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Glycemic Control and Wound Healing Around Dental Implants in "Type 2" Diabetes

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ABSTRACT

Background: Dental implants are effective for replacing missing teeth, but Type 2 diabetes can impair wound healing and impact implant success. Glycemic control is crucial for postoperative outcomes.

Aim: To evaluate early-stage soft tissue healing on 7th day post-implant placement in patients with Type 2 diabetes, focusing on their HbA1c levels.

Settings and Design: A retrospective analysis was conducted at ITS Centre for Dental Studies and Research, Ghaziabad, from April 2022 to March 2023. Sixty patients were divided into three groups based on HbA1c levels: <6%, 6-8%, and >8%.

Methods and Material: Patients aged 25-50 years with Type 2 diabetes and adequate bone height for implants were included. Exclusion criteria: hypersensitivity to local anesthetics, localized pathologies, bleeding disorders, and need for bone augmentation. Postoperative pain, erythema, edema, discharge, dehiscence, hematoma, and infection were evaluated on 7th day.

Statistical Analysis Used: Data was analyzed using SPSS v26.0. Non-parametric Kruskal-Wallis and Post hoc Bonferroni tests were used, with significance set at 5%.

Results: Higher HbA1c levels were associated with increased pain, edema, and infection, while no significant differences were observed in dehiscence, erythema, or hematoma.

Conclusions: Poor glycemic control negatively affects postoperative complications. Effective diabetes management is crucial for optimal implant outcomes.

Keywords: Dental Implant, Wound Healing, Hyperglycemia, Type-2 Diabetes

INTRODUCTION

Dental implants are widely acknowledged as a viable option for replacing missing teeth.[1] Successful osseointegration is crucial for the initial survival of an implant after its placement. If this biological process is disrupted, the treatment outcome could be negatively impacted. Wound healing can be hindered by various factors that impact different stages of tissue repair. Local factors such as oxygen supply, infection, and the presence of foreign bodies can interfere with healing, while systemic factors like aging, sex, stress, circulation problems, obesity, medications, alcohol consumption, smoking, immunosuppression, poor nutrition, and systemic diseases such as diabetes also play a significant role in impairing proper tissue repair.[2]

Diabetes mellitus is a metabolic disorder with multiple etiologies, characterized by chronic hyperglycemia and disturbances in carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action, or both.[3] Diabetes mellitus includes Type 1 diabetes (autoimmune destruction of beta cells), Type 2 diabetes (progressive insulin deficiency with resistance), diabetes due to specific causes (e.g., monogenic disorders or drug effects), and gestational diabetes (diagnosed during pregnancy).[4]

Patients with diabetes frequently exhibit an elevated incidence of periodontitis and subsequent tooth loss, delayed wound healing, and a compromised immunological response to infections.[5] Studies and recent discoveries indicate that diabetes mellitus influences nearly every tissue in the body, with effects that can be either direct or indirect, often through long-term complications.[6]

The Glycosylated hemoglobin (HbA1c) test has been designated as the standard protocol for evaluating and monitoring type 2 diabetes mellitus.[7] Oates et al. define a well-controlled case as having a value between 6% and 8%, a medium well-controlled case as having a value from 8.1% to 10%, and a poorly controlled case as having a value above 10%.[8]

The purpose of this study is to evaluate the early-stage soft tissue wound healing, specifically within the first week following dental implant placement in patients diagnosed with type 2 diabetes mellitus, with a focus on their HbA1c levels.

MATERIAL & METHOD

Patients & Samples

The study, designed as a retrospective analysis, was performed within the Department of Oral and Maxillofacial Surgery at ITS Centre for Dental Studies and Research in Ghaziabad, spanning from April 2022 to March 2023. A total of sixty patients, all receiving dental implants, were randomly assigned to three groups of twenty each: Group 1 with HbA1c less than 6, Group 2 with HbA1c between 6 and 8, and Group 3 with HbA1c greater than 8.

Patients for the study were chosen based on the following inclusion and exclusion criteria.

The inclusion criteria for the study were patients aged 25 to 50 years with sufficient bone height for implant placement. Additionally, the patients must be diagnosed with Type 2 Diabetes Mellitus. Patients with hypersensitivity to local anaesthetics, those exhibiting localized pathologies, individuals with bleeding disorders, and cases requiring additional bone augmentation were excluded from the study.

Parameters

Pain intensity was assessed using a 10-point Visual Analog Scale (VAS), with patients marking their pain from "no pain" (0) to "severe or intolerable pain" (10), while erythema, edema, discharge, dehiscence, hematoma, and infection were evaluated on a scale of none (0), mild (1), moderate (2), and severe (3) on the 7th day post-operatively.

Pre-operative planning

A comprehensive preoperative evaluation was conducted, including a thorough oral examination and diagnostic imaging of the concerned area or planned site using Cone Beam Computed Tomography (CBCT) scans. Detailed case histories were taken, and records included preoperative, intraoperative, and postoperative photographs. Additionally, diagnostic cast models were fabricated after taking impressions.

Surgical Intervention

After obtaining informed consent from the patient, the surgical intervention was carried out. Local anaesthetic agents were administered to achieve adequate analgesia in the surgical area. A surgical incision was made in the midline of the alveolus at the planned site to expose the underlying alveolar bone, and the flap was carefully elevated to access the bone. Sequential drilling was performed to prepare the osteotomy site to the required depth and diameter, and the titanium dental implant was inserted and torqued into place. The gingival flap was then repositioned over the implant and secured using an Ethicon 3-0 suture for primary closure.

Postoperatively, all patients were prescribed amoxicillin-clavulanate 625 mg three times daily and 100 mg aceclofenac plus 325 mg paracetamol twice daily for 5 days.

A follow-up appointment was scheduled for the removal of suture and to assess the soft tissue healing on the 7th day.

RESULTS

Table 1 and Figure 1 describes sixty patients with pre-diagnosed Type 2 diabetes received implants in this investigation (31 female, 29 male). Thirteen female and seven male patients made up Group 1, while twelve female and eight male patients made up Group 2. The very last group Group 3 included six females and fourteen males. The gender distribution showed a significant difference with p-value of 0.017.

Variable	**HbA1c Level %**			**Total**	**p-value**
	Less than 6	**6-8**	**More than 8**		
Gender	20	20	20	60	0.017*
Male	07	08	14	29	
Female	13	12	06	31	

Chi-square test; * indicates a significant difference at p≤0.05

Table 1: *Descriptive data for gender distribution in all the groups*

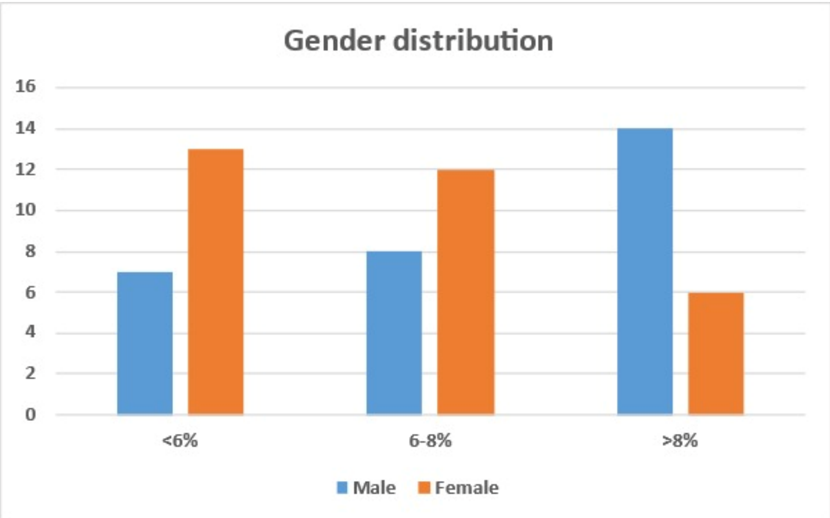

Figure 1. *Graphical representation for gender distribution in all the groups*

Table 2 and Figure 2 efficiently compares the VAS score among subjects with different HbA1c levels. Mean VAS score among the subjects with HbA1c levels >8% was significantly greater (p-value of <0.006) than the subjects with HbA1c levels <6%.

HbA1c	Mean	SD	p-value
<6%	0.00[a]	0.00	<0.006*
6-8%	0.30[a,b]	0.66	
>8%	0.85[b]	1.23	

Kruskal Wallis test; Post hoc Bonferroni test; * indicates a significant difference at p≤0.05

Table 2: *Descriptive data for VAS (visual analogue score) for pain in all the groups*

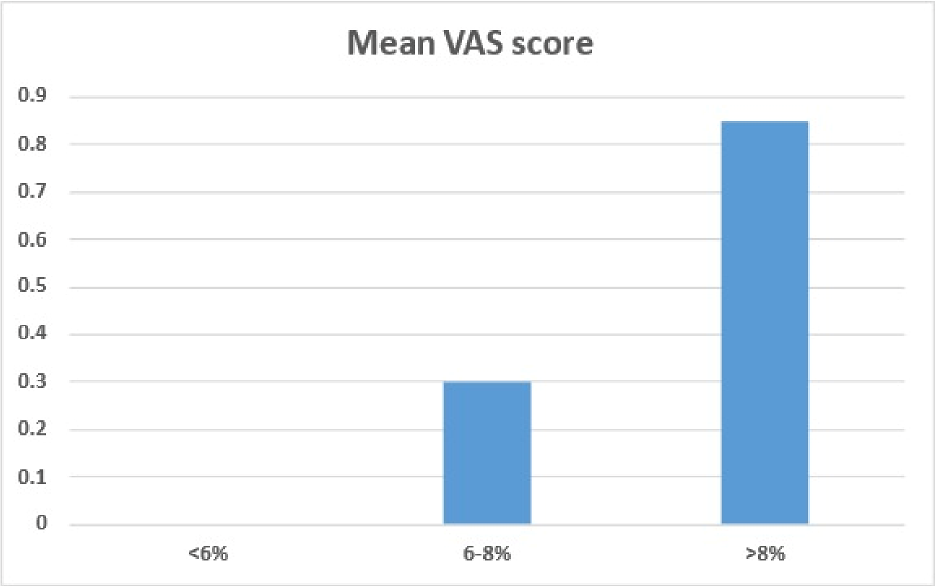

Figure 2. *Graphical representation for VAS (visual analogue score) for pain in all the groups*

Table 3 and Figure 3 compares the dehiscence among subjects with different HbA1c levels. There was a non-significant difference in the dehiscence among subjects with different HbA1c levels giving an impression of no resultant dehiscence post implant surgery whether the patient was systemic well or had Type 2 Diabetes.

HbA1c	None	Mild	Moderate	Severe	Mean rank	p-value
<6%	20 (100)	0	0	0	26.50	0.066
6-8%	17 (85)	2 (10)	1 (5)	0	30.92	
>8%	15 (75)	3 (15)	0	2 (10)	34.08	

Kruskal Wallis test

Table 3: *Descriptive data for dehiscence all the groups*

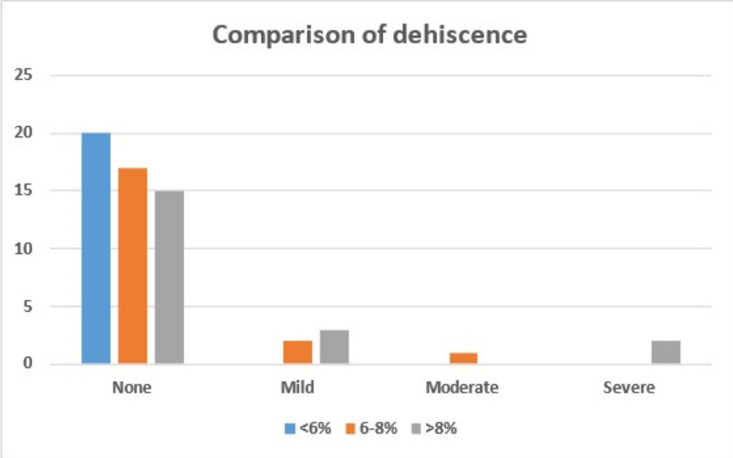

Figure 3. *Graphical representation for dehiscence in all the groups*

Table 4 and Figure 4 compares the edema among subjects with different HbA1c levels. All the subjects with HbA1c levels of <6% and 6-8% had no edema; whereas, only 15 subjects with HbA1c levels of >8% had no edema. Three subjects with HbA1c levels of >8% had mild edema, and two with HbA1c levels of >8% had moderate edema. There was a difference in the edema among subjects with different HbA1c levels. Subjects with HbA1c levels of >8% differed from that of the other two groups regarding the edema.

HbA1c	None	Mild	Moderate	Severe	Mean rank	p-value
<6%	20 (100)	0	0	0	28.00[a]	0.005*
6-8%	20 (100)	0	0	0	28.00[a]	
>8%	15 (75)	3 (15)	2 (10)	0	35.50[b]	

Kruskal Wallis test; Post hoc Bonferroni test; * indicates a significant difference at p≤0.05

Table 4: *Descriptive data for edema in all the groups*

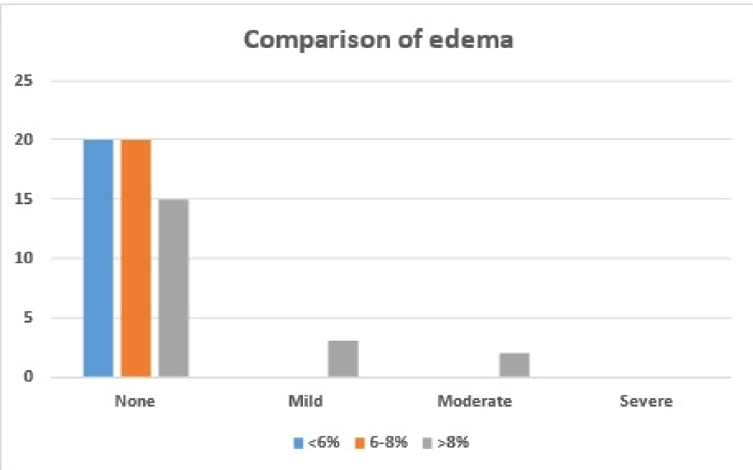

Figure 4. *Graphical representation for edema in all the groups*

Table 5 and Figure 5 compares the erythema among subjects with different HbA1c levels. There was a non-significant difference in the erythema among subjects with different HbA1c levels.

HbA1c	None	Mild	Moderate	Severe	Mean rank	p-value
<6%	18 (90)	2 (10)	0	0	28.30	0.130
6-8%	18 (90)	1 (5)	1 (5)	0	28.52	
>8%	14 (70)	3 (15)	2 (10)	1 (5)	34.68	

Kruskal Wallis test

Table 5: *Descriptive data for erythema in all the groups*

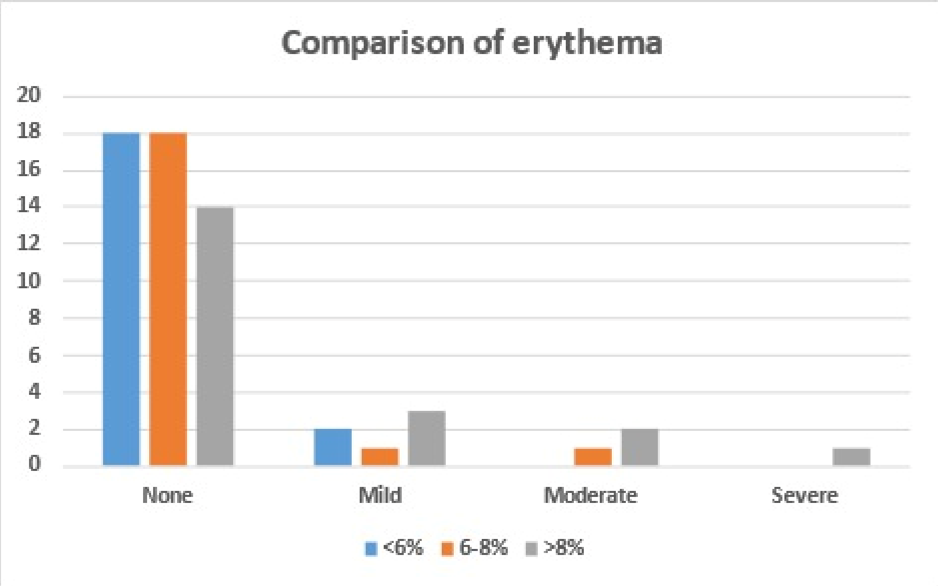

Figure 5. *Graphical representation for erythema in all the groups*

Table 6 and Figure 6 compares the hematoma among subjects with different HbA1c levels. There was a non-significant difference in the hematoma among subjects with different HbA1c levels.

HbA1c	None	Mild	Moderate	Severe	Mean rank	p-value
<6%	20 (100)	0	0	0	27.50	0.101
6-8%	18 (90)	1 (5)	1 (5)	0	30.35	
>8%	16 (80)	1 (5)	2 (10)	1 (5)	33.65	

Kruskal Wallis test

Table 6: *Descriptive data for hematoma in all the groups*

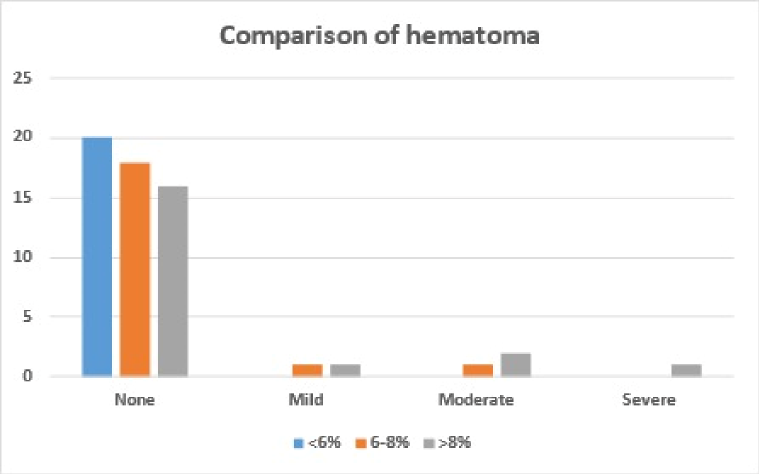

Figure 6. *Graphical representation for hematoma in all the groups*

Table 7 and Figure 7 compares the infection among subjects with different HbA1c levels. All the subjects with HbA1c levels of <6% and 6-8% had no infection; whereas, only 16 subjects with HbA1c levels of >8% had no infection. Two subjects with HbA1c levels of >8% had a mild infection and one with HbA1c levels of >8% had a moderate and severe infection. There was a difference in the infection among subjects with different HbA1c levels. Subjects with HbA1c levels of >8% differed from that of the other two groups regarding the infection.

HbA1c	**None**	**Mild**	**Moderate**	**Severe**	**Mean rank**	**p-value**
<6%	20 (100)	0	0	0	28.50[a]	0.015*
6-8%	20 (100)	0	0	0	28.50[a]	
>8%	16 (80)	2 (10)	1 (5)	1 (5)	34.50[b]	

Kruskal Wallis test; Post hoc Bonferroni test; * indicates a significant difference at p≤0.05

Table 7: *Descriptive data for infection in all the groups*

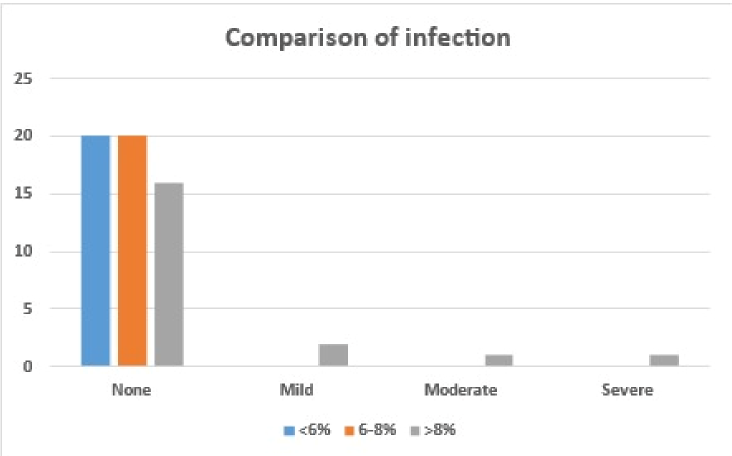

Figure 7. *Graphical representation for infection in all the groups*

Table 8 and Figure 8 compares the discharge among subjects with different HbA1c levels. There was a non-significant difference in the discharge among subjects with different HbA1c levels.

HbA1c	None	Mild	Moderate	Severe	Mean rank	p-value
<6%	19 (95)	1 (5)	0	0	27.40	0.205
6-8%	17 (85)	1 (5)	2 (0)	0	30.60	
>8%	15 (75)	3 (15)	1 (5)	1 (5)	33.50	

Kruskal Wallis test; Post hoc Bonferroni test; * indicates a significant difference at $p \leq 0.05$

Table 8: *Descriptive data for discharge in all the groups*

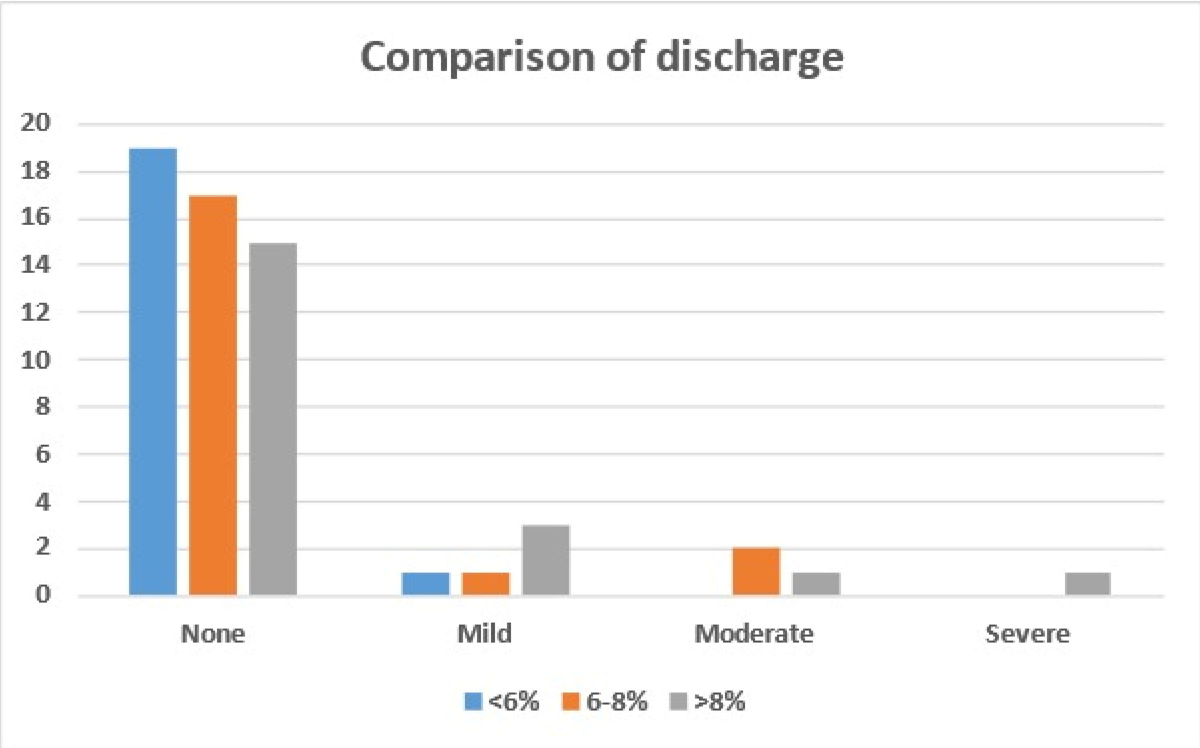

Figure 8. *Graphical representation for discharge in all the groups*

DISCUSSION

Uncontrolled diabetes poses risks such as extended healing times and the development of serious infections, both of which can impede the osseointegration process of implants.[9] The current study's findings build upon and confirm previous research on the effects of diabetes and glycemic control on dental implant outcomes. **Weyant RJ et al. (1994)** noted that implant survival was influenced by various factors, including the patient's medical status and implant surface coating. Their findings align with the current study, which highlights that glycemic control significantly impacts implant outcomes, particularly regarding pain, edema, and infection.[10] The current study revealed significant differences in pain levels among patients with varying HbA1c levels, with those having HbA1c levels above 8% experiencing higher mean Visual Analogue Scores (VAS) for pain compared to those with lower HbA1c levels. This indicates that poorer glycemic control is linked to increased postoperative pain. In contrast, dehiscence, erythema, and hematoma did not show significant differences across HbA1c levels, suggesting these complications are less influenced by glycemic control in this study. **Peled M et al. (2003)** reported high initial success rates for implants in Type 2 diabetes patients, though success rates declined over time. This finding aligns with the current study, which shows that well-controlled diabetes can achieve similar outcomes to those with lower HbA1c levels, underscoring the importance of maintaining good glycemic control to minimize complications such as pain and infection.[11] Similarly**, Moy PK et al. (2005)** identified increased implant failure rates associated with diabetes and other factors, which is corroborated by the current study. Higher HbA1c levels were linked to increased postoperative complications, including pain and infection, highlighting the need to consider diabetes as a significant risk factor in implant planning.[12] Significant findings emerged in the assessment of edema and infection. Subjects with HbA1c levels greater than 8% exhibited a higher incidence of edema and were more likely to experience infections postoperatively compared to those with lower HbA1c levels. These results underscore the importance of maintaining good glycemic control to reduce the risk of postoperative complications. Discharge rates, however, did not show significant differences among the groups, indicating that this particular outcome may not be influenced by HbA1c levels to the same extent as other complications. **Nevins ML et al. (1998)** demonstrated that diabetes impairs osseointegration by showing reduced bone-implant contact in diabetic rats, indicating a negative effect on implant stability.[13] **Gerritsen M et al. (2000)** further contributed by highlighting that diabetes alters tissue responses, complicating successful implant integration. The current study builds on these findings by linking high HbA1c levels to increased postoperative complications, such as pain, edema, and infection.[14] **Zhang L et al. (2018)** observed that poor glycemic control led to increased bleeding on probing and marginal bone loss around implants.[15] This finding supports the current study, which found that higher HbA1c levels were linked to increased pain, edema, and infection, reinforcing the critical role of managing blood glucose levels to maintain peri-implant health.This underscores how poor glycemic control not only impacts bone-implant contact but also exacerbates tissue responses, further complicating implant success and reinforcing the critical need for effective diabetes management to optimize implant outcomes.Overall, the study highlights that while HbA1c levels significantly impact postoperative pain, edema, and infection, other complications such as dehiscence, erythema, and hematoma may not be as closely related to glycemic control. These findings stress the need for careful management of diabetes to optimize surgical outcomes and minimize complications associated with poor glycemic control.

CONCLUSION

Wound healing in diabetic patients is significantly impacted by poor blood glucose control, which leads to delayed healing and increased complications. Effective glycemic management is essential to improve the outcomes. Future research should explore integrated strategies that combine diabetes management with advanced implant technologies. Enhanced care approaches will improve healing and overall implant success.

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