Evaluation and comparison of metabolic status of Type II diabetes mellitus and chronic periodontitis in patient with and without non-surgical periodontal therapy using glycosylated haemoglobin assay in a North Indian Population.

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Abstract:
Background: Type II diabetes mellitus (T2DM) and chronic periodontitis are two chronic inflammatory conditions that exhibit a bidirectional relationship. Poor glycemic control in diabetic patients exacerbates periodontal disease, while periodontal inflammation may worsen glycemic control. This study aims to evaluate the effect of non-surgical periodontal therapy on the periodontal and metabolic status of T2DM patients with chronic periodontitis over three months using glycosylated hemoglobin (HbA1c) as a biomarker. The study also compares these outcomes with those observed in patients undergoing surgical periodontal treatment.
Materials and methods: A total of 100 patients suffering from T2DM with chronic periodontitis were divided into two groups. Group A consisted of patients with non-surgical periodontal therapy, and Group B consisted of patients without non-surgical periodontal therapy but received only oral hygiene instructions.
Result: In group A, mean glycated hemoglobin (HbA1c) level values decreased significantly, indicating improved glycemic control. Probing depth and clinical attachment level decreased, and gingival index scores dropped down, between the baseline and after 3 months of non-surgical periodontal treatment, and was statistically significant ($p < 0.05$) thus indicating improved periodontal health. Group B, which did not undergo non-surgical periodontal treatment exhibited statistically insignificant difference between the baseline and after 3 months in glycated hemoglobin levels, periodontal depth and clinical attachment level ($p > .05$) but Gingival Index (GI) showed statistically significant difference between the baseline and after three months ($p < 0.05$).
Conclusion: The findings suggest that, with non-surgical periodontal therapy, significant improvement was observed in the periodontal and metabolic health of T2DM patients. While patients without non-surgical treatment, there was insignificant improvement in the periodontal (other than GI) and metabolic health in T2DM patients. These results underscore the importance of periodontal care in managing T2DM and highlight the potential of periodontal therapy to improve systemic health outcomes in diabetic patients.
Kerwords: Type II diabetes mellitus(T2DM), glycosylated hemoglobin (HbA1c), with and without non-surgical periodontal therapy, periodontal and metabolic status, oral hygiene.

Introduction:

Diabetes mellitus (DM) is one of the leading chronic health concerns worldwide, affecting millions of individuals across various populations. It is a group of metabolic disorders characterized by elevated blood glucose levels due to defects in insulin production, insulin action, or both. The prevalence of DM has nearly doubled globally since 1980. In India, the International Diabetes Federation reports that 61.3 million people suffer from DM, which is expected to rise to 101.2 million by 2030 [1]. Alarmingly, nearly 40–50% of affected individuals are unaware of their condition, posing a significant public health concern. Among the two primary types of DM, type II diabetes mellitus (T2DM) is the most common, accounting for 90–95% of all cases. T2DM is characterized by insulin resistance and progressive failure in insulin production, often leading to chronic hyperglycemia and systemic complications [2].

One of the lesser-known yet significant complications of T2DM is its relationship with periodontal disease, which is now recognized as the "sixth complication" of diabetes [3]. Chronic periodontitis is a common inflammatory condition affecting the teeth' supporting structures, primarily driven by anaerobic bacteria such as *Porphyromonas gingivalis* and *Prevotella intermedia*. Studies show that T2DM patients, particularly those with poor glycemic control, are more susceptible to periodontal destruction, with more severe and extensive tissue loss compared to non-diabetic individuals. Chronic hyperglycemia in T2DM impairs tissue repair and creates an environment conducive to periodontal damage [4].

Conversely, periodontitis can negatively impact glycemic control in T2DM. Periodontal infection leads to the release of pro-inflammatory mediators like tumor necrosis factor-α (TNF-α), interleukin-1β, and prostaglandin E2, which contribute to insulin resistance and exacerbate hyperglycemia [5,6]. This bidirectional relationship between T2DM and periodontitis suggests that improving periodontal health may positively affect metabolic control.

Monitoring blood glucose levels in diabetic patients is essential for managing the disease. The glycosylated hemoglobin (HbA1c) assay, which reflects average blood glucose levels over three months, is reliable for assessing long-term glycemic control. This study aims to evaluate the effects of non-surgical periodontal therapy on both periodontal and metabolic outcomes in T2DM patients, using HbA1c levels as an indicator of metabolic improvement.

Materials and methods:

This clinical study comprised 100 subjects suffering from type II diabetes mellitus with generalized chronic periodontitis and who visited the department of periodontology. The subjects were divided into two groups (fifty subjects in each group). Group A (Test group) consists of Type II diabetes mellitus with chronic periodontitis who underwent non-surgical periodontal therapy. In contrast, group B (Control group) comprises Type II diabetes mellitus with chronic periodontitis who did not undergo non-surgical periodontal treatment.
The armamentarium used for scaling and root planing included a mouth mirror, Explorer No. 17 and 23, a UNC periodontal probe, and cotton tweezers with cotton is shown in Fig.1. Scalers such as the U 15/30 sickle scaler and anterior and posterior Jacquette scalers were utilized, along with Gracey curettes numbered 1/2, 3/4, 5/6, 7/8, 9/10, 11/12, and 13/14 for precise instrumentation.

A 2 ml disposable syringe, 23-gauge needle, and tourniquet were used for blood sample collection. Surgical spirit-maintained asepsis and cotton were applied post-procedure. Blood samples were collected in vials containing 0.2 mg of EDTA as an anticoagulant.

Fig. 1: Armamentarium

PROCEDURE

Periodontal parameters, including the Gingival Index (GI), periodontal probing depth (PD), and clinical attachment level (CAL), were assessed to monitor the impact of periodontal therapy. These measurements were taken at baseline as shown in Fig. 2 and again three months after treatment in Group A, which received non-surgical periodontal therapy. In contrast, Group B, which did not receive any periodontal treatment during the study period, was assessed under the same timeline. Data for both groups were carefully recorded using a standardized case history form.

Fig.2: Pre-scaling and root planning

The **Gingival Index (GI)** was used to evaluate the severity of gingival inflammation by examining four surfaces of each tooth (distofacial, facial margin, mesiofacial, and lingual). A blunt UNC probe was used to assess tissue bleeding potential, with scores ranging from 0 (normal gingiva) to 3 (severe inflammation with spontaneous bleeding). The average score per tooth was calculated, and an overall GI score for each participant was obtained by averaging scores from all teeth. Gingival health was categorized into mild (0.1-1.0), moderate (1.1-2.0), and severe (2.1-3.0) gingivitis based on these scores.

Fig. 3 shows periodontal probing depth (PD), Which was measured as the distance from the gingival margin to the base of the periodontal pocket. A periodontal probe was used to explore six sites around each tooth, excluding third molars, with the most profound reading from each site recorded. The PD score for each individual was determined by averaging the depths from all examined teeth, providing an accurate reflection of the periodontal condition.

Fig. 3 Periodontal Probing Depth (PD)

Clinical attachment level (CAL) was assessed by measuring the distance between the cementoenamel junction (CEJ) and the pocket base. When the gingival margin was above the CEJ, the CAL was calculated by subtracting the distance between the margin and the CEJ from the total probing depth. If the margin was at or below the CEJ, this distance was added to the pocket depth to determine attachment loss. Like PD, CAL was measured at six sites per tooth, with an average score calculated for each participant.

Three months after treatment, both groups underwent a re-evaluation of their periodontal status. In **Group A**, non-surgical periodontal therapy involved supragingival scaling with an ultrasonic device, followed by subgingival scaling and root planning over two sessions within two weeks and the outcome is as shown in Fig.4. Participants in **Group B** received only oral hygiene instructions at baseline, with no active treatment provided. Both groups were instructed to continue their usual medical treatment, dietary habits, and lifestyle without modification throughout the study period, ensuring consistency in external factors that could influence the results.

This approach allowed for a clear comparison of the effects of non-surgical periodontal therapy on clinical periodontal and metabolic outcomes over the three-month study period.

Fig. 4 Post Scaling and root planing

Inclusion/exclusion criteria:

The study's inclusion criteria were subjects aged between 35 and 70, with at least 16 teeth (excluding third molars), and diagnosed with generalized chronic periodontitis. Additionally, participants had to have been receiving treatment for type II diabetes mellitus for at least one year, with no modifications to their medication in the three months before and during the study. Subjects were required to have a periodontal probing depth of 5 mm or less.

Exclusion criteria included pregnant and lactating females, individuals with a history of current or past smoking, those who had undergone periodontal treatment in the past six months, and those who had taken systemic antibiotics within the last three months. All participants provided informed written consent before being included in the study.

Results:

There were 50 participants in each group. In Group A, the mean age of males was 48.83 ± 9.29 years, and the mean age of females was 49.14 ± 10.61 years. In Group B, the mean age of males was 43.68 ± 7.23 years, and the mean age of females was 42.64 ± 6.83 years.

TABLE-1: Mean Age of Study Participants by Gender in the Two Groups:

Group	Gender	N	Minimum	Maximum	Mean	Std. Deviation
A	Male	36	35	68	48.83	9.29
	Female	14	34	70	49.14	10.61
B	Male	25	35	65	43.68	7.23
	Female	25	35	60	42.64	6.83

Table 2 compares clinical parameters within groups at different time intervals, including glycated hemoglobin levels, gingival index scores, probing depth, and clinical attachment levels measured at baseline and after three months.

In Group A, the mean glycated hemoglobin levels decreased from 6.79 ± 0.51% to 6.68 ± 0.48%, while gingival index scores dropped from 1.79 ± 0.29 to 1.60 ± 0.13. Additionally, probing depth reduced from 4.44 ± 0.40 mm to 4.05 ± 0.23 mm, and clinical attachment level improved from 4.56 ± 0.39 mm to 4.37 ± 0.34 mm following non-surgical periodontal treatment. These changes were statistically significant (p = 0.00).

In Group B, glycated hemoglobin levels slightly increased from 6.81 ± 0.75% to 6.82 ± 0.71%. The gingival index scores decreased marginally from 1.87 ± 0.16 to 1.85 ± 0.15, probing depth changed from 4.67 ± 0.44 mm to 4.66 ± 0.44 mm, and clinical attachment levels showed a reduction from 4.83 ± 0.44 mm to 4.81 ± 0.44 mm between baseline and the three-month follow-up. No statistically significant differences were observed in glycated hemoglobin levels, probing depth, or clinical attachment level (p > 0.05). However, the gingival index revealed a statistically significant difference between the baseline and the three-month assessment (p = 0.00).

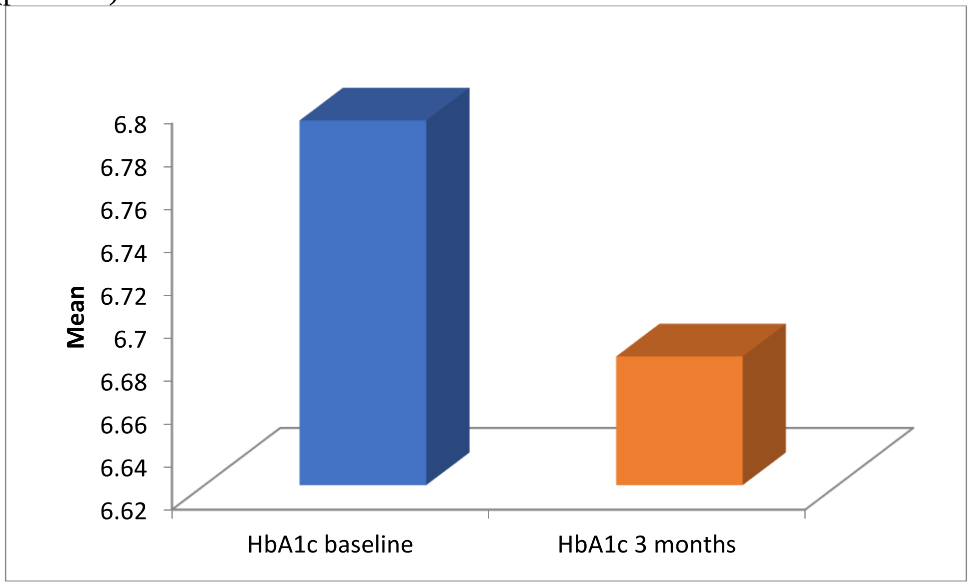
TABLE-2: Comparison of Clinical Parameters at Various Time Intervals Within the Groups

Group	Parameters	Mean	Std. Deviation	Paired Difference	t	p value
A	HbA1c baseline	6.79	0.51	.10	8.59	.00*
	HbA1c 3 months	6.68	0.48			
	GI baseline	1.79	0.29	.19	4.80	.00*
	GI 3 months	1.60	0.13			
	PD baseline	4.44	0.40	.39	11.39	.00*
	PD 3 months	4.05	0.23			
	CAL baseline	4.56	0.39	.20	12.92	.00*
	CAL 3 months	4.37	0.34			
B	HbA1c baseline	6.81	0.75	-.01	-.55	.59
	HbA1c 3 months	6.82	0.71			
	GI baseline	1.87	0.16	.02	3.97	.00*
	GI 3 months	1.85	0.15			
	PD baseline	4.67	0.44	.01	1.02	.31

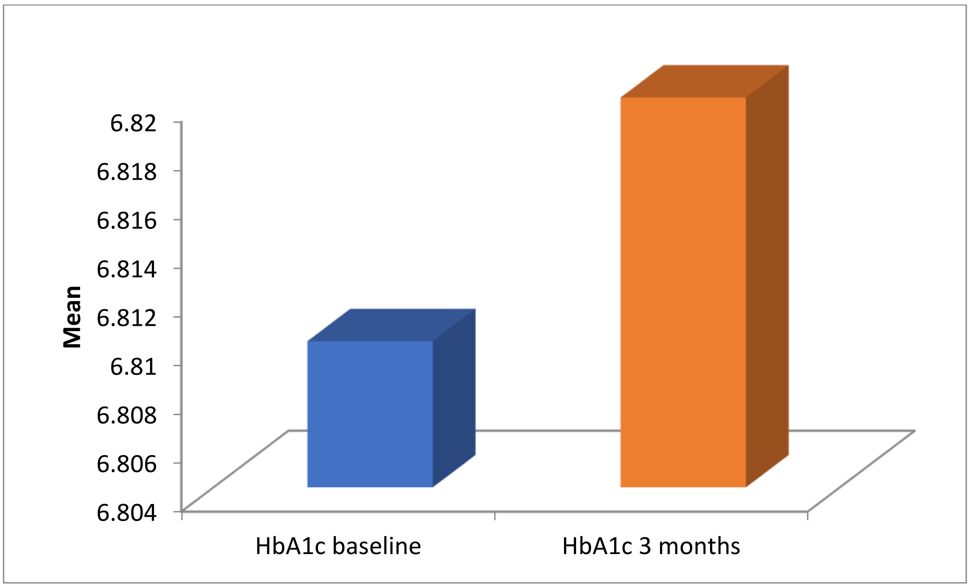
	PD 3 months	4.66	0.44			
	CAL baseline	4.83	0.44	.02	1.16	.25
	CAL 3 months	4.81	0.44			

* Statistically significant

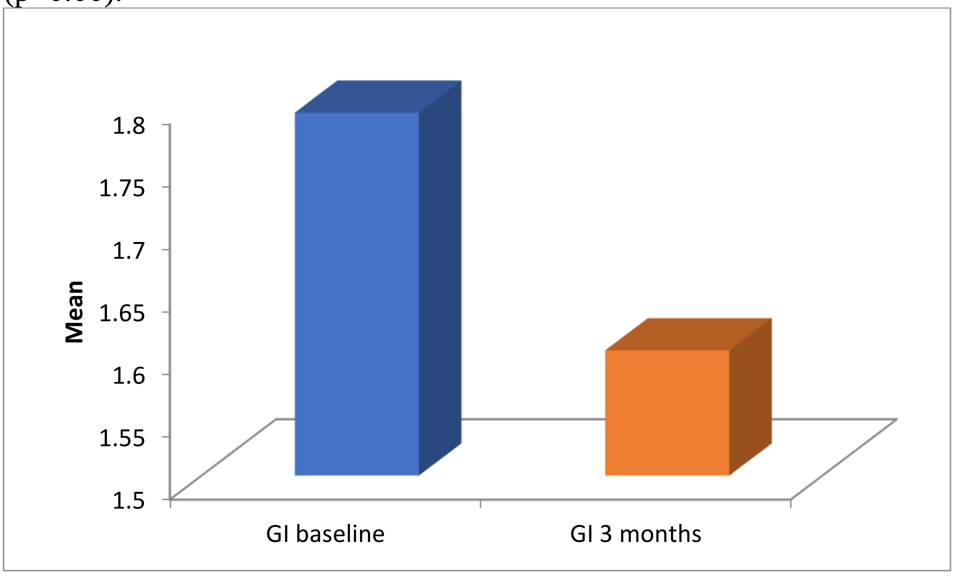
GRAPH-1: Mean HbA1c comparison between at baseline and after three months in group A. Three months after nonsurgical periodontal therapy, group A significantly reduced HbA1c levels (p = 0.00).



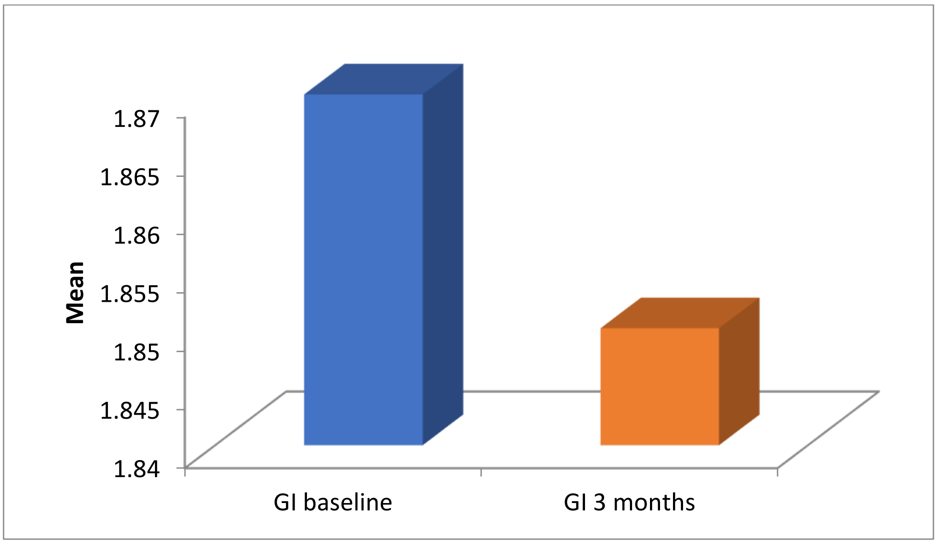
GRAPH-2: Mean HbA1c comparison between baseline and after three months in group B. After three months, group B showed a statistically insignificant increase in HbA1c level (p = 0.59).



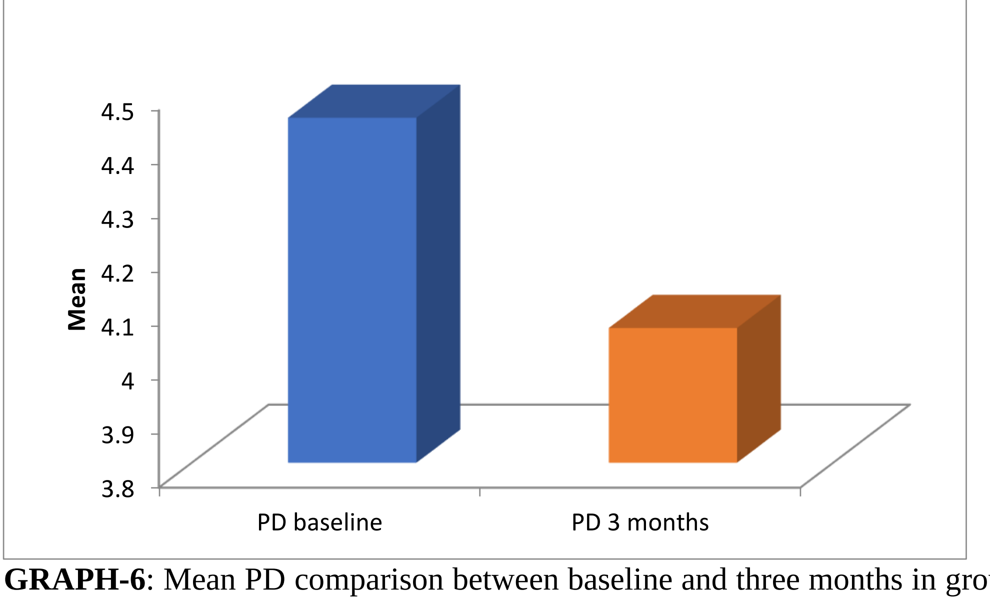
GRAPH-3: Mean GI comparison between baseline and after three months in group A. Three months after nonsurgical periodontal therapy, group A significantly reduced gingival index (p=0.00).



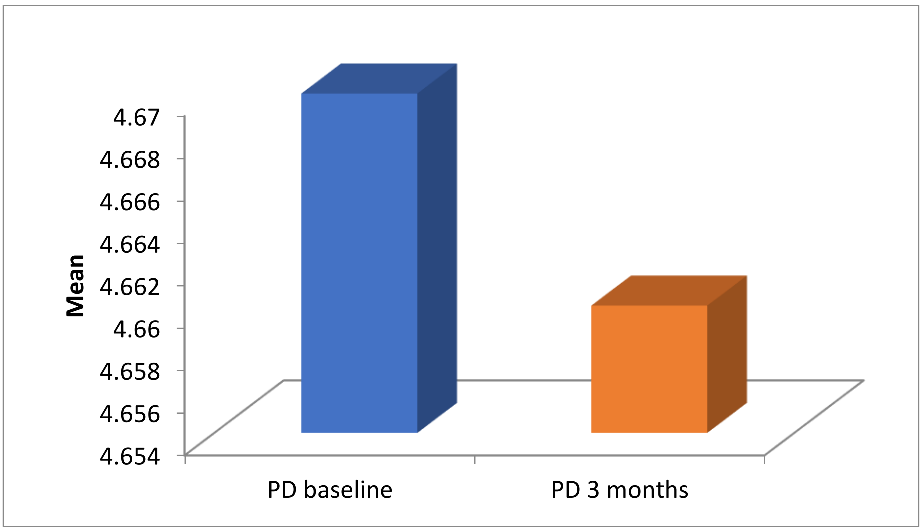
GRAPH-4: Mean GI comparison between baseline and three months in group B. After three months, group B significantly reduced the gingival index (p=0.00).



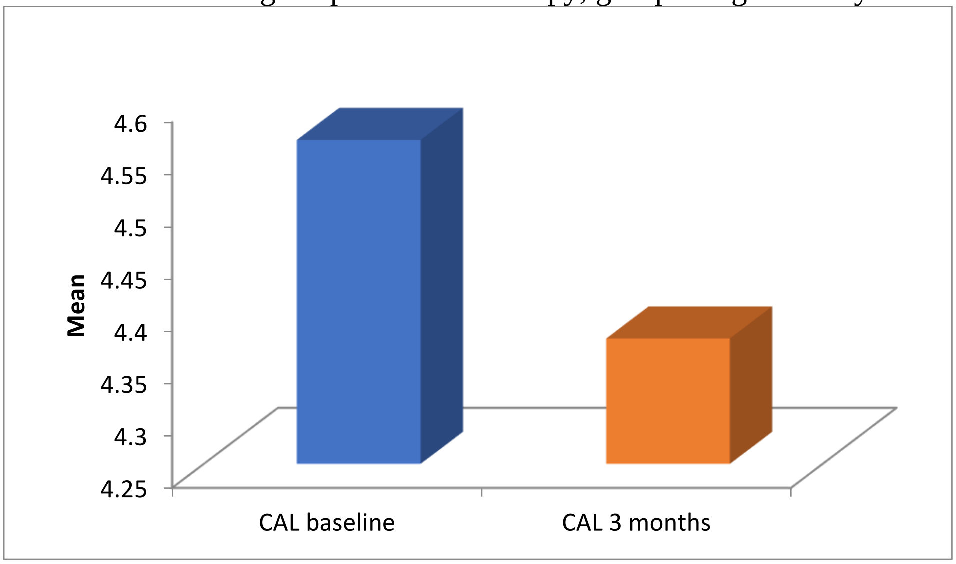
GRAPH-5: Mean PD comparison between baseline and after three months in group A. Three months after nonsurgical periodontal therapy, group A significantly reduced PD (p = 0.00).



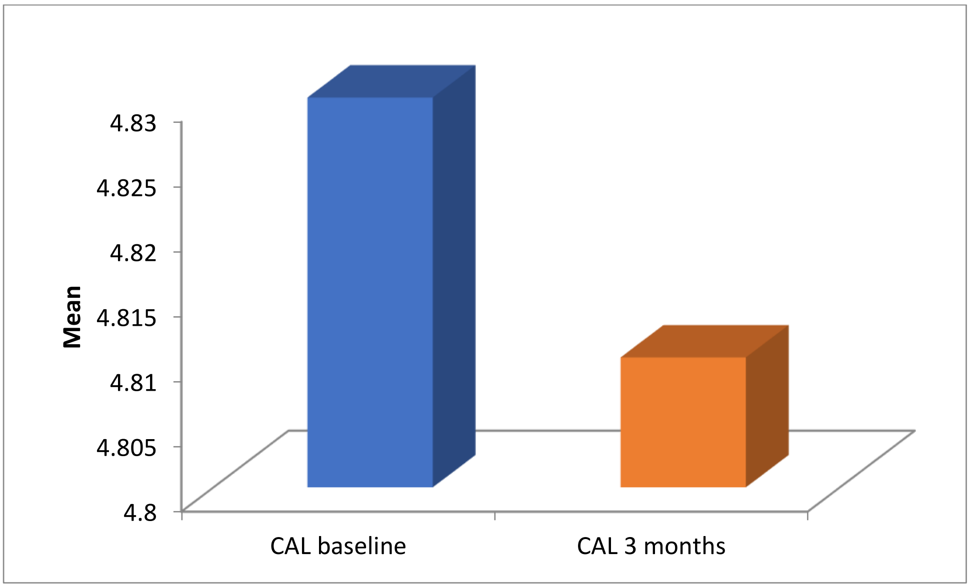
GRAPH-6: Mean PD comparison between baseline and three months in group B. After three months, group B did not show a significant reduction in PD (p = 0.31).



GRAPH-7: Mean CAL comparison between baseline and after three months in group A. Three months after nonsurgical periodontal therapy, group A significantly reduced CAL (p = 0.00).



GRAPH-8: Mean CAL comparison between baseline and three months in group B. After three months, group B did not show a significant reduction in CAL (p = 0.25).



EVALUATION OF METABOLIC STATUS:

Patients were seated comfortably, and a 2 ml sample of venous blood was drawn using a sterile disposable syringe and a 23-gauge needle. The collected blood was transferred to a vial containing 0.2 mg of EDTA, which was then labeled and transported to the laboratory for glycosylated hemoglobin (HbA1c) estimation. There has been considerable interest in using HbA1c as a diagnostic test for diabetes, as it reflects the average blood glucose levels over the past two to three months and serves as a screening tool for individuals at increased risk for the disease. HbA1c levels were measured at baseline and again after three months for both study groups. Typical HbA1c values are categorized as follows: Normal (below 6.0%), prediabetes (6.0% to 6.4%), and diabetes (6.5% or higher).

Statistical analysis:

The collected data were entered into MS Excel 2007 to compare the effects of non-surgical periodontal treatment in Group A with no treatment in Group B regarding glycated hemoglobin levels, gingival index, probing depth, and clinical attachment levels at baseline and three months. The data were analyzed using a paired T-test, with a significance level of $p < 0.05$. Pearson’s correlation test was also conducted to investigate the relationship between inflammation, periodontal destruction, and glycated hemoglobin levels at baseline and after three months.

Discussion:

According to the International Diabetes Federation, approximately 61.3 million people in India are currently affected by diabetes mellitus, a number projected to rise to 101.2 million by 2030. Alarmingly, about 40 to 50% of these individuals remain unaware of their condition. The first formal acknowledgment of the relationship between systemic diseases and periodontal health was made during the American Academy of Periodontology (AAP) international workshop on the classification of periodontal diseases in 1999 [7]. This workshop established the bidirectional relationship between chronic periodontitis and diabetes mellitus. Notably, Loe et al. proposed that periodontitis should be considered the sixth complication of type II diabetes [8, 9]. Furthermore, the current guidelines from the American Diabetes Association emphasize that individuals with chronic infections, such as gum diseases, may be at an elevated risk for developing diabetes.

The primary objective of our study was to manage periodontal infections and subsequently assess metabolic control of diabetes by evaluating changes in blood HbA1c levels after three months. Traditionally, diabetes mellitus has been diagnosed and monitored through fasting blood glucose levels. However, recent advancements in diagnostic techniques have led to the development of methods that do not require fasting and do not rely on patient compliance. These newer methods provide a more accurate indication of blood glucose levels over extended periods, exemplified by the HbA1c assay.

HbA1c is a crucial marker for evaluating glycemic control in patients with type II diabetes, as it reflects the binding of glucose to hemoglobin over the lifespan of red blood cells (approximately 30–90 days). A study by Demmer et al. highlighted that, in non-diabetic patients, periodontitis could anticipate the progression of HbA1c levels, suggesting that reducing periodontal inflammation could potentially lower the risk of developing diabetes. As a result, HbA1c levels were measured at baseline and three months after scaling and root planing treatment [10].

Our findings showed a significant improvement in the gingival index score for Group A, with a reduction from 1.79 ± 0.29 at baseline to 1.6 ± 0.13 after three months, demonstrating high statistical significance ($p = 0.00$). In Group B, a slight reduction in the gingival index score from 1.87 ± 0.16 to 1.85 ± 0.15 was also noted, which was statistically significant ($p = 0.00$). These results align with previous studies, such as those conducted by Raman et al., which indicated a substantial reduction in gingival index scores among Type II diabetic patients with chronic periodontitis two months post-therapy [11].

Similar studies conducted by Koromantzos PA *et al.* showed that the gingival index scores improved significantly ($p < 0.01$) and provided evidence that periodontal treatment contributes to reducing the gingival index score.[12]
A similar study by Almas K *et al.*, Page *et al.*, and Lee KH *et al.* found favorable results in assessing the effect of oral hygiene instructions on periodontal disease among type II diabetes mellitus patients. Oral hygiene instructions given to patients were to use an oral B medium toothbrush and brush three times daily using the bass technique for two minutes. The results showed a significant reduction in gingival index score ($p = 0.00$) [13,14,15].

The mean probing depth in Group A decreased significantly from 4.44 ± 0.4 mm at baseline to 4.05 ± 0.23 mm after non-surgical periodontal therapy ($p = 0.00$). In contrast, Group B showed an insignificant reduction in probing depth from 4.67 ± 0.44 mm to 4.66 ± 0.44 mm ($p = 0.31$). Previous studies, such as those by Rodrigues et al., corroborate these findings, showing a 25% reduction in probing depth following non-surgical periodontal therapy [16].

Regarding clinical attachment levels (CAL), Group A exhibited a significant improvement, with scores changing from 4.56 ± 0.39 mm at baseline to 4.37 ± 0.34 mm after therapy ($p = 0.00$). Conversely, Group B's CAL showed an insignificant reduction from 4.83 ± 0.44 mm to 4.81 ± 0.44 mm ($p = 0.25$). These findings are consistent with studies by Goel et al., which reported significant reductions in CAL after non-surgical periodontal therapy in Type II diabetes patients [17].

The relationship between probing depth and CAL indicates periodontal inflammation and destruction, suggesting that effective management of local periodontal inflammation may positively influence systemic glycemic control. In our study, HbA1c levels in Group A decreased from 6.79 ± 0.51% to 6.68 ± 0.48% after three months (p = 0.00). Meanwhile, Group B experienced a slight increase in HbA1c from 6.81 ± 0.75% to 6.82 ± 0.71% (p = 0.59). These findings indicate that non-surgical periodontal therapy can significantly reduce HbA1c levels, especially in patients with more severe diabetes and periodontal disease.

Our results align with previous research, such as that by Rodrigues et al., which demonstrated improved glycemic control following periodontal therapy. Similarly, Kiran et al. found significant decreases in HbA1c levels in treatment groups receiving full mouth scaling and root planing compared to controls [18]. Koromantzos et al. reported substantial reductions in HbA1c levels among Type II diabetes patients after non-surgical therapy [12].

Contrarily, a few studies, such as those by Engebretson et al. and Mizuno et al., suggested that non-surgical periodontal treatment did not significantly improve glycemic control. These inconsistencies may arise from differences in study designs or patient populations [19,20].

In conclusion, our study reinforces the understanding of the bidirectional relationship between diabetes mellitus and periodontitis. Treatment of periodontal infections in diabetic patients can reduce inflammatory mediators contributing to periodontal tissue destruction and improve insulin sensitivity. The effective management of periodontal disease through non-surgical therapy leads to lower HbA1c levels, supporting that periodontal health plays a significant role in glycemic control among diabetic patients.

Conclusion:

Periodontal therapy has proven effective in treating periodontal infections and improving metabolic control by reducing HbA1c levels in patients with type II diabetes mellitus, alongside enhancements in periodontal parameters. However, it is essential to note that the observed improvements in glycemic control and reductions in inflammatory markers may also be influenced by dietary factors, which were not controlled in our study. Therefore, further research involving a larger sample size and controlled dietary conditions must validate these findings. Nonetheless, we can conclude that incorporating periodontal therapy into existing medical treatments shows promising results in enhancing glycemic control for diabetic patients.

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