

# Sensory Testing: A Sensitive Method in the Follow-up of Nerve Involvement<sup>1</sup>

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The pathophysiology of nerve damage in leprosy is not yet fully understood, however, it is generally accepted that early and adequate treatment prevents nerve damage.

In reversal reaction the damage seems to be due to an enhanced cell-mediated immunity to *Mycobacterium leprae* antigen which gives rise to cellular invasion, granuloma formation and edema in the affected nerve (2, 10, 14). This will be followed by demyelination, compression of nerve fibers; and consequently, death of the distal part of the nerve fiber. Nerve recovery is accompanied by subsidence of the immunologic processes, resolution of edema, decompression, regeneration and remyelination (2, 10, 14).

Many methods are used to monitor these processes: motor nerve conduction velocity (MCV), which gives information about demyelination and remyelination; voluntary muscle testing (VMT) and sensory testing (ST), which depend on the number of conducting fibers (1, 4-6, 8, 9, 11, 13).

MCV requires capital investment and hospital conditions and is, therefore, not applicable everywhere. VMT, though a reliable test, is rough and requires damage to at least 30% of the fibers before significant changes are noticed. Furthermore, it is not possible to distinguish between nerve regeneration and muscle hypertrophy. Many methods of sensory testing have been used in assessing touch, but in our opinion the most sensitive method is Weddell's modification of the famous horse hairs of Von Frey (5, 11).

In this study we compare MCV, VMT and ST.

## MATERIALS AND METHODS

The patients studied were inpatients and outpatients of the Addis Ababa Leprosy Hospital in Addis Ababa, Ethiopia. The patients

were classified clinically according to the scale of Ridley and Jopling (12). Skin smears were taken in all cases and in over half the cases a biopsy classification was available.

In order to compare MCV, VMT and ST, a numerical system for each of the three methods had to be devised.

MCV was measured along both ulnar and median nerves (Fig. 1). The ulnar nerve was stimulated a) at the level of the wrist 5 cm above the recording electrode in the abductor digiti minimi muscle, b) at a point 4 cm below the medial epicondyle of the humerus, c) at a point 6 cm above the epicondyle, and d) at a point in the axilla.

The median nerve was stimulated a) at the level of the wrist, 6 cm above the recording electrode in the abductor pollicis brevis muscle, b) at a point 2 cm below the elbow groove, and c) at a point in the axilla.

The skin temperature was measured at the stimulation points and the computed MCVs were corrected for a skin temperature of 35°C, using the empirical formula derived by De Jesus *et al* (3).

To compare the consecutive readings we used the method previously described by Naafs *et al* (9). Points were given to the average speed over the whole nerve ranging from zero to ten. Zero was given to nerves with normal conduction speed (over 55 m/sec); ten points were given to nerves without conduction. Points were also given to grade the MCV over the most affected part of the nerve: zero points to normal conduction, 15 points to conduction block (Table 1). The figures derived in this way were added to show the involvement in one nerve. In order to get an overall figure the results for the four investigated nerves were added.

VMTs were done as described previously by the British Medical Research Council in 1943 (7). Goodwin (4) described the use of VMT in leprosy. In order to assess ulnar nerve function we graded the abductor digiti minimi muscle, the interosseus dorsal 1 and lumbricals 3 and 4 muscles. To assess median nerve function we used the abductor pollicis

<sup>1</sup> Received for publication 9 May 1977.

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brevis, opponens pollicis, and lumbricals 1 and 2 muscles. Our grading system was the reverse of that normally used: zero is normal strength; five is complete palsy (Table 2). For one nerve the grading points of the three investigated muscles were added to show the involvement of that particular nerve. To compare with VMT and ST, the points of the four measured nerves were added.

For ST, six stimulators (Fig. 2) were used. The stimulators used consisted of a handle and a nylon thread one inch long. This thread was applied to the skin bending slightly and indenting the skin, thus giving a standard pressure (0.1 gm, 0.4 gm, 1.0 gm, 2 gm, 4 gm, 7 gm).

The hypothenar area, which has ulnar innervation, was chosen to assess ulnar nerve function; and the thenar area, which has median innervation, to assess median nerve function.

The patient was shown the stimulator and told to indicate with one finger of the other hand wherever he/she felt the stimulator touching. When the patient understood, he/she was asked to close the eyes and each stimulator was applied at least four times to the hypothenar and thenar areas. The investigations began every time with the strongest stimulus. The stimulus was delivered at right angles and the thread was not allowed to

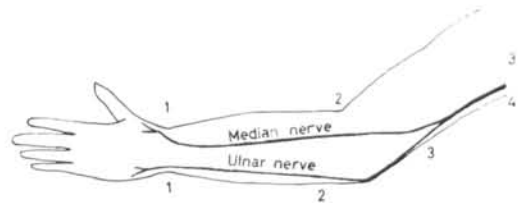


FIG. 1. Sites of stimulation of ulnar and median nerve.

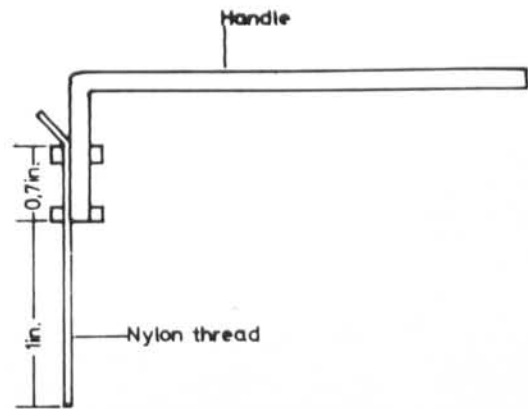


FIG. 2. The stimulator.

drag across the skin. In order to increase the accuracy of the test, stimuli were also applied outside the investigated areas.

The results were recorded as felt or not felt; minor degrees of misreference were recorded as felt, gross misreference or no response as not felt. Every area was investigated by the six stimulators, each should be felt four times. The "not felts" were recorded and added for both ulnar and median nerves to serve as a comparison with MCV and VMT.

## RESULTS

Figure 3 shows a graphic representation of the improvement in MCV, VMT and ST of 12 borderline (BT-BL) patients during and after antireaction treatment. This treatment consisted of standard DDS treatment together with prednisolone given in a single daily morning dose. The starting dose was usually 30-40 mg; the dose was gradually decreased in five to nine months. That there is continuous improvement in the parameters even after six months is remarkable. In our experience, even after one year further improvement of the parameters is possible. The MCV

TABLE 1. Conversion table: motor nerve conduction velocity in grading points.

MCV whole nerve (m/sec)	MCV most affected part of nerve (m/sec)
> 55: 0 points	> 55: 0 points
> 50: 2 "	> 50: 3 "
> 40: 4 "	> 40: 6 "
> 30: 6 "	> 30: 9 "
> 20: 8 "	> 20: 12 "
0: 10 "	0: 15 "

TABLE 2. Conversion table: voluntary muscle testing in grading points.

Normal power	0 points
Diminished power but full movement	1 point
Diminished power but not full range of movement	2 points
Only movement when gravity is eliminated	3 "
Flicker or trace of movement	4 "
No contraction	5 "

TABLE 3. Follow-up of ten borderline (BT-BL) patients with acro-edema during the first three months of antireaction treatment.

	On admission	1 week	1 month	2 months	3 months
VMT	11.8	11.6	9.9	8.0	7.1
MCV	42.7	38.3	37.1	37.0	36.9
ST	45.9	50.6	42.1	34.6	27.6

The figures are given in arbitrary grading points and represent the average for the ten patients.

in this graph shows an initial improvement in the first month, after that a plateau, and thereafter further improvement.

Figure 4 shows the result of antireaction treatment in the first six months. The patients are divided into two groups, the first with mild to severe nerve damage (VMT > 10 points), and the second with only slight to mild nerve damage (VMT < 10 points).

Looking at the graph, it is obvious that VMT is not a suitable parameter to show im-

provement in the group with slight to mild nerve involvement. Changes in the parameter are minimal and not significant. ST shows significant improvement in both groups, however, the improvement is most marked in the group with mild involvement.

MCV shows an immediate improvement in the first week in the group with mild nerve involvement and thereafter a plateau phase for about three weeks. This phenomenon has

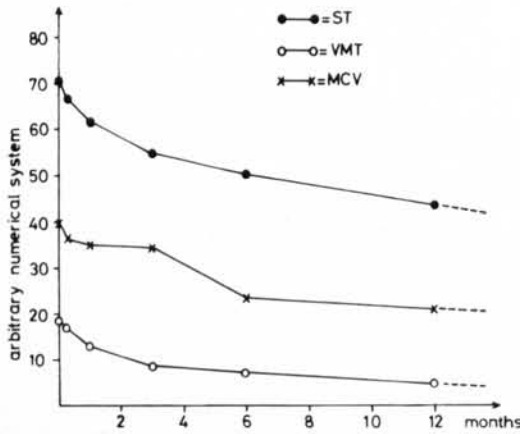


FIG. 3. Improvement of 12 borderline (BT-BL) patients during and after anti-reaction treatment.

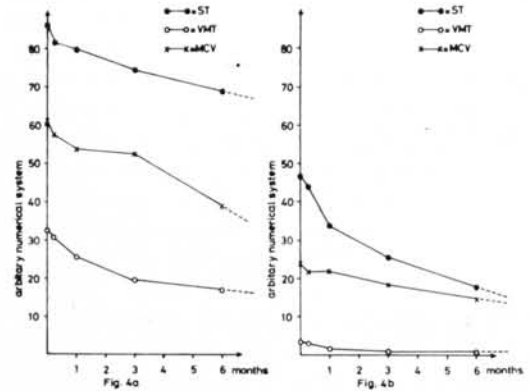


FIG. 4. A. Improvement of 12 borderline (BT-BL) patients with severe nerve damage during antireaction treatment. B. Improvement of 11 borderline (BT-BL) patients with mild nerve damage during and after antireaction treatment.

TABLE 4. Follow-up of one BL patient during and after antireaction treatment.

Date	24/4	20/6	15/8	9/9	16/9	30/9
Clinical condition	Well	Well	No complaints	Severe rheumatic pain; obvious reversal reaction	Better	Well
Antireaction treatment	Prednisolone	Stop prednisolone	—	Restart prednisolone	Prednisolone	Prednisolone
VMT	2	2	6	4	4	4
MCV	4	4	4	7	5	5
ST	39	25	56	69	52	37

been previously described (9). However, in more severe nerve involvement the initial improvement takes about a month and the plateau phase two months.

Table 3 represents a group of patients followed during the first three months of anti-reaction treatment. Many of these patients had acro-edema; in this group there was an initial deterioration in sensation before the start of improvement in ST.

Table 4 shows the follow-up of a patient during and after anti-reaction treatment. In this case (classified BL), prednisolone therapy was stopped too early and a new reaction developed. The table shows clearly the importance of monitoring nerve involvement, especially since the prognostic changes in the ST are evident.

### DISCUSSION

VMT is generally used to assess nerve involvement and improvement in leprosy centers all over the world. In the more advanced centers, or centers attached to modern hospitals with physiotherapy departments, MCV is also used to monitor improvements (1, 6, 8, 9, 13). In our series, VMT is shown to be a reliable method in assessing nerve involvement, especially in more severe nerve damage. However, in early and mild neuritis the test was not significant.

MCV in mild nerve damage (Fig. 4) shows an initial improvement in the first week, most probably due to the direct anti-inflammatory effect of prednisolone; remyelination starts after about a month. In severe cases, the initial improvement and the consecutive remyelination take much longer. This may be caused by the fact that in these cases the neuritis is usually of longer duration and the edema is no longer due to immune reactions only.

ST is shown to be an extremely good parameter in mild nerve involvement, less so in severe nerve involvement since the first sensation to reappear is very crude. The ST is shown to be of great value as a prognostic test too. This could be expected, since in early neuritis edema and compression are the dominant features; demyelination usually occurs later in the process and, because the ST is more sensitive than the VMT, the changes are more obvious.

In the group of patients with acro-edema, the initial deterioration in ST may be explained in the following way. Sensory per-

ception depends not only on the number of fibers conducting, but also on the stimulus threshold of the receptors. In acro-edema, reactional processes are taking place in the skin of hands and feet, even where no patches are present (Pearson, personal communication). Before the receptors are damaged by the reactional process, their threshold may have changed and they are actually more sensitive. This fits in with the observation that some patients experience hyperalgesia in early active patches.

Sensory testing with a graded stimulus as described in this article is a sensitive method in the follow-up of nerve involvement and, as such, is a valuable addition to VMT and MCV. As a prognostic test, it is also shown to be of use, especially in early and mild neuritis. The test will be very useful in hospital and clinic settings, where patients in danger of nerve damage can be assessed, and may even be used as a single test. A trial to assess its usefulness under field conditions is in progress.

### SUMMARY

Sensory testing (ST) as a parameter in assessing nerve damage and as a guide in anti-reaction treatment is discussed in comparison with established methods like voluntary muscle testing (VMT) and motor nerve conduction velocity (MCV). Sensory testing is shown to be a valuable addition to the existing tests and may even be used as a single parameter.

### RESUMEN

Se comparó la "prueba sensorial" con la "prueba de los músculos voluntarios" y con la "prueba de la velocidad de conducción nerviosa motora" como parámetros para definir el daño nervioso y como una guía para evaluar el tratamiento anti-reaccional. La "prueba sensorial" resultó ser una adición valiosa a las pruebas ya existentes pero puede utilizarse como el único parámetro para medir el daño nervioso.

### RÉSUMÉ

Les tests de la sensibilité (T.S.) employés comme critères dans l'appréciation des dommages nerveux de la lèpre, sont mis en parallèle avec les tests musculaires (T.M.) et les tests de la vitesse de conduction motrice dans les nerfs (V.C.M.).

Les tests sensoriels apparaissent comme des éléments de valeur à ajouter aux autres tests; et peuvent même être employés comme paramètres uniques.

**Acknowledgments.** This study was made possible thanks to financial support from the All Africa Leprosy and Rehabilitation Training Centre, the Netherlands Leprosy Relief Association, and the Dutch Government Technical Aid. We are grateful to Dr. J. M. H. Pearson who drew our attention to the described sensory test and who did most of the histologic classification. We thank the staff of the Addis Ababa Leprosy Hospital for their cooperation, especially Ato Berhanu Berhe; and also Mr. Peder Nilsson of the Armauer Hansen Research Institute who drew the figures.

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