and anticoagulation. However, such recommendations should be interpreted as clinical guidance rather than as evidence from robust comparative trials establishing a universally optimal surgical interval. Individual factors such as the dialysis regimen, anticoagulation strategy, post-dialysis

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condition, bleeding history, systemic stability, and surgical complexity should therefore influence the timing of treatment (YUAN et al., 2017).

Peritoneal dialysis represents an important evidence gap. The physiological and therapeutic characteristics of peritoneal dialysis differ from those of hemodialysis, particularly with regard to intermittent systemic anticoagulation. Consequently, recommendations developed for hemodialysis should not be automatically transferred to patients receiving peritoneal dialysis. The available literature remains insufficient to define a standardized implant-specific surgical timing protocol for this population. This limitation should be explicitly recognized in clinical decision-making and represents an important priority for future prospective research (SCARANO et al., 2024).

The timing of implant therapy in relation to kidney transplantation is similarly nuanced. Before transplantation, comprehensive dental care should prioritize elimination or stabilization of infectious and inflammatory oral conditions. Implant placement may be considered in selected candidates when sufficient time for healing and follow-up is reasonably expected. Conversely, when transplantation is anticipated imminently, elective implant therapy may be difficult to justify because osseointegration and early peri-implant healing may not be adequately monitored before transplantation. Therefore, the potential theoretical advantage of completing implant rehabilitation before immunosuppression should not automatically outweigh the practical limitations associated with an uncertain transplantation timeline (ALLA et al., 2023; SCARANO et al., 2024).

Following kidney transplantation, the early post-transplant period should be distinguished from the stable maintenance phase. During the early period, immunosuppressive therapy is generally more intensive, and susceptibility to infection and impaired wound healing may be increased. Elective invasive procedures may therefore be deferred until adequate systemic stability has been established. Importantly, however, the available evidence does not support a single universally applicable time threshold after transplantation. Clinical decisions should consider graft function, immunosuppressive regimen, history of complications, infection risk, and the recommendations of the transplant and nephrology teams (ALBAGIEH et al., 2024).

Evidence in stable kidney transplant recipients is comparatively more encouraging. Prospective studies have reported favorable implant outcomes in appropriately selected renal transplant recipients receiving long-term immunosuppressive therapy (HERNÁNDEZ et al., 2019; BERTON et al., 2024). In

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particular, the prospective kidney-specific evidence reported by BERTON et al. (2024) provides directly relevant information for renal transplant recipients. HERNÁNDEZ et al. (2019) similarly reported favorable outcomes in a prospective case-controlled study, suggesting that long-term immunosuppression alone does not necessarily preclude implant treatment.

Evidence from broader solid-organ transplant populations should nevertheless be interpreted cautiously. CHEN, TANG and LIAO (2025) evaluated dental implant outcomes in solid-organ transplant recipients and reported high implant survival. However, because the population included recipients of different transplanted organs, these findings cannot be assumed to represent kidney transplant recipients specifically. Consequently, evidence from broader solid-organ transplant populations should complement rather than replace kidney-specific clinical studies (CHEN; TANG; LIAO, 2025).

Another relevant issue is antibiotic prophylaxis. Historical literature involving hemodialysis patients and some clinical recommendations have supported prophylactic antibiotic use in selected circumstances. However, the available evidence does not establish that routine antibiotic prophylaxis is necessary for every patient with CKD, hemodialysis, peritoneal dialysis, or kidney transplantation undergoing implant surgery. Antibiotic decisions should instead be individualized according to the patient's medical condition, the presence of established infection, the nature and complexity of the procedure, and current antimicrobial recommendations. CKD or dialysis status alone should therefore not be interpreted as sufficient justification for routine prophylaxis (YUAN et al., 2017; SCARANO et al., 2024).

An important clinical implication of the present review is that implant treatment planning should extend beyond the surgical procedure itself. Long-term implant outcomes depend not only on osseointegration but also on peri-implant tissue stability, oral hygiene, periodontal status, maintenance, and the patient's ability to attend regular follow-up. This consideration may be particularly relevant in advanced CKD, where patients may already experience a substantial medical treatment burden. In selected cases, a less invasive prosthetic rehabilitation may provide a more appropriate balance between functional benefit, biological risk, and treatment burden than a complex implant-supported reconstruction (SCARANO et al., 2024).

The concept of proportionality may therefore be particularly valuable in clinical planning. The technical possibility of implant placement does not imply that the same surgical protocol used in medically healthy patients should be applied to medically complex individuals. The extent of surgery, need for bone augmentation, number of

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implants, healing period, loading strategy, and prosthetic design should be adapted to the patient's systemic condition and treatment objectives. Whenever possible, clinicians should aim to achieve the desired functional outcome while minimizing surgical morbidity and unnecessary procedural complexity (YUAN et al., 2017; SCARANO et al., 2024).

The present review also emphasizes the importance of interdisciplinary care. Implantologists should not be expected to independently interpret all aspects of advanced renal disease. Communication with nephrologists and transplant teams may provide clinically relevant information regarding renal stability, dialysis schedules, anticoagulation, immunosuppressive therapy, hematological abnormalities, and the anticipated timing of transplantation. Medical consultation should therefore address specific clinical questions and risk factors rather than functioning merely as a generic request for “medical clearance” (YUAN et al., 2017; ALBAGIEH et al., 2024).

Several limitations of both the available evidence and the present review must be acknowledged. The number of studies specifically investigating implant therapy in CKD remains small, and most available publications are observational. Sample sizes are frequently limited, patient populations are heterogeneous, and clinically important variables such as CKD stage, dialysis duration, CKD-MBD characteristics, PTH levels, bone turnover, immunosuppressive regimens, and peri-implant outcomes are not consistently reported. Implant survival alone may also be insufficient to characterize treatment success, as marginal bone loss, peri-implant disease, complications, patient-reported outcomes, and long-term maintenance are clinically relevant outcomes (ALLA et al., 2023; SCARANO et al., 2024).

In addition, the present study is a critical narrative review with a structured literature search rather than a systematic review with formal quantitative synthesis. Although a structured search was performed and reference lists were manually screened, study selection and interpretation were not conducted using a formal risk-of-bias framework or GRADE methodology. Consequently, publication bias, bibliographic selection bias, and selective availability of clinical evidence cannot be excluded. Greater interpretive weight was given to systematic reviews, prospective studies, and kidney-specific clinical evidence, whereas case reports and case series were considered primarily as evidence of feasibility or hypothesis generation rather than definitive evidence of safety or predictability.

Future research should prioritize prospective multicenter studies with standardized reporting of renal function, CKD stage, dialysis modality, CKD-MBD

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characteristics, systemic comorbidities, and immunosuppressive regimens. Studies should avoid grouping heterogeneous renal populations into a single category and should evaluate implant outcomes using standardized definitions and sufficiently long follow-up periods. Importantly, future research should assess outcomes beyond implant survival, including marginal bone changes, peri-implant disease, postoperative complications, patient-reported outcomes, quality of life, and long-term maintenance. Dedicated studies in ESRD, hemodialysis, and peritoneal dialysis populations are particularly warranted.

Overall, the current evidence supports a cautious but not prohibitive approach to dental implant therapy in patients with chronic kidney disease. CKD should neither be regarded as an automatic contraindication nor be interpreted as evidence of outcomes equivalent to those expected in medically healthy populations. The most defensible clinical approach is to determine whether the individual patient has sufficient systemic stability to undergo an elective surgical procedure, whether modifiable oral and medical risk factors have been addressed, and whether long-term maintenance can reasonably be achieved. In this context, individualized risk assessment, appropriate timing, control of oral disease, proportional treatment planning, and interdisciplinary collaboration represent the most defensible principles for clinical decision-making. Further prospective, kidney-specific research is required to clarify the long-term predictability and optimal management of implant therapy in patients with advanced CKD and those receiving renal replacement therapy.

CONCLUSION

Dental implant therapy should not be considered automatically contraindicated in patients with chronic kidney disease. However, the current evidence is insufficient to establish equivalent safety or predictability across the different stages and treatment modalities of CKD. Implant placement may be technically feasible in carefully selected patients, including some individuals undergoing dialysis and stable kidney transplant recipients, but advanced CKD and end-stage renal disease warrant particular caution because of the limited evidence and the possibility of early implant loss and peri-implant bone changes.

Implant treatment should therefore not be based exclusively on the presence or stage of CKD, nor on isolated laboratory parameters such as PTH. Clinical decision-making should integrate systemic stability, renal treatment modality, CKD-

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related mineral and bone abnormalities, hematological and pharmacological factors, oral health status, surgical complexity, and the patient's ability to maintain long-term peri-implant care. Treatment timing is particularly relevant in patients undergoing hemodialysis and in those awaiting or recovering from kidney transplantation, while implant-specific evidence remains insufficient to establish standardized timing protocols for peritoneal dialysis.

Current evidence supports an individualized and interdisciplinary approach in which active oral disease is controlled, elective surgery is considered during periods of clinical stability, and unnecessary surgical complexity is minimized. The central clinical question is therefore not simply whether patients with CKD can receive dental implants, but whether the potential benefits of implant therapy outweigh the individualized risks and whether adequate healing, follow-up, and long-term maintenance can reasonably be achieved.

Further prospective, multicenter, and well-designed clinical studies are needed to clarify implant survival, marginal bone changes, peri-implant complications, optimal treatment timing, and long-term outcomes across the different stages and treatment modalities of chronic kidney disease, particularly in patients with advanced CKD, ESRD, hemodialysis, and peritoneal dialysis.

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