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International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Original Research Article

Assessment of implant success in patients with immuno compromised conditions

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Abstract

Dental implants provide an effective method for replacing missing teeth, though their success rates can vary considerably among immunocompromised patients. This study focuses on evaluating implant outcomes in individuals with systemic conditions such as diabetes mellitus, HIV/AIDS, and autoimmune disorders, examining their effects on osseointegration and complications like peri-implantitis. Over a five-year period, a retrospective cohort of 400 patients—comprising 200 immunocompromised individuals and 200 healthy controls—was reviewed. Key metrics, including implant survival, peri-implant bone loss, and associated complications, were analysed. Findings showed that immunocompromised patients had a markedly lower survival rate of 81% compared to 96% in the control group. Potential strategies to enhance outcomes in this population are also explored.

Keywords: Dental implants, Implant survival rate, Immunocompromised patients, Osseointegration.

Received: 19-12-2024; **Accepted:** 31-03-2025; **Available Online**: 29-04-2025

1. Introduction

Dental implants have revolutionized modern dentistry, offering a reliable and aesthetically pleasing solution for the replacement of missing teeth. The long-term success of these implants is primarily dependent on osseointegration, a biological process that ensures the stable anchorage of an implant within the alveolar bone. The concept of osseointegration was first introduced by Brånemark et al., who demonstrated the direct structural and functional connection between living bone and implant surfaces, laying the foundation for modern implant dentistry.[1] Since then, significant advancements have been made to enhance implant longevity and success rates.

In healthy individuals, implant survival rates often exceed 95%, primarily due to efficient bone remodelling and immune regulation.[2] However, systemic conditions such as diabetes mellitus, HIV/AIDS, and autoimmune disorders can significantly compromise implant success by altering bone metabolism, impairing immune responses, and increasing susceptibility to peri-implantitis.[3] Understanding how these conditions affect osseointegration and peri-implant health is crucial for optimizing treatment strategies.

Diabetes mellitus (DM) is a significant risk factor for implant failure. Hyperglycemia negatively affects bone healing by impairing collagen synthesis, angiogenesis, and osteoblastic activity, ultimately delaying osseointegration.[4] Additionally, poor glycemic control (HbA1c >7%) has been linked to increased rates of peri-implantitis and bone loss, conditions that contribute to early implant failure.[5] However, studies indicate that diabetics with well-controlled glucose levels experience implant success rates similar to those of healthy individuals, highlighting the importance of metabolic regulation before undergoing implant therapy.[6]

Similarly, HIV/AIDS presents unique challenges for dental implant therapy due to immune dysregulation and increased microbial susceptibility.[7] Patients with low CD4+

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https://doi.org/10.18231/j.ijohd.2025.007

T-cell counts exhibit delayed wound healing, impaired bone remodelling, and a higher risk of peri-implant infections, leading to reduced implant survival.[8] However, antiretroviral therapy (ART) has been shown to improve implant success in HIV-positive patients by stabilizing immune function and reducing systemic inflammation.[9] Despite these advancements, HIV-positive individuals remain at higher risk for implant failure compared to healthy controls, necessitating meticulous preoperative planning and postoperative monitoring.[10]

Autoimmune diseases, such as rheumatoid arthritis, systemic lupus erythematosus, and Crohn's disease, further complicate implant therapy. Many of these conditions necessitate immunosuppressive therapy, which can impair bone metabolism and increase the risk of infection and implant failure. Corticosteroids, commonly used in autoimmune disease management, are known to cause osteoporosis and delayed wound healing, both of which negatively impact implant survival.[11] However, recent studies suggest that patients on well-managed immunosuppressive regimens may still achieve favorable implant outcomes, provided that adequate prophylactic measures and careful postoperative follow-up are implemented.[12]

Despite the growing number of immunocompromised patients seeking dental implant therapy, limited data exist regarding their implant survival rates and long-term outcomes.[13] This study aims to bridge this knowledge gap by analysing implant survival rates, peri-implant bone loss, and associated complications in immunocompromised individuals compared to healthy controls.14 Understanding these risk factors will enable clinicians to optimize treatment protocols and improve implant success in high-risk populations.[15]

2. Materials and Methods

2.1. Study design

A retrospective cohort study was conducted across three institutions from 2018 to 2023. Participants were categorized into two groups:

Immuno compromised group (n = 200):** This group included patients with diabetes mellitus (HbA1c >7%), HIV/AIDS (CD4+ <350 cells/μL), or autoimmune disorders.

Healthy controls (n = 200), Patients were matched by age, sex, and implant site.

Implant success was defined as the absence of mobility, pain, peri-implant radiolucency, or progressive bone loss during a 12-month follow-up period (9).

2.2. Inclusion criteria

Patients aged 25–70 years.
Placement of single or multiple dental implants in either jaw.
At least a 12-month follow-up period.

2.3. Exclusion Criteria

Current smokers (consuming more than 10 cigarettes per day).
History of active chemotherapy or craniofacial radiotherapy.
Uncontrolled systemic conditions (HbA1c >10%).

2.4. Data collection

Data on demographics and clinical factors, including age, sex, systemic condition, implant location, and type of prosthesis, were obtained from patient records. Outcome measures assessed included:

1. Implant survival rates.
2. Peri-implant bone loss, measured radiographically.
3. Complication rates, including peri-implantitis and delayed healing (10).

2.5. Statistical analysis

Kaplan-Meier survival analysis was utilized to evaluate implant survival rates. Bone loss was assessed using independent t-tests, and logistic regression was employed to identify risk factors for failure. Statistical significance was defined as $p < 0.05$.(11)

3. Results

3.1. Patient demographics

The mean age was 54 ± 8 years, without significant differences between groups ($p = 0.07$). Among the immunocompromised patients, 50% were suffering from diabetes mellitus, 30% were HIV-positive, and 20% had autoimmune conditions.

3.2. Implant survival

Overall survival was 81% among immunocompromised subjects and 96% among controls ($p < 0.001$). In subgroup analyses, survival was as follows:

Diabetes: 84%, HIV/AIDS: 76%, Autoimmune diseases: 86%.

3.3. Bone loss

The mean peri-implant bone loss was significantly higher ($p < 0.001$) in the immunocompromised group, with a mean of 1.8 ± 0.7 mm compared to 0.6 ± 0.3 mm among controls. The highest magnitudes of bone loss were found among the HIV-positive subjects.

3.4. Complications

The incidence of peri-implantitis was 28% in immunocompromised patients versus 8% in controls. The difference in delayed soft tissue healing and implant mobility was higher among the former.

4. Discussion

These results confirm that systemic diseases adversely affect the success of dental implants. Diabetes mellitus, marked by hyperglycemia, impairs osseointegration by disrupting bone remodeling and collagen synthesis.[3] Previous studies have also highlighted a link between poor glycemic control (HbA1c >7%) and increased failure rates.[4] HIV/AIDS patients showed the lowest survival rates, driven by immune dysfunction and a heightened risk for peri-implant infections.[5] Similar findings have been noted in studies correlating CD4+ counts with implant outcomes.[6]

Autoimmune diseases, while less severe, posed challenges like corticosteroid-induced bone resorption and infection risk.[7] Improved results in this group may reflect advancements in immunosuppressive therapies.[8]

The following strategies aim to enhance implant success in immunocompromised patients:

1. Diabetes Management: Achieving pre-operative HbA1c <7% is critical.[9]
2. HIV Prophylaxis: Administering prophylactic antibiotics and ensuring stable pre-operative CD4+ levels can minimize complications.[10]
3. Emerging Therapies Platelet-rich fibrin (PRF) and bioactive surfaces hold promise for improving osseointegration in high-risk populations.

This study highlights the importance of tailored approaches for immunocompromised patients receiving dental implants. Diabetic patients, especially those with HbA1c >7%, face delayed osseointegration due to impaired collagen synthesis and angiogenesis. These findings align with prior research emphasizing tight glycemic control. Preoperative blood sugar optimization and consistent postoperative monitoring are crucial for success.[11]

In HIV-positive patients, the interplay between immune suppression and microbial challenges explains the higher peri-implantitis rates.[12] Prophylactic antibiotics, strict oral hygiene, and antiretroviral therapy can mitigate these risks, as supported by systematic reviews.[13] A CD4+ count above 350 cells/μL correlates with better outcomes, underscoring the importance of immune function in implant success.[14]

Patients with autoimmune disorders generally showed higher survival rates, likely due to advances in immunosuppressive therapies that reduce inflammation while preserving immune response.[15] However, prolonged corticosteroid use remains a challenge, particularly for peri-implant bone loss and infection susceptibility.[16]

5. Future Perspectives

Advancements in regenerative therapies, such as PRF, BMPs, and stem cell technologies, are likely to improve treatment outcomes in immunocompromised populations. Among these, PRF has been demonstrated to enhance soft tissue healing and bone remodeling by releasing growth factors, including PDGF and TGF-β.[18]

Recent literature also points to the potential of digital implantology, guided surgery, and immediate loading protocols that may reduce surgical time and enhance precision in immunocompromised patients.[19]

6. Limitations

Although this study offered significant insights, certain limitations must be acknowledged:

1. The retrospective design may be prone to selection bias, as the medical records of patients are inherently limited in accuracy and completeness.[20]
2. The 12-month follow-up, while clinically relevant, may not account for long-term complications such as late peri-implantitis or progressive bone loss.[21]
3. Heterogeneity within the immunocompromised cohort, due to variability in disease severity and medications, may affect generalizability.[22]

Future studies with prospective, multicenter designs and longer follow-up durations are needed to confirm these findings and explore novel therapeutic interventions.[6]

7. Conclusion

This study emphasizes the intricate interplay between systemic health conditions and the success of dental implants, underscoring that immunocompromised patients represent a unique and high-risk demographic in implant dentistry. While implant therapy remains a viable treatment option, systemic factors such as diabetes mellitus, HIV/AIDS, and autoimmune disorders significantly interfere with bone remodeling, immune responses, and wound healing.

A comprehensive and personalized approach is crucial for optimizing outcomes in these patients. Preoperative measures such as glycemic control in diabetics and immune stabilization in HIV-positive individuals, combined with thorough postoperative monitoring, can greatly enhance implant survival rates. Additionally, emerging innovations like bioactive surfaces, platelet-rich fibrin (PRF), and digital implant planning provide promising new avenues for improving osseointegration and reducing complications in high-risk populations.

To ensure the long-term success of dental implants in such challenging cases, clinicians must adopt advanced therapeutic strategies alongside meticulous treatment planning and robust patient education. Future research should focus on multicenter, longitudinal studies to explore novel biomaterials and regenerative techniques, setting new benchmarks for implant therapy in immunocompromised individuals. By prioritizing evidence-based, patient-specific protocols, the field of implant dentistry can continue to advance, increasing its accessibility and success across all patient groups.

8. Source of Funding

None.

9. Conflict of Interest

None.

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Cite this article: Kumar S, Kumar S, Rai NA, Gupta A. Assessment of implant success in patients with immunocompromised conditions. *Int J Oral Health Dent*. 2025;11(1):35–38.