Original Article

An exploratory study to understand the relationship between diabetes and various pulpal conditions: An Indian perspective

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Abstract

Aim: Diabetes mellitus (DM) affects an estimated 100 million Indians, ranking second globally in diabetic prevalence. Despite this, the correlation between DM and specific pulpal diagnoses remains underexplored. This study compares pulpal conditions in DM patients and nondiabetic controls.

Designs: The study was started after taking ethical approval.

Subjects and Methods: Two thousand and five hundred and sixty teeth were examined over 4 months at the institute, evenly distributed between diabetic and nondiabetic cases, we assessed diagnoses – normal pulp, reversible pulpitis (RP), symptomatic irreversible pulpitis, asymptomatic irreversible pulpitis, pulp necrosis (PN), missing teeth (MT), and root canal-treated teeth (RCT). Statistical analysis used the Chi-square test.

Results: PN and MT prevalence in DM patients significantly exceeded the control group. Conversely, the control group showed higher RP prevalence in the older subgroup.

Conclusions: PN prevalence was higher in diabetics, suggesting reduced pulp sensitivity in individuals over 60 years. This diminished sensitivity might lead to delayed dental treatment, increasing PN prevalence.

Keywords: Diabetes mellitus; missing teeth; pulp diagnosis; pulp necrosis; pulpitis

INTRODUCTION

Globally, over 500 million individuals grapple with diabetes mellitus (DM), as reported by the IDF Atlas.[1]

In India, where the diabetic population stands at 100 million, the country secures the second-highest position worldwide, trailing only China.[2,3] Diabetes-related complications affect various organs, encompassing retinopathy, neuropathy, nephropathy, cardiovascular issues, and delayed tissue healing.[4,5] Factors such as elevated saliva glucose, poor neutrophil function, neuropathy, and vascular damage contribute to oral complications.[6] Despite an extensive literature on the ties between oral health and diabetes, including recognizing periodontitis as the 6th complication of DM, its impact on pulp remains understudied.[7,8]

In the field of endodontics, both experimental and clinical studies reveal a heightened prevalence of pulpal inflammatory mediators and periapical lesions in individuals with uncontrolled diabetes. Studies examining the glycated hemoglobin (HbA1c) levels of diabetic patients

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found a significant association with periapical status as well.[8-11]

Despite the wealth of literature on the relationship between diabetes and oral health, studies evaluating the association between DM and dental pulp diagnosis in the Indian population are lacking. Our study aimed to assess the prevalence of various pulpal diagnoses, including normal pulp (NP), reversible pulpitis (RP), symptomatic irreversible pulpitis (SIP), asymptomatic irreversible pulpitis (AIP), pulp necrosis (PN), missing teeth (MT) due to caries, and root canal-treated teeth (RCTt) in DM patients compared to a nondiabetic control group, considering HbA1c levels.

Our analysis revealed a significantly higher prevalence of PN and MT in elderly DM patients, whereas the control group exhibited a higher prevalence of RP in the elderly population. Our goal is to illuminate this intriguing observation and explore its implications for pulp treatment.

SUBJECTS AND METHODS

Upon receiving ethical approval (Approval No: 64/02/2022), our study commenced. The patient pool, comprising both control and diabetic groups based on HbA1c reports, underwent detailed medical history assessments. A total of 2560 teeth, evenly distributed between diabetics and nondiabetics, were examined during a 4-month period at our institute. Patients were thoroughly briefed on the procedure, and written consent was obtained for their participation in the study. Our evaluation focused on the 1st and 2nd permanent molars, with patients providing information on symptomatology, including onset, duration, and severity. Sensibility tests were conducted as deemed necessary, accompanied by Radio visio graphy (RVG) for comprehensive assessment. Final diagnoses were determined following the AAE consensus conference recommended diagnostic terminology.

The study documented the prevalence of various diagnoses, such as normal pulp, RP, SIP, AIP, PN, MT due to caries, and RCT. All collected data were meticulously recorded in an Excel Sheet for analysis.

Case record

The recorded information included: tooth number and pulp diagnosis, sex (male, female, or unidentified), age at the time of the study (20–69), completed medical history, including DM with HbA1c report, medical ID number, and date.

Statistical analysis

The independent variables of the group were age and sex. There were six categories described in Table 1.

Table 1: Grouping of the patient according to their age and medical condition

Group according to age and medical history	Group category
20–39 years of age with a healthy condition	20–39 control
40–59 years of age with a healthy condition	40–59 control
>60 years of age with a healthy condition	>60 control
20–39 years of age with a DM	20–39 DM
40–59 years of age with a DM	40–59 DM
>60 years of age with a DM	>60 DM

DM: Diabetes mellitus

Table 2: Descriptive statistics in the diabetic group (n=160)

Variables	Age group	Mean±SD	F	Significance
HbA1c	20–39	10.81±2.56	4.671[c]	0.011
	40–59	9.94±2.91		
	>60	8.83±2.26		
	Total	9.56±2.70		
Duration of diabetes (years)	20–39	2.1±1.96	4.206[c]	0.017
	40–59	5.2±5.59		
	>60	7.1±6.94		
	Total	5.7±6.14		

[c]ANOVA. SD: Standard deviation, HbA1c: Glycated hemoglobin

First, the analysis of variance (ANOVA) test was used to describe the correlation between age and HbA1c level as described in Table 2.

Then Chi-square test was used to determine the relationship between the type of diagnoses and group category [Tables 3 and 4].

SPSS (version 19.0, IBM Corporation, Armonk, NY, USA). software was used for statistical analysis after entering all the data in the Excel Sheet.

The statistical significance level was set at $P < 0.05$ for all tests.

RESULTS

After a thorough analysis of data from 2560 teeth, a significant trend emerged, indicating that 97.5% of the 160 diabetic patients under study were diagnosed with type 2 diabetes. The findings revealed a balanced distribution within the diabetic group, comprising 52.1% males and 47.7% females, whereas the control group displayed a distribution with 47.9% males and 52.3% females.

The investigation into mean HbA1c levels across various age categories illuminated intriguing insights. In the 20–39 age range, the mean HbA1c level was 10.81 ± 2.56, a figure that decreased to 9.94 ± 2.91 for ages 40–59 and further to 8.83 ± 2.7 for individuals over 60 for diabetics. For the control group, all of them had a value of ≤5.9, with a mean value of 5.3.

Table 3: Association between type of diagnoses and group category

Group category	Total	Normal pulp		PN		MT	
		n (%)	*P*	*n* (%)	*P*	*n* (%)	*P*
20–39 control	304	220 (72.4)	<0.0052	1 (0)	<0.0001	1 (0.32)	<0.0017
20–39 DM	112	65 (58)		11 (10)		5 (4)	
40–60 control	632	339 (53.6)	<0.00001	9 (1.40)	<0.00001	80 (12.65)	<0.00001
40–60 DM	672	245 (36.4)		64 (9.50)		209 (31.10)	
>60 control	264	72 (27.27)	0.3	25 (9.46)	<0.0009	68 (25.75)	0.04
>60 DM	368	87 (23.6)		70 (19.02)		180 (48.91)	

DM: Diabetes mellitus, PN: Pulp necrosis, MT: Missing teeth

Table 4: Association between type of diagnoses and group category

Group category	Total	RP		SIP		AIP		RCT	
		n (%)	*P*	*n* (%)	*P*	*n* (%)	*P*	*n* (%)	*P*
20–39 control	304	60 (19.73)	0.1	11 (3.61)	<0.01	5 (1.64)	0.9	6 (1.97)	0.6
20–39 DM	112	15 (13.39)		11 (10)		2 (1.78)		3 (3)	
40–60 control	632	125 (19.70)	0.6	24 (3.79)	<0.01	22 (3.48)	0.6	25 (3.95)	<0.001
40–60 DM	672	106 (15.70)		9 (1.33)		27 (4.01)		5 (0.74)	
>60 control	264	73 (27.65)	<0.00001	3 (1.10)	0.8	2 (0.70)	0.3	20 (7.57)	<0.001
>60 DM	368	16 (12.50)		5 (1.35)		6 (1.63)		4 (1.08)	

RP: Reversible pulpitis, SIP: Symptomatic irreversible pulpitis, AIP: Asymptomatic irreversible pulpitis, RCT: Root canal-treated teeth, DM: Diabetes mellitus, HbA1c: Glycated hemoglobin

A statistically significant difference was observed, emphasizing higher mean HbA1c levels in the younger diabetic age group [Table 2].

Shifting the focus to the duration of diabetes, distinct patterns emerged across age groups. The 20–39-year age category exhibited a mean duration of 2.1 ± 1.96 years, whereas the 40–59-year age group displayed 5.2 ± 5.59 years, and participants over 60 showcased a longer duration of 7.1 ± 6.94 years. This temporal progression was statistically significant as confirmed by ANOVA testing, establishing a meaningful difference between the groups ($P < 0.05$) [Table 2].

Delving into pulp diagnoses and their prevalence among different age groups, the data, meticulously presented in Table 3, shed light on key observations. PN and MT stood out as consistently higher in all age groups of diabetic patients. Strikingly, RP exhibited a statistically significant prevalence in the control group over 60 years. Exploring the outcomes related to SIP, the prevalence was higher in the control group up to age 60 years.

Intriguingly, the prevalence of RCT exhibited nuanced variations. Notably higher in the control group aged 40–60 years and beyond 60, this finding adds depth to our understanding of dental outcomes in different age brackets [Table 4].

DISCUSSION

The research underscores a robust correlation between DM and various oral disorders, accentuating heightened vulnerability to dental diseases in individuals with diabetes. The impact on periodontal health is evident, emphasizing the pivotal role of addressing oral health in diabetes management. Reduced saliva production in diabetes contributes to xerostomia, increasing the risk of tooth decay and oral infections. The presence of burning mouth syndrome in diabetic individuals introduces complexity to overall well-being challenges. The susceptibility to oral candidiasis underscores the necessity for a comprehensive approach to oral health. The heightened risk of tooth decay in diabetes is compounded by dry mouth conditions. Recognized as a complication of diabetes, delayed wound healing impacts both oral and systemic recovery. Despite an abundance of literature on the diabetes-oral health relationship, there is a dearth of studies evaluating the association between DM and dental pulp diagnosis in the Indian population. Further research is warranted to deepen insights into the specific effects of diabetes on various pulp pathoses.[6-8,12,13]

This pioneering study is the first of its kind, exploring the correlation between pulpal conditions in DM patients and a control group stratified by age.

The observation of a higher mean HbA1c in the younger age group emphasizes the crucial necessity for targeted diabetes control programs. This discovery points to less effective diabetes management within this demographic, as elevated HbA1c levels indicate poorer long-term blood glucose control. It has been observed that patients with higher HbA1c levels had heightened disease as well. It is vital to recognize the importance of early and proactive diabetes management in younger individuals to prevent long-term complications and promote overall better health.[14,15]

Significantly, our findings emphasize a prevalent association between DM and pulp pathology across all age groups, raising a noteworthy concern. The increased incidence of PN in DM patients is a significant issue, considering their susceptibility to microvascular complications, which negatively impact dental pulp vascularity, ultimately leading to vital pulp demise. Previous research aligns with our observations, suggesting that the dental pulp of diabetic patients tends to be in an inflamed state due to nerve damage and local microcirculation breakdown, resulting in PN. Histological studies further corroborate this, revealing fibrotic transformation, calcifications, arteriosclerosis, and inflammatory infiltration in the dental pulp of diabetic individuals. Animal studies supplement these findings by demonstrating a diminished chemotactic response in the dental pulp of diabetic rats compared to control rats. This implies that dental pulp in diabetic conditions exhibits lower resistance against bacterial infections.[16-23]

Remarkably, our study unveils a noteworthy pattern: up to the age of 60 years, the control group exhibits a higher prevalence of a healthy pulp state compared to DM patients. However, beyond the age of 60 years, this distinction becomes less significant.

RP appears to exhibit a lesser prevalence among older individuals grappling with diabetes, offering a suggestive insight into the potential influence of diabetic neuropathy in tempering initial pain symptoms.

This intriguing connection hints at a scenario where the presence of diabetes may contribute to a dampened sensitivity to dental pain, thereby fostering delayed visits to the dentist and consequent delays in receiving diagnoses. This, in turn, elevates the risk of conditions progressing into irreversible pulpitis. The subtle interplay of diabetic neuropathy and pain perception, as elucidated by our observations, underscores intricate age-related variations in dental pain symptoms between those with diabetes and their nondiabetic counterparts. These nuanced findings underscore the profound significance of regular dental checkups and heightened awareness within the diabetic population. By recognizing and addressing potential delays in perceiving and responding to dental pain, individuals with diabetes can be empowered to undertake timely interventions and preventive measures. This proactive approach not only facilitates the preservation of oral health but also contributes to a more comprehensive understanding of the intricate dynamics between diabetes and dental well-being.

SIP was significantly higher in the 40–60 control group compared to DM. Contrary to another study that has found high SIP in DM patients but supported by recently published data,[11,24] our investigation highlights a concerning observation – the higher incidence of MT in DM patients. This is particularly alarming in developing countries like India, where a lack of awareness contributes to a substantial burden of a large population living without functional molars. Irrespective of age group, the continuous higher prevalence of PN and MT in DM patients as well as less number of RCT in DM patients compared to the control group showing that there is a lack of awareness, poor oral hygiene, lack of access to dental care, and poor affordability among DM individuals. DM patients are more prone to dental caries and PN due to altered immune response, higher salivary glucose, reduced salivary flow, neuropathy, and arteriosclerosis, which also delay symptoms recognition , signifies that we need to establish combined DM and dental health checkup on regular intervals. By integrating routine examinations for individuals with diabetes, we can initiate treatment at the earliest signs of issues, resulting in more effective and favorable outcomes for both diabetes and dental health. This integrated approach ensures comprehensive care, addressing potential complications promptly and contributing to overall well-being.

Limitation of the study

One point to consider is that the study lacks an analysis of how the presence of underlying medical conditions such as hypertension in patients might interact with diabetes, either independently or concurrently, to affect the pulpal status of teeth. Understanding these potential interactions could enhance the comprehensiveness of the findings. In addition, the study does not investigate whether specific HbA1c values are indicative of more severe pulpal conditions, leaving room for further exploration in subsequent research.

Although could not gauge the exact cause of MT, more studies are needed in this aspect as well.

CONCLUSIONS

The prevalence of PN was higher in comparison to the nondiabetic group. In individuals aged over 60 years, there was a lower incidence of RP, indicating reduced pulp sensitivity possibly linked to their diabetic condition. This diminished sensitivity could contribute to delayed dental treatment, subsequently resulting in a higher prevalence of PN.

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Conflicts of interest

There are no conflicts of interest.

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