Reliability of Clinical Nerve Function Assessment in Peripheral Neuropathies

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Summary

Introduction: Sensory and/or motor nerve function impairment as a consequence of neuropathy is often assessed using electroneurophysiological tests. However, in low-resource countries where the required equipment is rarely available, manual muscle strength testing (MMST) and monofilament testing (MFT) offer very reliable alternatives. In six leprosy programmes in four Asian countries, a multi-centre randomised clinical trial (RCT) was carried out to assess the effect of corticosteroids on neuropathy in leprosy-affected people. The sensory and motor nerve function was tested using MMST and MFT, including new test sites for the sural and radial cutaneous nerves (MFT) and the posterior tibial and common peroneal nerves (MMST). The reliability studies of the MMST and MFT tests of the TENLEP (Treatment of Early Neuropathy in LEprosy) trials are presented here.

Methods: Two assessors in each centre independently used the MFT and MMST in 30 leprosy-affected people.

Results: Reliability is good to very good for MFT in nearly all nerves. MMST also shows good to very good agreement, with a few exceptions.

Conclusion: Our study confirms that MMST and MFT can be performed reliably, and that the new tests also have acceptable reliability.
Introduction

There are many neuropathies that may result in sensory and/or motor function impairment that can be assessed and evaluated with practical clinical techniques such as manual muscle strength testing (MMST)\(^a\) and monofilament testing (MFT).\(^1\) Electroneurophysiological assessments have an important place in the differential diagnosis and follow up of suspected neurological diseases but are very rarely available in low-resource countries. When clinicians are trained, MMST and MFT could still be a useful clinical adjunct to the electroneurophysiological assessments. Various studies have reported good reliability of both MMST and MFT.\(^2-8\) Many of these studies have been conducted in leprosy-endemic countries because of the ‘availability’ of large numbers of subjects which makes it easier to conduct such studies in a relatively short time. MMST and MFT, however, could also be very useful in assessing neuropathies due to other common diseases such as diabetes, or neuromuscular diseases such as hereditary motor and/or sensory neuropathies.

This study is in part a replicate study of reliability testing. The difference, however, is that this is a multi-centre reliability study that includes sensory and motor tests at sites for which reliability had not yet been determined.

In a randomised clinical trial (RCT), studying the efficacy of corticosteroids in the prevention and treatment of leprosy neuropathy, MMST and MFT were used to screen patients for intake, and for the follow-up of patients for the duration of the trials.\(^9\)

TENLEP (Treatment of Early Neuropathy in LEProsy) consists of two related multi-centre, multi-country trials. In the Sub-clinical trial, patients with normal monofilament and muscle strength values, but with impaired electrodiagnostic or thermodiagnostic parameters, are enrolled. The outcomes for a group that will receive corticosteroids for 20 weeks will be compared with the outcome for a placebo group. The aim is to assess whether corticosteroids may prevent the onset of clinically detectable nerve function loss.

Patients with impaired nerve function of less than 6 months duration, as confirmed by MMST and MFT, are enrolled in the other arm of the study: the Clinical trial. In this trial, the currently recommended corticosteroid treatment for reaction is compared with an alternative regimen that is 3-4 months longer. The protocols for both trials have been published.\(^9\)

As decisions for enrolment and follow-up in both trials are based on the results of MMST and MFT, we felt that these assessments needed to show good reliability in and between the participating study centres. Hence, for both studies, we determined the reliability of MMST and MFT.

Methods

Following approval by local and national ethical committees, reliability was assessed in the six study centres where TENLEP is implemented: two each in India and Nepal and one centre each in Indonesia and Bangladesh.

The level of experience of selected staff varied between and within centres; therefore all participating staff were trained to perform testing in a standard manner. For this purpose, a Standard Operational Procedure (SOP) manual was developed.

\(^a\)VMT (Voluntary Muscle Testing) is the more commonly accepted abbreviation for muscle testing. However, ‘voluntary’ muscles can also be assessed with dynamometers. To distinguish between the two the first author prefers to add Manual.
TEST-SITES AND PROCEDURE

Table 1 shows nerves in which motor and sensory function are commonly affected and assessed in the diagnosis and follow up of leprosy neuropathy.

MOTOR:

For each nerve with motor function, tests on one muscle group stimulated by that nerve were performed, using the Medical Research Council (MRC) grades.\(^1\) Motor function tests for facial, ulnar, median, radial cutaneous and common peroneal were carried out as described elsewhere.\(^1\) As a relatively new test we introduced the ‘great toe up and down’ test to assess the motor function of the terminal branch of the common peroneal nerve, and the posterior tibial nerve respectively. The great toe up test is performed when the patient is sitting with his/her feet flat on the ground. The patient is asked to lift the great toe only and the assessor determines muscle strength, applying pressure on the proximal phalanx. The great toe down test is also called the ‘paper grip test’.\(^10\) For this, an MRC score of 5 (strong), 4 (weak) or 0 (paralysed) could be given.

SENSORY:

For each nerve with a sensory component, three test-sites were used within the innervation area of that nerve. Monofilament testing was performed using five monofilaments: 200 mg, 2 g, 4 g, 10 g and 300 g. For the foot, because of known higher thresholds, the lightest, 200 mg filament, was omitted. Each of three sites was then given a score based on the filament felt, the heaviest monofilament getting the highest score, allowing a maximum total score of 15 for the ulnar, median and radial nerves (4 filaments) and 12 for the foot (3 filaments).

For the ulnar, median and posterior tibial nerves, the same sites were examined as in the INFIR study,\(^11\) except for the median nerve where we used the tip of the middle finger instead of the index finger. For the first time, the radial cutaneous and sural nerves were also assessed using three test-sites, which are shown in Fig. 1.

RELIABILITY TESTING

To develop expertise, a large number of patients was assessed under supervision of experienced assessors before the reliability study was initiated. Following that period of skill

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Table 1. Overview of nerves and their test-sites for MMST and MFT (see also Fig. 1)

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Muscle strength testing</th>
<th>Sensory testing with monofilaments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial</td>
<td>Eye closure</td>
<td>Little finger/hypothenar</td>
</tr>
<tr>
<td>Ulnar</td>
<td>Little finger abduction</td>
<td>Thumb – middle finger</td>
</tr>
<tr>
<td>Median</td>
<td>Thumb abduction</td>
<td>Rad. site index / thumbweb</td>
</tr>
<tr>
<td>Radial (cut)</td>
<td>Wrist extension</td>
<td></td>
</tr>
<tr>
<td>Common Peroneal (CP)</td>
<td>Foot dorsiflexion</td>
<td></td>
</tr>
<tr>
<td>Deep branch CP</td>
<td>Great toe extension</td>
<td>Great toe plantar surface/ forefoot</td>
</tr>
<tr>
<td>Posterior tibial</td>
<td>Great toe plantar flexion</td>
<td>Lateral border foot</td>
</tr>
<tr>
<td>Sural</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
development, both therapists were asked to randomly and independently assess a minimum of 30 subjects, all of whom were leprosy-affected people. The testers were blind to each other’s results and the order of subjects was changed randomly between testers. Motor and sensory nerves were assessed bilaterally, effectively doubling the number of tests.

Test results of both assessors were sent to, and analysed by the same statistician (PN). Weighted Kappa’s were used to express reliability: moderate (0.41–0.6), good (0.61–0.8) and very good (more than 0.81).

**Results**

Reliability for monofilament testing for all nerves was good to very good in all centres, with the exception of one centre where agreement on testing the sensory function of the radial cutaneous nerve was moderate (Table 2).

Table 3 shows that, in general, the muscle strength tests show good to very good reliability. For the few tests that did not show acceptable reliability the two therapists

<table>
<thead>
<tr>
<th>Centre</th>
<th>Ulnar</th>
<th>Median</th>
<th>Radial Cutaneous</th>
<th>Posterior tibial</th>
<th>Sural</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.981</td>
<td>0.986</td>
<td>0.986</td>
<td>0.992</td>
<td>0.988</td>
</tr>
<tr>
<td>B</td>
<td>0.948</td>
<td>0.945</td>
<td>0.932</td>
<td>0.982</td>
<td>0.960</td>
</tr>
<tr>
<td>C</td>
<td>0.776</td>
<td>0.877</td>
<td>0.815</td>
<td>0.863</td>
<td>0.869</td>
</tr>
<tr>
<td>D</td>
<td>0.799</td>
<td>0.807</td>
<td>0.601</td>
<td>0.731</td>
<td>0.834</td>
</tr>
<tr>
<td>E</td>
<td>0.938</td>
<td>0.901</td>
<td>0.960</td>
<td>0.919</td>
<td>0.930</td>
</tr>
<tr>
<td>F</td>
<td>0.987</td>
<td>0.986</td>
<td>0.989</td>
<td>0.993</td>
<td>0.993</td>
</tr>
</tbody>
</table>

0.41–0.6 = moderate agreement; 0.61–0.8 = good; > 0.8 = very good
involved in each study centre were both requested to recheck the muscle group where disagreement was apparent, and to come to an agreement on the grading before making a clinical decision.

Discussion

Our study confirms the findings of other studies that MMST and MFT can be reliably performed.2-8 The tables show results that reflect the agreements of one pair of testers in each centre. As intake to TENLEP was initially slow, additional staff also had to be trained to enable the involvement of more clinics. Intertester reliability of new staff was also determined prior to intake. The tables only give results of the initial pairs of testers. Testers were encouraged to repeat MMST and VMT for a sample of subjects at regular intervals to maintain standards in the execution and interpretation of tests.

The testing of the sural and radial cutaneous nerves for sensibility with monofilaments was a new development. A related study in leprosy neuropathy had shown good reliability but only one test site was used for these two nerves whereas we tested three sites for all nerves in our study.6 We decided to give equal value to sensory nerve function and decided on three sites for these two nerves that could be affected.

New tests that were introduced for grading motor nerve function were great toe down and up for the posterior tibial and deep common peroneal nerve (terminal motor branch), respectively.9 These tests also showed good to very good reliability in all but one study centre. These tests are, as yet, not routinely used in leprosy neuropathy but should be considered clinically as important. Isolated weakness of great toe flexion and/or extension, with normal foot dorsiflexion-eversion indicates nerve function impairment at ankle level or dorsal site of the foot. Paralysis of the intrinsic foot muscles may contribute to the onset of tissue breakdown in the presence of loss of protective sensation, which is often the case in leprosy neuropathy. The great toe down test is the only test that can reliably test the motor function of the posterior tibial nerve, a nerve often involved in leprosy and diabetic neuropathy. Weakness in great toe flexion will indicate impaired posterior tibial function at ankle level involving the intrinsic foot muscles. Toe flexion will still be possible because the extrinsic toe muscles are rarely involved in leprosy neuropathy (i.e. impairment of the posterior tibial nerve at knee level). This test was validated by Win et al., asking control subjects to perform the test with and without an anesthetised posterior tibial nerve.10

<table>
<thead>
<tr>
<th>Centre</th>
<th>Eye closure</th>
<th>Ulnar APB</th>
<th>Median</th>
<th>Radial wrist</th>
<th>Common Peroneal</th>
<th>Toe up</th>
<th>Toe down</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>B</td>
<td>1.000</td>
<td>0.908</td>
<td>0.877</td>
<td>0.662</td>
<td>0.797</td>
<td>0.710</td>
<td>0.471</td>
</tr>
<tr>
<td>C</td>
<td>0.600</td>
<td>0.943</td>
<td>0.922</td>
<td>N/A</td>
<td>0.675</td>
<td>0.958</td>
<td>0.918</td>
</tr>
<tr>
<td>D</td>
<td>0.575</td>
<td>0.641</td>
<td>0.257</td>
<td>N/A</td>
<td>0.869</td>
<td>0.756</td>
<td>0.688</td>
</tr>
<tr>
<td>E</td>
<td>0.615</td>
<td>0.956</td>
<td>0.881</td>
<td>0.851</td>
<td>0.967</td>
<td>0.977</td>
<td>0.943</td>
</tr>
<tr>
<td>F</td>
<td>0.191</td>
<td>0.968</td>
<td>0.827</td>
<td>0.705</td>
<td>0.965</td>
<td>0.970</td>
<td>0.991</td>
</tr>
</tbody>
</table>

0.41–0.6 = moderate agreement; 0.61–0.8 = good; > 0.8 = very good
N/A Not available. Not done in these centres. Too few subjects (Radial motor – wristdrop – is relatively rare)
Low reliability coefficients were recorded for eye closure (i.e. facial nerve/orbicularis oculi) in some centres. In cases where isolated facial nerve impairment was suspected at intake and during the trial and follow up, the advice given was that testers should ‘double check’ and agree on a grade.

Differences in reliability between centres were seen, mainly for MMST, most likely as a consequence of differences in levels of experience. One centre even scored a perfect 1.0 for muscle testing. This was the only centre in which both testers had lengthy experience with muscle grading and may illustrate the point that correct practice makes perfect.

Table 3 does not specifically mention isolated muscles with their official anatomical names. The table indicates that movements are tested rather than individual muscles, which is what happens in most MMST tests.\textsuperscript{1,4-6} Testing muscles in ‘isolation’ is, with rare exceptions, not possible. In most muscle tests there is synergistic action of multiple muscles.

Most of the studies of reliability of MMST and MFT have been conducted with leprosy patients. This is probably because in many leprosy hospitals and their out-patient departments there are enough patients with neuropathy to be able to conduct a reliability study in a short time. We suggest, however, that for many other neuropathies and neuromuscular diseases these simple clinical tests of MMST and MFT could also be used, although it would require sufficient practice by clinicians using a standard protocol to achieve a reliable assessment. It is our opinion that where neurophysiological assessments such as nerve conduction studies and warmth detection thresholds, in other neurological conditions, are frequently performed alone, MMST and MFT could be of complementary value.

Conclusion

Manual muscle strength testing and monofilament testing can be reliably performed by experienced testers using a standard protocol. These tests can be usefully applied in diagnosis and follow up of neuromuscular diseases, neuropathies and suspected nerve lacerations and repairs, either as stand-alone procedures or as complementary procedures to electroneurophysiological and warmth detection assessments.

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References