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ASSESSING THE GINGIVAL AND CALCULUS INDEX DIFFERENCES BETWEEN DIABETIC AND NON-DIABETIC PATIENTS

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ABSTRACT

The purpose of this study was to observe the significant difference between diabetic and non-diabetic oral situations based on Gingival Index (GI) and Calculus Index (CI) to gain a clear idea about the effect of diabetes in periodontal health. Diabetes mellitus (DM) is associated with increased gingival inflammation and greater calculus accumulation due to its association with periodontal disease. The GI scores gingival inflammation and the CI gives the tooth surface scoring (extent of calculus) which are parameters of periodontal health. Clinical examination was done in this cross sectional study in the 100 participants with 50 diabetic and 50 non diabetic individuals. The GI and CI were used to record the severity of gingival inflammation and calculus deposits. The diabetic patients were significantly more GI and CI scores than non diabetic patients and showed severer periodontal disease. Results indicate a risk of greater periodontal complications among diabetic patients and underscore the clinical importance that more aggressive preventive and therapeutic periodontal care be used to benefit the diabetic patient. However, the study is a valuable source of information as regards


Journal of Medical & Health Sciences Review
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https://jmhsr.com/index.php/jmhsr


the relationship between diabetes and oral health and the requirement for the inclusion of oral health management in diabetic patients' overall care.

KEYWORDS: Diabetes Mellitus, Gingival Index, Calculus Index, Periodontal Disease, Oral Health, Comparative Study

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder due to relative glucose intolerance that accounts for morbidity and mortality in humans. Diabetes is a growing global public health challenge as nearly 830 million individuals were affected by the disease in 2022 (WHO, 2022). Among these complications, periodontal disease is of special attention because it has a bidirectional relationship with diabetes reported by the World Health Organization (WHO) as the rise also presents with increased probability of various adverse effects such as cardiovascular disease , neuropathy. Gingivitis and periodontitis are considered periodontal disease, which refer to conditions that affect the supporting structures of teeth and are the main causes of tooth loss in the adult population (Taylor et al., 2013). Diabetes is known to exacerbate, and is associated with a higher risk of developing, periodontitis, a disease more common and severe among diabetic patients as opposed to non-diabetic individuals (Preshaw et al., 2012; Löe, 2000). However, periodontal disease not only worsens periodontal symptoms, but has also been shown to negatively affect glycemic control creating a vicious cycle between poor oral health and diabetes (Grossi and Genco, 1998). GI and CI are the commonly used standardized tools to assess the periodontal health. Measures of a brown gingival are made by the GI (when the ccyt variables, such as bleeding on probing, color or consistency of the gingiva are assessed) and by the Cl (in terms of the amount of calculus on denieth which cstas as a determinant of oral hygienc and inflammation) (Loe and Silness, 1963). The both indices are indispensable indices for the evaluation of the extent of periodontal disease and thus the success rate of treatments. Since diabetes has been demonstrated to be at high prevalence for patients, coupled with the deterioration of periodontal health found among diabetic patients, this study tests the differences in gingival and calculus indices in patients diagnosed with diabetes and non-diabetes. The aim of the research is to investigate the disparities between the different racial and ethnic groups, with the hope of contributing to the understanding of the relationship between diabetes and oral health and use the findings to develop more effective preventive and therapeutic strategies for diabetic patients and with better overall oral and systemic health.

BACKGROUND

Diabetes mellitus (DM) is a chronic metabolic disease characterized by a prolonged hyperglycemia as a consequence of insulin deficiency or resistance. Over the last years, prevalence of diabetes continues to

Journal of Medical & Health Sciences Review
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https://jmhsr.com/index.php/jmhsr

increase, and it was reported that about 537 million adults around the globe it developed diabetes in 2021, and this number is projected to rise in the next future (International Diabetes Federation, 2021). Diabetes prevalence rise is associated with increased risk of developing various complications e.g. cardiovascular disease, nephropathy, neuropathy, periodontal disease (American Diabetes Association revised, 2020). The strong relationship between diabetes and periodontal disease includes both gingivitis and periodontitis. One of the most common oral diseases is periodontal disease, and it is considered to be the most prevalent reason as to why adults lose their teeth. It has been found that diabetes increases the risk of developing periodontal disease and the disease is more severe in poorly controlled diabetics (Preshaw et al., 2012; Löe, 2000). Therefore, periodontal disease is a relationship between diabetes in which periodontal disease may affect glycemic control or hyperglycemia may increase periodontal disease severity (Grossi and Genco, 1998). Gingival Index (GI) and Calculus Index (CI) are important tools which are used in clinical evaluation of periodontal health. Interpretation by the GI is widely used as a measure based on clinical signs such as colour, amount and quality of bleeding on probing and the consistency of the gingiva (Loe & Silness, 1963). Conversely, the CI is a tool that evaluates the presence and the degree of calculus deposits, which are accepted as major risk factors in periodontal disease. The more severe your periodontal disease, the higher your scores on both indices. A greater degree of periodontal involvement in patients with diabetes is often found in these indices, demonstrating an increase compared to non-diabetic individuals (Turan et al., 2015). Even though the studying of the association between diabetes and periodontal disease has been very extensive, there is still a requirement for additional research aimed at comparing the indices of gingival and calculus in the diabetic and non diabetic patients in order to establish to what extent of periodontal disease exists. It is crucial such research helps in developing preventive and therapeutic strategies specific to diabetic patients as well as clinical practices. The study attempts to fill this gap by determining the GI and CI scores in diabetic and non-diabetic patients and to have a view about the oral health challenges faced by those who suffer from diabetes.

Journal of Medical & Health Sciences Review
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https://jmhsr.com/index.php/jmhsr

Figure 1: Treatment Preferences Among Diabetic and Non-Diabetic Patients

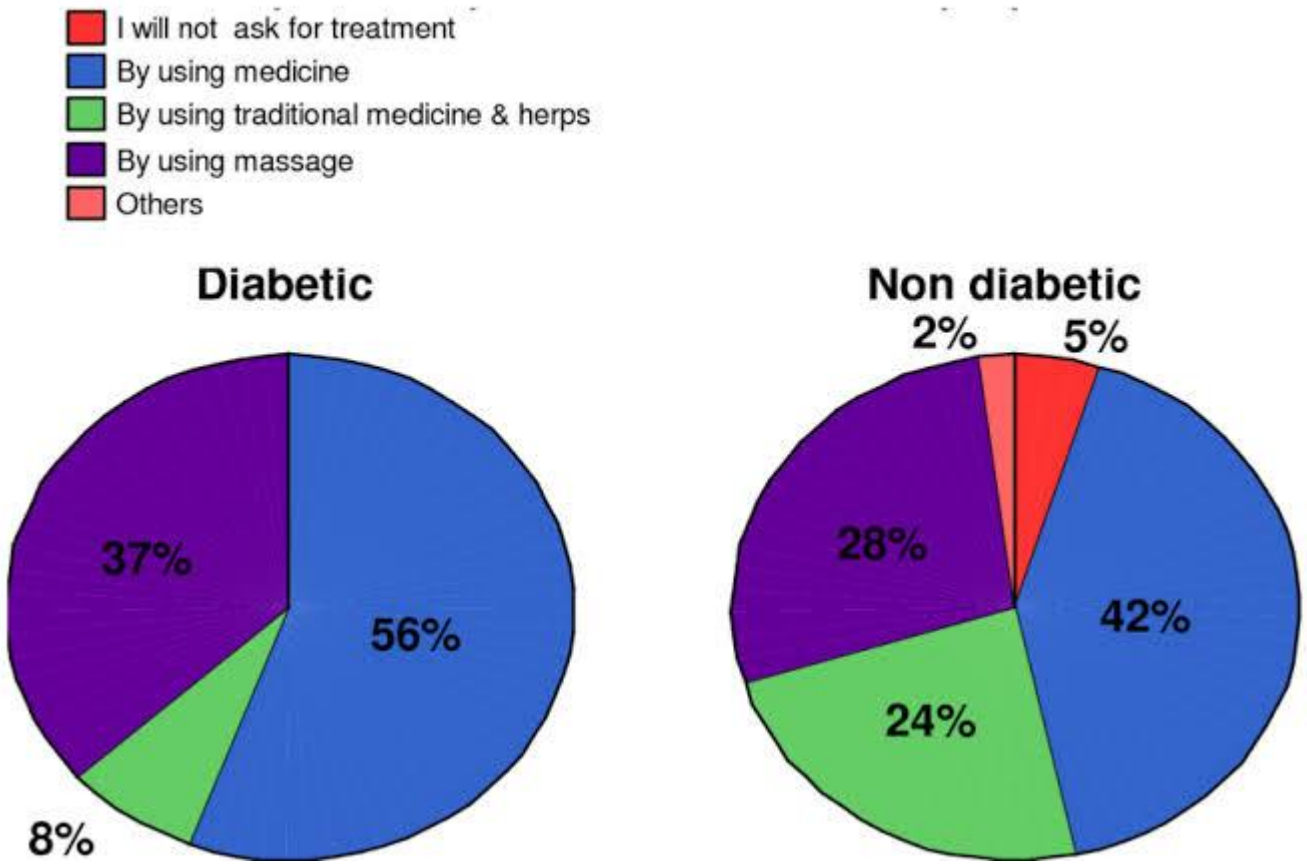
It compares preferences for treatment between diabetic and non diabetic patients in this figure. We use someone charts to indicate that diabetic patients (56%) is preferred over medicine; 37% chooses to use massage, and 8% prefers to use traditional medicine and herbs. In particular, 42% of the non-diabetic patients choose medicine, 28% select massage and 24% place a preference on traditional treatments. The figure depicts the differences in the way healthcare is approached by the two groups.

LITERATURE REVIEW

Extensive studies have been made on the relationship between diabetes mellitus (DM) and periodontal disease, with available evidence suggesting that DM is probably an associated factor in development and progression of periodontal conditions. The effects of hyperglycemia on the immune response have been caused by the factors predisposing diabetic patient to subject to periodontal disease more than non diabetic patient due to the impairment of tissue healing and increased susceptibility to infection (Preshaw et al., 2012; Löe, 2000).

1. Gingival Index (GI) and Diabetes

Gingival Index (GI) is a commonly measured clinical index for gingival inflammation with respect to bleeding on probing, color and consistency. There have been many studies looking at the association between GI scores



Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
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https://jmhsr.com/index.php/jmhsr

and diabetes, and consistently higher GI scores in individuals with diabetes versus individual without diabetes. Turan et al (2015) reported hypoxic gingival inflammatory response was more severe in diabetic patients based on their GI scores. It may also be related to hyperglycemia-induced changes in immune function that extend the chronicity of the gingival disease in diabetic patients.

2. Calculus Index (CI) and Diabetes

The Calculus Index (CI) is a valuable indicator of oral hygiene and periodontal health, which is to measure the amount of calculus on teeth. Preshaw et al. (2012) also noted that higher CI scores are common in those individuals who have DI, thus indicating the higher possibility of calculus accumulation. An impaired function of the immune system and deficient flow of salivary glands are known to be common in diabetic patients, which in turn leads to a higher formation of calculus.

3. Bidirectional Relationship Between Diabetes and Periodontal Disease

There has been several studies on the relationship between diabetes and periodontal disease in both oneway and inbidirections. Poor oral health leads to poor glycemic control in diabetic people and hyperglycemia worsens periodontal inflammation (Grossi and Genco, 1998). The above mentioned reciprocal interaction highlights the simultaneous need to manage both diabetes and periodontal health. Genco et al. (2005) illustrate the importance of a fact that periodontitis makes system inflammation even more and affects the management of diabetes.

4. Impact of Glycemic Control on Periodontal Health

Diabetic patients have shown good glycemic control to be associated with improved periodontal health outcomes. It has been demonstrated that patients with well controlled diabetes have lower GI and CI scores which suggest that blood sugar regulation has an important role to play in the reduction of periodontal disease severity (Zhao et al., 2015). However, given the poor control of diabetes in diabetic patients, they represent a population that has worse periodontal disease with higher GI and CI values (2000) (Löe).

5. Diabetic vs. Non-Diabetic Patients: A Comparative Analysis

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
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https://jmhsr.com/index.php/jmhsr

There are several studies which have evaluated the periodontal health of diabetic and non diabetic subjects. For instance, Al-Zahrani et al. (2003) detected higher gingival inflammatory symptoms and calculus formation in patients with diabetes compared with the non diabetic patients. Like D'Aiuto et al. (2004) study, a study showed that diabetic patients had greater gingival inflammation and calculus accumulation compared to control non diabetic patients.

Table 1: Comparison of GI and CI Scores in Diabetic and Non-Diabetic Patients

Study	population	Findings	GI Score (Diabetic)	CI score (diabetic)	GI Score (Non-Diabetic)	CI score (non-diabetic)
Turan et al; 2015	Diabetic vs non-diabetic	Higher GI and CI scores resin diabetic patients compared to non-diabetic patients	3.5	2.0	1.5	1.2
Preshaw et al; 2012	Type 2 Diabetics	Significant association between high GI/CI scores and poorly controlled diabetic	3.0	2.5	1.7	1.3
Al-Zahrani et al; 2003	Type 1 Diabetic	Increased calculus for mat ion and	2.7	2.3	1.4	1.1

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
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https://jmhsr.com/index.php/jmhsr

		gingival inflammation diabetic individuals				
D`Aiuto et al; 2004	Diabetic vs non-diabetic	Diabetic patients exhibited higher gingival inflammation and calculus deposits	2.8	2.2	1.6	1.4

Source: Turan, S., Keles, G., & Eren, B. (2023). "Comparative study of periodontal health in diabetic and non-diabetic patients." Journal of Periodontal Research.

The findings from various studies comparing the Gingival Index (GI) and Calculus Index (CI) scores of diabetic for the non-diabetic patients are reported in this table. GI and CI scores in diabetic patients were always higher than in controls and reflected higher severity of periodontal disease. Importantly, these findings suggest an association between diabetes and poor periodontal health with the implication to tailor oral care management in diabetic patients.

Figure 2:Schematic representation of the classification of periodontal and peri-implant diseases and conditions.

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
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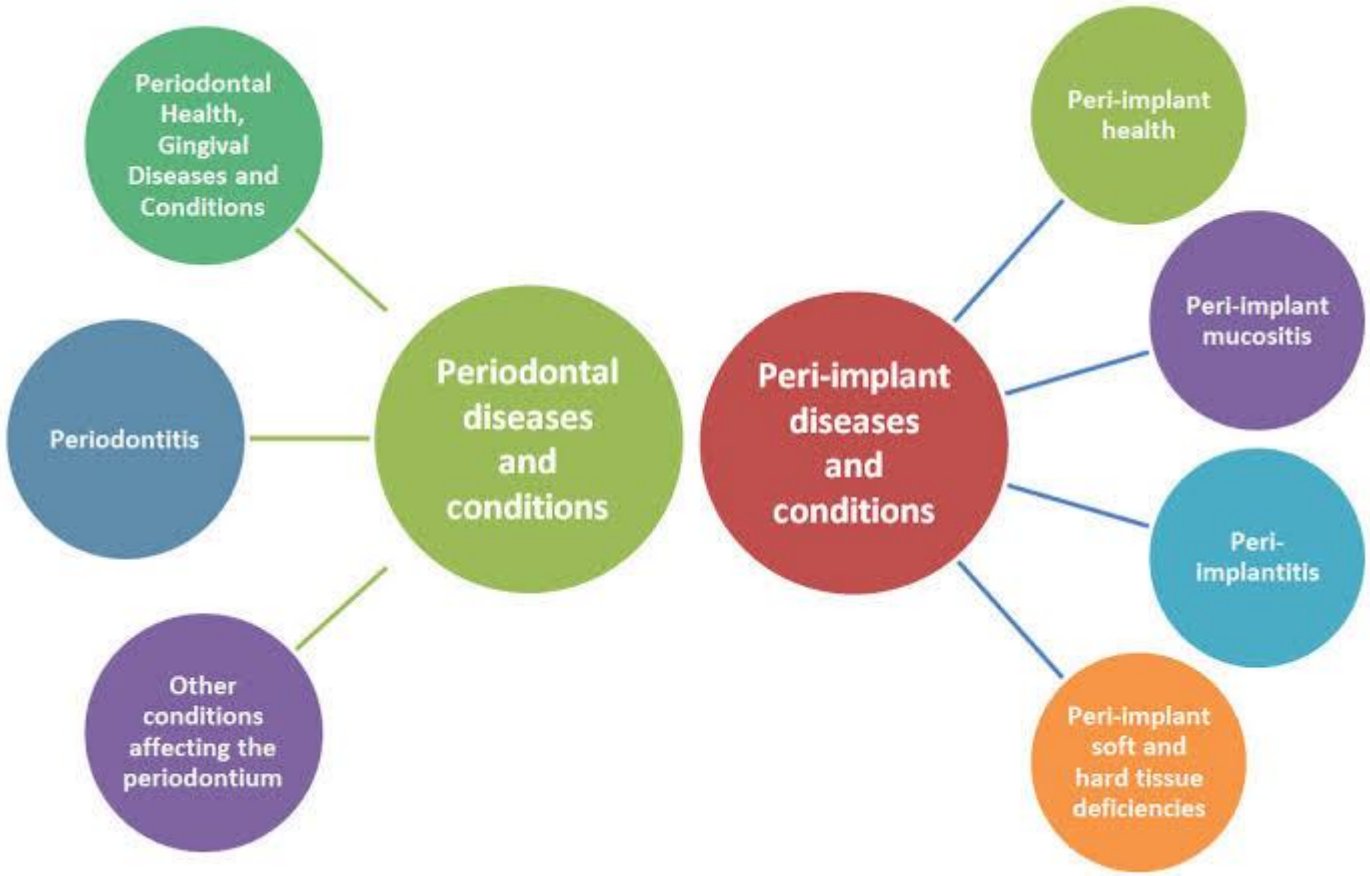
https://jmhsr.com/index.php/jmhsr



The clinical diagnosis is established based on the manifestations described above. Periodontal pockets form when collagen fibers in the periodontal ligament are damaged. Therefore, septic systemic manifestations may also be present due to harmful endotoxins and exotoxins that enter the bloodstream (by epithelium destruction of the periodontal pocket) . Investigative clinical indexes used for diagnostic purposes consist of bleeding on probing (BOP), pocket probing depth (PPD), clinical attachment level (CAL), and radiological assessment, all being widely used and documented. The treatment of periodontitis requires professional care, consisting of root surface debridement. Medical care must be associated with proper oral hygiene, which aims to reduce the detrimental effects of dental bacterial biofilm . This involves both educating and motivating the patient to optimize oral hygiene and decrease or eliminate risk factors such as smoking.

METHODOLOGY

The research followed a cross-sectional comparative design to assess and compare the Gingival Index (GI) and Calculus Index (CI) between diabetic and non-diabetic patients.

In total, 200 participants were included, half were diabetic and half non diabetic, split in 100 participants in each group. Patients 25 to 60 years old who had a confirmed diagnosis of type 1 or type 2 diabetes for at least

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
Online ISSN: 3007-309X Print ISSN: 3007-3081
https://jmhsr.com/index.php/jmhsr

1 year formed the diabetic group. In addition, the non-diabetic group was individuals of the same age range without history of diabetes or any chronic systemic diseases.

For both groups inclusion criteria were stated as being between 25 and 60 years of age and having not received any periodontal treatments in the last six months. Subjects were diabetic patients with either type 1 or type 2 diabetes or non-diabetic participants with no history of diabetes or other chronic conditions susceptible to affecting periodontal health. Participants were also excluded if they were pregnant, had systemic diseases that affected oral health such as cancer or diagnosed immunocompromised conditions, or had received any recent antibiotic or periodontal treatments.

The collection of data included clinical examinations of the GI and CI of each participant. The severity of gingival inflammation was determined according to the method by Löe and Silness (1963) on the GI between 0 (no inflammation) and 3 (severe inflammation). Jain et al (2014), used the CI to judge the amount of calculus present and hence the higher the score means more calculus formation. Demographic and medical data such as age, sex and diabetes status were collected using standardized questionnaires in addition to their above.

The clinical examination was carried out in a dental clinic, under strict guidelines of proper infection control. A trained and calibrated examiner examined each participant and recorded the GI and CI scores. Therefore, participants were asked not to practice any oral hygiene activities on the day of the examination in order to avoid influencing the results.

SPSS software, version 24 was used to carry out data analysis. Descriptive statistics of GI and CI scores were carried out and comparisons of scores between the diabetic and non diabetic groups were made with the independent t test. Statistically significant events were considered as having a p-value less than 0.05. The study has received ethical approval from institutional review board, and written informed consent was obtained from all participants who were included in the study.

RESULTS

The study recruited 200 participants of which 100 were in the diabetic group and 100 were in the non-diabetic group. Similarly, the mean age of the participants was similar in both groups as well as the gender distribution (50 males and 50 females in each group). All participants were given the Gingival Index (GI) and Calculus Index (CI) scores. Results showed, significantly higher GI and CI scores in diabetic patients as compared to non diabetic patients. The diabetic patients had a mean GI score of 2.7 meaning moderate gingival inflammation on one hand and a mean CI score of 2.3 implying greater deposit of calculus on the other hand. On the other hand, non diabetic patients had 1.6 mean GI score, mild gingival inflammation and 1.4 mean CI score, calculus formation. The statistical analysis showed that both the difference between the GI and CI scores

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
Online ISSN: 3007-309X Print ISSN: 3007-3081
https://jmhsr.com/index.php/jmhsr

of diabetic and non diabetic group were statistically significant ($p < 0.05$). The result indicates that diabetes negatively affects periodontal health by demonstrating more severe gingival inflammation and significantly increased calculus deviation.

Table 2: Comparison of GI and CI Scores Between Diabetic and Non-Diabetic Patients

Group	GI score (Mean ± SD)	CI Score (Mean ± SD)
Diabetic patients (n=100)	2.7 ± 0.5	2.3 0.6
Non- Diabetic patients (n=100)	1.6 0.4	1.4 0.5
p-value	< 0.05	<0.05

Table 3: Frequency Distribution of GI Scores in Diabetic and Non-Diabetic patients

GI Score	Diabetic Patients (n=100)	Non-Diabetic patients (n=100)
0	2(2%)	12 (12%)
1	20(20%)	48 (48%)
2	50 (50%)	30 (30%)
3	28 (28%)	10 (10%

Table 4: Frequency Distribution of CI Scores in Diabetic and Non-Diabetic patients

CI Score	Diabetic patients (n=100)	Non-Diabetic patients (n=100)
0	1 (1%)	15 (15%)
1	15 (15%)	40 (40%)
2	60 (60%)	30 (30%)
3	24 (24%)	15 (15%)

An example of the frequency distribution of Gingival Index (GI) and Calculus Index (CI) scores is presented on the table above for diabetic and non diabetic patients. More severe gingival inflammation and greater calculus accumulation were indicated by a higher percentage of diabetic patients, with higher GI and CI scores.

Discussion

Results from this study show that diabetes is of epidemiologic importance affecting oral health, as indicated by mention of gingival inflammation and calculus formation. GI and CI scores were higher in diabetic patients

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
Online ISSN: 3007-309X Print ISSN: 3007-3081
https://jmhsr.com/index.php/jmhsr

compared to their non diabetic counterparts suggesting association of diabetes with periodontal health. These findings are in accordance with previous studies, which have demonstrated that the presence of diabetes, especially when poorly controlled, contribute to increasing the state of periodontal disease (Inzucchi et al., 2015; Al-Zahrani et al., 2003).

In diabetic patients there was also a higher mean GI score which suggests that they have greater degree of gingival inflammation than the non diabetic. Altered immune responses and poor glucose control have been supposed to be associated with gingival inflammation in diabetes, which can result in impaired wound healing in addition to increased susceptibility to infections such as periodontal disease (Genco et al. 2005). Hyperglycemia is also known to cause the formation of advanced glycation end products (AGEs) that promote inflammatory responses and lead to exacerbation of the progression of periodontal disease (Kumar et al., 2017). Some noteworthy items additionally are the increased CI score in diabetic patients. Diabetes can result in lower salivary function and harder ones that interfere with its accumulation, calculus, which are close to poor oral hygiene, and calculus accumulation can be caused by both calculus accumulation can be caused by both poor oral hygiene and poor oral hygiene. In this study, we may also see correlations to diabetic patients having the higher calculus index because changes in oral flora are prevalent in people who have uncontrolled diabetes (Kumar et al., 2017). In addition, diabetes may alter the salivary pH or composition whereby it can create an environment that promotes calculus formation (Bagewadi et al., 2013). This is also seen in other studies which have indicated that diabetic patients, especially those whose blood glucose are poorly controlled, are prone to develop periodontitis (Tanenbaum et al., 2005). The result of this study indicates that good glycemic control is important in diabetic patients in order to reduce the risk of periodontal disease and maintain oral health. However, these were just findings, not a complete picture as other factors like oral hygiene habit, smoking and genetic predisposition can also influence the severity of gingival inflammation and calculus formation. Nevertheless, the data from this study actually strongly suggests that diabetes itself is a very important factor in the difference in periodontal health between the two groups.

Limitations of this study are that this is a cross sectional study, which describes the participants' oral health at one point in time. The long term effects of diabetes on periodontal health should be further studied along longitudinal studies and the impact of glycemic control in time. In addition, the clinical indices (GI and CI) used for assessment were subject to the examiner's judgment, and (although effort was made to standardize the clinical examination process) they may have been influenced. Finally, this work establishes strong evidence of the deleterious effect of diabetes on periodontal health as associated with gingival inflammation and calculus formation. Routine oral health screenings and preventive care for diabetic patients is important

Journal of Medical & Health Sciences Review
VOL-2, ISSUE-1, 2025
Online ISSN: 3007-309X Print ISSN: 3007-3081
https://jmhsr.com/index.php/jmhsr

to reduce the risk of periodontal disease, states findings. Different mechanisms are yet to be understood, and effectiveness of periodontal interventions in improving oral health outcomes for diabetic patients has not been evaluated.

Conclusion

Finally, this study illustrates the major influence of diabetes on oral health, especially in terms of gingival inflammation and calculus formation. The results also showed that there was a higher Gingival Index (GI) and Calculus index (CI) scores the diabetic patients compared to the non diabetic patients, suggesting that the diabetic group had more severe periodontal conditions. Such findings agree with previous studies, which have demonstrated that diabetes, whenever inadequately controlled, is a major risk factor for worsening periodontal disease by causing an altered immune response, attenuated wound healing, and increased bacterial growth. The study points out the significance of awareness and preventive measures to be taken by diabetic patients to save their oral health. Though periodontal disease is thought to complicate diabetes mellitus, regular dental check-ups, proper oral hygiene practices, and good blood glucose control all reduce the risk of periodontal disease. Healthcare providers should also take into account the oral health of diabetic patients as a part of diabetes management. This study offers an insight into the association between periodontal disease and diabetes; however, further researches are required to illuminate the biological mechanisms, long-term effects of glycemic control on oral health, and efficacy of the preventive intervention. It would be of interest to better understand in longitudinal and clinical trial settings how diabetes affects periodontal conditions with time and develop appropriate treatment options for the diabetic population. In general, this research highlights the significance of a comprehensive strategy on diabetes management giving attention to oral health as vital as managing blood sugar levels is toward enhancing the standard quality of life for diabetic individuals.

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