

Screening and identifying diabetic patients at risk of foot ulceration: use of the Semmes–Weinstein monofilament

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Abstract

The diabetic foot can present with many different problems and the most important clinically are ulceration, amputation, and Charcot neuropathy. The majority of lower limb amputations in patients with diabetes are preceded by foot ulceration. Neuropathy results in loss of protective sensation and the use of 5.07/10 g Semmes–Weinstein monofilament is a simple device that detects patients with insensate feet. Clinical and demographic parameters of all consenting consecutive type 2 diabetes patients were documented. A history of the presence of peripheral neuropathy and sensory modalities of light touch, vibration sense, and joint position were assessed and the 5.07/10 g Semmes–Weinstein monofilament was used to detect patients with insensate feet. A total of 117 patients were examined (mean age 58 years, diabetes duration 6 years: there were 51% males and 49% females, and mean fasting plasma glucose was 8.1 ± 2.9 mmol/L. Ninety-three (79%) presented with a history of peripheral neuropathy and 96% had one or more impaired sensory modality. The use of the monofilament showed impairment in 49%. Twenty-seven (23%) of these had severe peripheral neuropathy. The most frequent site of loss of sensation was the heel (31%). We concluded that the prevalence of peripheral neuropathy in our patients is high. Most patients walked sometimes barefoot, which may account for a high occurrence of foot ulceration. The Semmes–Weinstein monofilament should be routinely used in diabetes clinics.

Introduction

Individuals with diabetes have a higher risk of amputation than non-diabetic subjects.^{1,2} The two most common risk factors for amputation associated with diabetes are peripheral neuropathy and peripheral vascular disease.

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The diabetic foot can present with many different problems, but the most important clinically are ulceration, amputation, and Charcot neuropathy. Foot ulceration develops in approximately 15% of patients with diabetes and foot disorders are a leading cause of hospitalisation among such patients.^{3–5} Eighty-five percent (85%) of lower limb amputations in patients with diabetes are preceded by foot ulceration, suggesting that prevention and appropriate management are of paramount importance.^{6,7} Ulceration is caused by several factors acting together, in particular neuropathy.⁸ Peripheral neuropathy results in loss of protective sensation of pain, autonomic dysfunction, sympathetic denervation, dry skin, and warm feet.

Current teaching promotes early detection of neuropathy, so that treatment can be commenced for individuals at risk. Clinical assessment depends on the criteria used, and the skill and interpretation of the individual clinician. Nerve conduction studies can quantitate neurophysiological changes, but are not suitable for widespread clinical use. The use of the 5.07/10 g Semmes–Weinstein monofilament is recommended by the International Diabetes Federation (IDF) and World Health Organization (WHO) as a simple device that can be used by health professionals at every level of care.^{9,10}

We therefore set out to:

- detect patients with insensate feet using the 5.07/10 g Semmes–Weinstein monofilament;
- evaluate the impact of using different sites on the foot for testing peripheral neuropathy with the Semmes–Weinstein monofilament;
- evaluate which sensory perception (light touch, vibration sense, joint position sense, and monofilament test) best determined peripheral neuropathy in our patients.

Patients and methods

Clinical and demographic parameters of all consenting consecutive type 2 diabetes patients (with duration not less than 6 months) attending the Diabetic Clinic of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Osun State, Nigeria were included and studied. Patients with diabetic foot ulcers or amputation were excluded from the study.

The presence of neuropathy was tested via a neurological

assessment using:

- a history of the presence of neuropathy, i.e. numbness, tingling sensation, burning sensation, crawling sensation, peppery sensation, etc.
- examination of sensory modality assessed for light touch using a wisp of cotton wool, vibration sense using a 128 Hz tuning fork, and joint position sense;
- eight different sites¹¹ (see Figure 1) were tested with the Semmes-Weinstein monofilament;

Figure 1 Sites used for monofilament testing



this buckles when a force of 10 g is exerted.

For the purpose of this study an insensate foot was defined as loss of perception to the monofilament, and severe peripheral neuropathy as impaired perception for touch with the monofilament in three or more sites.¹² Caution was taken by the examiner as the Semmes-Weinstein monofilament may not exert up to 10 g buckling force if it is not properly applied.¹³

For the laboratory parameters, the means of all preceding blood glucose readings (fasting and 2-hour post-prandial) over the past 3 months for each patient were used to assess blood glucose control.

The results were analysed by descriptive statistical methods, including means and standard deviations. In addition, Spearman's rank coefficient of correlation and chi-square tests were used. The choice between parametric and non-parametric methods was dependent on the frequency distribution of the data analysed. Statistical analysis was done using the SPSS (Statistical Package for the Social Sciences) software version 11.1. A 95% confidence was used for the determination of significance of probabilities, i.e. the difference was significant when $p < 0.05$.

Results

A total of 117 patients were examined. There were 60 males (51%) and 57 females (49%). Their mean (\pm SD) age was 58 ± 9 years (range of 41–76). Duration of diabetes was 6 ± 5 years (range of 1–20). The mean \pm SD height of the patients was 1.63 ± 0.08 metres.

Figure 2 shows the type of footwear used by patients. While 99 (85%) usually wore shoes, only 6 (5%) usually went about barefoot. Ninety-three (79%) presented with a history of peripheral neuropathy that ranged from numbness (alone or in combination with other forms of parasthesia) in 69 (74%), to tingling, burning sensation, crawling sensation cramps, and others. Figure 3 shows the frequency of the assessed impaired

Figure 2 Frequency of footwear use in patients

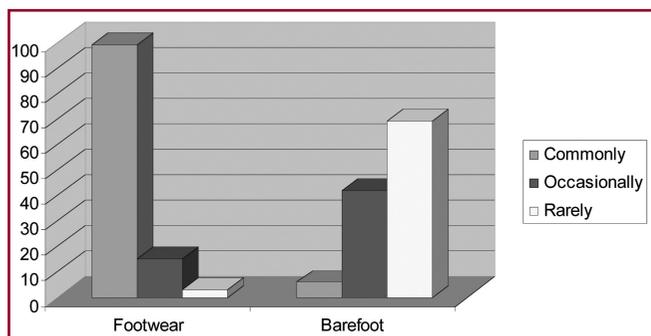
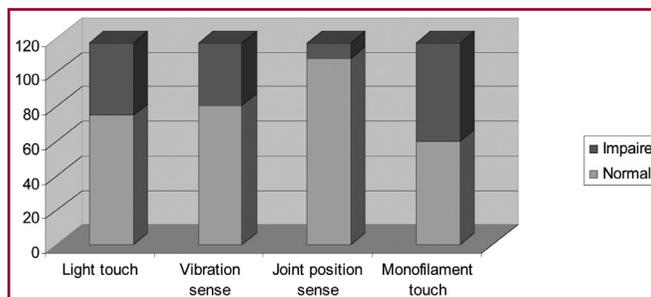


Figure 3 Frequency of assessed sensory modality



sensory modalities. One hundred and twelve (112 or 96%) had one or more impaired sensory modality. Use of the monofilament showed more impairment in 49% compared to other sensory modalities.

Of the ten sites tested, with Semmes-Weinstein monofilament, 60 (51%) patients had normal sensation while 57 (49%) showed impaired loss in one or more sites. Twenty-seven (27 or 23%) of these fitted our definition of persons with severe peripheral neuropathy. Table 1 shows the relationship between the history of peripheral neuropathy and the impaired sensory modality tested. The most frequent site of loss of sensation was the heel in 36 (31%) followed by the head of the second metatarsal and the dorsum of the little toe in 24 (20%). The least frequent site of impaired sensation to the monofilament tests were the head of the first and third metatarsal in 15 (13%) each (see Figure 4). There was a relationship

Table 1 Association between the history of peripheral neuropathy and impaired sensory modalities tested

Sensory modality		History of peripheral neuropathy		Significance
		Present	Absent	
Light touch	Intact	63	12	p=0.106
	Impaired	30	12	
Vibration sense	Intact	66	15	pNS
	Impaired	27	9	
Joint position sense	Intact	90	18	p<<0.001
	Impaired	3	6	
Monofilament test	Intact	72	18	$\chi^2=0.063$ df=1 p=0.802
	Impaired	21	6	

Figure 4 The frequency of impaired sensation with Semmes–Weinstein monofilament on the tested sites

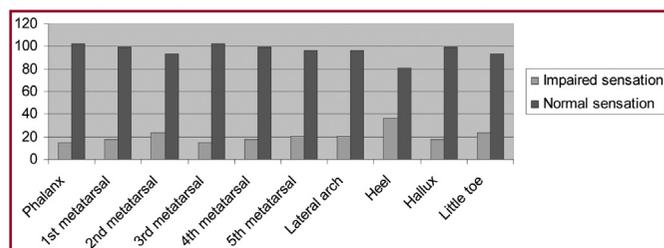


Table 2 Association of peripheral neuropathy using the Semmes–Weinstein monofilament versus other sensory modalities

Sensory modality		Insensate foot		Significance
		Yes	No	
Light touch	Intact	6	69	p<<0.01
	Impaired	21	2	
Vibration sense	Intact	15	66	p=0.079
	Impaired	12	24	
Joint position sense	Intact	18	90	p<<0.001
	Impaired	9	0	

between an insensate foot and light touch and joint position sense (p<0.001) (see Table 2).

Discussion

The symptoms of diabetic neuropathy vary. Often these symptoms are slight at first and since most damage occurs over a period of years, mild cases may go unnoticed. In this study about 80% of the patients presented with a history of peripheral neuropathy. This could be because of the relatively long duration of diabetes or due to the fact that a large proportion 42 (36%) of our patients still occasionally walked barefoot at home. The symptoms of numbness and tingling in the feet are often the first features, and in our study 74% of patients presented with this feature either alone or in combination with other forms of paresthesia. The history of peripheral neuropathy did not show any relationship to the tested modality, except for joint position sense. The early detection of peripheral neuropathy in diabetes is still important since it is the main risk factor for foot ulceration,¹⁴ and so preventive action can be implemented by means of patient education and routine assessment.

Detection of the insensate foot is an important aspect in the identification of patients with sufficiently severe neuropathy who may be at greater risk of a neuropathic ulcer. In this study, out of the 80% with history of peripheral neuropathy, 96% of patients had one or more impaired sensory modality on testing, while 23% had severe peripheral neuropathy using the monofilament by our definition. This is in keeping with the prevalence found in other studies of peripheral neuropathy.¹⁵ In fact, 49% of our patients had an insensate foot using the Semmes–Weinstein monofilament. This difference could be because of the reasonable sensitivity and specificity of

80–86%¹⁵ documented when the first and fifth metatarsal heads cannot feel the monofilament. In our study, this was seen in 18 (21%) and 21 (25%), respectively. Again the use of monofilament showed a higher association to two (light touch and joint position sense) of the tested sensory modalities than did a history of peripheral neuropathy (See Tables 1 and 2).

In conclusion, the prevalence of peripheral neuropathy remains high in our patients. This may be contributed to by poor glucose control and type of footwear. The prevalence of severe neuropathy as documented by the use of monofilaments is equally high. As the foot is frequently neglected and over looked, this may result in the high occurrence of foot ulcer noted.¹⁴ Therefore the 5.07/10g Semmes–Weinstein monofilament, an inexpensive instrument (though not still commonly available in most developing world) needs to be frequently used in diabetic clinics to screen and identify patients with insensate foot and reduce the risk of lower limb amputation in people with diabetes; especially in areas where prostheses are not easily available.

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