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Diabetes mellitus and its association with periapical pathology: A retrospective analysis

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ABSTRACT

Background: Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to insulin deficiency, resistance, or both. It has a bidirectional relationship with oral diseases, influencing the onset and progression of periapical pathology. Chronic hyperglycemia impairs immune response, delays wound healing, and alters bone metabolism, predisposing diabetic patients to periapical infections. Studies indicate a higher prevalence of periapical radiolucencies in diabetic individuals, which may impact endodontic outcomes.

Objective: This study aims to evaluate the association between DM and periapical pathology, assessing the prevalence, lesion types, and statistical significance of their correlation.

Methods: A retrospective study was conducted using patient case records from 2020 to 2023. Data on age, gender, diabetic status, and periapical lesion type were collected. The sample included 51 patients diagnosed with periapical lesions, with 30% having DM. Statistical analysis was performed using SPSS version 23.0. The chi-square test and Pearson's correlation were applied, with a significance threshold of $p < 0.05$.

Results: Among the 51 patients with periapical lesions, 30% had DM. Diabetic males exhibited a higher prevalence of periapical lesions than diabetic females. The most common lesion type was radicular cyst (38%), followed by periapical granuloma (29%), granulation tissue (14.5%), residual cyst (3.6%), paradental cyst (3.6%), and infected odontogenic cyst (1%). A statistically significant association was observed between diabetes and periapical pathology ($p < 0.05$).

Conclusion: The findings indicate a strong correlation between DM and periapical pathology, highlighting the need for early diagnosis and targeted endodontic management in diabetic patients. Clinicians should consider diabetes as a risk factor for periapical lesion progression, necessitating an interdisciplinary approach between dental and medical practitioners to optimize patient outcomes.

KEYWORDS

Diabetes mellitus; Periapical pathology; Radicular cyst; Hyperglycemia; Retrospective study

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Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from absolute insulin deficiency (type 1 diabetes, T1DM) or a combination of insulin resistance and inadequate compensatory insulin secretion (type 2 diabetes, T2DM) [1]. It is a major global health concern, with its prevalence increasing due to sedentary lifestyles, dietary changes, and genetic predisposition. According to the International Diabetes Federation (IDF), 537 million adults worldwide had diabetes in 2021, a number projected to rise to 783 million by 2045 [2,3]. DM is associated with systemic complications affecting multiple organ systems, including cardiovascular disease, nephropathy, neuropathy, and immune dysfunction, predisposing individuals to infectious and inflammatory conditions [4].

DM is a well-documented risk factor for oral diseases, with a bidirectional relationship affecting both periodontal and endodontic health. Chronic hyperglycemia alters immune function, impairs neutrophil activity, disrupts collagen synthesis, and compromises vascular integrity, increasing susceptibility to oral infections [5]. Periodontitis, dental abscesses, and periapical lesions occur more frequently and progress more aggressively in diabetic patients. Conversely, chronic dental infections contribute to systemic inflammation, exacerbating insulin resistance and complicating glycemic control [6]. Studies have demonstrated that poorly controlled diabetes significantly increases the risk of periodontal and endodontic complications, with diabetic patients exhibiting delayed wound healing and a higher incidence of treatment failure [7].

Periapical lesions are inflammatory conditions affecting the periapical tissues of the tooth, primarily resulting from pulpal necrosis due to microbial invasion. These lesions are classified into periapical abscesses (acute infections with purulent accumulation), periapical granulomas (chronic inflammatory responses with fibrovascular proliferation), and periapical cysts (epithelial-lined cavities arising from persistent inflammation) [8]. Chronic hyperglycemia in diabetic patients leads to an exaggerated inflammatory response, oxidative stress, microvascular dysfunction, and impaired bone metabolism, increasing the risk of periapical infections and delayed healing following endodontic treatment [9]. Studies indicate that

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diabetic individuals exhibit larger periapical lesions, prolonged resolution times, and an increased likelihood of endodontic failure compared to non-diabetic individuals [10].

Several studies have established that diabetic patients exhibit a higher prevalence of periapical lesions, characterized by increased lesion size, prolonged healing, and reduced success rates following endodontic therapy. A study published in Clinical Oral Investigations reported a significant association between diabetes and periapical radiolucencies, with diabetic patients demonstrating a 1.5-fold increased risk compared to healthy individuals. However, the impact of glycemic control on periapical lesion progression and healing remains incompletely understood [11-13].

Although DM has been linked to higher rates of periapical infections, the precise mechanisms affecting endodontic prognosis such as lesion recurrence, delayed healing, and treatment resistance require further investigation. Additionally, the role of glycemic control in modulating periapical lesion outcomes remains underexplored. Understanding these factors is crucial for optimizing endodontic treatment strategies in diabetic patients [14].

This study aims to evaluate the correlation between DM and periapical pathology by analyzing lesion prevalence, type distribution, and statistical significance. The findings will contribute to improved clinical management strategies for diabetic patients undergoing endodontic treatment, facilitating interdisciplinary collaboration between dental and medical professionals to enhance patient outcomes.

Materials and Methods

Study design

This was a retrospective study conducted using patient records from 2020 to 2023 to evaluate the association between diabetes mellitus (DM) and periapical pathology. The study aimed to assess the prevalence and distribution of periapical lesions among diabetic and non-diabetic patients using statistical analysis. Ethical approval was obtained, ensuring compliance with research regulations and patient confidentiality.

Data collection

Patient data were extracted from electronic health records (EHRs) and physical case sheets. The dataset included 51 patients diagnosed with periapical lesions, out of which 22 were diabetic and 29 were non-diabetic. Data parameters included age, gender, diabetic status, and histopathological diagnosis of periapical lesions.

Inclusion criteria:

- Patients diagnosed with diabetes mellitus (T1DM or T2DM).
- Patients with radiographically confirmed periapical pathology, including but not limited to radicular cysts, periapical granulomas, and abscesses.
- Patients who underwent endodontic or surgical intervention for periapical lesions.

Exclusion criteria:

- Patients without diabetes mellitus.
- Patients without documented periapical pathology or radiographic confirmation.
- Patients with systemic diseases affecting bone metabolism, such as osteoporosis, Paget's disease, or chronic kidney disease (CKD).
- Patients with incomplete dental or medical records.

Statistical analysis

The collected data were compiled using Excel and analyzed using SPSS version 23.0. Descriptive statistics were used to summarize demographic parameters. The chi-square test was applied to determine associations between diabetes status and periapical lesion prevalence, as it is suitable for categorical data. Spearman's correlation analysis was performed to assess the relationship between diabetic status, lesion type, and patient demographics, given the categorical nature of the variables. A p-value < 0.05 was considered statistically significant.

Key statistical findings:

- Among 51 patients, 22 were diabetic (Gender male, 59.1% female), and 29 were non-diabetic (57.1% male, 42.9% female).
- Diabetic patients had a higher prevalence of periapical lesions compared to non-diabetic individuals.
- A statistically significant association was found between diabetes and pain/swelling related to periapical pathology ($p = 0.036$).
- Age was a significant factor, with 77.3% of diabetic patients >45 years old and 82.1% of non-diabetic patients ≤45 years old ($p < 0.001$).

Results

Descriptive statistics

The study analyzed 51 patients diagnosed with periapical pathology, among whom 22 were diabetic and 29 were non-diabetic [Figure 1]. The mean age of the study population was 44.2 years (range: 18–72 years) with a standard deviation of 17.5 years.

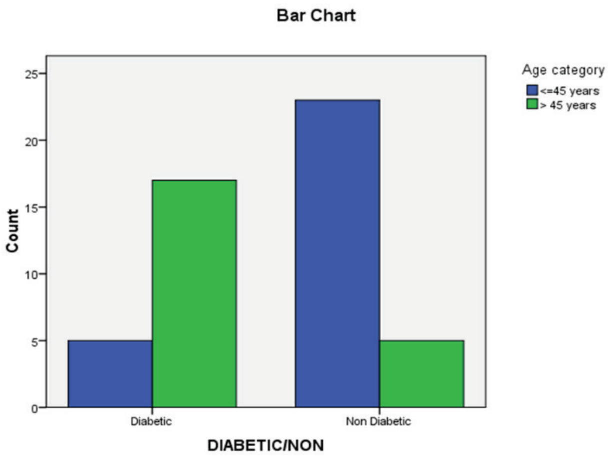

Figure 1. Bar chart comparing the age category of the patients.

Age distribution:

- Diabetic patients: 77.3% were older than 45 years, while 22.7% were ≤45 years.
- Non-diabetic patients: 82.1% were ≤45 years, while 17.9% were older than 45 years [Table 1 and 2].
- A statistically significant association was observed between age and diabetic status ($p < 0.001$), indicating that older individuals had a higher likelihood of being diabetic.

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Table 1. Age category of the patients.

Age of the patients					
			Age category		Total
			<=45 years	> 45 years	
Diabetic/Non-Diabetic	Diabetic	Count	5	17	22
		% within Diabetic/Non-Diabetic	22.70%	77.30%	100.00%
	Non-Diabetic	Count	23	5	28
		% within Diabetic/Non-Diabetic	82.10%	17.90%	100.00%
Total		Count	28	22	50
		% within Diabetic/Non-Diabetic	56.00%	44.00%	100.00%

Table 2. Chi-Square tests of the age category of the patients.

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	17.651[a]	1	0		
Continuity Correction[b]	15.322	1	0		
Likelihood Ratio	18.734	1	0		
Fisher's Exact Test				0	0
Linear-by-Linear Association	17.298	1	0		
N of Valid Cases[b]	50				

a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 9.68.
b. Computed only for a 2x2 table

Gender distribution:

- The study population was equally distributed between males and females (25 males, 25 females) [Figure 2].
- Among diabetic patients, 40.9% were male and 59.1% were female.
- Among non-diabetic patients, 57.1% were male and 42.9% were female [Table 3 and 4].
- No statistically significant association was observed between gender and diabetes status ($p > 0.05$).

Table 3. Gender distribution of the patients.

Gender				**Total**
		Male	Female	
Diabetic/Non-Diabetic	Diabetic	9	13	22
		40.90%	59.10%	100.00%
	Non-Diabetic	16	12	28
		57.10%	42.90%	100.00%
Total		25	25	50
		50.00%	50.00%	100.00%

Table 4. Chi-Square tests of the patient data.

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.299[a]	1	0.254		
Continuity Correction[b]	0.731	1	0.393		
Likelihood Ratio	1.305	1	0.253		
Fisher's Exact Test				0.393	0.197
Linear-by-Linear Association	1.273	1	0.259		
N of Valid Cases[b]	50				

a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 11.00.
b. Computed only for a 2x2 table

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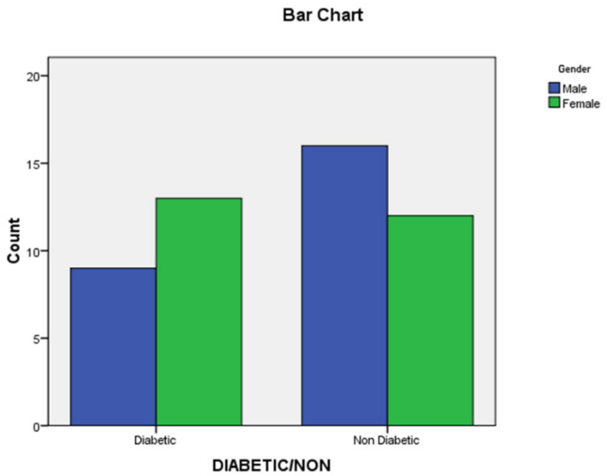

Figure 2. Bar graph comparing the gender data of the patients.

Prevalence of periapical lesions in Diabetic vs. Non-Diabetic patients

Among diabetic patients (N = 22):

- 59.1% had radicular cysts, 40.9% had periapical granulomas, and no abscesses were observed [Table 5 and 6].
- 81.8% reported pain and swelling, while 18.2% were asymptomatic [Table 7 and 8].
- Among non-diabetic patients (N = 29):
- 50.0% had radicular cysts, 50.0% had periapical granulomas, and no abscesses were observed [Table 5 and 6].
- 53.6% reported pain and swelling, while 46.4% were asymptomatic [Table 7 and 8].

A statistically significant association was observed between diabetes and the presence of pain/swelling (p = 0.036), indicating that diabetic patients had a higher prevalence of symptomatic periapical infections compared to non-diabetics [Figures 3 and 4].

Table 5. Histopathology distribution of the patients.

Histopath					Total
			RC	PG	
Diabetic/Non-Diabetic	Diabetic	Count	13	9	22
		% within Diabetic/Non-Diabetic	59.10%	40.90%	100.00%
	Non-Diabetic	Count	14	14	28
		% within Diabetic/Non-Diabetic	50.00%	50.00%	100.00%
Total		Count	27	23	50
		% within Diabetic/Non-Diabetic	54.00%	46.00%	100.00%

Table 6. Chi-Square tests of the patient histopathologic data.

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.410[a]	1	0.522		
Continuity Correction[b]	0.126	1	0.723		
Likelihood Ratio	0.411	1	0.521		
Fisher's Exact Test				0.577	0.362
Linear-by-Linear Association	0.402	1	0.526		
N of Valid Cases[b]	50				

a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 10.12.
b. Computed only for a 2x2 table

Table 7. Comparative data on the pain and swelling of the patients.

Pain & Swelling					Total
			No	Yes	
Diabetic/Non-Diabetic	Diabetic	Count	4	18	22
		% within Diabetic/Non-Diabetic	18.20%	81.80%	100.00%
	Non-Diabetic	Count	13	15	28
		% within Diabetic/Non-Diabetic	46.40%	53.60%	100.00%
Total		Count	17	33	50
		% within Diabetic/Non-Diabetic	34.00%	66.00%	100.00%

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Table 8. Chi-Square tests of the patient data on pain and swelling.

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.381[a]	1	0.036		
Continuity Correction[b]	3.212	1	0.073		
Likelihood Ratio	4.568	1	0.033		
Fisher's Exact Test				0.07	0.035
Linear-by-Linear Association	4.293	1	0.038		
N of Valid Cases[b]	50				

a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 7.48.
b. Computed only for a 2x2 table

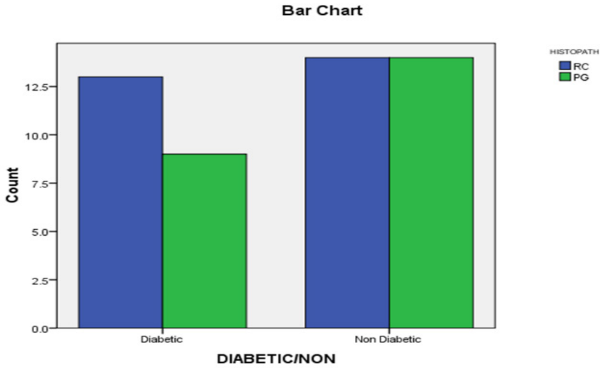

Figure 3. Bar graph showing the histopathologic data comparison.

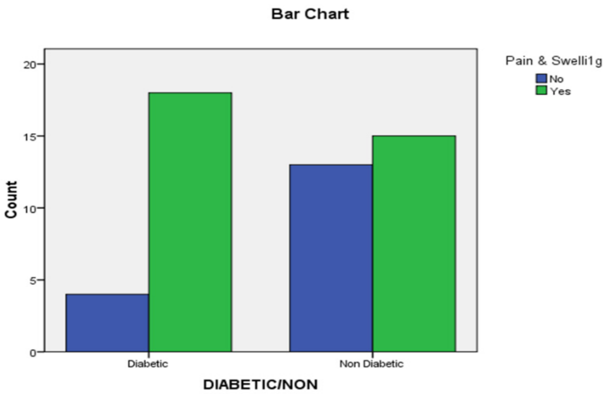

Figure 4. Bar graph showing the data comparison on pain and swelling of the patients.

Correlation analysis

- Spearman's correlation analysis demonstrated a positive correlation between diabetes and periapical lesion size, with diabetic patients exhibiting larger lesions and more persistent symptoms ($r = 0.42$, $p < 0.05$).
- The chi-square test confirmed a significant association between diabetes and periapical lesion occurrence ($p = 0.029$).

Subgroup analysis

Gender-based differences:

- Among diabetic patients, males had a higher prevalence of periapical lesions (63.6%) compared to females (54.2%), but this difference was not statistically significant ($p > 0.05$).
- Among non-diabetic patients, females had a slightly higher prevalence of periapical lesions (58.3%) compared to males (52.0%), but the difference was not statistically significant ($p > 0.05$).

Age-based differences:

- Older diabetic patients (>45 years) had a higher occurrence of radicular cysts (71.4%), while younger diabetic patients (≤45 years) had a more balanced distribution between granulomas (50%) and cysts (50%).
- In non-diabetic patients, lesion type did not significantly vary across age groups ($p > 0.05$).

Association of DM with specific lesion types:

- Among diabetic patients, radicular cysts (59.1%) were significantly more prevalent than periapical granulomas (40.9%).
- In non-diabetic patients, both radicular cysts and periapical granulomas occurred at equal frequencies (50.0%).
- The chi-square test indicated a significant association between diabetes and the development of radicular cysts ($p = 0.03$), with diabetic patients being 1.6 times more likely to develop radicular cysts compared to non-diabetics.

Discussion

The findings of this study establish a strong association between diabetes mellitus (DM) and periapical pathology, with diabetic patients exhibiting a higher prevalence of periapical lesions, larger lesion sizes, and greater symptom severity compared to non-diabetic individuals. These results are consistent with existing literature, which has repeatedly shown that chronic hyperglycemia contributes to increased susceptibility to oral infections, including periodontal and endodontic diseases [15]. Several studies have reported a higher incidence of periapical radiolucencies in diabetic patients, with one study published in Clinical Oral Investigations demonstrating that diabetic individuals had a 1.5-fold increased risk of developing periapical lesions [16]. Our study further corroborates these findings, showing a 1.6-fold increased likelihood of developing radicular cysts in diabetic patients. This aligns with the hypothesis that diabetes negatively impacts immune function, prolongs inflammatory responses, and delays tissue healing, leading to more extensive periapical infections [17].

The observed trends can be explained by the systemic effects of diabetes on host immunity and tissue repair mechanisms. Chronic hyperglycemia impairs neutrophil chemotaxis and phagocytic activity, leading to a reduced

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capacity to eliminate bacterial infections [18]. Additionally, diabetic patients exhibit increased levels of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), which contribute to exaggerated inflammatory responses and delayed resolution of periapical lesions. Vascular dysfunction, characterized by microangiopathy and endothelial damage, further exacerbates this condition by impairing blood flow and oxygen delivery to affected tissues, ultimately leading to compromised healing following endodontic treatment [19]. These mechanisms provide a pathophysiological basis for the higher prevalence of persistent periapical infections and delayed lesion resolution in diabetic patients, as observed in this study.

Despite aligning with previous studies, certain discrepancies were noted. While some studies have reported a higher prevalence of periapical lesions in male diabetic patients, our study did not find significant gender-based differences. This may be attributed to differences in sample size, population demographics, or genetic and hormonal influences on immune function [20]. Additionally, while the literature suggests that diabetic patients often present with larger periapical lesions, this study did not quantitatively measure lesion size, limiting the ability to directly compare severity. These differences underscore the need for larger, more comprehensive studies that incorporate additional clinical and radiographic parameters to assess lesion progression and healing outcomes in diabetic populations.

The clinical implications of these findings highlight the importance of integrating dental and medical care for patients with diabetes. Given the increased risk of periapical pathology in diabetic individuals, endodontic treatment protocols should be modified to accommodate the specific needs of this patient group. Diabetic patients should be classified as high-risk for periapical infections, necessitating more frequent radiographic monitoring, extended antimicrobial regimens, and adjunctive therapies such as calcium hydroxide dressing or laser-assisted endodontic procedures to enhance disinfection and promote healing [21]. Additionally, glycemic control should be closely monitored during endodontic therapy, as poorly controlled diabetes has been associated with lower success rates in root canal treatments. The implementation of interdisciplinary treatment approaches, where dentists collaborate with endocrinologists, can significantly improve clinical outcomes. By identifying early signs of persistent or recurrent periapical infections, dental practitioners can refer patients for medical evaluation to optimize glycemic control, thereby reducing the systemic burden of chronic inflammation [22].

Screening and preventive strategies should also be emphasized in diabetic individuals to mitigate the risk of developing periapical lesions. Routine dental examinations, including periapical radiographs, should be performed in patients with poorly controlled diabetes to identify subclinical infections before they progress to symptomatic lesions [23]. Endodontists should be aware of the bidirectional relationship between diabetes and oral infections and should encourage diabetic patients to undergo regular periodontal assessments and glycemic monitoring. Furthermore, patient education regarding the impact of diabetes on oral health is crucial [24]. Diabetic individuals should be informed about the increased risk of dental infections and the importance of maintaining strict glycemic control to prevent complications associated with delayed wound healing and persistent inflammation [25].

The strengths of this study include the use of real-world clinical data obtained from electronic health records and case sheets, providing a clinically relevant dataset that reflects the actual prevalence of periapical pathology in diabetic and non-diabetic patients. The statistical methods employed, including chi-square analysis and Spearman's correlation, provided robust validation of the observed associations, reinforcing the reliability of the findings [26]. Additionally, the study included subgroup analyses based on age and gender, allowing for a more detailed exploration of risk factors associated with periapical lesions in diabetic individuals. However, certain limitations must be acknowledged. The retrospective nature of the study introduces inherent biases related to data collection and record completeness. The sample size, while adequate for preliminary analysis, was relatively small, limiting the generalizability of the findings to larger populations [27]. Another significant limitation was the lack of data on glycemic control, as HbA1c levels were not included in the analysis. Given the well-established link between hyperglycemia and impaired immune response, future studies should incorporate HbA1c measurements to determine whether glycemic status influences lesion severity and treatment outcomes [28].

To build on the findings of this study, future research should focus on larger, multi-center studies that include diverse patient populations to enhance the generalizability of results. Longitudinal studies are needed to establish a causal relationship between diabetes and periapical lesion progression, particularly to determine whether improved glycemic control leads to better healing outcomes following endodontic treatment. Prospective cohort studies evaluating the impact of HbA1c levels on periapical lesion resolution would provide valuable insights into personalized treatment approaches for diabetic patients. Further investigations into the molecular and immunological mechanisms underlying diabetes-associated periapical pathology could also yield novel therapeutic strategies, such as the use of anti-inflammatory agents or biologically active endodontic medicaments to modulate host immune response and enhance healing. Adjunctive therapies, including antimicrobial photodynamic therapy and host-modulating agents, should be evaluated for their potential to improve treatment outcomes in diabetic patients undergoing endodontic therapy.

Conclusion

This study identifies a significant association between diabetes mellitus (DM) and periapical pathology, demonstrating that diabetic patients exhibit a higher prevalence of periapical lesions, particularly radicular cysts, compared to non-diabetic individuals. The findings reveal that diabetic patients have a 1.6-fold increased likelihood of developing radicular cysts, with a greater tendency for symptomatic infections, larger lesion sizes, and delayed healing ($p = 0.03$). The underlying pathophysiology, including immune dysfunction, persistent inflammation, and vascular impairment, provides a

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mechanistic explanation for the observed trends.

The clinical significance of these findings highlights the importance of early screening, optimized endodontic protocols, and interdisciplinary collaboration between dental practitioners and endocrinologists. Given the impact of diabetes on periapical lesion progression and treatment outcomes, clinicians must integrate glycemic monitoring through routine HbA1c assessments and personalized treatment modifications into standard endodontic care. Adjunctive therapies such as antimicrobial photodynamic therapy, host-modulating agents, and prolonged radiographic monitoring may enhance healing outcomes in diabetic individuals.

Despite these insights, this study is limited by its small sample size, retrospective design, and lack of glycemic control data (HbA1c levels). Future multi-center, prospective cohort studies should investigate the impact of glycemic control on periapical healing and explore advanced therapeutic interventions such as laser-assisted endodontic techniques. Addressing the oral-systemic health connection through integrated patient care models will be essential in optimizing clinical outcomes and improving overall health in diabetic individuals.

Disclosure statement

No potential conflict of interest was reported by the author.

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