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Periodontal Status and Glycaemic Control among Type 2 Diabetic Patients- a Comparable Study between 2 Teaching Hospitals in 2 Geographical Zones in Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: There is clinical evidence that periodontitis and diabetes mellitus (DM) are interconnected. Thus, periodontitis can promote systemic chronic inflammation that can exacerbate type 2 diabetes mellitus.
Methodology: Data was collected with self-administered questionnaire. Glycaemic control and periodontal status were evaluated by glycated Hb values and CPI respectively. Analysis was done using the Statistical Package for Social Sciences version 20.0 (IBM SPSS Statistics Armonk New York). Association of glycaemic index with periodontal status was explored by the $\chi 2$ test and statistical significance was set at $P < 0.05$.

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Results: One hundred and eighty-five participants with type 2 diabetes were recruited with a female predominance in both centers. Majority of participants were above the fifth decade. The mean duration of diabetes was 8.97±7.14. 73.3% of participants in UPTH and 84.7% in LASUTH were out of (p=0.001). One-fourth of participants in LASUTH and 14.2% of participants from UPTH had poor oral hygiene. Twice participants in LASUTH had good glycaemic control compared to those in UPTH (p=0.001). The periodontal status of majority of the participants in the two centers was between CPI score 2 and 4 (p=0.02). The association between good glycaemic control and gender and between good glycaemic control and age were statistically significant (p=0.014; p=0.001).

Conclusion: The periodontal status of participants did not worsen with poor glycaemic control. However, education was significantly associated with extent of control. Periodontal care should be incorporated into the management of the diabetics for improved quality of life.

Keywords: Demographics; DM; glycaemic control; periodontal status.

1. INTRODUCTION

Studies have reported an association between periodontal disease (periodontitis) and poor glycaemic control in diabetics [1-5].

Periodontal disease (PD) is both a chronic infectious and inflammatory disease that is caused by the microorganisms that are found in dental plaque [1]. These microorganisms which are gram negative cause local inflammation that progresses from the gingiva to the alveolar bone resulting in destruction and loss of periodontal attachment through infiltration of inflammatory cells such as lymphocytes, macrophages and polymorphonuclear leukocytes into the periodontal tissues [2].

These micro-organisms produce byproducts such as lipopolysaccharide (LPS) that activate macrophages and T-lymphocytes to produce pro-inflammatory molecules like interleukin-1 (IL-1), prostaglandin E2 (PGE2), tumor necrosis factor-α (TNF-α) and lymphotoxin (LT) that has properties that are similar to those of TNF-α [2]. These cytokines are important in the mechanisms that produce periodontal tissue destruction through collagenolytic enzymes such as metalloproteinases (MMPs) that are activated by reactive oxygen leading to the resultant elevation of interstitial collagenase in inflamed gingival tissues [2,3]. The consequence is the resultant attachment loss with formation of periodontal pocket with millions of bacterial whose metabolism further worsens the initial destruction [4-7,8].

Many recent studies have reported that the effect of PD might not only be in the oral cavity but involves the entire body system since the human body acts as a unity and biologic processes in one part of the body can affect other body areas [9-11].

Diabetes mellitus (DM) on the other hand is a chronic disease that affects individuals in every age group. If poorly controlled, it can result in hyperglycaemia that can lead to a lot of complications in other organs of the body such as the heart, kidney and eyes [12].

Increased glucose levels have been shown to cause non-enzymatic glycation and oxidation of proteins resulting in the accumulation of advanced glycation end products (AGEs) in diabetic tissues [13]. AGEs have receptors on cell surfaces [receptor for AGE (RAGE)], which they bind to causing various pathological changes [14]. The AGE-RAGE interaction on the macrophages surfaces induces the production of pro-inflammatory cytokines such as Tumour Necrosis Factor alpha (TNF-α) and Interleukin -1 beta (IL-1β) [14,15].

Diabetes is recognized presently as one of the two true risk factors (the other is smoking) for periodontal and has been recategorized into the new classification of periodontal diseases by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP) [16-17]. Furthermore, a bidirectional relationship has been established between PD and DM by several studies that concluded that periodontitis resulting from periodontal inflammation may be a complication of diabetes creating a negative effect on their glycaemic control by raising the blood glucose levels [18-20].

This study therefore assessed the periodontal status and glycaemic control of diabetic patients.

2. METHODOLOGY

This was a descriptive cross-sectional study done between July and September 2019 at two outpatient diabetic clinics of two Teaching Hospital in two zones in Nigeria (University of Port Harcourt Teaching Hospital (UPTH) in South-South zone of Nigeria and Lagos State University Teaching Hospital (LASUTH) in Lagos, South West zone in Nigeria).

The included subjects were patients with type 2 diabetes aged 18years and above who had been diagnosed with diabetes for at least 1 year before the study; those who gave consent to be part of the study and resided in the study locations. Excluded were diabetic patients with physical or mental challenges, those with chronic systemic diseases such as asthma and epilepsy, those on xerostomia causing drugs (anti-hypertensives, anti-depressants, diuretics and radiation therapy) and those who smoked or consumed alcohol. One hundred and eighty-five diabetics were recruited for this study; 105 from UPTH and 80 from LASUTH.

Self-administered questionnaire was used to collect data on demographics. The oral cleanliness and periodontal status were assessed with Simplified Oral hygiene index by Greene and Vermillion and CPI index respectively. Values of glycated heamoglobin levels in the blood (HbA1c) values were retrieved from patients records and confirmed with laboratory reports. Using the American Diabetes Association (ADA) guidelines, HbA1c < 7% HbA1c ≥ 7% were taken to indicate good and poor glycemic control respectively [21].

2.1 Simplified Oral Hygiene Index (OHI-S) [22]

OHI-S, a composite index that scores both debris and calculus deposition on selected teeth was developed by Greene and Vermillion in 1964. It is the sum of the mean debris index (DI-S) and calculus index (CI-S) of the examined teeth. The OHI-S is interpreted as good, fair or poor. (Score 1 (good oral hygiene) = 0.0 – 1.2, Score 2 (fair oral hygiene) =1.3 – 3.0, Score 3 (poor oral hygiene) = 3.1 – 6.0).

The periodontal status was measured using a Community Periodontal Index according to the World Health Organization (WHO) recommendation for oral health surveys [23]. The scoring for the community periodontal index (CPI) are as follows:

Code-0- Coloured band of the probe remains completely visible in the deepest sulcus of the sextant-healthy.

Code-1- Coloured band of the probe remains completely visible in the deepest sulcus of the sextant, some bleeding after gentle probing.

Code-2- Coloured band of the probe still completely visible, but there is bleeding on probing, supragingival or subgingival calculus and/or defective margins.

Code-3- The coloured band is partially submerged. Pocket 4-5 mm deep.

Code-4- The coloured band completely disappears in the pocket, indicating a depth greater than 5.5 mm and a loss of attachment of 3mm or more.

Data analysis was done using the Statistical Package for Social Sciences version 20.0 (IBM SPSS Statistics Armonk New York). Continuous variables were described with mean and standard deviation and nominal variables with frequencies. Association of glycaemic index with periodontal status was explored by the $\chi 2$ test and statistical significance was set at $P < 0.05$.

3. RESULTS

The study population was one hundred and eighty-five patients with type 2 diabetes (105 from UPTH and 80 from LASUTH). Mean age was 57.11±13.45 year and mean DM duration was 8.97±7.14years. There was a female predominance in both centers; UPTH (F:M of 1.76:1), LASUTH (F:M of 2.64:1) Table 1a.

Table 1b shows the mean parameters of the study participants.

Fig. 1 shows the clustered count bar of Hb1Ac by CPI scores. The CPI score among the two groups was majorly 2.

Participants glycaemic control and periodontal status showed that twice participants in LASUTH had glycaemic control than those in UPTH (51.3% in LASUCOM vs 26.7 % of participants in UPTH had good glycaemic control) ;(p= 0.001). One-fourth of participants in LASUTH had poor oral hygiene, while 14.2% of participants from

UPTH had poor oral hygiene. More participants in UPTH had poor glycaemic control (73.3%). The periodontal status of majority of the participants in the two centers were CPI score between 2 and 4. Statistical analysis showed a statistical significance (p=0.02) Table 2.

The association between participants' glycaemic control and periodontal status showed that the oral hygiene status of about two-third of participants with or without glycaemic control in both centers was fair and the periodontal status showed a CPITN score of between 2 and 3 majorly. The CPITN score of participants with good glycaemic control showed a statistical significance (p= 0.03) Table 3.

Association between gender and good glycaemic control was statistically significant (p=0.014). Likewise, the association between age group and good glycaemic control (p=0.001) and poor glycaemic control (0.02) Table 4a.

Table 1a. Participants' demographics

Variables	Teaching Hospitals						X^2	p-value
	UPTH		LASUTH		Total			
	Freq	%	Freq	%	Freq	%		
Sex							**1.57**	**0.21**
Female	67	63.8	58	72.5	125	67.6		
Male	38	36.2	22	27.5	60	32.4		
Age group							**29.82**	**<0.0001***
20-29	2	1.9	2	2.5	4	2.2		
30-39	11	10.4	4	5.0	15	8.1		
40-49	30	28.6	3	3.7	33	17.7		
50-59	30	28.6	21	26.3	51	27.6		
60-69	19	18.1	22	27.5	41	22.2		
>70	13	12.4	28	35.0	41	22.2		
Tribe							**78.29**	**<0.0001***
Hausa	7	6.7	0	0.0	7	3.8		
Igbo	34	32.4	20	25.0	54	29.2		
Yoruba	10	9.5	53	66.2	63	34.0		
Rivers	34	32.4	0	0.0	34	18.4		
Others	20	19.0	7	8.8	27	14.6		
Education							**9.51**	**0.02***
Informal	18	17.1	3	3.8	21	11.4		
Primary	19	18.1	22	27.5	41	22.2		
Secondary	27	25.7	25	31.2	52	28.1		
Tertiary	41	39.1	30	37.5	71	38.4		
Occupation							**15.09**	**0.005***
Civil servant	26	24.8	15	18.7	41	22.2		
Retired	14	13.3	28	35.0	42	22.7		
Farmer	4	3.8	1	1.3	5	2.7		
Self-employed	56	53.3	36	45.0	92	49.7		
Professionals	5	4.8	0	0.0	5	2.7		
Duration of diagnosis (years)							**5.13**	**0.53**
1-5	43	41.0	31	38.7	74	40.0		
6-10	34	32.4	20	25.0	54	29.2		
11-15	17	16.2	14	17.5	31	16.8		
16-20	8	7.7	10	12.5	18	9.7		
21-25	1	0.9	3	3.8	4	2.2		
26-30	1	0.9	2	2.5	3	1.6		
>30	1	0.9	0	0.0	1	0.5		
Total	**105**	**100.0**	**80**	**100.0**	**185**	**100.0**		

Mean age = 57.11±13.45 years; Mean DM duration 8.97±7.14 years

Table 1b. Participants' characteristics

Variables	Mean ± SD; % Well controlled (Hb1AC <7%)	Mean ± SD; % Poorly controlled (Hb1AC ≥7%)	Total
Age (years)	58.1±16.0	56.5211.7	57.11±13.46
Duration (years)	9.0±7.8	8.9±6.8	8.97±7.17
BMI (kg/m^2)	26.9±5.1	27.6±4.9	27.34±5.00
Hb1Ac (%)	6.1±0.6	9.5±2.3	8.22±2.49
Total Cholesterol	2.8±1.1	3.1±1.6	2.95±1.44
LDL (mmol/L)	1.8±1.0	2.1±1.3	1.31±1.99
HDL (mmol/L)	0.8±0.6	0.9±0.7	0.84±0.62
Triglycerides (mmol/L)	1.5±1.0	2.3±1.7	1.99±1.54
OHI-S	2.2±1.1	2.3±1.2	2.25±1.12
CPI	2.2±1.0	2.2±0.9	2.19±0.92

Table 2. Participants glycaemic and periodontal status

Variables	Teaching Hospitals						X^2	p-value
	UPTH		LASUTH		Total			
	Freq	%	Freq	%	Freq	%		
HbA1c							**11.73**	**0.001***
<7% (well controlled diabetes)	28	26.7	41	51.3	69	37.3		
≥7% (poorly controlled diabetes)	77	73.3	39	48.7	116	62.7		
OHI-S							**3.59**	**0.17**
Good	24	22.9	18	22.5	42	22.7		
Fair	66	62.9	42	52.5	108	58.4		
Poor	15	14.2	20	25.0	35	18.9		
CPI scores							**11.46**	**0.02***
0	0	0.0	7	8.7	7	3.8		
1	14	13.3	14	17.5	28	15.1		
2	51	48.6	36	45.0	87	47.0		
3	30	28.6	19	23.8	49	26.5		
4	10	9.5	4	5.0	14	7.6		
Total	**105**	**100.0**	**80**	**100.0**	**185**	**100.0**		

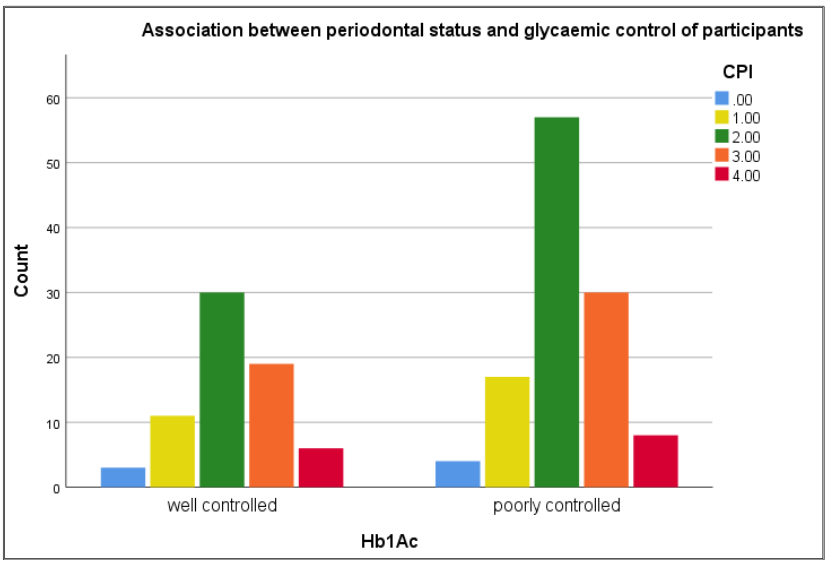

Fig. 1. Community periodontal index scores with glycated haemoglobin

Table 3. Association between glycaemic control and periodontal status

Variables		Teaching Hospitals						X^2	p-value
		UPTH		LASUTH		Total			
HbA1c		Freq	%	Freq	%	Freq	%		
<7%	**OHI-S**							**1.07**	**0.59**
Good	7	25.0	12	29.2	19	27.6			
Fair	17	60.7	20	48.8	37	53.6			
Poor	4	14.3	9	22.0	13	18.8			
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**			
≥7%	**OHI-S**							**3.45**	**0.18**
Good	17	22.1	6	15.4	23	91.8			
Fair	49	63.6	22	56.4	71	61.2			
Poor	11	14.3	11	28.2	22	19.0			
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**			
<7%	**CPI scores**							**10.63**	**0.03***
0	0	0.0	3	7.3	3	4.4			
1	1	3.6	10	24.4	11	15.9			
2	12	42.8	18	43.9	30	43.5			
3	11	39.3	8	19.5	19	27.5			
4	4	14.3	2	4.9	6	8.7			
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**			
≥7%	**CPI Scores**							**9.17**	**0.06**
0	0	0.0	4	10.3	4	3.4			
1	13	16.9	4	10.3	17	14.7			
2	39	50.6	18	64.2	57	49.1			
3	19	24.7	11	28.2	30	25.9			
4	6	7.8	2	5.1	8	6.9			
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**			

Table 4a. Association between participants glycaemic control and some demographics

Variables	Teaching Hospitals						X^2	p-value
	UPTH		LASUTH		Total			
HbA1c	Freq	%	Freq	%	Freq	%		
<7%	**Gender**						**6.97**	**0.014***
Female	15	53.6	34	82.9	49	71.0		
Male	13	46.4	7	17.1	20	29.0		
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**		
≥7%	**Gender**							
Female	52	67.5	24	61.5	76	65.5	**0.41**	**0.52**
Male	25	32.5	15	38.5	40	34.5		
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**		
<7%	**Age group (years)**						**19.64**	**0.001***
20-29	2	7.1	1	2.4	3	4.3		
30-39	5	17.9	3	7.3	8	11.7		
40-49	8	28.6	1	2.4	9	13.0		
50-59	7	25.0	7	17.1	14	20.3		
60-69	2	7.1	10	24.5	12	17.4		
>70	4	14.3	19	46.3	23	33.3		
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**		
Mean age± SD	58.10±16.02 years							
≥7%	**Age group (years)**						**13.27**	**0.021***
20-29	0	0.0	1	2.6	1	0.9		
30-39	6	7.8	1	2.6	7	6.0		
40-49	22	28.6	2	5.1	24	20.7		
50-59	23	29.9	14	35.8	37	31.9		
60-69	17	22.0	12	30.8	29	25.0		
>70	9	11.7	9	23.1	18	15.5		
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**		
Mean age± SD	56.52±11.70 years							

Variables	Teaching Hospitals						X^2	p-value
	UPTH		LASUTH		Total			
HbA1c	Freq	%	Freq	%	Freq	%		
<7%	**Year of diagnosis (years)**						**3.01**	**0.08**
0-5	16	57.2	17	41.5	33	47.9		
6-10	6	21.4	7	17.1	13	18.8		
11-15	4	14.3	9	21.9	13	18.8		
16-20	2	7.1	4	9.8	6	8.7		
21-25	0	0.0	3	7.3	3	4.4		
26-30	0	0.0	1	2.4	1	1.4		
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**		
Mean duration± SD	6.10± 0.57 years							
≥7%	**Year of diagnosis (years)**						**1.25**	**0.54**
0-5	27	35.1	14	35.9	41	35.3		
6-10	28	36.3	13	33.3	41	35.3		
11-15	13	16.9	5	12.8	18	15.6		
16-20	6	7.8	6	15.4	12	10.3		
21-25	1	1.3	0	0.0	1	0.9		
26-30	1	1.3	1	2.6	2	1.7		
>30	1	1.3	0	0.0	1	0.9		
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**		
Mean duration± SD	9.48±2.34 years							

Table 4b. Association between participants glycaemic control and some demographics

Variables	Teaching Hospitals						X^2	p-value
	UPTH		LASUTH		Total			
HbA1c	Freq	%	Freq	%	Freq	%		
<7%	**Education**						**6.24**	**0.10**
Informal	3	10.7	1	2.4	4	57.9		
Primary	3	10.7	14	34.1	17	24.6		
Secondary	8	28.6	9	22.0	17	24.6		
Tertiary	14	50.0	17	41.5	31	44.9		
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**		
≥7%	**Education**						**5.96**	**0.11**
Informal	15	19.5	2	5.1	17	14.7		
Primary	16	20.8	8	20/5	24	20.7		
Secondary	19	24.7	16	41.0	35	30.2		
Tertiary	27	35.1	13	33.3	40	34.5		
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**		
<7%	**Occupation**						**7.50**	**0.11**
Civil servant	5	17.9	7	17.1	12	17.4		
Retired	5	17.9	18	43.9	23	33.3		
Farmer	1	3.5	1	2.4	2	2.9		
Self-employed	15	53.6	15	36.6	30	43.4		
Professionals	2	7.1	0	0.0	2	2.9		
Total	**28**	**100.0**	**41**	**100.0**	**69**	**100.0**		
≥7%	**Occupation**						**6.59**	**0.16**
Civil servant	21	27.3	8	20.5	29	25.0		
Retired	9	11.7	10	25.6	19	16.4		
Farmer	3	3.9	0	0.0	3	2.6		
Self-employed	41	53.2	21	33.9	62	53.4		
Professionals	3	3.9	0	0.0	3	2.6		
Total	**77**	**100.0**	**39**	**100.0**	**116**	**100.0**		

The associations between glycaemic control and occupation (p=0.10; p= 0.16) and between glycaemic control and education (p=0.10, p=0.11) showed no statistical significance Table 4b.

4. DISCUSSION

The bidirectional relationship between PD and DM is well documented, though it is still unclear if it is a causal one or due to their common risk

factors [17,24-27]. The interaction could be because diabetes may directly influence the oral microbes leading to dysbiosis or the common inflammatory pathways as inflammatory markers have been reported to be elevated in these two comorbidities. As such, studies have reported a positive effect on glycated haemoglobin levels in the blood (HbA1c) when periodontal therapy is done as it reduces the periodontal inflammatory load [11,17,25,26]. This study reported a good glycaemic control among a quarter and half of participants in UPTH and LASUTH respectively.

The mean age of the study population was 57.11±13.45 years and comparable to other studies done among diabetes [28]. More female predominance in this study comparable to some other studies [28-31].

HbA1c, the glycosylated haemoglobin assay, is an indicator of blood glucose levels and a suitable prognostic marker widely accepted since the 1980s as the laboratory test of choice for determining glycaemic control in the diabetics [32]. It is still widely in use today and measurement is done using a number of different methods based on internationally adopted standards such as the Diabetes Control and Complications Trial (DCCT) or the International Federation of Clinical Chemistry (IFCC) [33,34]. The latter consistently gives lower values (non-diabetic reference range is about 3% to 5% IFCC and 4% to 6% DCCT) with good control in diabetic groups taken as 5% IFCC and 7% DCCT. The American Diabetes Association (ADA) guidelines has however endorsed HbA1c < 7% and HbA1c ≥ 7% as indicates of good and poor glycemic control respectively [21].

The participants in this study based on Glycated hemoglobin were classified into three groups. These are well controlled (Glycated hemoglobin <7.0%) and poorly controlled (Glycated hemoglobin ≥.0%). Our study showed no association between duration of diabetes, glycated haemoglobin and periodontal disease severity similar to the findings in other studies [35,36]. This contrasted with other studies that reported association between higher glycated haemoglobin and severe periodontitis [37-42].

In our study, participants with poor glycaemic control were more than those with good glycaemic control. This correlated with the findings of other studies [43-45].

The Simplified oral hygiene index (OHI-S) measures the cleanliness of the mouth and is used to classify individuals into good, fair or poor oral hygiene. Majority of our participants had fair oral hygiene. This compares to the study done among T2DM in Lucknow, India that reported that 68.8% of their participants had fair oral hygiene.

The periodontal status of the participants in this study did not worsen with poor glycaemic control. This compares to the study done among diabetics in Harvard Medical School, Boston [46]. The means of participants parameters examined in this study are comparable to those reported by other studies [46,47].

Community periodontal index is used to detect periodontal diseases. It scores the presence and absence of supra and sub gingival plaque and calculus as well as pocket depth correlating it with the extent and severity of the disease. Two-fifth and about half of those with well controlled and poorly controlled DM respectively had CPI score 2. However, a third of all participants irrespective of glycaemic control had CPI scores 3 and 4. This contrast with another study that recorded that two-fifth of their participants with poorly controlled DM had CPI code 3 and three-fifth had CPI code 4.

5. CONCLUSION

The periodontal status of participants did not increase with poor glycaemic index as participants had CPI scores of 0-4 irrespective of Hb1Ac. However, the resultant increase in systemic inflammation shows the adverse effect of periodontal infections on diabetes mellitus and this can contribute to insulin resistance in those diagnosed with it.

6. RECOMMENDATION

There is the need to increase patients' awareness of the link between diabetes mellitus and periodontitis and encourage collaboration between medical and dental professionals for the management of affected individuals.

7. LIMITATION

This study did not assess gingival recession.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our

area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The ethical approval for the study was gotten from the ethics committees of the two hospitals (UPTH and LASUTH).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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