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Prevalence of leprous neuropathy determined by neurosensory testing in an endemic zone in Ecuador: Development of an algorithm to identify patients benefiting from early neurolysis

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Summary The success of a microneurosurgical intervention in leprous neuropathy (LN) depends on the diagnosis of chronic compression before irreversible paralysis and digital loss occurs. In order to determine the effectiveness of a different approach for early identification of LN, neurosensory testing with the Pressure-Specified Sensory Device™ (PSSD), a validated and sensitive test, was performed in an endemic zone for leprosy. A cross-sectional study was conducted to analyze a patient sample meeting the World Health Organization (WHO) criteria for Hansen's disease. The prevalence of LN was based on the presence of ≥1 abnormal PSSD pressure threshold for a two-point static touch. A total of 312 upper and lower extremity nerves were evaluated in 39 patients. The PSSD found a 97.4% prevalence of LN. Tinel's sign was identified in 60% of these patients. An algorithm for early identification of patients with LN was proposed using PSSD testing based on the unilateral screening of the ulnar and deep peroneal nerves.

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Introduction

Surgeons skilled in microneurosurgery have much to offer leprosy patients. Leprous morbidity is largely a consequence of nerve damage, as loss of protective sensation leads to skin ulceration, amputation of digits, and limb contractures.[2] Leprosy patients represent a widespread group with peripheral nerve disorder, whose global prevalence was between two and three million as of 2012.[1,2] New cases continue to occur in all of the 105 endemic countries or territories reported by the World Health Organization (WHO), with 219,075 cases being reported during 2011 and the first quarter of 2012.[1,2]

Because of late diagnosis and management, leprous neuropathy (LN) often leads to irreversible disability. At the time of diagnosis, a reported 33—56% of patients present with irreversible neuropathy, and up to one-third of patients show signs of disability related to ulceration and amputation.[3] As a result of such morbidities, affected individuals experience significant functional impairment and are subject to debilitating stigma in both domestic and civic life.[4] For >50 years, microneurosurgical intervention in neurolysis has been able to restore upper and lower extremity functions and sensory and motor functions.[5—10] Timely microneurosurgical intervention requires an early diagnosis of peripheral nerve dysfunction.

In 1968, Goodwin and Watson recommended the use of a "small, blunt instrument" for sensory screening in leprosy patients. Since then, standard screening for nerve impairment in leprosy has involved the use of the Semmes—Weinstein nylon monofilament or a ballpoint pen.[11] The latter instrument, which is the predominant method of screening in some endemic countries, is widely available and inexpensive.[12,13] However, it has several major limitations. First, its use in the field lacks standardization.[11,13] In addition, compared with the 10-g Semmes—Weinstein monofilament, the ballpoint pen was shown to underdiagnose sensory nerve function impairment for test points by 21% on hands and 30% on feet.[13] Thus, there is a substantial risk of delaying detection of LN with the ballpoint pen screening method. Furthermore, as this is the most commonly performed screening modality in several endemic zones, the prevalence of LN remains obscure and potentially underestimated. The Pressure-Specific Sensory Device™ (PSSD) has emerged as a validated tool for the assessment of peripheral nerve dysfunction with the potential to overcome the deficits of conventional screening methods.[14,15] In a study published by Seiler et al., in 2005, the PSSD was shown to accurately identify abnormal peripheral nerve function caused by *Mycobacterium leprae* in both early and late stages, suggesting the possibility of using the PSSD as a screening tool for early detection of peripheral nerve impairment in leprosy.[16]

The purpose of this study was to determine the prevalence of LN in an endemic zone (Los Ríos, Ecuador) using cutaneous pressure thresholds measured with the PSSD. In addition, we sought to evaluate the performance of the ballpoint pen test in determining the prevalence in comparison to the PSSD, and Tinel's sign in identifying potential sites of chronic nerve compression in LN. We also investigated the possibility of establishing an algorithm for clinical screening in endemic areas of leprosy based on the hypothesis that the pattern of chronic nerve compression in leprosy is more frequently due to the involvement of superficial peripheral nerves (ulnar and deep peroneal) than deep nerves as *M. leprae* is known to prefer replicating in cool environments.[17] Finally, we formulate clinical recommendations for the implementation of the PSSD screening in endemic regions, which can identify patients who might benefit from early neurolysis.

Methods

A cross-sectional study was conducted in a leprosy endemic area (Los Ríos, Ecuador) in July 2013. The study protocol followed the Declaration of Helsinki, as each patient provided oral consent in their native Spanish and could decline participation without consequences. Patients who met the WHO criteria for Hansen's disease diagnosis in endemic zones (i.e., skin lesion consistent with leprosy and with definite sensory loss or symptoms, with or without thickened nerves) were eligible for participation.[18] Individuals with other potential sources of neuropathy, such as diabetes mellitus or HIV, were excluded from the study.

The mean age of the population was 34.8 ± 21.7 years (range 7.2—84.1 years).

Four sites were selected for neurosensory testing based on the pathophysiology of nerve compression syndromes and our previous experience with peripheral nerve assessment in leprosy patients.[16,19] These included the ulnar nerve at the little finger pulp, median nerve at the index finger pulp, deep peroneal nerve at the dorsal foot web space, and tibial nerve at the great toe pulp, which were designed to assess nerve entrapment at the elbow, wrist, fibular neck, and ankle, respectively.

The PSSD, ballpoint pen, and Tinel testing were performed at each site bilaterally by the same operator and under standardized conditions. Ballpoint pen test outcomes were recorded as normal or abnormal based on the ability to detect the touch of the tip of the ballpoint pen. Tinel's sign was reported as positive or negative at each site tested.

The PSSD (Sensory Management Services, LLC, Towson, MD 21204, USA) quantifies the cutaneous pressure threshold for one- and two-point moving and static touch (0.1—100.0 g/mm^2) via two hemispherical metal prongs separated by an adjustable distance (2.5—20 mm). A computer linked to the device records the measured values (Figure 1). The interprong distance was set to the 99% upper confidence limit for distance based on age (age above or below 45), and the outcomes were dichotomized into normal or abnormal, based on the previously published normative data.[20,21] The diagnosis of LN was based on the presence of ≥1 abnormal pressure thresholds. We evaluated Tinel's sign at the known anatomic sites of potential nerve entrapment (elbow, wrist, fibular neck, and tarsal tunnel), as a measure of potential chronic nerve entrapment.

We used the results of the PSSD testing to estimate the prevalence of LN and calculate the percentage of