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# A FOLLOW-UP STUDY OF NERVE LESIONS IN LEPROSY DURING AND AFTER REACTION USING MOTOR NERVE CONDUCTION VELOCITY

B. Naafs,
All Africa Leprosy Rehabilitation & Training Centre,
Addis Ababa, Ethiopia,

J.M.H. Pearson,
Medical Research Council Leprosy Project, Addis Ababa,

A.J.M. Baar,
Department of Dermatology, R.U. Groningen, the Netherlands.

Peripheral nerve involvement is common in leprosy and is in fact its major problem, although many aspects of the pathophysiology are still obscure. At the first congress of electromyography (EMG) in 1961 Lambert summarised the clinical value of stimulating peripheral nerves and recording the evoked action potentials.(1) According to Lambert, 1962,(2) almost every aspect of the response may give information on peripheral nerve lesions; we consider this is certainly true in leprosy. The latency of the response is largely a measure of the time required for conduction of the nerve impulse from the point of stimulation to the nerve endings and across the neuromuscular junction. The duration of an action potential is related to differences in latency of response of the various motorfibres of the nerve. The amplitude of the action potential is roughly proportional to the number of fibres of the muscle that respond to the nerve impulse. When the nerve is stimulated successively at two or more points along its length, the amplitude and degree of temporal dispersion of the evoked response at different points can be compared and the conduction velocity (MCV) of the nerve between the points estimated.

In leprosy there have been several studies of EMG and MCV (Hackett *et al* 1968 (3), Sheskin *et al* 1969 (4), Antia *et al* 1970 (5), Verghese *et al* 1970 (6)). A major follow-up study of lepromatous patients during and without reaction has been done by Magora *et al*, 1970 (7). They compared prednisolone with thalidomide treated patients. Our study is designed to investigate nerve involvement of borderline patients, an important group, to our knowledge not studied previously. The aim was not only to study EMG and MCV in untreated cases and during reversal reaction, but also to monitor the recovery from reactions during prednisolone treatment, in order to obtain information on optimal treatment regimes. Therefore different groups of borderline patients have been followed without reversal reaction and during

reaction. The reaction was treated with prednisolone at an initial dose of 40-60 mg daily, then tapered off to a maintenance dose of 20 mg and a slow diminishing to 0, and the recovery monitored.

## PATIENTS AND METHODS

The investigations were carried out on in- and out-patients of the Princess Zenebework Memorial Hospital in Addis Ababa (Ethiopia). The patients were classified clinically according to the scale of Ridley and Jopling, 1966 (8). Skin smears were taken in all cases, and in over 60% of the patients a biopsy confirmation of the classification was available.

The MCV was used as a parameter of nerve trunk involvement, and was measured in both ulnar and median nerves using a Medelec MS7 portable electromyograph. The ulnar nerve was stimulated at four points along its course (fig.1):

1. At the level of the wrist 5 cm. above the recording electrodes in the abductor digiti minimi muscle,
2. At a point 4 cm below the epicondyle of the humerus,
3. At a point 6 cm above the epicondyle,
4. At a point in the axilla.

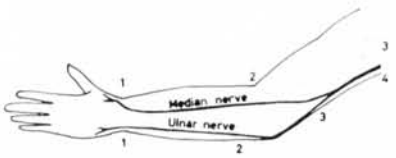


Fig.1 Sites of stimulation of ulnar and median nerve.

The median nerve was stimulated at three points:

1. At the level of the wrist, 6cm above the recording electrodes in the abductor pollicis brevis muscle,

2. 2 cm below the elbow groove,

3. At the axilla.

After cleaning the skin a supramaximal stimulus was applied in order to ensure activity in all functioning motor nerve fibres. The stimulus consisted of a rectangular pulse with a duration of 300 microsecs. and was applied through two electrodes placed 18 mm apart along the nerve. The polarity of the electrodes was the same in all investigations. The muscle action potentials evoked by the stimulation were recorded with concentric needle electrodes. Only action potentials with identical shape for all stimulations were used to estimate nerve conduction velocities. The distances between the stimulation points were measured with a measuring tape. During all investigations the arm was at rest and the elbow not flexed more than 10-20 degrees. The skin temperature near the nerve was measured by means of a thermocouple mounted at the top of a needle (Light Laboratories). The temperature was measured at the stimulation points and the calculated MCVs were corrected for a skin temperature of 35°C using a formula derived by de Jesus et al (9).

| MCV whole nerve in m/sec. | MCV most affected part of the nerve in 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 1 Conversion table: Motor Nerve Conduction Velocity in grading points.

A system was devised to give a numerical grading to the overall degree of nerve damage as measured by the MCV. Points were given to the average speed over the whole nerve, ranging from 0 to 10;

zero was given to speeds over 55 m/sec., 10 to nerves without conduction (see Table 1). Points were also given to grade the involvement of the most affected part of the nerve; a speed higher than 55 m/sec. received 0 points, no conduction, 15 points. The two figures were added to show the involvement of each nerve. The results of the 4 measured nerves were added together to give the overall grading ("whole patient" scores). This method gave reliable and reproduceable results: the higher the figure, the more severe the nerve damage. It was particularly valuable for comparing the results of serial tests.

## RESULTS AND COMMENTS

### 1. Segmental Involvement of Ulnar Nerves

| Segment of nerve | Normal Controls ( 67 ) (nerves) | Leprosy Patients | | |
|---|---|---|---|---|
| | | BT ( 17 ) (nerves) | BB ( 8 ) (nerves) | BL ( 28 ) (nerves) |
| Upper arm | 66 | 63 | 54 | 58 |
| Around elbow | 69 | 48 | 27 | 40 |
| Lower arm | 64 | 48 | 36 | 46 |
| Whole nerve | 65 | 50 | 34 | 44 |

Table 2 Motor Nerve Conduction Velocity of ulnar nerve segments in normal subjects and in tender ulnar nerves of leprosy patients in reversal reaction.

The average MCVs of tender ulnar nerves are shown in Table 2, compared segment by segment with figures for normal controls. There was no significant difference in the involvement of the ulnar nerve around the elbow and in the lower arm. However, in the upper arm the MCV was reduced in BB and BL patients, indicating that in these cases nerve involvement was more generalised than in BT leprosy (where the MCV in this segment was usually normal).

### 2. Response to anti-reaction Treatment

#### (a) Comparison of tender and not-tender ulnar nerves

The MCVs of the whole length of ulnar nerves of patients

in reversal reaction and after 6 months of effective anti-reaction treatment are shown in fig.2: the responses of tender and not-tender nerves are compared. (In BT patients 46% of the ulnar nerves were tender; in BB, 50%; and in BL, 75%).

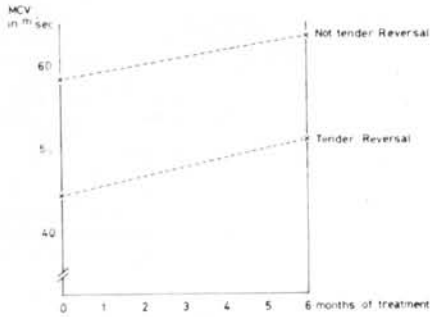


Fig.2 Improvement of Motor Nerve Conduction Velocity in tender (53) and not-tender (39) ulnar nerves in borderline leprosy patients during anti-reaction treatment.

Comparing tender and not-tender nerves there are two important findings:-

(i) Tender nerves conduct more slowly than not-tender nerves.

(ii) Both tender and not-tender nerves improve markedly with anti-reaction treatment.

(b) Comparison of "whole patient" scores in different types of leprosy

The improvement of BT, BB, and BL patients during anti-reaction treatment (using the above-described grading system) is shown in fig. 3. 95% of patients received prednisolone for at least 4 months. All groups of patients showed significant improvement.

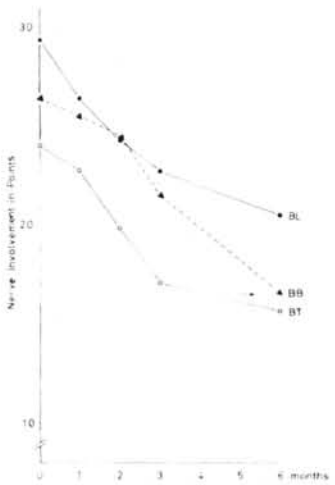


Fig.3 Improvement of BT (24), BB (8) and BL (25) patients during 6 months' anti-reaction treatment.

(c) Improvement during the First 4 Weeks

In some patients it was possible to perform repeated MCVs during the first 4 weeks of anti-reaction treatment. The "whole body" scores of these 46 cases are shown in fig.4. It is remarkable that all the improvement during the first month in these borderline patients occurs during the first 3 days of treatment.

3. Comparison with Patients Not Developing Reaction

Serial MCVs were available from 16 patients with borderline leprosy who did not develop reaction. (fig.5) Their "whole body" scores improved during a 6 months' period of DDS treatment. Patients with borderline leprosy who received effective anti-reaction treatment also improved markedly both during the first month and subsequently; their final scores almost reached those of the non-reaction group. Both groups were matched for duration of anti-leprosy treatment and were comparable in age, sex and onset of the disease.

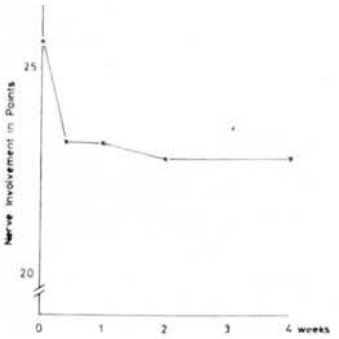


Fig.4 Improvement of 46 borderline patients during the first month's anti-reaction treatment.

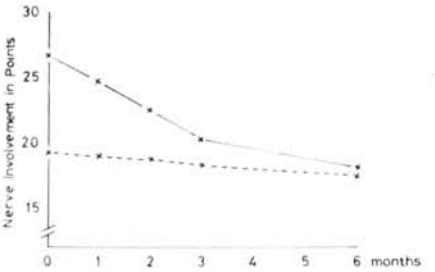


Fig.5 Improvement of 57 borderline patients during anti-reaction treatment compared with the improvement of 16 borderline patients without reaction over a 6 month period.

## DISCUSSION

Previous microscopic and EMG studies have shown that during neuritis the ulnar nerve of leprosy patients is usually involved around the elbow and above the carpal tunnel (Brand (10), Job *et al* (11), Antia *et al* (5) and Dastur *et al* (12)). In all our patients there is obvious involvement of these zones; but we also found EMG evidence of damage to the nerve in the upper arm in BB and BL patients, though usually not in BT cases. We also noted that when BB and BL patients develop reactions a higher proportion of their nerves are tender than in BT cases.

When we compare tender and not-tender nerves of patients in reaction, the tender nerves conduct more slowly than not-tender nerves, which in turn are slightly slower than the normal nerves of healthy adults. A striking feature, however, is that during anti-reaction treatment there is an increase in the MCV of both tender and not-tender nerves. This clearly indicates that both are involved in the reactional process. Hence patients with

reversal reactions should receive effective treatment even in the absence of nerve tenderness, in order to avoid "silent" nerve damage.

Reversal reactions are known to be associated with a transient increase in the cell mediated immune response to antigens of M. leprae. Immunosuppressive therapy with corticosteroids is a logical therapy; and our findings show it to be effective. The biphasic response indicates that recovery is in two stages: initially (a few days) there is resolution of oedema; and subsequently (many months) remyelinisation and nerve regeneration.

We have found no evidence that the use of corticosteroids is essential for nerve improvement in patients who do not develop reaction. On the contrary, even patients who, before treatment, develop active erythematous lesions show improvement when treated with DDS alone. It is important, however, that after 6 months of anti-reaction treatment the MCV of patients who have reversal reactions return to the values of patients with no obvious reaction.

## CLINICAL IMPLICATIONS

1. Patients in reversal reaction have nerve involvement whether or not nerves are tender, and adequate anti-reaction treatment should be established even in the patients with clinical skin involvement only.

2. Recovery in reversal reaction is biphasic during prednisolone treatment; the quick resolution of the oedema immediately after the start of treatment may indicate that prednisolone with its dual action (anti-inflammatory and cytostatic) is a good choice. Moreover in 6 months the recovery in MCV is nearly complete.

3. Borderline patients under DDS treatment and without reaction recover in MCV during a 6 months' follow-up. This shows that anti-leprosy treatment on its own can reverse nerve damage. Patients can be reassured, when starting treatment, that their nerve damage should not get any worse, and will probably show some improvement.

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