The Use of the Slipping Slipper Sign to Explore the Connection between the Feet and the Mouth in Patients with Diabetes Mellitus

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Objective: Both periodontal disease and peripheral neuropathy are complications associated with poorly controlled diabetes. This study aimed to determine whether periodontal disease was more prevalent and more severe among patients with severe diabetic peripheral neuropathy.

Methods: A case-control study was performed; 46 patients with and 48 without the slipping slipper sign (SSS)—a surrogate clinical marker for severe peripheral neuropathy—were recruited from a diabetic outpatient clinic. Demography and data from the Basic Periodontal Examination (BPE) were assessed, in addition to the patients' periodontal health by 2 examiners blinded to patients' SSS status. Multivariate logistic regression was used to evaluate the associations between the risk factors for and the presence of the SSS, adjusting for age, gender, and ethnicity.

Results: The mean age of the sample was 55.8 years (±10.69 years). Most of the participants (77.7%) had either never been to a dentist or had last attended a dental clinic more than a year before this examination, and 83% did not have a dentist. Periodontal disease was advanced in 61.7%, and there was no association between the SSS and periodontal disease. Dental-service-utilization variables were significantly associated with the SSS. Patients who did not have a regular dentist were more than 7 times more likely to have the SSS than were those who did (OR = 7.70; 95% CI: 1.12-53.21).

Conclusion: In diabetic patients, oral health–related risk factors, such as not having a dentist, wearing a denture or dentures, and visiting a dentist once a year or more, may be associated with systemic complications, including peripheral neuropathy. Early collaboration between dentists and doctors on the care of patients with diabetes is recommended. [*P R Health Sci J 2020;39:216-221*]

Key words: Slipping slipper sign, Periodontal disease, Diabetes, Feet

Poorly controlled diabetes mellitus is well recognized to be a risk factor for both periodontal disease (1,2) and peripheral neuropathy (3,4). In a previous paper, we described a very high burden of periodontitis among Trinidadian patients with diabetes mellitus (1). Both the duration and degree of diabetic control have been shown to impact the frequency and severity of periodontal disease (2). Additionally, poorly controlled diabetes increases susceptibility to infection and the risk of acquiring oral complications (3). As is the case with periodontal disease, microvascular complications of diabetes—retinopathy, neuropathy, and nephropathy—are closely related to the duration and degree of diabetic control (or lack thereof, as the case may be) (3,4). In sharing common antecedents, we here posit that diabetic peripheral neuropathy - as evidenced by a slipping slipper sign (SSS) - and periodontal disease—a marker of oral health—might be closely associated.

The SSS has been defined as the inadvertent and unrecognized loss of a slipper—any kind of footwear that either does not have a strap (or that does but that is not fastened) at the ankles—while walking (5). This sign, when present, has been shown to be useful in screening for the presence of severe diabetic

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neuropathy. In a subsequent study (6), individuals with the SSS were universally afflicted with retinopathy and also had a very high likelihood of nephropathy, a classic microvascular complication of diabetes. The true clinical value of the SSS lies in its simplicity. Thus, answering "yes" to the question "Have you ever lost a slipper from one of your feet while walking and not realized that you had done so?" is an indication of a positive SSS. When this question has been asked, it has been shown to have a high degree of sensitivity (83%) and specificity (91%) for neuropathy (7). Determining the presence of the sign does not require any specialized or expensive equipment; the SSS has been used as a screening tool to alert clinicians to the high risk for peripheral neuropathy that some of their patients have (7). Its potential value as a screening tool has been highlighted, previously (6).

Given that the SSS has been shown not only to predict peripheral neuropathy (5,7) but also to have a strong association with diabetic retinopathy (6), we, the authors hypothesized that it may also be able to predict both the periodontal status and oral health of patients with diabetes. The objective of this study was to determine the relationship between severe peripheral neuropathy (as assessed by a positive SSS) and the indices of oral health practices, including health-seeking behaviors and the presence and severity of periodontal disease.

Materials and Methods

This was a case-control study involving subjects selected from a tertiary diabetic out-patient clinic at the San Fernando General Hospital, Trinidad, from January 2015 through May 2016. Subjects were selected for the presence and absence of the SSS (n = 46 and n = 48, respectively) and invited to undergo oral examinations at the University of the West Indies (UWI) School of Dentistry clinic, Mt. Hope. Patients were recruited throughout the period of this study until 100 consecutive patients had been approached. The SSS status was determined by a single trained examiner (KL) at the San Fernando Hospital, and the resulting data were used to develop a patient pool, from which our convenience sample was obtained. Inclusion criteria included having a diagnosis of diabetes mellitus and being able to give informed consent to an oral examination. Patients were excluded if edentulous. Oral examinations were performed by 2 examiners who were blinded to the SSS status of the study participants to prevent a potential source of bias during examination.

Ethical approval was obtained by the University of the West Indies Research Ethics Committee, and written informed consent was obtained from each patient. Furthermore, the research was conducted in full accordance with the World Medical Association Declaration of Helsinki.

Demographic data such as name, gender, self-reported ethnicity, medical and dental history, the frequency of dental visits, the reason for dental attendance, and partial denture hygiene practices (when applicable) were gathered with an interviewer-administered questionnaire. The examination involved making an extra-oral assessment, ascertaining the visible plaque score (using the plaque index of Silness and Löe) (8), and performing the Basic Periodontal Examination (BPE) to determine the periodontal health status of the individual being examined. The dental examiners, who had previously been trained and calibrated, were blinded towards each patient's SSS status, and each patient's SSS case-control status information was kept separate until the final analyses were performed.

The guidelines of the Silness and Löe plaque index were followed using the criteria of 4 surfaces of the 6 selected teeth

$$\frac{6\,2\,|\,4}{4\,|\,2\,6}$$

There was no substitution for a missing tooth and wisdom teeth were excluded. All the surfaces were selected, and the scores from the 4 areas of the tooth were added and divided by 4 in order to obtain the plaque index (8) for that tooth; the following scores were used:

0 No plaque

1 A film of plaque adhering to the free gingival margin and adjacent area of the tooth, and which could not be seen with the naked eye, but only by using disclosing solution or a probe.

2 A moderate accumulation of deposits within the gingival pocket and on the gingival margin and/or adjacent tooth surface, which could be seen with the naked eye.

3 An abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.

The BPE, also known as the Periodontal Screening and Recording system, is a screening tool for determining periodontal treatment needs; it identifies the presence or absence of disease (2). The BPE criteria and coding were based on those described by Corbet, 2012 (Table 1) (2).

Firstly, the mouth was divided into 6 sextants; only those sextants with 2 or more teeth present were used, all third molars and root remnants were excluded, and—given those criteria—the highest score was recorded for that sextant. The BPE score was determined using the World Health Organization Community Periodontal Index of Treatment Needs periodontal probe (Figure 1). The probe was used to detect bleeding and loss of attachment around the teeth, as well as bone loss between the roots of the teeth (furcation involvement) (9). Once periodontal diseases are identified, treatment is aimed at controlling the bacterial biofilm and other risk factors in order to arrest periodontitis and re-establish tooth support (10).

Upon completion of the clinical examination, the patients were informed of their periodontal status and given the appropriate oral hygiene advice, a toothbrush and toothpaste, and a pamphlet on the home care of the mouth. Additionally, healthy refreshments were provided. Those who required periodontal treatment were given the option to have the treatment done at a subsidized cost at the UWI Dental School or at a private dental office.

Table 1. Summary of codes used in BPE and their clinical descriptions*

Code	Examination findings	Clinical condition
0	No pockets exceeding 3 mm, no calculus or overhangs, and no bleeding on gentle probing	healthy periodontium
1	Colored band remains totally visible, indicating no pockets exceeding 3 mm, no calculus or overhangs, but bleeding present on gentle probing	gingivitis
2	Colored band remains totally visible, indicating no pockets exceeding 3 mm, but calculus or other plaque-retentive factors found at or below the gingival margin, with or without bleeding on probing	gingivitis or plaque retention factors
3	Colored band on probe remains partially visible when inserted into the deepest pocket, indicating pocket depths greater than 3.5 mm but less than 5.5–6 mm	mild periodontitis
4	Colored band on the probe covered by gingiva, indicating a pocket at least 6 mm in depth	moderate to severe periodontitis
*	Attachment loss at any site is 7 mm or greater, furcation involvement.	severe periodontitis

*Corbet, 2012 (2)

Data were collected during the period of the study and subsequently analyzed using Stata 14.2 (StataCorp, College Station, Texas). Descriptive characteristics with Pearson's chi-square test were used for univariate analyses; Fisher's exact test was used for the variable "dentures worn at night time" due to the limited number of cases in the non-SSS group. Additionally, Student's t-test was applied to the age variable after testing for the normality assumption using the test for normality in Stata 14.2. Multivariate logistic regression models were run to evaluate the significant associations between periodontal and gingival health and other risk factors (selected based on their clinical relevance), and the SSS case-control status as the outcome; all models were adjusted for age, gender, and ethnicity as confounders. There were no missing data. All analysis was conducted at 0.05 level of statistical significance.

Figure 1. WHO periodontal probe (17)

Results

Demographics and baseline characteristics

Ninety-four of 100 diabetic patients attending an outpatient clinic participated in the study. Reasons for non-participation were not ascertained. Age was maintained as a continuous variable in the analyses. The participants were aged "from 24 and 86 years" with a mean age of 55.81 years (SD: 10.69). More participants (51%) had a negative SSS. The majority (66%) were female, with the main ethnic group comprising Indo-Trinidadian patients (72.3%).

Most (77.7%) had never attended a dental clinic, except when in pain, or had last attended one more than a year before the study examination, and 83% did not have a dentist. Of the 21.3% of participants who wore a denture or dentures, 50% did not take it/them out at night. The majority of participants (93.5%) were non-smokers. Abundant "severe" plaque was present in 39.4% of the patients, and 38.3% had severe periodontitis (Table 2).

Univariate analyses identified 2 factors that were significantly associated with the SSS: self-reported use of dentures ($p = 0.009$) and whether the last visit to a dentist had been more than a year prior or had been never ($p = 0.006$). In multivariate analyses (Table 3), after adjusting for age, gender, and ethnicity, diabetic patients who did not have a regular dentist were nearly 8 times more likely to have the SSS than were those who did (adjusted OR = 7.70; 95% CI: 1.12–53.21). Diabetics who had required emergency visits to a dentist within the last year were 5 times more likely to have the SSS than were those who had not had a dental emergency in that period (adjusted OR = 5.23; 95% CI: 1.16–23.66). Those who wore a denture or dentures were 4 times more likely to have the SSS than were those who did not (adjusted OR = 4.27; 95% CI: 1.24–14.69).

Discussion

In this study of diabetic patients, over half were found to have advanced periodontal disease; however, there was no association of the participants' periodontal status and the SSS. Interestingly, not having a dentist, wearing dentures, and visiting a dentist within the last year were significantly associated with the SSS. Participants who did not have a regular dentist were more than 7 times more likely to have the SSS than were those who did. Irregular dental attendance has been associated with poorer oral health in older adults (11) and has previously been reported in diabetic patients (12).

Periodontal diseases include gingivitis, a mild form of disease which is reversible and caused by dental plaque, and periodontitis, a more severe form which causes loss of connective tissue and bone support (10). Common forms of periodontal disease have been associated with adverse pregnancy outcomes, cardiovascular disease, stroke, pulmonary disease, and diabetes, but causal relations have not been established (13).

Periodontal disease and diabetes mellitus are common chronic conditions, the latter of which has been shown to be a risk factor for periodontal disease. Periodontal disease can be up to 2-fold higher among patients with diabetes (14). The biological mechanism that has been hypothesized for this association includes the induction of an increased inflammatory response

Table 2. Characteristics for 94 DM patients with and without the SSS

Variable	Total (N = 94)	SSS (N = 46)	No SSS (N = 48)	P value
Age (years), mean ± D¤	55.8 ± 10.69	57 ± 9.24	53 ± 11.70	0.08
Sex				
Male	32 (34.0)	14 (30.4)	18 (37.5)	
Female	62 (66.0)	32 (69.6)	30 (62.5)	0.47
Ethnicity				
Indo-Trini	68 (72.3)	31 (67.4)	37 (77.1)	
Non-indo- Trini	26 (27.7)	15 (32.6)	11 (22.9)	0.30
Do you have a dentist?				
Yes	16 (17.0)	7 (15.2)	9 (17.0)	
No	78 (83.0)	39 (84.8)	39 (81.3)	0.65
Last visit to dentist				
≤ 1 year	23 (24.5)	17 (37.0)	06 (12.5)	
>1 year or never	71 (75.5)	29 (63.0)	42 (87.5)	0.006**
Frequency of dental attendance				
Only when in pain	73 (77.7)	35 (76.1)	38 (79.2)	
More than once per year/at least once per year/less than once per year	21 (22.3)	11 (23.9)	10 (20.8)	0.09
Wear denture(s)				
Yes	20 (21.3)	15 (32.6)	5 (10.4)	
No	74 (78.7)	31 (67.4)	43 (89.6)	0.009**
Denture(s) worn at night§				
Yes	10 (50.0)	8 (53.3)	2 (40.0)	
No	10 (50.0)	7 (46.7)	3 (60.0)	1.00
Current Smoker				
Yes	6 (6.5)	4 (8.7)	2 (4.3)	
No	87 (93.5)	42 (91.3)	45 (95.7)	0.44
Plaque				
Mild	25 (26.6)	11 (23.9)	14 (29.2)	
Moderate	32 (34.0)	16 (34.8)	16 (33.3)	
Severe	37 (39.4)	19 (41.3)	18 (37.5)	0.84
BPE (See Table 1 for categories)				
Gingivitis or mild periodontitis (2–3)	36 (38.3)	21 (35.7)	15 (31.3)	
Moderate to severe periodontitis (4)	22 (23.4)	10 (21.7)	12 (25.0)	
Severe periodontitis	36 (38.3)	15 (32.6)	21 (43.8)	0.43

Absolute frequencies (percentages) are listed, unless otherwise specified. **Highly statistically significant. ¤Student's t-test. §Fisher's exact test. Pearson's chi-square tests were used for the other univariate analyses. Mild plaque: A film of plaque adhering to the free gingival margin and adjacent area of the tooth, and which cannot be seen with the naked eye and can be seen only by using disclosing solution or by using a probe. Moderate plaque: An accumulation of deposits within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen with the naked eye. Severe plaque: An abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.

to the periodontal microbiota, impairment of inflammation and repair, resulting in the augmentation of periodontal destruction (13). The association between these 2 diseases has also been described as 2-way, with periodontitis shown to adversely affect glycemic control (14) and periodontal treatment potentially improving glycemic control (12).

This study showed that 61.7% of the participants had advanced (moderate to severe) periodontal disease, which was higher than the prevalence (38.8%) reported in our study of a few years ago (1), but was similar to that described for type 2 diabetes patients in a German population, in which population the prevalence was 63.1% (15).

In the current study, there was no statistically significant difference in the BPE results between those with or without the SSS, which did not corroborate our research hypothesis. This may be partially due to the small sample size; a power calculation was not conducted in this study. Additionally, we hypothesize that the periodontal effects or complications may occur early in diabetes and therefore are independent of the other longer-term complications, such as those identified by the SSS. On the other hand, overall poor dental hygiene (34.0% and 39.4% of our sample had moderate or severe plaque scores, respectively) as well as the lack of routine dental care (73.3% of patients went to the dentist only when they were in pain) may have obscured the effect of poor diabetic control in our study group, accounting for the similarities between the patients with and those without the SSS. In our study, diabetic patients with the SSS had abundant plaque deposits (41.3%), and 76.1% had visited a dentist only when in pain. Those without the SSS also had a high prevalence (37.5%) of plaque deposits and a similar percentage (79.2%) regarding their visiting a dentist only in emergencies.

It seems that, in general, the local population is averse to seeking dental care on a routine basis, preferring instead to seek emergency care for pain. Our data showed that 83% of the patients in this study did not have a regular dentist, and 77.7% stated that their dental attendance was due to pain. Furthermore, patients with diabetes who did not have a regular dentist were nearly 8 times more likely to have the SSS (multivariate-adjusted OR = 7.70; 95% CI: 1.12–53.21), and those who had had reason to seek emergency dental care within the last year were 5 times more likely to have the SSS (multivariate-adjusted OR = 5.23; 95% CI: 1.16–23.66). Thus, in our population the SSS may have clinical value in identifying a subgroup of patients with diabetes who deserve special attention.

Those who wore a denture or dentures were 4 times more likely to have the SSS than were those who did not (adjusted OR = 4.27; 95% CI 1.24–14.69). The reason for tooth loss and, therefore, the need for dentures was not ascertained; however, it may be hypothesized that patients who wore dentures had lost their teeth to periodontal disease, which is one of the 2 leading causes of tooth loss, worldwide (10).

Our study has important clinical implications for the diabetic patients in our population; the high prevalence of periodontal disease underscores the necessity for regular

Table 3. Multivariate-adjusted odds ratios (OR) age, gender, and ethnicity as confounders, and 95% confidence intervals (CI) for SSS as outcome variable, according to potential risk factors.

Variable	Adjusted OR (95% CI)	P value
Age (years)	1.05 (1.01, 1.10)*	0.048
Sex		
Male	1	
Female	1.78 (0.64, 4.48)	0.269
Ethnicity		
Indo-Trini	1	
Mixed/Afro-Trini	1.24 (0.40, 3.82)	0.705
Do you have a dentist?		
Yes	1	
No	7.70 (1.12, 53.21)*	0.038
Last visit to dentist		
>1 year or never	1	
≤ 1 year	5.23 (1.16, 23.66)*	0.032
Wear denture(s)		
No	1	
Yes	4.27 (1.24, 14.69)*	0.021
Frequency of dental attendance		
Only when in pain	1	
More than once per year/at least once per year/less than once per year	2.08 (0.60, 7.16)	0.245
Plaque		
Mild	1	
Moderate	2.04 (0.56, 7.45)	0.282
Severe	1.65 (0.38, 4.59)	0.458
BPE		
Gingivitis or mild periodontitis (2–3)	2.54 (0.82, 7.86)	0.107
Moderate to severe periodontitis (4)	1.32 (0.38, 4.59)	0.661
Severe periodontitis	1	

*Statistically significant

dental screening (1). Earlier attendance to the dentist would aid in both disease prevention and improved periodontal management and treatment of patients with diabetes. The treatment and prevention of periodontal disease could also reduce chronic systemic disease risk to patients (16). Additionally, dentists are ideally placed to screen diabetic patients for SSS, given that its screening involves asking a simple question during the history taking of the patient. Diabetics may present to their dentists with a positive SSS and be unaware of the meaning of this clinical sign, which has been shown to be a marker for some of the more severe complications of diabetes, such as retinopathy and nephropathy (6). Moreover, through a collaborative approach to overall health, all healthcare professionals can aid in the effective prevention of periodontal disease through health promotion and disease prevention strategies among those with diabetes (10). Dentists having identified high-risk mouths, and doctors finding high-risk feet should certainly take the opportunity to collaborate and cross-refer patients for the optimization of care.

Strengths

This is the first study to look at oral health–related risk factors for SSS compared to non-SSS diabetic patients. The oral examiners were blinded towards the SSS status of the patients and were calibrated before data collection.

Limitations

The study had a small sample size and the sampling was non-random; therefore, generalizations cannot be made based upon its results. All the patients in this study came from the San Fernando General Hospital, which a is a government-funded teaching hospital catering to the needs of a population of half a million. Fewer than 30% of the people in this population seek dental healthcare from dentists in the private sector.

Conclusion

In diabetic patients, oral health–related risk factors, such as not having a dentist, wearing dentures, and only visiting a dentist for an emergency visit within the last year, may be associated with systemic complications, including peripheral neuropathy. That being the case, there is need for early collaboration between dentists and doctors on the care of patients with diabetes.

Resumen

Objetivo: la enfermedad periodontal y la neuropatía periférica son complicaciones asociadas con diabetes mal controlada. Este estudio busca determinar si la enfermedad periodontal es más severa y prevalente entre pacientes con neuropatía periférica diabética grave. Métodos: se realizó un estudio de casos y controles; con 46 pacientes con signos de zapatillas deslizantes (SSS, por siglas en inglés) -marcador clínico sustituto de la neuropatía periférica severa- y 48 pacientes sin signos reclutados en una clínica ambulatoria para diabéticos en Trinidad. La demografía, los índices de cuidado bucal y los datos del Examen periodontal básico (EBP) sirvieron para evaluar la salud periodontal de los pacientes por dos examinadores ignorantes del estado SSS de dichos pacientes. Se utilizó la regresión logística multivariada para evaluar las asociaciones entre los factores de riesgo y el SSS, de acuerdo con edad, género y etnia. Resultados: La edad media fue de 55.8 años (± 10,69). La mayoría (77.7%) nunca había ido a un dentista o había asistido por última vez a una clínica dental más de un año atrás antes de este examen y el 83% no tenía dentista. La enfermedad periodontal avanzó en 61.7%, y no hubo asociación entre SSS y enfermedad periodontal. Variables como, no tener un dentista, usar dentaduras postizas y no visitar a un dentista en el último año, se asociaron significativamente con SSS. Los pacientes que no atendieron a un dentista regularmente tuvieron siete veces más probabilidades de tener SSS que aquellos que sí (OR = 7.70, IC 95% 1.12-53.21). Conclusión: en pacientes diabéticos, los factores de riesgo en salud bucal, como no tener un dentista, usar una dentadura postiza y visitar al dentista al menos una vez al año, pueden estar asociados con complicaciones sistémicas, incluida la neuropatía periférica. Se recomienda la colaboración temprana entre dentistas y médicos en el cuidado de pacientes con diabetes.

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