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Periodontal treatment and HbA1c levels in subjects with diabetes mellitus

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SUMMARY It has earlier been reported that individuals with poorly controlled diabetes have severe periodontal disease (PD) compared to well-controlled diabetes. This longitudinal interventional study compared periodontal treatment outcomes with HbA1c level changes in four groups of diabetic and non-diabetic patients with or without PD, respectively. HbA1c, bleeding on probing (BOP), plaque index and periodontal pocket depth (PPD) 4 < 6 mm and ≥6 mm were recorded at baseline to 3 months after non-surgical treatment and 3–6 months for surgical treatment in subjects with or without T2D, and with or without PD. A total of 129 patients were followed from baseline to 6 months. Diabetics with PD and without PD showed reductions in HbA1c levels with a mean value of 0·3% after 3 months and mean values of 1% and 0·8%, respectively, after 6 months. Diabetics with PD showed higher levels of BOP versus non-diabetics without PD ($P < 0·01$) and versus diabetics without PD ($P < 0·05$) at baseline. After 6 months, diabetics with PD showed higher number of PPD 4 < 6 mm versus diabetics without PD ($P < 0·01$) and non-diabetics with PD ($P < 0·01$). Diabetics without PD showed higher levels of PPD 4 < 6 mm versus non-diabetics without PD ($P < 0·01$). Surgical and non-surgical periodontal treatment in all groups improved periodontal inflammatory conditions with a decrease in HbA1c levels in a period of three and 6 months. No change was seen in the number of pockets PPD 4 < 6 mm in diabetic subjects with PD after non-surgical and surgical treatment.

KEYWORDS: dental plaque indexes, gingival bleeding on probing, HbA1c, periodontal disease, type 2 diabetes mellitus

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Introduction

Periodontal disease (PD) is an oral inflammatory condition commonly induced by bacteria that destroys the supporting tissues of the teeth (1). Periodontal disease has been reported as a strong predictor in subjects with T2D as a result of insulin resistance and is considered to be one of the six complications of diabetes (2, 3). Previously, it has been reported that individuals with poorly controlled diabetes have severe PD as compared to well-controlled diabetes (4). HbA1c is also called glycosylated haemoglobin and is formed when haemoglobin binds with glucose. HbA1c has been able to accurately measure average plasma glucose concentrations over a period of 8–12 weeks (5).

It has been reported in short-term trials that periodontal treatment with or without antibiotics improves periodontal conditions and glycemic control in diabetic subjects (6). In a study by Al-Mubarak's *et al.* (7), the researchers reported a reduction in HbA1c levels and an improved periodontal condition after periodontal treatment comprising of ultrasonic scaling, root planning and subgingival water irrigation in the control and test group. In another study by Rocha *et al.* (8), subjects with PD and T2D received

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periodontal treatment. In addition, the test group received alendronate 10 mg day^{-1}, while the control group was given multivitamins as placebo. The results showed improvements in periodontal conditions, but no changes in HbA1c levels in the test group. In the study by Kiran *et al.* (9), the authors reported improvement in periodontal condition and blood glucose levels of patients with T2D over a 3-month period as compared to the patients in the control group.

In a number of reported studies, diabetic subjects received periodontal treatment and have also been treated with antibiotics (10–13). In five studies, the mean values of HbA1c at baseline ranged from 7·31% to 9·89%. After periodontal treatment, with or without antibiotics, HbA1c levels in diabetic subjects decreased in 3 months post-treatment, and the mean values varied between 0·3% to 0·8% (7, 9–11, 13). In two studies, subjects were evaluated after 6 months and showed a decrease in mean values of HbA1c levels of 0·2% and 2·5%, respectively (8, 12).

In four studies, the reported periodontal pocket depth (PPD) mean values were between 2·3 and 3·86 mm at baseline, and after periodontal treatment, there was a decrease from 0·4 to 0·8 mm in the 3-month period after treatment (9–11, 13). Three studies have reported PPD with mean values between 3·5 and 4·1 mm at baseline, and after periodontal treatment, there was a measured decreased in PPD, with mean values ranging from 0·51 to 1·3 mm after 6 months (7, 8, 12).

Diabetes mellitus has also been described to be a risk factor for gingivitis, and poorly controlled diabetic subjects have higher gingival bleeding scores compared to non-diabetics and well-controlled diabetics (14).

There is a lack of research on the efficacy of surgical versus non-surgical treatments in reducing HbA1c levels and therefore must be investigated further.

The aim of this study was to investigate and compare the effect of non-surgical and surgical periodontal treatment outcomes on HbA1c levels in Pakistani diabetic and non-diabetic patients with or without periodontal disease.

To our knowledge, this is the first time a research on periodontal conditions and HbA1c levels has been investigated and evaluated in four comparison subject groups. The four groups used in this research include diabetic patients with or without PD and non-diabetic patients with or without PD, respectively.

Materials and methods

Ethical aspects

The ethical committees: Regional Ethical Review Board in Stockholm, Sweden, and Ethical committee at Altamash Institute of Dental Medicine, Karachi, Pakistan, approved the study design in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Study design

The study design chosen for this research was longitudinal comparative design on four groups of diabetic and non-diabetic subjects with and without periodontal disease. As patients who enrolled in the study were actual patients who came to Altamash Dental Hospital to avail periodontal treatment, it was not possible to assign them to a control group which is a primary requirement of a randomised control trial (RCT). The patients could not be assigned randomly to the four groups due to their peculiar diabetic state and periodontal treatment needs. This prevented adopting the RCT design like preceding studies according to the standards placed by CONSORT guidelines, which require randomised allocation of the participants at very early stages.

A total of 330 subjects were examined at Altamash Institute of Dental Medicine, Karachi, Pakistan. Inclusion criteria included individuals aged 25 years or older. Exclusion criteria included subjects with current or previous history of hepatitis and HIV/AIDS and subject who are edentulous and pregnant. Patients with a prior history of using narcotics, non-steroidal anti-inflammatory drugs, antibiotics or blood thinners were also excluded.

The purpose of research was explained to the subjects, and informed consent form written in Urdu was obtained. The subjects were then given a questionnaire form to fill out. The patients were analysed in three stages. In the first stage the patient's periodontal condition was assessed, and based on these findings and their diabetic state, they were assigned to their appropriate group. Non-surgical and surgical treatment modalities for periodontal disease were achieved. Non-surgical treatment included root planning, supra and subgingival scaling for PPD $4 < 6$ mm. Surgical treatment included modified Widman flap surgery with scaling and root planning for elimination of PPD ≥ 6 mm.

At the baseline, all participants were given supragingival scaling therapy, oral hygiene instructions and plaque control assessment. The patients were then assessed after 3 months. Both diabetic and non-diabetic patients with PPD <6 mm were given another treatment of subgingival scaling. Those patients (diabetic and non-diabetic) with PPD ≥ 6 mm were given periodontal treatment with modified Widman flap (15). Individuals receiving periodontal surgery were given post-operative instructions of rinsing with 0·2% chlorhexidine mouthwash thrice a day for 3 weeks. Subjects with and without PD were recalled after 6 months to be examined for periodontal conditions and blood glucose levels.

HbA1c

All individuals were examined for HbA1c levels at baseline, 3 and 6 months post-treatment. HbA1c levels were determined from venous blood that was collected. The samples were analysed at Karachi Laboratory Diagnostic Center, Karachi, Pakistan. Roche Diagnostic®* Hemoglobin A1c II method was used to analyse the specimens on a Hitachi Modular P Analyzer.† Subjects with HbA1c levels ≥6·5% (48 mmol HbA1c/mol Hb) were categorised as diabetics (16).

Periodontal examination

Measurements of BOP, PI and PPD were recorded by a dental hygienist. The dental hygienist and the author (M.A) calibrated periodontal measurements of PPD in 15 subjects and compared their results as earlier reported (4). A graded probe‡ was used to assess PPD to the nearest millimetre. PD was defined with the criteria of at least three pockets ≥6 mm on three different teeth. PPD was recorded between 4 < 6 mm and ≥6 mm. Teeth were considered missing when roots remnants were embedded.

Statistical analysis

Statistical analyses were performed using SPSS 17.0 software§ for all diabetic and non-diabetic subjects with or without PD for PI, BOP, PPD and HbA1c levels. Mean (standard deviation) was computed for quantitative variables for PI, BOP, PPD and HbA1c and analysed by repeated measures analysis of variance (ANOVA) with a confidence interval of 95% between groups. Bonferroni was also used for variables PI, BOP and PPD.

Results

In this study, 330 individuals were examined at baseline. After 6 months, 129 subjects were clinically examined and included in the study. The study dropouts were from the lower economic classes who did not attend follow-up sessions maybe due to socioeconomic factors. Twenty-one subjects (12 males and nine females) were diabetics with PD, eight subjects (five males and three females) were non-diabetics with PD, 68 subjects were non-diabetics without PD (51 males and 17 females), and 32 subjects (15 males and 17 females) were diabetics without PD.

Age and number of teeth present at baseline

The mean age of diabetic subjects with PD, non-diabetics with PD, non-diabetics without PD and diabetics without PD was 53 (range 28–75), 46 (range 30–62), 32 (range 25–71) and 44 (range 25–69), respectively. The mean number of teeth for diabetic subjects with PD, non-diabetics with PD, non-diabetics without PD and diabetics without PD was 23 (range 11–28), 24 (range 17–28), 26 (range 5–28) and 26 (range 15–28), respectively.

HbA1c levels and periodontal conditions

HbA1c levels in diabetics at baseline are shown in Fig. 1. Diabetics with PD and without PD showed reductions in HbA1c levels with a mean value of 0·3% after 3 months, while at 6 months post-treatment, the mean recorded reduction in HbA1c levels for diabetics with PD and without PD was 1% and 0·8%, respectively.

Periodontal conditions at baseline showed PPD ≥6 mm higher in number in diabetics with PD versus diabetics without PD ($P < 0·01$) and non-diabetics without PD ($P < 0·01$). At baseline, non-diabetics with PD showed increased number of PPD ≥6 mm versus diabetics without PD ($P < 0·01$) and non-diabetics without PD ($P < 0·01$).

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†Indianapolis, IN, USA.

‡Hu-Friedy Manufacturing, Chicago, IL, USA.

§SPSS Inc., Chicago, IL,USA.

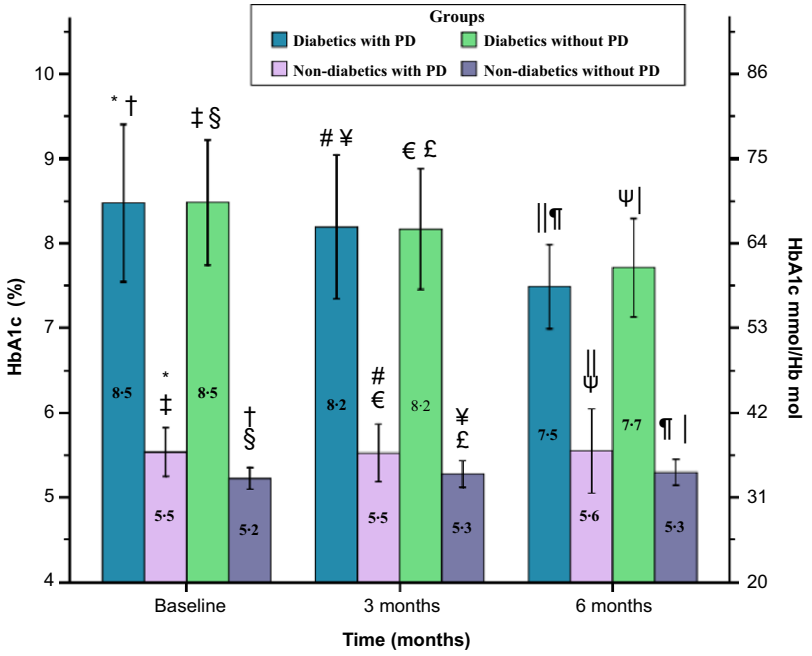

Fig. 1. Comparison of mean HbA1c among groups with respect to time. (Baseline: *$P < 0{\cdot}01$; †$P < 0{\cdot}01$; ‡$P < 0{\cdot}01$; §$P < 0{\cdot}01$) (3rd month: #$P < 0{\cdot}01$; €$P < 0{\cdot}01$; ¥$P < 0{\cdot}01$ £$P < 0{\cdot}01$) (6th month: ‖ $P < 0{\cdot}01$; Ψ $P < 0{\cdot}01$; ¶ $P < 0{\cdot}01$; | $P < 0{\cdot}01$).

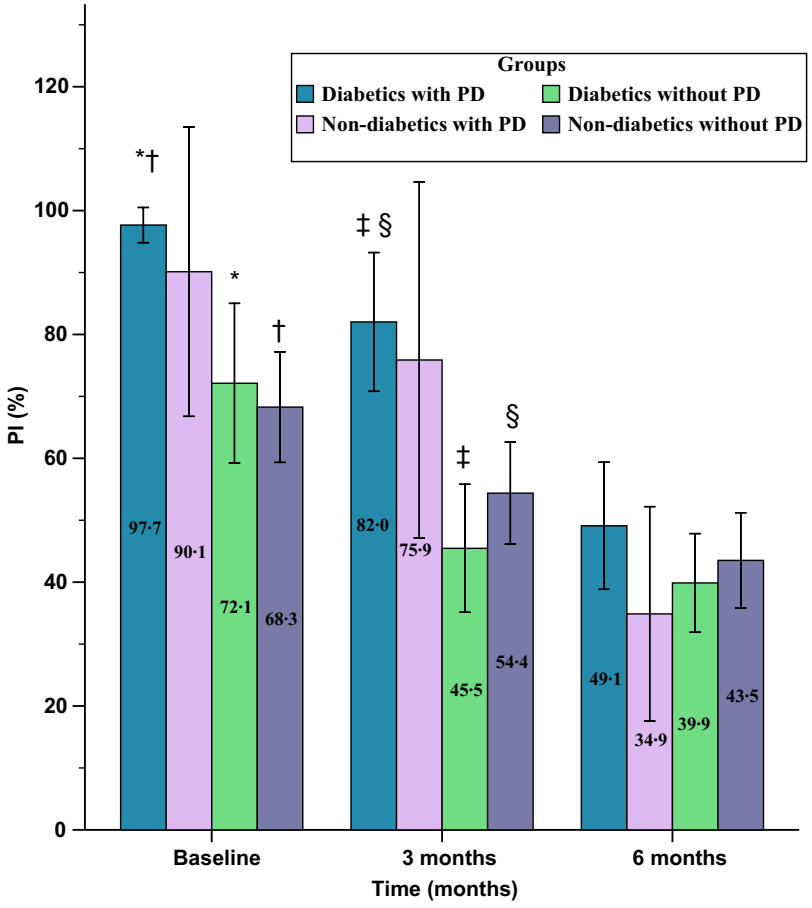

Fig. 2. Comparison of mean plaque index (%) among groups with respect to time. (Baseline: *$P < 0{\cdot}05$; †$P < 0{\cdot}05$) (3rd month: ‡$P < 0{\cdot}01$; § $P < 0{\cdot}05$).

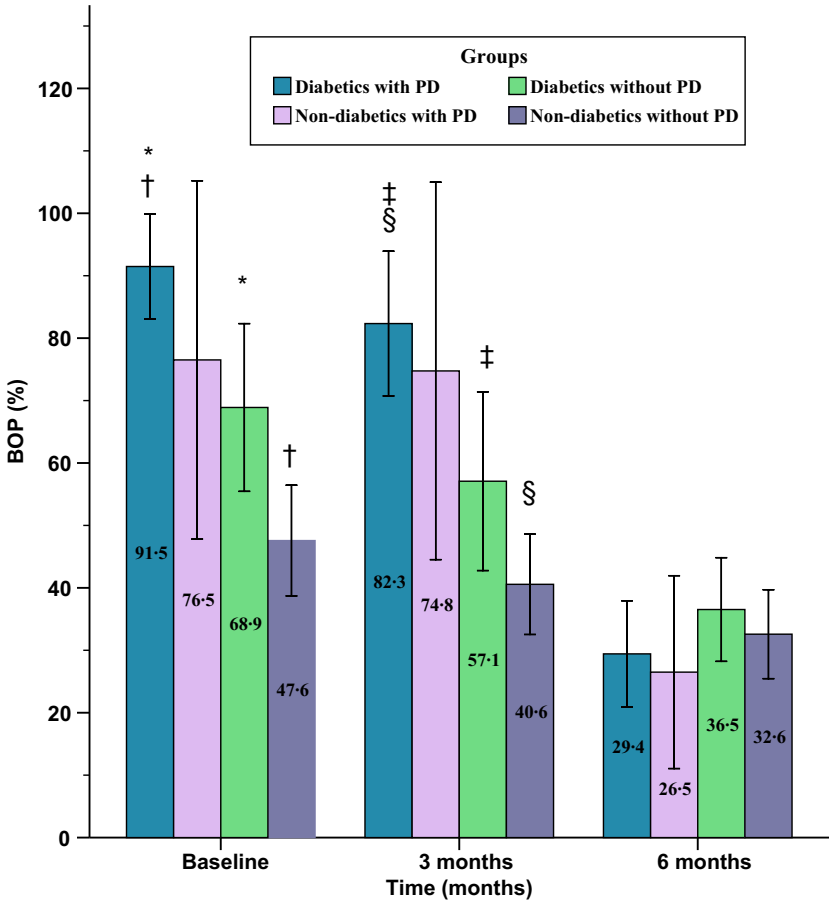

Fig. 3. Comparison of mean bleeding on probing among groups with respect to time. (Baseline: †$P < 0{\cdot}01$; *$P < 0{\cdot}05$) (3rd month: ‡$P < 0{\cdot}05$; § $P < 0{\cdot}01$).

At baseline, PPD 4–<6 mm had higher levels in diabetics with PD versus non-diabetics without PD ($P < 0{\cdot}01$). PI had higher levels in diabetics with PD versus diabetics without PD ($P < 0{\cdot}05$) and non-diabetics without PD at baseline ($P < 0{\cdot}05$). BOP at baseline also had higher levels in diabetics with PD versus non-diabetics without PD ($P < 0{\cdot}01$) and diabetics without PD ($P < 0{\cdot}05$) (Figs 2–5).

After 3 months, diabetics with PD and non-diabetics with PD showed higher levels of PPD ≥6 mm versus diabetics ($P < 0{\cdot}01$) and non-diabetic without PD ($P < 0{\cdot}01$). Higher numbers of PPD 4–<6 mm were present in diabetics with PD versus diabetics without PD ($P < 0{\cdot}05$) and non-diabetics without PD ($P < 0{\cdot}05$). Diabetics with PD showed increased levels of PI versus diabetics without PD ($P < 0{\cdot}01$) and non-diabetics without PD ($P < 0{\cdot}05$). Similarly, higher levels of BOP were presented in diabetics with PD versus diabetics without PD ($P < 0{\cdot}05$) and non-diabetics without PD ($P < 0{\cdot}01$) (Figs 2–5).

At the end of 6 months, elevated occurrences of PPD ≥ 6 mm were recorded in diabetics with PD versus diabetics without PD ($P < 0{\cdot}01$) and non-diabetics without PD ($P < 0{\cdot}01$). Increased levels of PPD ≥ 6 mm were found in non-diabetics with PD versus diabetics without PD ($P < 0{\cdot}05$) and non-diabetics without PD ($P < 0{\cdot}05$). Higher numbers of PPD 4–<6 mm were found in diabetics with PD versus diabetics without PD ($P < 0{\cdot}01$) and non-diabetics with PD ($P < 0{\cdot}01$). Diabetics without PD showed higher levels of PPD 4–<6 mm versus non-diabetics without PD ($P < 0{\cdot}05$) (Figs 4 and 5).

Discussion

In this study, we investigated and compared the effect of periodontal treatment outcomes on HbA1c levels in four groups of diabetic and non-diabetic subjects with and without periodontal disease. The study also aimed at identifying and recording the difference between

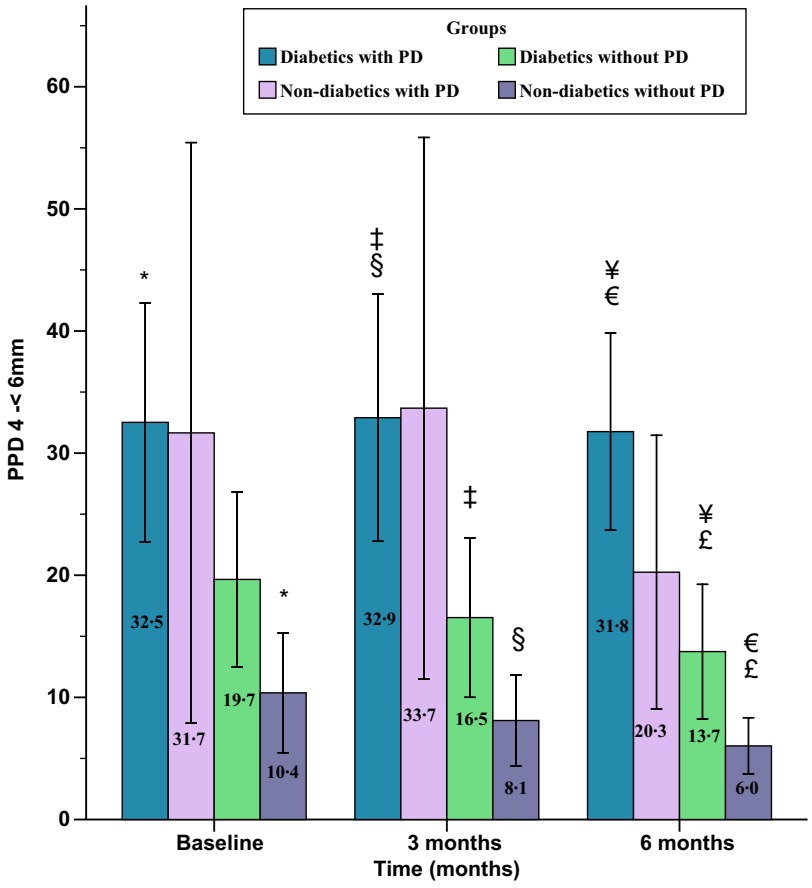

Fig. 4. Comparison of mean number of periodontal pocket depth (PPD 4 to <6 mm) among groups with respect to time. (Baseline: *$P < 0{\cdot}01$) (3rd month: ‡$P < 0{\cdot}05$; §$P < 0{\cdot}05$) (6th month: ¥ $P < 0{\cdot}01$; € $P < 0{\cdot}01$; £ $P < 0{\cdot}05$).

surgical versus non-surgical periodontal therapy in reducing HbA1c levels. The difference in PPD between subjects with and without PD was statistically analysed. Non-diabetic subjects with PD were uncommon in the study. One assumption towards this finding is that socio-economic status and low education levels contribute towards a higher frequency of diabetes (17).

Most of the individuals who dropped out occurred between the baseline and 3 months after non-surgical treatment. The high number of dropouts may be due to low socio-economic status and low education levels (18). There was only a slight improvement in periodontal conditions in diabetic and non-diabetic subjects with PD after 3 months compared to the improvement after 6 months. The decrease in disease state intensity found after 6 months was mostly likely due to reinforced education and instruction to the subjects after 3-month period, in addition to non-surgical and surgical treatment carried out at that time. The healing process in diabetic subjects with PD differed from non-diabetic subjects with PD in relation to PPD 4–<6 mm, and diabetic subjects with PD showed similar numbers of pockets after 3 and 6 months. However, non-diabetic patients with PD showed a 37% decrease in their PPD scores. The mean values of PPD ≥6 mm decreased by 73% for non-diabetics with PD and by 44% for diabetics with PD after periodontal surgery.

In several studies, a moderate reduction in 0·4% mean value of HbA1c was found among diabetic PD patients who underwent non-surgical periodontal treatment with or without antibiotics (6, 19). In our study, the reduction in HbA1c levels in diabetic subjects receiving scaling had a mean value of 0·3% after 3 months. An improved periodontal condition in accordance with decreased HbA1c levels suggests an influence of periodontal conditions on blood glucose levels. However, the discrepancy of almost unchanged periodontal conditions and a decrease in HbA1c levels after 3 months in our study may be due to the Hawthorne effect (20, 21). Even after 6 months, the Hawthorne effect cannot be ruled out.

Reductions in HbA1c levels in diabetic subjects with or without PD compared to baseline (mean value 1% and 0·8%, respectively) were noted at 6 months. A

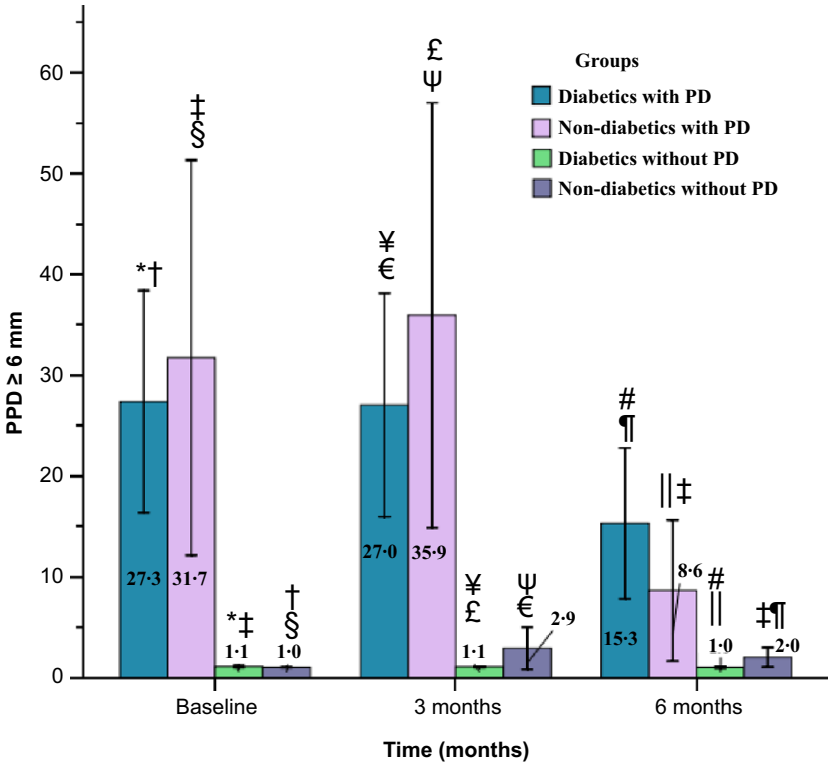

Fig. 5. Comparison of mean number of periodontal pocket depth (PPD) ≥ 6 mm with respect to time. (Baseline: *$P < 0{\cdot}01$; †$P < 0{\cdot}01$ ‡$P < 0{\cdot}01$; §$P < 0{\cdot}01$) (3rd month: ¥$P < 0{\cdot}01$; €$P < 0{\cdot}01$; £$P < 0{\cdot}01$; ΨP<0·01) (6th month #$P < 0{\cdot}01$; ¶$P < 0{\cdot}01$; ‖ $P < 0{\cdot}05$ ‡$P < 0{\cdot}05$).

reduction in 1% in HbA1c levels has been reported to correspond to a 37% decrease in microvascular complications and a 21% decrease in deaths related to diabetes (22).

In summary, there was only slight improvement in periodontal conditions during the time between baseline and 3 months. The reported changes in periodontal conditions were marginal at this point in time. However, at 3 months, blood glucose levels among diabetic group with PD and without PD decreased by the same level as has been reported in earlier studies.

Between three and 6 months, without regular checkups, there was a reduction in BOP, PI and PPD ≥6 mm for T2D patients with PD. BOP, PI and PPD 4–<6 mm levels for subjects without T2D showed a reduction in scores after 6 months as compared to the 3-month evaluation.

According to the present study, periodontal treatment should exceed 3 months to reduce blood sugar levels in subjects with diabetes mellitus. The 6-month evaluation showed a substantial decrease in blood sugar levels compared to the 3-month evaluation. A *post hoc* power calculation showed that with a sample size of more than 30 in each group, we had 90% power to detect a 10% reduction in HBA1c with 5% type I error.

Conclusions

Surgical and non-surgical periodontal treatment in all groups improved periodontal inflammatory conditions in subjects with T2D along with a decrease in HbA1c levels in a period of 3 and 6 months. There was no decrease in PPD 4 < 6 mm in diabetic subjects with PD after non-surgical and surgical treatment. The reduction in blood sugar levels in subjects with diabetes mellitus requires periodontal treatment for at least 6 months.

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Conflict of interest

No conflicts of interest declared.

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