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Progression of leprosy neuropathy: a case series study

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Abstract

A need still exists to determine the clinical and neurophysiological characteristics of leprosy neuropathy at distinct times of the disease by different methods that measure the various nerve fiber functions. A prospective clinical study was performed with 10 paucibacillary (PB) and 12 multibacillary (MB) patients evaluated at diagnosis and one year after cessation of multidrug therapy (MDT). Peripheral nerve function was assessed clinically and by means of the sympathetic skin response, skin vasomotor reflex, and nerve conduction study (NCS). At diagnosis, 73% of the total 22 patients had nerve function impairment (NFI). Autonomic function ($\chi^2 = 5.5$, $P = 0.019$) and NCS ($\chi^2 = 7.765$, $P = 0.01$) were significantly more altered in MB than PB patients. At final evaluation, NFI of the MB patients had worsened, especially among the six who had leprosy reaction. As the NFI of PB patients showed improvement, a significant difference between the two groups ($\chi^2 = 12.320$, $P = 0.001$) was observed. A high prevalence of neuropathy was observed in newly diagnosed patients. Associating different tests with a thorough clinical neurological evaluation increases detection rates.

Introduction

Leprosy, a disease known for its characteristic insensitive skin patches, is the main cause of peripheral neuropathy in endemic countries. Neuropathy is often clinically silent in its evolution making early diagnosis exceptionally challenging so that even highly skilled clinical management may not be able to prevent permanent nerve damage (Job 1989).

The Enhanced Global Strategy for 2011–2015 emphasizes the goal of reducing the number of patients with permanent disabilities, which in 2009 totaled 14,320 new patients (WHO 2010). Fortunately, crucial information concerning the etiology, incidence, risk factors, and treatment of peripheral neuropathy is becoming more and more readily available despite the fact that many key questions regarding early diagnosis and prevention strategies continue unanswered.

Clinical neurological examination, especially of sensory function, is essentially subjective in that it is based on a certain level of patient awareness. Accordingly, distinct techniques aiming toward a more objective detection of early nerve function impairment (NFI), imperative for successful therapeutic interventions, have been developed and tested (Van Brakel et al. 2007).

Nerve conduction study (NCS) provides reliable information regarding large myelinated nerve fiber (LNF) impairment, often a late event in leprosy (Anthia et al. 1975). However, a special approach is required to detect impairment of the small, nonmyelinated and poorly myelinated fibers that are so, particularly vulnerable to early damage from the *Mycobacterium leprae (M. leprae)*-induced inflammatory infiltrate (Rambukkana 2000). Specifically, autonomic abnormalities can be effectively studied by measuring the skin vasomotor reflex (SVMR) (Low et al. 1983) and the sympathetic skin response (SSR) (Shahani et al. 1984).

Leprosy neuropathy is complex, with the superposition of acute and chronic sensory, motor and/or autonomic events (Charosky and Cardama 1983). A prospective clinical study was performed in newly diagnosed leprosy patients to evaluate the small and large myelinated fibers by means of clinical neurological examination and neurophysiological

studies. The different methods were applied to determine the frequency of neuropathy at diagnosis and one year after cessation of multidrug therapy (MDT) in paucibacillary (PB) and multibacillary (MB) leprosy patients.

Patients and Methods

Twenty-two leprosy patients (16 men and six women, aged 19–60) diagnosed at the Leprosy Outpatient Clinic, Oswaldo Cruz Foundation, Rio de Janeiro, RJ, Brazil, were evaluated prior to and one year after cessation of MDT and consecutively selected regardless of their neurological condition. Patients with associated diseases such as diabetes mellitus, alcoholism, Human immunodeficiency virus or Human T-linphotrofic virus-I infections, rheumatoid/rheumatic diseases, or with toxic, drug-induced, or hereditary neuropathies were excluded. All patients received MDT: PB patients with no observable bacilli in six slit-skin smears (baciloscopic index = 0) were treated for six months with one supervised monthly dose of 600 mg rifampicin and 100 mg dapsone in conjunction with 100 mg/day dapsone; MB patients with positive slit-skin smears to *M. leprae*, received a monthly supervised dose of 600 mg rifampicin, 100 mg dapsone, and 300 mg clofazimine together with 100 mg/day dapsone and 50 mg/day clofazimine for 12 months. Upon completion of MDT, the patients were directed to return in the case of the development of new lesions, the worsening of old ones, or the appearance of neurological symptoms.

The research was carried out in compliance with the International Norms on Ethics in Human Research, having been previously approved by the Ethics Committee of the Oswaldo Cruz Foundation. All patients voluntarily provided their written, informed consent.

A clinical neurological evaluation of the peripheral nerves of all patients was performed. LNF were complementarily evaluated by means of NCS and autonomic function via SVMR and SSR. The evaluations at diagnosis and one year after cessation of MDT were performed by different neurologists.

A detailed neurologic examination was performed to record the number and distribution of affected nerves. The analyzed components of the neurologic examination were: motor strength and tactile sensation for LNF evaluation, thermal and pain sensation, presence of cyanosis on the palms and/or soles, and paraesthesia for the small nerve fiber (SNF) evaluation. Sensory impairment, motor deficit, and disability/deformity status were assessed using standard methods.

In brief, tactile threshold was tested with Semmes-Weinstein monofilaments. The monofilaments vary in thickness, with a different value in grams for each one (1 = 300 g, 2 = 4 g, 3 = 2 g, 4 = 0.2 g, and 5 = 0.05 g), and the inability to perceive the touch of even one of them represents an absence of tactile sensitivity to that given pressure (Ministério da Saúde 2001, 2002). Thermal sensation was determined by the use of cold metal (15°C cold) objects, and a safety pin was utilized to ascertain pain perception in the median, ulnar, radial, sural, superficial fibular, and plantar bilaterally nerves. Individual muscle strength of the upper and lower extremities was determined by voluntary muscle testing. Disability was recorded in accordance with the standard World Health Organization grading criteria (WHO 1988). NFI was defined as clinically detectable impairment of the motor, sensory, and/or autonomic functions.

The following tests were used in the neurophysiological studies for the SNF evaluation:

SVMR was tested by means of a Laser-Doppler fluxometer (Periflux 5000 system, PERIMED^{TM}, Stockholm, Sweden) according to Illarramendi et al. (2005). In brief, patients were requested to refrain from eating, drinking any caffeine-containing beverages, and smoking for 3 h prior to examination. All individuals were tested in the morning hours to reduce the effect of the circadian variation in the peripheral blood flow. Blood perfusion was measured on the fingertips of the second and fifth digits using small, angled thermostatic probes attached by double-sided adhesive strips. The inspiratory gasp—a sudden, deep, full inspiration without holding the breath—was used to stimulate the SVMR. Baseline blood perfusion was registered after the individuals were comfortably seated with their arms on a table at heart level. The onset of the stimulus was marked and the resultant variation in skin blood perfusion was recorded. The procedure was repeated at least three times and the two largest reductions were averaged. The reduction in perfusion was expressed as a percentage of the baseline blood perfusion. Abnormal SVMR was defined as the 95th percentile of the values obtained from an endemic control group (Illarramendi et al. 2005).

SSR was recorded by way of a conventional electromyography apparatus: the Neuropack2 (Nihon-Koden) two-channel system. Surface disc electrodes were applied to the ventral and dorsal surfaces of the hand. Recordings were filtered at a band pass of 0.5–1 KHz with an analytical time of 5 sec. A fixed stimulus of 0.2 msec duration and 25 mA intensity was applied to the median nerve at the opposite wrist. Application of random stimuli of sufficient intensity was used to overcome habituation. Only the absence of response was considered abnormal.

LNFs were measured via NCS that was performed using the same Nihon-Koden apparatus in accordance with standard procedures (Delisa et al. 1994). Amplitude, velocity, and latency were recorded for the median, radial, ulnar, and sural sensory nerves in addition to the median, ulnar, and peroneal motor nerves (total of 14 nerves). Lower limits of normal (cutoff) for sensory conduction velocity (m/sec) were: radial (41), median (42), ulnar (43), sural (38); for sensory amplitude (μV) were: radial (8), median (15), ulnar (8), sural (7). Lower limits of normal (cutoff) for motor conduction velocity (MVC) (m/sec) were: median (52), Ulnar (55), Peroneal

(42); for motor amplitude (mV) were: median (4), ulnar (4), peroneal (2). The upper limits of normal (cutoff) for sensory latency (milliseconds) were: radial (2.2), median (3.4), ulnar (2.7), sural (3.6) and for motor latency were: median (3.8), ulnar (3.3), peroneal (4.6).

The results of the conduction studies were used to determine LNF impairment and classified, as follows: (1) normal; (2) axonal lesion, defined by a reduction of Compound Muscle Action Potentials (CMAP) and/or Sensory Nerve Action Potentials (SNAP), the amplitude being less than 30% of reference values and the sensory and/or MVC above 70% of reference value; (3) demyelination lesion, defined when the CMAP and/or SNAP latency prolonged compared to the reference value together with a reduction of sensory and/or MCV below 85% of reference value; (4) mixed lesion, whenever there were both axonal and demyelinating lesions in the same nerve; and (5) no conduction. Abnormal temporal dispersion was defined as a proximal distal compound muscle action potential duration increase of more than 30% (Olney et al. 2003).

Data were analyzed via SPSS^{TM} 11.5 for Windows. The χ^2, the Fisher's exact, and the Mann–Whitney U tests were utilized to compare PB and MB patient variables. The first and second exams were compared by the McNemar test; and P values under 0.05 were considered significant.

Results

Ten (45%) patients received the PB scheme (according to type of leprosy: one indeterminate, one tuberculoid, and eight borderline tuberculoid); and 12 (55%) received the MB scheme (four borderline lepromatous and eight lepromatous). Before treatment, most of the MB patients (92%) had a high ($\geq$3.0) baciloscopic index. While 90% of all MB patients were male, only 50% of PB patients were ($P = 0.056$).

A majority of the PB (90%) and MB (58%) patients had no observable disability at diagnosis according to grade of disability, but 73% of the 22 patients had NFI. All of the clinical parameters showed a nonsignificant higher percentage of alteration in MB as compared to PB patients (Table 1). While eight (36%) of the 22 patients (five MB) had nerve enlargement, none complained of nerve tenderness and were thus not diagnosed with acute neuritis. All patients ($n = 12$) who had at least one sensory nerve impairment had thermal and/or pain impairment, six of whom had tactile impairment as well.

Eight patients (36%) had altered SVMR, seven on the ulnar topography (85% bilaterally), and five on the median topography (40% bilaterally). SSR was absent in eight (36%) of the patients. MB patients evidenced more frequent impairments on both tests, but only SVMR (Table 2) was significantly more altered in MB than PB patients ($\chi^2 = 5.5$, $P = 0.019$). Interestingly, an association of the SVMR with the SNF clinical examination was observed in this sample of patients. Of the four patients with SNF clinical impairment, all had SVMR dysfunction ($\chi^2 = 8.556$, $P = 0.010$).

Five (23%) patients (all PB) had a normal NCS. The NCS result was significantly more compromised in MB than PB patients ($\chi^2 = 7.765$, $P = 0.01$) in both the motor ($\chi^2 = 9.900$, $P = 0.003$) and sensory nerves ($\chi^2 = 6.712$, $P = 0.02$) (Table 1). In addition, temporal dispersion was only observed in three patients: two in the ulnar and one in the median nerves.

Sensory and motor alteration was more evident in the NCS than in the respective clinical parameters. For example, although no tactile sensory impairment of the ulnar nerve was

Table 1. Neuropathy evaluation in paucibacillary (PB) and multibacillary (MB) patients: comparison between PB ($n = 10$) and MB ($n = 12$) patients (*P value of Fisher's exact test), at diagnosis and follow-up (**P value of McNemar test).

	SNFi	LNFi			NCS		
Group	T/P	MFT	VMT	NFI	Sensory	Motor	Total
At diagnosis							
PB	40%	20%	0%	60%	40%	40%	50%
MB	67%	33%	17%	83%	92%	100%	100%
*P	0.391	0.646	0.481	0.348	**0.020**	**0.003**	**0.010**
Follow-up							
PB	20%	10%	0%	30%	60%	70%	70%
MB	83%	25%	25%	100%	92%	83%	92%
*P	**0.008**	0.594	0.221	**0.001**	0.135	0.624	0.293
**P (at diagnosis and follow-up)							
PB	0.625	1.000	–	0.375	0.625	0.250	0.625
MB	0.500	1.000	1.000	0.479	1.000	0.500	1.000

SNFi, small nerve fiber impairment; LNFi, large nerve fiber impairment; NFI, nerve function impairment; NCS, nerve conduction study; T/P, thermal and/or pain; MFT, monofilament test; VMT, voluntary muscle test; –, not done due to 0 values.

Table 2. Clinical and neurophysiological findings in ulnar and median nerves.

		Clinical impairment						NCS	
Nerve	Group	Pc	Sen	T/P	MFT	VMT	SVMR	sNCS	mNCS
At diagnosis									
Ulnar	PB	10%	10%	10%	0%	0%	20%	10%	30%
	MB	67%	25%	25%	0%	0%	38%	67%	79%
*P		<**0.001**	0.259	0.259	–	–	0.205	<**0.001**	**0.003**
Median	PB	10%	0%	0%	0%	0%	0%	15%	10%
	MB	67%	13%	13%	0%	0%	29%	50%	67%
*P		<**0.001**	0.239	0.239	–	–	**0.011**	**0.034**	<**0.001**
Follow-up									
Ulnar	PB	5%	0%	0%	0%	0%	15%	40%	50%
	MB	21%	17%	17%	4%	8%	13%	75%	42%
*P		0.197	0.114	0.114	1.000	0.493	1.000	**0.041**	0.800
Median	PB	5%	0%	0%	0%	0%	10%	15%	35%
	MB	21%	17%	17%	0%	0%	13%	67%	54%
*P		0.197	0.114	0.114	–	–	1.000	<**0.001**	0.330
**P (at diagnosis and follow-up)									
Ulnar	PB	1.000	–	–	–	–	1.000	0.980	0.157
	MB	**0.003**	0.500	0.500	–	–	**0.031**	0.660	**0.014**
Median	PB	1.000	–	–	–	–	–	1.000	**0.025**
	MB	**0.003**	1.000	1.000	–	–	0.344	0.194	0.317

Pc, palmar cyanosis; Sen, sensory impairment; PB, paucibacillary; MB, multibacillary; SVMR, skin vasomotor reflex; NCS, nerve conduction study; sNCS, sensory nerve conduction study; mNCS, motor nerve conduction study; T/P, thermal and/or pain impairment; MFT, monofilament test; VMT, voluntary muscle test impairment; –, not done due to 0 values.

*P value of Fisher's exact test used to compare variables between PB and MB patients; **P value of McNemar test used to compare variables at diagnosis and follow-up.

clinically observed, the NCS showed sensory dysfunction in 41% (18/44) of all ulnar nerves (Table 2). Among the sensory nerves, the most commonly clinically affected were those of the lower extremities, namely, the calcaneal and plantar (19% and 14%, respectively), followed by the sural and superficial peroneal (13% each), while the sural nerve was the most impaired (43% with no conduction) in the NCS. Similarly, even though motor alteration was not clinically evident, it was detected by NCS (25 nerves: 57%). Both sensory and motor alterations were significantly more frequent in MB over PB patients ($\chi^2 = 7.25$, $P = 0.027$).

No conduction was more commonly observed in the sensory (17%) than motor nerves (3%): 19 sural, followed by five radial, three ulnar, and two median, sensory nerves, and only in four motor nerves, namely the common peroneal nerve.

After excluding nonconducting nerves, prolonged latency was the most frequent abnormality in both the sensory—20.4% (30/147)—and motor—28.9% (37/128) nerves. Sensory nerve action potential amplitude was reduced in 18.4% (27/147) of the nerves and compound muscle action potential amplitude, in 15.1% (58/384) of the stimulation sites. Velocity, the least-affected parameter among the sensory nerves (4.1%[6/147]), was reduced in 21.8% (56/256) of the motor nerve segments evaluated.

When inferring pathophysiological alteration by means of NCS (after excluding nonconducting nerves), demyelinating lesions (48%)—mainly among MB patients—predominated as the nerve-conduction abnormality pattern (Table 3), followed by the occurrence of axonal lesions in 20 (42%) nerves (two PB and three MB). Mixed lesions, however, were observed in only five (10%).

All patients were reevaluated one year after cessation of MDT. As in the first evaluation, NFI was frequently observed (68% of the patients). However, while all the MB patients had NFI, considerable improvement was observed in the PB cases (Table 1), leading to a significant difference between the two groups ($\chi^2 = 12.320$, $P = 0.001$), mainly regarding SNF impairment. A total of four PB patients recovered full nerve function. Even so, despite overall clinical improvement, the frequency of nerve enlargement was stationary and 50% of these patients recovered sensory improvement. Conversely, the frequency of nerve enlargement increased among the MB patients (10 patients) in conjunction with worsening in SNF impairment.

Among the 12 (55%) patients with sensory impairment, all had thermal and/or pain impairment in at least one impaired sensory nerve; and four (33%) also had tactile impairment in at least one of the affected nerves. Regarding motor strength, impairments were detected in only three (14%) patients (all MB). In addition, most patients recovered autonomic function, as represented by the SVMR ($n = 4$) and SSR ($n = 7$).

Table 3. Number of nerves (%) according to lesion patterns on nerve conduction study in leprosy groups.

	Lesion patterns on NCS result				
Group	Axonal	Demyelination	Mixed	No conduction	Total altered
At diagnosis					
PB	5 (50)	1 (10)	0 (0)	4 (40)	10 (100)
MB	15 (21)	22 (31)	5 (7)	29 (41)	71 (100)
*P	0.314	**0.003**	0.203	**0.006**	<**0.001**
Follow-up					
PB	1 (9)	6 (55)	0 (0)	4 (36)	11 (100)
MB	19 (40)	10 (21)	7 (14)	12 (25)	48 (100)
*P	**0.011**	0.418	0.203	0.254	<**0.001**

NCS, nerve conduction study; PB, paucibacillary; MB, multibacillary.
*P value of Mann–Whitney U test.

Four patients (three PB) (18%) had a normal NCS. Among the 18 patients (39% PB and 61% MB) with an abnormal NCS, 17 (94%) had an abnormal sensory NCS (35% PB and 65% MB), and 17 (94%) had an abnormal motor NCS (41% PB and 59% MB). Except for one MB patient, all patients recovered from temporal dispersion.

Nerve conduction was recovered in most nerves, but particularly in the radial, median, and common peroneal nerves. Yet, no conduction was obtained from 13 sural and three ulnar nerves. As to the number of affected nerves, a significant improvement ($\chi^2 = 6.3$, $P = 0.012$) was observed in MB patients while PB patients remained about the same (Table 3). However, even though the axonal lesions of most PB patients ($n = 3$) improved, those of MB patients ($n = 4$) worsened. Conversely, three PB patients had demyelination while eight MB patients recovered from demyelination ($P = 0.029$).

Five MB patients (21%) developed type 2 reaction, four had erythema nodosum leprosum during MDT, and one had multiform erythema after release from treatment. Since the patients had exclusively cutaneous lesions without clinical signs or symptoms of neuritis, they were treated with thalidomide for an average of 13 months (3–27 months). The one patient with multiform erythema also received oral prednisone for nine months. However, nerve function worsened in two of these patients later diagnosed to be without clinical symptoms. On admission, all but one patient enduring leprosy reaction had an altered neurological examination.

Discussion

Leprosy neuropathy is a particularly complex ailment in view of the superposition of acute and chronic sensory, motor, and/or autonomic events. It is important to recognize that, in many leprosy patients, nerve damage may occur with or without symptoms from the very beginning of infection. It has been reported that NFI at diagnosis varies from 9.8% in a cohort of 315 PB patients from Bangladesh (Richardus et al. 1996) to 55% in Ethiopia (Van Brakel et al. 2005). In the present sample, the use of additional clinical parameters to evaluate NFI may have contributed to the higher rate of NFI than has been customarily found. Likewise, a high prevalence of abnormality in NCS parameters has been reported by various authors at the moment of diagnosis, of up to 92% in MB patients (Capadia et al. 2010) and even in clinically unaffected nerves (McLeod et al. 1975).

In the present study, a different frequency of both clinical and neurophysiological nerve function alteration was observed between the PB and MB patients assessed. As seen by other authors (Richardus et al. 1996), more MB than PB patients had NFI at leprosy diagnosis. Croft et al. (2000) found that 21% of PB patients with NFI at diagnosis experienced new NFI events during the second year of evaluation. In addition, other authors (Samant et al. 1999), regardless of the detection of NFI at diagnosis, have reported a higher frequency of nerve function worsening among PB (20%) over MB (13%) patients at the end of MDT both clinically and/or electrophysiologically. This difference could be due to the earlier period of follow-up evaluation in the latter study. It should also be taken in consideration that reaction may develop after MDT (Nery et al. 2006) leading to NFI, and NCS alterations may take a longer time than NFI to recover from damage (Jardim et al. 2007).

A high prevalence of peripheral autonomic dysfunction, ranging from 43% to 62%, has been observed in newly diagnosed leprosy patients (Abbot et al. 1996; Illarramendi et al. 2005). In the present study, however, a lower prevalence of autonomic dysfunction was seen. This difference may be explained by the inclusion of SVMR and SSR evaluations of the lower extremities in previous studies (Abbot et al. 1996; Wilder-Smith and Wilder-Smith 1996). Again, in the present study, SSR and SVMR were more efficient than the clinical examination at detecting small fiber neuropathy. In addition, both tests managed to detect almost all clinical SNF dysfunctions.

A clear recovery of autonomic function was observed during follow-up, both clinically and in the SSR and SVMR evaluations. Although both tests evaluate the sympathetic function, the reflex pathways are different (Low et al. 1983; Shahani et al. 1984), which may be responsible for the higher improvement rate observed in SSR as compared to SVMR. Moreover, SVMR impairment, while strongly associated to leprosy reaction (Illarramendi et al. 2005), has been shown to recover after steroid therapy (Wilder-Smith and Wilder-Smith 1997).

Consistent with previous findings, SNF was more frequent than LNF impairment, confirming that, in leprosy, small and unmyelinated nerve fiber involvement is more extensive than LNF involvement (Dastur et al. 1973). Furthermore, the prevalence of sensory impairment was higher than the incidence of motor dysfunction, also in conformity with other studies (Solomon et al. 1998; Jardim et al. 2003). The dissociation between SNF and LNF impairment is explained by the fact that, in leprosy, the nerve fascicles are unevenly impaired. Nerve fiber involvement is a complex phenomenon with the simultaneous presence of segmental de- and remyelination concomitant with Wallerian degeneration of preferentially small myelinated fibers (Gibbels et al. 1988).

In this study, demyelinating lesions were more frequently observed in motor nerves, although previous studies (van Brakel et al. 2008) have demonstrated that sensory nerves are committed earlier. It can be justified by the fact that motor NCS was performed in proximal segments while sensory NCS was only evaluated distally. In leprosy neuropathy, motor nerve conduction shows higher rates of abnormality in entrapment segments such as ulnar nerve in elbow segment, peroneal nerve in peroneal head segment. So, we observed higher slowed velocity among motor than sensory nerves since only the distal segment was evaluated in the latter.

In terms of NCS, and as reported by other authors, the patients worsened overall; and abnormalities persisted, particularly in the lower limbs, despite clinical improvement (Samant et al. 1999). A two- to threefold higher percentage of deterioration over improvement of sensory and motor nerve function was shown in 365 MB patients (Capadia et al. 2010). However, the majority (64%) had already shown involvement of more than five nerves and a high prevalence of reaction (39%) upon admission to the study. Nonetheless, some recovery could be observed when number of nerves and type of lesion were considered. Regarding nonconducting nerves, improvement was also evident in both PB and MB patients. Predominance of no conduction has been observed in sensory nerves by other authors, with rates as high as 45% in the sural nerves demonstrating improvement in 5% of these same nerves (Capadia et al. 2010) despite leprosy reaction. The differences in deterioration and recovery rates, however, may be attributed to the presence of reaction, the timely administration of steroid treatment, the longer duration of NFI, and/or type of leprosy evaluated in these studies.

Again, in the present study, at leprosy diagnosis, there was a higher incidence of demyelinating lesions. However, indicative of axonal loss, low amplitudes have been found as the most important early electrodiagnostic finding in leprosy neuropathy (Singh et al. 1977; Thacker et al. 1996; Van Brakel et al. 2005). These changes have been shown to be mainly confined to compound muscle action potential and sensory nerve action potential, particularly regarding the tender nerves. This difference may be due to the fact that the patients in the present study were free of neuritis at diagnosis, as decreased velocity is produced by the inflammatory oedema of the nerves during acute neuritis (Thacker et al. 1996).

The variable nerve patterns detected in the NCS lesions in conjunction with the variations in the damage found within the many nerves studied clearly highlight the abovementioned complex nature of nerve damage in leprosy, even in such a small patient sample, suggesting that a thorough nerve evaluation is essential to be able to delineate a more realistic picture of the patient at hand. Thus, leprosy neuropathy studies should, in principle, never be limited to only one or even just a couple of particular nerves but expanded to include all the peripheral nerves.

NCS allowed for the diagnosis of neuropathy better than the clinical parameters. As expected, there was less NCS alteration in patients with normal tactile sensation than in patients with SFN. While other authors have not found advantages in motor nerve conduction over voluntary muscle testing (Samant et al. 1999), the former made it possible to detect motor neuropathy in patients with normal voluntary muscle testing. High NCS sensibility has been reported by others as well (van Brakel et al. 2008; Khambati et al. 2009). NCS is useful for detecting and evaluating the extension of leprosy neuropathy (van Brakel et al. 2008).

Leprosy neuropathy remains a significant medical challenge because it may develop during any of the phases of the disease and its evolution depends on a number of factors that are both difficult to evaluate and, ultimately, control. Full neurological evaluation of the peripheral nerves of each patient is recommended at different stages in a focused effort to decipher the ongoing clinical and neurophysiological patterns of neuropathy. In addition, recovery depends on a number of other variables such as point in time of recognition and treatment of neuritis, number and extent of reactional episodes, and the clinical form of the disease, all of which should determine the need for additional surveillance.

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