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Possible Association between Cigarette Smoking Habit with Periodontal Disease in Diabetic patients in Nepal

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Key words : Cigarette smoking, diabetes mellitus, periodontitis

Abstract

Introduction : Diabetes mellitus is a chronic metabolic disorder that affects humans over a wide range of age. A significant number of diabetic patients with a concurrent history of cigarette smoking visit the dentist for dental treatment. The relationship between periodontal diseases and cigarette smoking in diabetic patients has not yet been documented in the Nepalese population. In this cross sectional study, we evaluated the periodontal status of diabetic patients attending a private hospital in Kathmandu.

Materials and Method : A semi-structured questionnaire was used to record patient history, and clinical examinations were performed to assess the oral health status of the patients. The relationship between cigarette smoking and periodontal health in diabetic patients was statistically evaluated by calculating the odds ratios. Logistic regression analysis was done to examine the effect of cigarette smoking on periodontitis in diabetic patients and non-diabetic controls with controlling the demographic and oral variables.

Result : An odds ratio of 37.27 (95% confidence interval, 34.90-39.64) demonstrated a strong relationship between cigarette smoking and poor periodontal status in the diabetic patients. A significantly higher number of diabetic patients suffered from xerostomia (20% vs 4.76% ; p value < 0.001) and oral candidiasis (34.28% vs 14.70% ; p value < 0.001) when compared with the non-diabetic controls. The logistic regression analysis shows significant relationship between periodontal disease and xerostomia ; however, xerostomia decreased the periodontitis in diabetic group in contrary to increase the later in non-diabetic group. Smoking was strongly associated with periodontitis in diabetic group. Age and calculus were associated with periodontal disease in non-diabetic group.

Conclusion : The findings from the present study show that the habit of smoking poses a much higher risk for periodontal disease in diabetic patients than in healthy individuals among the Nepalese population.

Introduction

Diabetes mellitus is one of the commonest medical disorders encountered by dentists worldwide, and has been re-

cently declared as a pandemic by the World Health Organization (WHO, 2009). The main causes of death in diabetic patients are the microvascular and macrovascular complications associated with the condition (Moore et al., 2003 ;

Jain & Saraf, 2010). In addition diabetic patients often suffer from oral and dental problems, including xerostomia, burning mouth syndrome, taste dysfunction, dental caries, periodontal diseases and oral infectious diseases, which are mainly caused due to oral dryness and increased susceptibility to microbial infections (Kakoei et al., 2015). Periodontal diseases are the most common and crucial problems seen in patients with diabetes, and an association between periodontal disease and diabetes has been widely accepted (Demmer et al., 2012 ; Abrar et al., 2015). Recent evidence shows that periodontal treatment decreases the level of blood glucose and/or HbA1c in patients with periodontitis (Faggion et al., 2016). In addition to diabetes, which is a systemic factor, local factors such as microbes, tobacco smoke and alcohol are crucial for the development of periodontal diseases (Genco & Borgnakke, 2013). Although diabetes and smoking are two, well–documented risk factors for periodontal disease (Bergstrom J., 1989 ; Loe H., 1993), their interactions with the diseases still remain unclear. In Nepal, 18.5% of the population (aged between 15–69 years) smoke cigarettes, with 85 % of them being daily smokers (MoHP, Nepal, 2014) ; this ratio is almost similar to the international ratio (Giovino et al., 2012). Similarly, the prevalence rate of diabetes mellitus among the Nepalese population is almost similar to the international prevalence rates 3.6%, (Wild et al., 2004). However, to the best of our knowledge, there is no statistical data on smoking as a risk factor for periodontal diseases in diabetic patients in Nepal so far. The present study assessed the periodontal status in smokers and non–smokers with and without diabetes mellitus in a representative population of Kathmandu.

Materials and methods

Case selection and criteria

A cross sectional study was conducted among patients attending the Kastamandap Polyclinic, and Department of Oral Diagnosis at Dental Care Hospital, Kathmandu during a period of 12 months from January to December in the year 2014. A total of 210 diabetic patients were included in the study. The diagnostic criterion for diabetes was taken as $\geq 6.5\%$ HbA1c and ≥ 126 mg/dl fasting plasma glucose (American Diabetes Association, January 2013). The medical conditions of the patients were previously examined by the attending physician. The inclusion criteria of the patients in this study were subjects older than 18 years of age who

were diagnosed with diabetic mellitus and had a minimum of 20 teeth. The exclusion criteria included patients with the following : 1) orthodontic devices ; 2) extended fixed prosthodontic devices (replacement of more than two missing teeth), removable partial dentures, or overhanging restorations ; 3) systemic diseases or other conditions that could influence the periodontal status (other than diabetes within the diabetes group) ; 4) pregnancy or breastfeeding ; and 5) antibiotic prophylaxis for any medical condition within the last 5 years. In addition, 210 non–diabetic individuals who presented at the dental hospital during the study period were assigned as a control group. Informed written consent, as per the institutional review committee guidelines, was taken from each participant for clinical examination and publication of data.

Questionnaire and data collection

A structured questionnaire and a data recording format was prepared for data collection (Table 1 & 2). The questionnaire included demographic details (name, age, gender, address, medical and dental treatment history, and present cigarette smoking habit) and dental care awareness (number of visits to the dentist, treatments previously received including oral prophylaxis and periodontal treatment, knowledge regarding the influence of systemic disease on oral health) of the participants. The recording data sheet contained general oral examination (of the hard and soft tissues in the oral cavity including signs of xerostomia, candidiasis and dental caries), and specific examinations for periodontal diseases (including calculus, stains, bleeding on probing (BOP), gingival recession, periodontal pocket and clinical attachment loss). The data collection and clinical examination team consisted of two principal investigators (BRA and MS), one trained data–recording clerk and two qualified dental assistants. Subsequent to the examination of every 15 patients, a patient was interchanged between the clinical examiners to confirm the reliability, consistency and uniformity of the clinical parameters.

Clinical examination

Gingival recession, defined as the distance between the free gingival margin (FGM) and the cemento–enamel junction (CEJ), pocket depth (PD ; defined as the distance from FGM to the bottom of the sulcus or periodontal pocket, clinical attachment loss (CAL ; defined as the distance from

Table 1 : Questionnaire

| |
|--|
| Questionnaire No : |
| Name : |
| Age/Gender : |
| Address : |
| Chief complaint : |
| Past and Present Medical History : |
| Past Dental Treatment History : |
| 1. Have you ever visited a dentist? |
| a. Yes, I visit dentist regularly |
| b. Yes, I visit dentist when I have pain in teeth |
| c. No, this is my first visit |
| 2. For what reason did you visit a dentist previously? (Please mention all that is applicable) |
| 3. Do you smoke cigarette? |
| a. Yes |
| b. No |
| 4. Do you have diabetes? |
| a. Yes |
| b. No |
| 5. Do you feel dryness in your mouth? |
| a. Yes |
| b. No |
| 6. Do you feel burning sensation and/or swallowing problem in your mouth? |
| a. Yes |
| b. No |
| 7. Do you know that the signs of medical diseases can be seen in the mouth as well? |
| a. Yes |
| b. No |

the CEJ to the base of the pocket), and BOP were measured at six sites (mesio-, mid-, and disto-buccal ; mesio-, mid-, and disto-lingual) per tooth in all teeth, excluding the third molars. For measurements, a periodontal probe (Hu-Friedy PCP 2™, Chicago, IL, USA) with 2, 4, 6, 8, 10, and 12 mm graduations was positioned parallel to the long axis at each of the six sites of the tooth. Calculus, gingivitis and periodontitis were graded as per the criteria mentioned in

Table 3. Supra-gingival debridement was performed in patients with high amount of calculus prior to the gingival recession, PD and CAL measurement. Restorations on the proximal, facial and lingual / palatal surfaces were examined using dental explorer, dental floss and intraoral periapical / bitewing radiograph where applicable. Oral candidiasis was examined based on the clinical criteria and confirmed with laboratory examination whenever necessary (Laura and Yo-

Table 2 : Data collection and examination sheet

| |
|---|
| Data collection and clinical examination sheet No : |
| Name : |
| Age/Gender : |
| Address : |
| Chief complaint : |
| General Physical Examination : |
| Past and Present Medical History : |
| Past Surgical History : |
| Past Dental Treatment History : |
| Oral Hygiene measures : |
| Brushing.....times a day |
| Flossing |
| Professional Dental care |
| Extra-oral Examination : |
| Intra-oral Examination : |
| Examination of Soft tissue : |
| Buccal Mucosa : |
| Labial Mucosa : |
| Floor of the mouth : |
| Hard/Soft Palate : |
| Others : |
| Examination of Gingiva : |
| Color : |
| Consistency : |
| Contour : |
| Stippling : |
| Calculus : |
| Stain : |
| Bleeding on Probing : |
| Recession : |
| Periodontal Pocket : |
| Clinical Attachment Loss : |
| Examination of Hard Tissue : |
| Teeth present : |
| Teeth Missing : |
| Loose teeth : |
| Dental caries : |
| Restoration : |
| Prosthesis : |
| Others : |
| Investigation : |
| Diagnosis : |
| Treatment Plan : |

Table 3 : The grading of calculus and diagnosis of gingivitis and periodontitis

| Calculus index | | |
|-------------------|------------------------|---|
| Grade 0 | | No observable calculus |
| Grade 1 | | Scattered calculus covering less than one-third of the buccal surface of the tooth |
| Grade 2 | | Calculus covering between one- and two-thirds of the buccal surface with minimal subgingival deposition |
| Grade 3 | | Calculus covering greater than two-thirds of the buccal surface and extending sub-gingivally |
| Gingival index | | |
| Grade 0 | Normal gingiva | No inflammation, healthy gingiva with sharp, non-inflamed margins |
| Grade 1 | Mild gingivitis | Mild inflammation, slight change in color, slight edema, no bleeding on probing |
| Grade 2 | Moderate gingivitis | Moderate inflammation, moderate glazing, redness, bleeding on probing |
| Grade 3 | Severe gingivitis | spontaneous bleeding |
| Periodontal Index | | |
| Grade 0 | Normal periodontium | With or without gingivitis but showing features less severe than that of grade 1 periodontitis |
| Grade 1 | Mild periodontitis | ≥ Two interproximal sites with ≥ 3 mm AL and ≥ Two interproximal sites with ≥ 4 mm PD or one site with ≥ 5 mm |
| Grade 2 | Moderate periodontitis | Two or more interproximal sites with ≥ 4 mm CAL or two or more interproximal sites with PD ≥ 5 mm |
| Grade 3 | Severe periodontitis | Presence of two or more interproximal sites with ≥ 6 mm AL and one or more interproximal site(s) with ≥ 5 mm PD |
| | Total periodontitis | Patient having any level of severity of periodontitis |

CAL= clinical attachment loss ; PD= pocket depth

Table 4 : Number and percentage of subjects (diabetic and non-diabetic) with oral candidiasis, xerostomia, and dental caries)

| | Diabetic patient | Non-diabetic control |
|------------------|------------------|----------------------|
| Oral Candidiasis | 72 (34.28 %) | 7 (14.7 %) |
| Xerostomia | 42 (20 %) | 10 (4.76 %) |
| Dental caries | 164 (78.1 %) | 147 (70 %) |

landa, 2013). Xerostomia was diagnosed based upon the subjective symptoms of dry mouth as per the participant's complaint (Hopcraft and Tan, 2010) ; Typical complaints of dry mouth and difficulty swallowing and / or speaking were the main criteria considered. Detection of dental caries was done under dental operatory light using a mouth mirror, dental probe and explorer, and was based on the criteria described previously (Ekstrand, 2004).

Statistical evaluation

Data were collected, coded, categorized, analyzed and evaluated statistically. An odd ratio (OR) with 95% confidence interval (CI) was calculated to measure the association between cigarette smoking as exposure and periodontitis as the outcome in diabetic and non-diabetic individuals. Logistic regression analysis was conducted for the demographic and oral variables in order to examine the effect of smoking on periodontitis in diabetic and non-diabetic individuals. Statistical significant was set at $p < 0.05$.

Results

The occurrence of oral candidiasis, xerostomia, dental caries and periodontal diseases was examined in order to assess

the oral health status of the patients. Oral candidiasis was seen in 34.28% of diabetic patients, which was higher than that in the individuals belonging to the control group. Xerostomia and dental caries were present in 20% and 78.1% of the diabetic patients, respectively. The number of diabetic patients suffering from xerostomia and oral candidiasis was significantly higher than that of the non-diabetic controls (4.76% and 14.70%, respectively ; $p < 0.001$). The diabetic group showed higher prevalence of dental caries when compared with the control group (78.1% vs 70%) ; however, the difference was not statistically significant (Table 4).

In total, 55.23% of the patients participating in this study revealed that this was their first dental visit, 17.63% had visited the dentist previously for one or more dental treatments, and 27.14% visited the dentist regularly. Table 5 shows the distribution of patients with calculus, gingivitis and periodontitis in the present study. Further evaluation revealed that 10.95% of diabetic patients and 52.86% of the controls had calculus-free teeth, with 28.10%, 53.81% and 7.14% of the diabetic patients presenting with grade 1, 2 and 3 calculus, respectively. Alternatively, 10%, 28.10% and 9.04% of the non-diabetic control had grade 1, 2 and 3 calculus, respectively. Gingival tissue was normal in 21.91% of the dia-

Table 5 : Clinical evaluation and comparison of different oral health indices in diabetic patients and non-diabetic control group individuals

| | Diabetic group – frequency (%) | Non-diabetic Control group – frequency (%) |
|---------------|--------------------------------|--|
| Calculus | | |
| Grade 0 | 23 (10.95 %) | 111 (52.86 %) |
| Grade 1 | 59 (28.10 %) | 21 (10 %) |
| Grade 2 | 113 (53.81 %) | 59 (28.10 %) |
| Grade 3 | 15 (7.14 %) | 19 (9.04%) |
| Gingivitis | | |
| Normal | 46 (21.91 %) | 99 (47.14 %) |
| Mild | 101 (48.10 %) | 65 (30.95 %) |
| Moderate | 46 (21.90 %) | 38 (18.10 %) |
| Severe | 17 (8.09 %) | 8 (3.81%) |
| Periodontitis | | |
| Normal | 52 (24.76 %) | 107 (50.95 %) |
| Mild | 107 (50.95 %) | 63 (30.00 %) |
| Moderate | 40 (19.05 %) | 36 (17.14 %) |
| Severe | 11 (5.24 %) | 4 (1.91%) |

Table 6 : Comparison of periodontitis between habitually smoking and non-smoking diabetic patients and non-diabetic controls

| | | Patient with Periodontitis | Patient without Periodontitis |
|----------------------------|-----------------------------|----------------------------|-------------------------------|
| Diabetic Patients | +ve cigarette smoking habit | 142 | 10 |
| | -ve cigarette smoking habit | 16 | 42 |
| Non-diabetic control group | +ve cigarette smoking habit | 53 | 60 |
| | -ve cigarette smoking habit | 50 | 47 |

betic patients and 47.14% of the controls. Mild, moderate and severe gingivitis was found in 48.10%, 21.90% and 8.09% of the diabetic patients, and 30.95%, 18.10% and 3.81% of the non-diabetic control, respectively. There were no signs of periodontitis in 24.76% and 50.95% of the diabetic patients and non-diabetic control respectively; whereas 50.95%, 19.05% and 5.24% of the diabetic patients, and 30%, 17.14% and 1.91% of the controls showed signs of grade 1, 2 and 3 periodontitis, respectively.

Table 6 illustrates the number of patients with positive and negative findings of all the three parameters: diabetes, smoking and periodontitis. The total number of patients with any form of periodontitis was found to be 158 among the diabetic group and 103 among the controls. One hundred and forty two (89.87%) diabetic patients and 53 (51.45%) non-diabetic controls with a history of cigarette smoking were found to be affected by periodontal disease. The OR of periodontal problems was 37.27 with 95% CI (34.90 to 39.64) in cigarette smokers when compared with non-smokers among the diabetic patients. In comparison, the OR

value was close to 1 (OR = 0.83; 95% CI, -0.89 to +2.55) in the non-diabetic control group indicating the strong association between cigarette smoking and periodontal problem in diabetic patients.

Furthermore, logistic regression analysis was conducted with controlling the demographic and oral variables. Significant effects of smoking were observed on periodontitis in the diabetic group, thereby strongly suggesting the association between cigarette smoking and periodontal disease in the diabetic group; however, no statistically significant association were found between the two in the non-diabetic control group (Table 7).

Result of the logistic regression analysis revealed associations between age and periodontal disease in the non-diabetic group. Furthermore, xerostomia was found to be associated with periodontal disease in both diabetic and non-diabetic groups; however, contrary to that seen in the control group, xerostomia appeared to decrease in periodontitis in the diabetic patients. Calculus was found to negatively affect the periodontal tissue in the non-diabetic individuals. No

Table 7 : Logistic regression analysis for demographic and oral variables.

| | Diabetic patients | | Non Diabetic control | |
|--------------|-------------------|--------------|----------------------|-----------|
| | OR | 95% CI | OR | 95% CI |
| Age | 1.00 | 0.96–1.03 | 0.97* | 0.95–0.99 |
| Female | 0.80 | 0.25–2.54 | 0.64 | 0.34–1.21 |
| Calculus | 3.58 | 0.85–15.05 | 2.32* | 1.28–4.22 |
| Candidosis | 0.59 | 0.20–1.72 | 1.38 | 0.6–3.18 |
| Xerostomia | 0.16* | 0.05–0.58 | 6.92* | 1.3–36.93 |
| Dentalcaries | 0.50 | 0.14–1.81 | 0.92 | 0.49–1.73 |
| Smoking | 87.89* | 26.00–297.03 | 0.674 | 0.37–1.22 |

OR=odd ratio ; CI=confidence interval ; * = $p < 0.05$

statistically significant associations were observed between gender, dental caries and candidiasis and periodontal disease in both the groups.

Discussion

The results of the present study demonstrated that the habit of smoking poses a much higher risk for periodontal disease in diabetic patients than in healthy individuals. An OR value of 37.27 (95% CI, 34.90 to 39.64) in the diabetic group indicates that cigarette smoking was strongly associated with periodontal diseases in the diabetic group. On the other hand, the OR value in the non-diabetic control group (OR = 0.83 ; 95% CI, -0.89 to +2.55) indicated that the habit of smoking did not pose as a significantly high risk for the individuals in this group. In the present study, 89.87% of the diabetic patients diagnosed with periodontal diseases had a history of cigarette smoking when compared with their counterparts in the non-diabetic group (51.45%). After controlling for demographic and oral variables, the result of the logistic regression analysis demonstrated statistical significance between cigarette smoking and periodontal disease in the diabetic patients, thus suggesting that cigarette smoking is one of the most important contributing factors in periodontal disease.

Habitual smoking and diabetes are local and general risk factors, respectively, for periodontal disease (Hugoson et al., 1989 ; Al-Maskari et al., 2011). Smoking has been shown to be a risk indicator for periodontal diseases (Grossi et al., 1995). Nevertheless, the interaction between these two risk factors and periodontal disease is not fully understood. There are conflicting data regarding periodontal disease and smoking in patients with type 1 diabetes. Although cigarette smoking was a major risk factor for periodontal problems, there was no significant difference in the risk between type 1 diabetes patients and healthy individuals in a population-

based study conducted in the USA (Haber et al., 1993). In contrast, another study conducted in the same country reported cigarette smoking as a major risk factor in type 1 diabetes patients when compared to healthy individuals (Moore et al., 1999). A recent study in Saudi Arabia demonstrated that periodontal severities were higher in type 2 diabetic patients with smoking habits when compared with healthy individuals who smoked (Javed et al., 2015). In the present study, we evaluated the periodontal status of habitually smoking diabetic patients in a Nepalese population and confirmed that the cigarette smoking posed a much higher risk in these patients when compared with healthy individuals within the same population. However, we did not distinguish between the type 1 and 2 diabetic patients in this study. Further investigations are needed to assess and compare the effects of smoking between the different types of diabetic patients.

Cigarette smoking is one of the several factors that govern the periodontal status. Both cigarette smoking and alcohol consumption are known to adversely affect the oral microflora. Tobacco chewing is one of the established risk factors for the development of periodontal disease in healthy as well as health compromised individuals (Parmar et al., 2008). In addition, a majority of the Nepalese people do not visit the dentist regularly (Wagle et al., 2014). In the present study, xerostomia, oral candidiasis and dental caries were commonly observed in a higher proportion of the diabetic patients when compared with the healthy individuals, and were in accordance with the findings of earlier investigations regarding xerostomia in diabetic patients (Sreebny et al., 1992 ; Ben-Aryeh et al., 1993). Furthermore, statistical evaluation demonstrated inverse correlations between xerostomia and periodontitis in the diabetic patients in the present study. Hyposalivation is one of the risk factors for periodontitis (Al-Maskari et al., 2011) and is known to cause xeros-

tomia ; yet, xerostomia is only a subjective symptom in these patients regardless of reduced salivary flow (Hopcraft and Tan, 2010). It has been shown that patients with diabetic neuropathy may present with increased or decreased salivary flow rate (Lamey et al., 1984 ; Sreebny et al., 1989), which may be attributed to normal variations in salivary function, duration of illness in the individual studied, and limited sample size (Lamey et al., 1984). The decrease in periodontitis in diabetic patients with increased xerostomia may be due to variation in salivary flow rate among the individuals in the present study. Besides cigarette smoking several other factors such as heredity, stress, socio-economic factors, decreased immunity, poor nutrition, hormonal changes govern periodontal status of an individual (Genco & Borgnakke 2013). These cofounding factors always play an important and contributory role in the disease process. However, further studies are required to clearly understand the mechanisms by which these factors affect the periodontal status.

In conclusion, the present study shows that smoking poses a much higher risk for periodontal disease in diabetic patients than in healthy individuals among the Nepalese population. Besides cigarette smoking, many other risk factors associated with diabetes may be involved in the occurrence and progression of periodontal problems. However, the mechanisms involved in the associations between these factors and smoking remain unclear, thus meriting further investigations.

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Author's contribution : BRA, MS and YA conceived the idea and wrote the manuscript, BRA and MS did the clinical examination and data collection, HM, OU, IC did the statistical analysis, TM, FH, ABD, MRH, TS, HN and YA contributed for the literature review. All authors read and approved the final draft of the manuscript.

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