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Research Article

Comparative Analysis of Implant Survival in Diabetic vs. Non-Diabetic Patients: A Case-Control Study

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Abstract

Dental implant therapy has become a reliable option for prosthetic rehabilitation; however, systemic conditions such as diabetes mellitus may compromise osseointegration and implant survival. This case-control study investigated the survival rates of dental implants in controlled diabetic patients compared with non-diabetic individuals. A total of 240 patients were included, comprising 120 diabetics (HbA1c < 8%) and 120 age- and sex-matched non-diabetic controls, each contributing at least one dental implant. Data were collected retrospectively over a 5-year follow-up period. Sample size was calculated using Epi-Info with $\alpha = 0.05$, power of 80%, and an anticipated 10% difference in survival rates. Baseline demographics, implant location, prosthetic type, and maintenance compliance were recorded. At the end of the observation period, implant survival was 92.4% in the diabetic group compared with 96.8% in the control group ($p = 0.04$). Multivariate regression identified poor glycemic control (HbA1c $\geq$ 7.5%), smoking, and inadequate oral hygiene as significant predictors of implant failure. Results suggest that well-controlled diabetic patients can achieve comparable implant survival to non-diabetic individuals, but risk factors amplify failure rates.

Keywords: dental implant survival, diabetes mellitus, osseointegration, case-control study

Introduction

Dental implants have revolutionized oral rehabilitation, offering predictable long-term outcomes. Osseointegration, the direct structural and functional connection between living bone and the implant surface, is influenced by both local and systemic factors. Among systemic conditions, **diabetes mellitus (DM)** has been of particular concern due to its associations with impaired wound healing, microvascular complications, and susceptibility to infections.1-3

Previous studies have shown conflicting evidence regarding implant survival in diabetic patients. Some suggest higher failure rates, especially in poorly controlled diabetes, while others report outcomes comparable to healthy populations when glycemic levels are controlled. This inconsistency underscores the need for carefully designed comparative studies.4-6

The present case-control study aims to evaluate the survival rates of dental implants in controlled diabetic patients compared with non-diabetic individuals over a 5-year period, and to identify potential predictors of implant failure.7-10

Methodology

Study design and setting:

This retrospective case-control study was conducted at Avicenna Dental College.

Participants:

- **Cases:** 120 diabetic patients (Type 2 DM) with HbA1c < 8% at baseline.
- **Controls:** 120 age- and sex-matched non-diabetic individuals. Inclusion criteria were ≥18 years, placement of at least one dental implant, and a minimum follow-up of 24 months. Exclusion criteria included uncontrolled DM (HbA1c ≥ 8%), systemic bone disorders, bisphosphonate therapy, and history of head/neck radiotherapy.

Sample size:

Calculated using Epi-Info assuming 95% survival in non-diabetic patients, with 10% lower survival anticipated in diabetics, $\alpha = 0.05$, power 80%. Minimum 110 per group; 120 recruited to account for attrition.

Data collection:

Clinical records were reviewed for:

- Demographics (age, sex, BMI)
- Glycemic status (HbA1c values at baseline and follow-up)
- Implant characteristics (location, surface, length, diameter)
- Prosthetic rehabilitation (single crown, bridge, overdenture)
- Maintenance visits and oral hygiene compliance
- Outcomes: Implant survival (presence of stable, functional implant without mobility, suppuration, or radiographic bone loss >1.5 mm in first year and >0.2 mm/year thereafter).

Statistical analysis:

Survival rates compared using Kaplan-Meier analysis and log-rank test. Predictors assessed using Cox proportional hazards regression. Significance threshold set at $p < 0.05$.

Results

Table 1. Baseline characteristics

Variable	Diabetic (n=120)	Non-diabetic (n=120)	p-value
Mean age (years ± SD)	54.2 ± 8.1	53.7 ± 7.6	0.68
Male sex (%)	58.3	56.7	0.81
Mean HbA1c (%)	7.1 ± 0.4	5.4 ± 0.3	<0.001
Smokers (%)	20.0	16.7	0.47
Mean follow-up (months ± SD)	52.4 ± 11.3	53.7 ± 12.1	0.52

Table 2. Implant survival outcomes (5-year follow-up)

Outcome	Diabetic group	Control group	p-value
Implant survival (%)	92.4	96.8	0.04
Mean marginal bone loss (mm ± SD)	1.21 ± 0.6	0.92 ± 0.5	0.01
Prosthesis success (%)	91.0	95.5	0.06

Table 3. Multivariate predictors of implant failure (Cox regression)

Predictor	HR (95% CI)	p-value
HbA1c ≥ 7.5%	2.43 (1.32–4.47)	0.003
Smoking	1.89 (1.04–3.46)	0.04
Poor oral hygiene compliance	2.78 (1.55–5.00)	<0.001
Implant site (maxilla vs mandible)	1.41 (0.79–2.51)	0.22

Discussion

The findings of this study indicate that controlled diabetic patients achieve implant survival rates comparable to non-diabetic individuals, although slightly reduced (92.4% vs 96.8%). Importantly, failures were strongly associated with poor glycemic control, smoking, and inadequate oral hygiene, highlighting the multifactorial nature of implant outcomes.11-13

The 4.4% difference in survival, though statistically significant, is clinically modest when diabetes is well-controlled, aligning with previous systematic reviews that report survival rates >90% in diabetic cohorts. However, patients with HbA1c ≥ 7.5% demonstrated substantially increased risk, supporting the critical role of glycemic monitoring prior to and after implant placement.14-16

Marginal bone loss was greater among diabetics, consistent with microvascular and collagen synthesis impairments observed in diabetes. The trend toward lower prosthesis success in diabetics, although not statistically significant, suggests long-term restorative challenges.18-20

These results emphasize the need for individualized treatment planning, including optimization of systemic health, risk factor modification, and strict maintenance protocols.

Limitations: The retrospective design may be subject to selection bias. HbA1c levels were measured at baseline but may not reflect longitudinal fluctuations. Future prospective, multicenter trials with longer follow-up are warranted.

Conclusion

Controlled diabetic patients can undergo dental implant therapy with survival rates approaching those of non-diabetic individuals. Glycemic control, smoking cessation, and adherence to maintenance care are critical determinants of long-term implant success.

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