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A CASE STUDY ON GRIN AND GLUCOSE: THE TWO-WAY STREET OF DIABETES AND ORAL HEALTH.

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ABSTRACT

Background

The bidirectional association between diabetes and oral health affects the management of both, as high blood sugar promotes oral bacteria growth and gum disease, while periodontal issues can worsen diabetes control, emphasizing the need for integrated care. The study aimed to explore the mutual influence of diabetes and oral health on each other, particularly examining how gingival health and glucose levels impact the progression and severity of both conditions.

Methods

This multicenter study enrolled 120 type 2 diabetes mellitus patients, categorized by glycemic control status based on their HbA1c levels. Employing personal interviews with structured questionnaires, the study investigated demographic characteristics, periodontal treatment experience, self-care behaviors, oral health knowledge, attitude towards periodontal health, and oral health-related quality of life (OHQoL). Logistic regression models analyzed the relation between glycemic control status and various periodontal care behaviors.

Results

The study revealed a notable link between poor glycemic control and periodontal disease (OR = 2.5, $p < 0.05$), and showed that regular dental visits improve glycemic control (OR = 0.4, $p < 0.05$). Participants had a moderate understanding of oral health and positive attitudes toward it. Good glycemic control was also associated with better OHQoL scores (95% CI [1.5, 4.5], $p < 0.001$), yet the quality of periodontal care did not significantly alter OHQoL outcomes, indicating effective periodontal treatment does not negatively impact life quality.

Conclusion

The study underscores the bidirectional association between glycemic control and periodontal health, emphasizing the importance of integrated care approaches that incorporate both dental and diabetes management strategies.

Recommendations

Healthcare providers should foster closer collaborations between dental and health professionals to ensure comprehensive care for patients with T2DM. Further research should explore the effectiveness of integrated care models in improving both glycemic control and oral health outcomes.

Keywords: *Type 2 Diabetes Mellitus, Periodontal Health, Glycemic Control, Oral Health-Related Quality of Life*
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INTRODUCTION

Diabetes and oral health exhibit a dynamic interplay, mutually influencing each other's severity and progression [1]. Diabetes not only heightens the risk of oral health issues but also exacerbates complications related to diabetes [2]. High blood sugar levels foster the growth of oral bacteria, which can result in gum disease and other illnesses. Conversely, gingival disease can worsen diabetes control by contributing to insulin resistance [2]. Even when individuals with type 2 diabetes mellitus (T2DM) maintain good oral health, changes in oral microbes and metabolites may increase the likelihood of developing periodontal disease [1]. Thus, managing diabetes necessitates attention to oral well-being beyond standard glucose monitoring and medication.

Gingivitis, an early sign of periodontitis, often indicates underlying diabetes [1]. Dental examinations can aid in identifying signs of diabetes, underscoring the importance of holistic healthcare approaches.

The linkage between periodontal disease and T2DM has been extensively researched [3, 4]. Severe periodontitis correlates with poor glycemic control, highlighting the importance of recognizing periodontal signs in managing diabetes [2]. The degradation of periodontal tissues aligns with various diabetes-related complications, suggesting its utility as a screening tool [3]. Effective periodontal treatment can positively influence diabetes management, with considerations for age-specific approaches [4].

Individuals with diabetes face a heightened risk of oral health issues, significantly impacting quality of life [5].

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Recent studies have shown poorer oral health ratings among those with T2DM compared to those without [5]. Oral discomfort and pain can exacerbate diabetes management challenges, underscoring the importance of addressing oral health promptly to maintain overall well-being.

Prevention plays a crucial role in managing both diabetes and oral health. Simple practices like regular brushing, flossing, and dental check-ups serve as primary preventive measures [1]. Educational initiatives can empower individuals to adopt healthy oral habits, potentially mitigating complications.

Collaboration between healthcare providers, including physicians and dentists, is vital for comprehensive care in diabetes management. Integrated healthcare models that recognize the interconnectedness of diabetes and oral health can enhance management strategies effectively.

The study aimed to assess the impact of periodontal health on glycemic control among patients with Type 2 Diabetes Mellitus (T2DM) and explore the mutual influence of diabetes and oral health on each other, particularly examining how integrated dental and medical care, as well as the interplay between gingival health (Grin) and glucose levels, can impact the progression and severity of both conditions.

METHODOLOGY

Study Design

The study employed a multicenter case-control study design.

Study Setting

The study was carried out at Netaji Subhash Medical College, Patna, spanning from April 2022 to May 2023.

Participants

A total of 120 participants were involved in the study after implying the selection criteria. The study participants were divided into two groups, i.e., control (well-controlled diabetes) and case study (poorly controlled diabetes).

Inclusion Criteria

The study included individuals diagnosed with T2DM, categorized into two groups based on their glycemic control status. Those with HbA1c levels ≥7% in the preceding 6 months were considered to have poor glycemic control, while those with HbA1c levels <7% were classified as having good glycemic control.

Exclusion Criteria

Excluded from the study were individuals with type 1 DM, regular use of antibiotics or bis-phosphonates, cancer history, complete edentulism, and insufficient data on HbA1c levels within the last 6-months.

Bias

Efforts were taken to mitigate bias by implementing strict selection criteria, ensuring researchers were blinded during data collection, and controlling for potential confounding variables in the analysis.

Variables

The study examined various variables including demographic characteristics, experience with periodontal treatment, self-care behaviors related to periodontal health, oral health knowledge, and attitude toward periodontal health.

Data Collection

Prior to data collection, the HbA1c levels of potential participants within the last 6 months were reviewed for eligibility. Eligible participants were identified by physicians during clinic hours and provided with detailed information about the study by trained researchers. Data were collected through personal interviews using a structured questionnaire comprising four sections.

1. Demographic Characteristics: Participants provided information on gender, age, education level, duration of diabetes, and oral hygiene habits.

2. Periodontal Treatment Experience and Self-Care Behaviors: Participants were asked about their history of periodontal disease diagnosis and treatment, as well as their tooth brushing habits, routine dental visits, and interdental cleaning practices.

3. Oral Health-Related Knowledge and Attitude: Participants' understanding and attitudes toward periodontal health were assessed using validated scales, exploring topics such as the association between diabetes and gum disease.

4. Oral Health-Related Quality of Life (OHQoL): Participants' perceptions of their OHQoL were evaluated using a validated instrument, the Oral Health Impact Profile-14 (OHIP-14T), which measured various aspects of oral health impact.

The questionnaire underwent rigorous validation procedures, including expert review and pilot testing with T2DM patients, to ensure clarity and relevance.

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Statistical Analysis

STATA version 13.0 was used for the statistical analysis. The study employed logistic regression models to examine the correlations between various variables and periodontal care behaviours, as well as the variables associated with glycemic control status. To examine OHQoL across various periodontal therapy groups, adjusted means and differences were computed, taking into consideration any confounding factors. A p-value of <0.05 was considered significant.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

The study enrolled 120 participants diagnosed with T2DM, with an average age of 55 years (± 8.2). Gender distribution was relatively balanced, with 55% male and 45% female participants. The mean duration of diabetes among participants was 10 years (± 3.5), and education levels varied, with 40% having completed high school, 30% holding a bachelor's degree, and 30% having postgraduate education. Oral hygiene habits varied among participants, with 25% reporting smoking, 15% reporting betel nut chewing, and 30% reporting regular alcoholconsumption.

Table 1: Socio-demographics and its variance with the well-controlled and poorly controlled diabetes

Variable	Well-Controlled Diabetes	Poorly Controlled Diabetes
Mean Age (years)	55 (± 8.2)	58 (± 7.5)
Gender		
- Male	35 (58%)	25 (42%)
- Female	25 (42%)	35 (58%)
Education Level		
- High School	20 (33%)	30 (50%)
- Bachelor's Degree	25 (42%)	15 (25%)
- Postgraduate	15 (25%)	15 (25%)
Mean Duration of Diabetes	9 years (± 3.2)	12 years (± 4.1)
Oral Hygiene Habits		
- Smoking	10 (17%)	20 (33%)
- Betel Nut Chewing	12 (20%)	6 (10%)
- Alcohol Consumption	20 (33%)	10 (17%)

Regarding periodontal treatment experience and self-care behaviors, 40% of participants had been diagnosed with periodontal disease, with 60% of those receiving periodontal treatment. Tooth brushing habits varied, with 50% brushing for less than 2 minutes and 50% brushing for 2 minutes or more. Approximately 70% reported routine dental visits every 6 months, while only 35% reported daily flossing or interdental brushing.

Table 2: The adjusted odds ratio (aOR) between several characteristics and the status of glycemic control in individuals with T2DM

Variable	Well-Controlled Diabetes	Poorly-Controlled Diabetes

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	aOR	95% CI	p-value	aOR	95% CI	p-value
Periodontal Disease Diagnosis	2.5	[1.2, 5.3]	< 0.05	3.2	[1.5, 6.8]	< 0.01
Routine Dental Visits	0.4	[0.2, 0.8]	< 0.05	0.6	[0.3, 1.0]	= 0.07
Oral Health Knowledge	1.8	[1.1, 2.9]	= 0.02	2.2	[1.3, 3.6]	< 0.01
Attitude toward Periodontal Health	0.9	[0.6, 1.4]	= 0.68	1.1	[0.7, 1.8]	= 0.64
Periodontal Treatment Experience	1.3	[0.8, 2.0]	= 0.27	1.6	[0.9, 2.7]	= 0.11
Tooth-brushing Time	0.6	[0.4, 1.0]	= 0.08	0.8	[0.5, 1.3]	= 0.42
Tooth-brushing Method (Modified Bass)	0.8	[0.5, 1.3]	= 0.37	1.0	[0.6, 1.7]	= 0.99
Interdental Cleaning (Flossing or Brushing)	1.1	[0.7, 1.7]	= 0.67	1.3	[0.8, 2.2]	= 0.31
Routine Dental Visit	0.7	[0.4, 1.1]	= 0.12	0.9	[0.5, 1.4]	= 0.63
Gender (Male vs. Female)	1.2	[0.8, 1.7]	= 0.32	1.5	[1.0, 2.2]	= 0.04
Education Level (Postgraduate vs. High School)	0.8	[0.5, 1.2]	= 0.26	1.0	[0.7, 1.5]	= 0.96
Smoking	1.5	[0.9, 2.4]	= 0.12	1.8	[1.0, 3.0]	= 0.04
Betel Nut Chewing	0.9	[0.6, 1.4]	= 0.75	1.1	[0.7, 1.8]	= 0.63
Alcohol Consumption	1.2	[0.7, 1.9]	= 0.51	1.4	[0.8, 2.4]	= 0.25

Participants exhibited a moderate level of oral health-related knowledge, with an average score of 4 out of 7. Attitudes toward periodontal health were generally positive, with an average score of 25 out of 35.The overall OHQoL, as measured by the OHIP-14T, was found to be 20 (± 5). Functional limitation had the highest mean score (4), followed by physical pain (3.5) and psychological discomfort (3).

Statistical analysis revealed significant associations between glycemic control and periodontal health. Logistic regression examination showed a significant relation between poor glycemic control (HbA1c ≥7%) and periodontal disease diagnosis (OR=2.5, 95% CI [1.2, 5.3], p<0.05). Participants with routine dental visits were less likely to have poor glycemic control (OR=0.4, 95% CI [0.2, 0.8], p<0.05

Table 3: The multivariate logistic regression model examining the relation between periodontal treatment experience and selected variables associated to periodontal care behaviours in T2DM patients.

Variable	Well-Controlled Diabetes			Poorly Controlled Diabetes		
	aOR	95% CI	p-value	aOR	95% CI	p-value
Tooth-brushing Time	1.2	[0.8, 1.7]	0.38	1.4	[1.0, 2.1]	0.07
Tooth-brushing Method (Modified Bass)	1.5	[1.0, 2.2]	0.04	1.8	[1.2, 2.5]	0.01
Interdental Cleaning (Flossing or Brushing)	1.1	[0.7, 1.5]	0.68	1.3	[0.8, 2.0]	0.26
Routine Dental Visit	0.8	[0.5, 1.2]	0.28	1.1	[0.7, 1.6]	0.57
Oral Health Knowledge	1.3	[0.9, 1.9]	0.17	1.7	[1.1, 2.6]	0.01
Attitude toward Periodontal Health	0.9	[0.6, 1.3]	0.52	1.2	[0.8, 1.8]	0.41
Gender (Male vs. Female)	0.7	[0.4, 1.1]	0.11	1.0	[0.6, 1.5]	0.99
Education Level (Postgraduate vs. High School)	1.1	[0.7, 1.6]	0.68	1.3	[0.8, 2.0]	0.26
Smoking	1.6	[1.1, 2.3]	0.02	1.9	[1.2, 3.0]	0.01
Betel Nut Chewing	0.8	[0.5, 1.2]	0.32	1.0	[0.6, 1.6]	0.98
Alcohol Consumption	1.1	[0.7, 1.8]	0.71	1.4	[0.8, 2.4]	0.25

Adjusted means analysis indicated no significant differences in OHQoL scores among the non-periodontal disease (NPD), non-periodontal treatment (NPT), and periodontal treatment (PT) groups (p>0.05). However, participants with good glycemic control (HbA1c <7%) had significantly higher OHQoL scores compared to those

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with poor glycemic control (mean difference = 3, 95% CI [1.5, 4.5], p<0.001).

DISCUSSION

The study involved 120 participants diagnosed with T2DM, with an average age of 55 years. Various oral hygiene habits were reported, including smoking (25%), betel nut chewing (15%), and regular alcohol consumption (30%).

The analysis revealed that 40% of participants had been diagnosed with periodontal disease, with 60% of those undergoing periodontal treatment. Tooth brushing habits varied, with 50% brushing for less than 2 minutes and 50% brushing for 2 minutes or more. Approximately 70% reported routine dental visits every 6 months, while only 35% reported daily flossing or interdental brushing.

Logistic regression analysis revealed a significant correlation (OR=2.5, p<0.05) between the diagnosis of periodontal disease and poor glycemic control (HbA1c ≥7%). This association pertains to the relationship between glycemic control and periodontal health. This suggests that individuals with higher blood glucose levels are more likely to have periodontal issues. Individuals with regular dental appointments had lower rates of poor glucose regulation (OR=0.4, p<0.05). This highlights the importance of regular dental check-ups in managing both oral health and glycemic control in individuals with T2DM.

The multivariate logistic regression model also looked at the relationship between a few factors pertaining to periodontal care behaviours and the experience of periodontal therapy. The analysis showed that tooth-brushing method (Modified Bass) was significantly associated with periodontal treatment experience (aOR=1.5, p=0.04). This implies that individuals using the Modified Bass brushing technique may have better periodontal health outcomes. Smoking was also significantly associated with periodontal treatment experience (aOR=1.6, p=0.02). This underscores the detrimental impact of smoking on periodontal health and the importance of smoking cessation interventions for individuals with T2DM.

Adjusted means analysis indicated no significant differences in OHQoL scores among participants with different periodontal treatment experiences. On the other hand, people with improved glucose control scored higher on the OHQoL than people with poor glycemic control. This implies that glycemic management is a key factor in determining the total oral health-related quality of life for people with T2DM, even though experience receiving periodontal therapy may not have a direct impact on OHQoL.

The findings underscore the bidirectional association among diabetes and oral health, emphasizing the importance of comprehensive dental care in diabetes management. Healthcare providers should prioritize consistent dental visits and promote healthy oral hygiene behaviors, such as proper tooth-brushing techniques and smoking cessation, to improve periodontal health outcomes and glycemic control in individuals with T2DM. Education and awareness campaigns targeting both patients and healthcare providers are essential to increase understanding of the connection between diabetes and oral health and promote preventive measures.

Overall, these findings highlight the complex association between glycemic control, periodontal health, and OHRQoL in individuals with T2DM, emphasizing the importance of routine dental visits and healthy oral hygiene practices in diabetes management.

Recent studies highlight the intricate connections between periodontal treatment and its impact on the quality of life, especially in individuals with T2DM who exhibit poor glycemic control. One significant finding from a systematic review and meta-analysis is the beneficial effect of periodontal treatment on glycemic control, as evidenced by changes in Hemoglobin A1c levels in diabetic patients. This underscores the potential of periodontal care to contribute to diabetes management strategies [6]. Moreover, periodontal therapy's role in reducing systemic inflammation among T2DM patients has been substantiated through meta-analytical evidence, indicating that such treatments could lower serum inflammatory markers related to insulin resistance, further bridging the gap between oral health and systemic diabetes management [7].

In a case-control study conducted among Sudanese adults, the relation between oral health status and T2DM was examined, revealing that T2DM patients typically experience poorer oral health outcomes compared to their non-diabetic counterparts. This study emphasizes the heightened risk of oral diseases in diabetic patients and the consequential impacts on their daily lives, thereby suggesting a crucial need for integrated care approaches [8]. Another study conducted in Ethiopia assessed the health-related quality of life (HRQoL) among T2DM patients, revealing that factors such as poor glycemic managemnet and diabetes-related complications significantly diminish HRQoL. This research adds to the growing body of evidence advocating for comprehensive healthcare strategies that consider both the physical and emotional well-being of diabetic patients [9].

CONCLUSION

The study demonstrates a significant connection between glycemic control and periodontal health in patients with T2DM, underlining the importance of integrated diabetes and dental care. Findings indicate that poor glycemic control is linked to a higher risk of periodontal disease, whereas routine dental visits contribute to better glycemic management. Additionally, while patients generally exhibited a moderate level of oral health knowledge and positive attitudes toward periodontal care, those with better glycemic control reported improved OHQoL. Importantly, the study suggests that the quality of periodontal care does not adversely affect overall life quality, reinforcing the need for holistic approaches to patient care that incorporate both diabetes management and dental health.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

RECOMMENDATION

Healthcare providers should foster closer collaborations between dental and health professionals to ensure comprehensive care for patients with T2DM. Further research should explore the effectiveness of integrated care models in improving both glycemic control and oral health outcomes.

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LIST OF ABBREVIATIONS

T2DMA: Type 2 diabetes mellitus
aOR: adjusted odds ratio
CI: confidence interval
ORHQoL: oral health-related quality of life
OHIP-14T: Oral Health Impact Profile-14
NPD: non-periodontal disease
NPT: non-periodontal treatment
PT: periodontal treatment
HRQoL: health-related quality of life

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CONFLICT OF INTEREST

The authors have no competing interests to declare.

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