

The slipping slipper sign: a simple test with high specificity and positive predictive value for peripheral neuropathy among diabetic patients

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Abstract

This study evaluated the ability of the slipping slipper sign (defined as unknowingly losing a slipper while walking) to identify diabetic neuropathy in Jamaican patients. A single question was used to ascertain the presence of the slipping slipper sign (SSS) among 69 patients attending a diabetes clinic. Nurses assessed pain, vibration and pressure perception among the same patients in order to detect diabetic neuropathy. The sensitivity, specificity and positive predictive value for the SSS were calculated. Eight participants (men=5, women=3) reported positive SSS. The SSS had a sensitivity of 28.6%, specificity of 100% and positive predictive value (PPV) 100% for neuropathy on at least one of the three tests. These findings indicate that the SSS has high specificity and PPV for diabetic neuropathy but the sensitivity is low. The sign may be a useful adjuvant to conventional methods of screening for severe neuropathy.

Introduction

Diabetic neuropathy is one of the most frequent diabetic foot lesions, affecting 20-40% of persons with diabetes.¹ Neuropathy increases the risk for diabetic foot ulcers, which precede 84% of lower limb amputations, and is associated with decreased quality of life and a high mortality rate.²⁻⁵ Currently accepted screening methods for diabetic neuropathy include pressure perception using the 10 g monofilament, superficial pain perception, and vibration perception.^{6,7} In a recent study in Trinidad, Teelucksingh *et al.* showed that in addition to these screening tests, the simple enquiry of the unrecognised loss of one's slippers [the slipping slipper sign (SSS)] has 83% sensitivity and 91% specificity for detecting the presence of severe neuropathy in patients with dia-

betes.⁸ We evaluated whether the slipping slipper sign was also associated with diabetic neuropathy in Jamaica and calculated the sensitivity, specificity and positive predictive value (PPV) for the SSS in this setting.

Materials and Methods

We analyzed data from 69 participants comprising a sub-sample of participants in a study of diabetic foot complications at the diabetes clinic at the University Hospital of the West Indies (UHWI). The full study was conducted between August 2009 and September 2010. Details of the study procedures have been previously published.⁹ Ethical approval was obtained from the UHWI/University of the West Indies/ Faculty of Medical Sciences Ethics Committee and written informed consent was obtained from all participants prior to administration of questionnaires or performing tests.

The primary study encompassed data collected by trained research nurses from a stratified random sample of 188 patients from the UHWI diabetes clinic. Anthropometric measurements were done along with foot examinations that included a general assessment (for amputations, ulcer or foot infections), a vascular examination using ankle brachial index and a neurological examination. The neurological exam consisted of pain perception, assessed 0.5 cm proximal to the nail-fold of the great toe, using the Neuropen[®] device and Neurotips[®] (Owen Mumford, Oxford, England); vibration perception, assessed at the dorsal aspect the distal inter-phalangeal joints of the great toe, using a 128 Hz tuning fork; and pressure perception, assessed at the plantar surface of the great toe and the head of the 1st, 3rd and 5th metatarsals, using a 10 g monofilament. In addition to the above, a foot care questionnaire, which included a question on the SSS, was completed by 69 participants. For evaluation of the slipping slipper sign participants were asked: *Have you ever lost your slipper from your feet while walking and not realized that you had done so?* A yes response to this question was considered a positive slipping slipper sign.

Analysis was performed using Stata 10.1 (College Station, Texas). We obtained proportions of persons with a positive SSS and compared proportion with positive SSS for participants with any one of the three types of neuropathy or for those having impairment of one, two or all three manifestations of neuropathy. Bivariate analyses were performed by the chi square (χ^2) test and Fisher's exact test as appropriate. Statistical significance was set at $P < 0.05$. Sensitivity, specificity, and positive predictive value for the various types of neuropathy were calculated.

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Results

Eighty-eight per cent (88%) of participants in the study reported wearing slippers at some time. The proportion of persons with positive SSS and calculated sensitivity, specificity and PPV are shown in Table 1. Of the 69 participants 28 (40.6%) had evidence of neuropathy (impaired pain perception, vibration perception or pressure perception) on clinical examination. Prevalence of neuropathy was higher among men (71.4%) compared with women (32.7%). The proportion of participants with SSS for each type of neuropathy is shown in Figure 1. None of the participants without neuropathy had a positive SSS. Eight patients (12%) reported positive SSS. All eight patients with a positive SSS had evidence of neuropathy on at least one of the three sensory testing modalities used. Twenty patients with neuropathy had a negative SSS. This translated to

Table 1. Number, proportion, sensitivity, specificity and positive predictive value for patients with positive and negative slipping slipper sign by neuropathy status and testing modality.

Characteristic	SSS positive n (%)	SSS negative n (%)	P value	Sensitivity %	Specificity %	PPV%
Any neuropathy on examination* (N=28)	8 (28.6)	20 (71.4)	<0.001	28.6	100	100
Severe neuropathy ^o (N=13)	6 (46.2)	7 (53.8)	<0.001	46.2	96.4%	75.0
Impaired pain perception (N= 12)	7 (58.3)	5 (42.7)	<0.001	58.3	98.3	87.5
Impaired vibration perception (N= 9)	3 (33.3)	6 (66.7)	0.063	33.3	91.7	37.5
Impaired monofilament (N=27)	7 (25.9)	20 (74.1)	0.005	25.9	97.6	87.5

SSS, slipping slipper sign; PPV, positive predictive value. *Examination findings consisting of any combination of impaired pain perception, impaired vibration, or impaired pressure perception on monofilament testing; ^oHaving impairment of two or more of the modalities above. P-value is for difference in proportion for SSS positive and SSS negative.

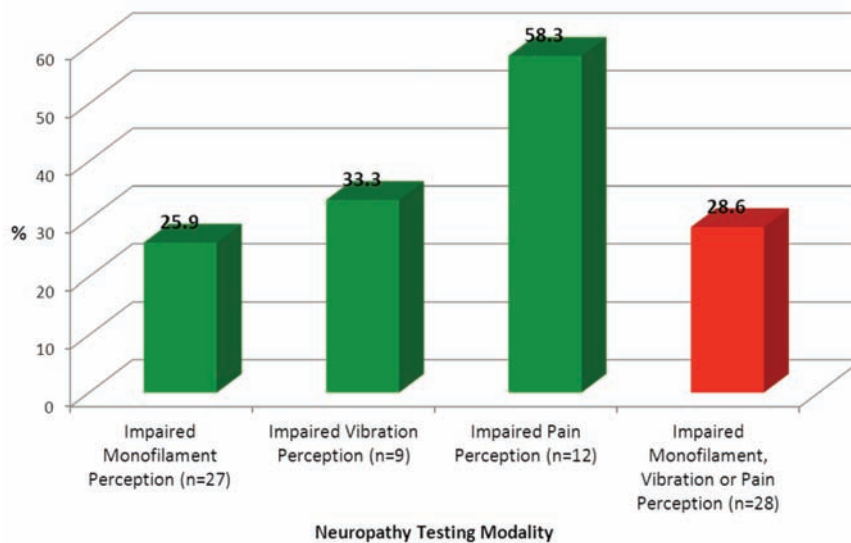


Figure 1. Proportion of participants with positive slipping slipper sign for each neuropathy testing modality and for any neuropathy (= impairment of any of the three modalities tested i.e. monofilament, vibration perception and pain perception).

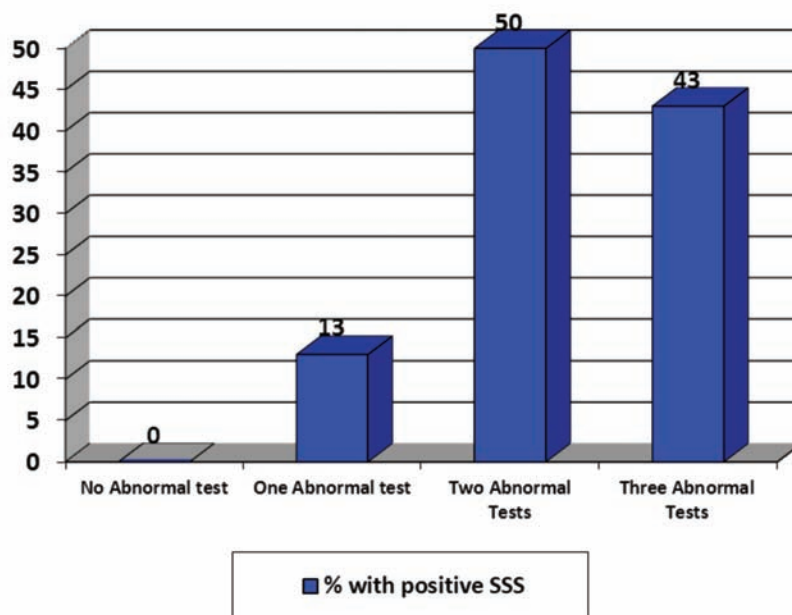


Figure 2. Frequency of slipping slipper sign by number of abnormal neurological tests. SSS, slipping slipper sign; P for trend <0.001.

a sensitivity of 28.6%, specificity of 100% and PPV 100% for neuropathy on at least one of the three sensory modalities tested. For pressure perception by monofilament sensitivity for the SSS was 25.9%, specificity was 97.6% and PPV 87.5%. Impaired vibration perception had sensitivity of 33.3%, specificity of 91.7%, and PPV of 37.5%. Sensitivity was higher for impaired pain perception (58%), but specificity and PPV were similar (specificity 98.3%, PPV 87.5%). The presence of SSS was also associated with the severity of neuropathy (P for trend <0.001) as illustrated in Figure 2. Among patients with severe neuropathy defined as having impairment on two or more testing modalities 46% had a positive SSS, which translated to a sensitivity of 46.2%, specificity of 96.4%, and PPV of 75%.

Discussion

This study corroborates the association between the SSS and peripheral neuropathy, in particular its association with more severe neuropathy based on number of positive tests. In this study the SSS had high specificity and PPV but fairly low sensitivity. Apart from Teelucksingh's paper⁸ we found no other published reports on the SSS. In light of the strong association of neuropathy with the development of diabetic foot ulceration, lower extremity amputation, and Charcot arthropathy,¹⁰ detection of peripheral neuropathy is of paramount importance to prevent lower extremity complications. Although sensory perception testing methods (such as 10 g monofilament, pain perception and vibration testing) are sensitive in identifying patients at risk for foot ulceration,¹⁰ the SSS allows the clinician to identify patients with severe neuropathy with a single question and no testing equipment. Adding this question to the regular diabetic history will serve to alert the clinician of the patients' high-risk status. We note that although the sensitivity of the SSS in this study was relatively low (28.6% for any neuropathy), this may reflect a higher proportion of persons with mild neuropathy in our study compared to Teelucksingh's original study.

This is supported by that fact that in our study sensitivity was higher among persons with impairment on two or more modalities (46.2%) and for impaired pain perception (58%), which may be considered markers of more severe neuropathy as compared to impaired vibration perception or pressure perception. We therefore support Teelucksingh's position that the SSS is a useful addition to the physician's tool box as a novel method for mass screening for feet at risk because it is simple and has no cost implications.⁸ In light of the low sensitivity for overall neuropathy in this study, it cannot replace formal sensory testing, however it has the potential to be *limb-saving* and may be a useful adjuvant to conventional methods of screening for severe neuropathy and to identify patients who should be advised against wearing slippers. We acknowledge that the low sensitivity of the SSS and ready availability of other screening tools may limit the applicability of the SSS in developed countries; however, the test could be of high value in low resource settings, to identify patients with high-risk feet and thus ensure that they receive adequate care. Additionally, the SSS could be used in public education campaigns to alert patients of the presence of neuropathy and to encourage them to seek medical attention.

Further studies are warranted to assess frequency of the SSS among patients with estab-

lished neuropathy and to assess its predictive validity for the development of diabetic foot complications. Studies evaluating the incorporation of the SSS in neuropathy screening instruments may also demonstrate additional uses of the test.

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