Dorsal sensory impairment in hands and feet of people affected by Hansen’s disease in Israel

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Accepted for publication 12 October 2007

Summary
Introduction  Sensory testing in people affected by Hansen’s disease is usually performed on palms and soles only. In Israel, both palmar/plantar and dorsal aspects of limbs are routinely tested.
Objectives  The aim of this study was to describe the magnitude of dorsal sensory impairment (SI) in limbs and compare the frequency of SI on palms and soles with that on the dorsum of hands and feet.
Design  In a cross-sectional study, limbs of 140 patients registered at The Israel Hansen’s Disease Centre during the years 1999–2003 were tested for their sensory status. Both palmar/plantar and dorsal aspects were tested using Semmes–Weinstein monofilaments. SI was defined as not feeling stimuli applied with the 2 g monofilament.
Results  SI was detected on the dorsum in 43% of sites on hands and only in 27% on palms. 64% of sites on dorsum of feet had SI compared to 53% on the soles. SI was detected in up to 18% in hands with no palmar SI, and in 6% of feet with no plantar SI. Furthermore, SI on palms and soles was found to be accompanied by dorsal SI in all hands and in 97% of feet.
Conclusion  SI on dorsum of limbs occurs more frequently than SI on palms and soles. Therefore sensory testing should also consider inclusion of the dorsal aspect of hands and feet.

Background
In Hansen’s disease, the ulnar, median and radial nerves in the upper limb and posterior tibial and peroneal nerves in the lower limb are potentially in danger of impairment. Early detection of nerve function impairment enhances the chances of nerve function recovery following adequate treatment and is a key intervention for prevention of disabilities.
Nerve function assessment (NFA) is recommended for newly diagnosed patients and as part of the follow-up, especially during reactional episodes. Clinical testing with different tools is used to detect and evaluate the presence of deficit to sensory, motor and autonomic function in...
these nerves. The commonly used tools for sensory testing are Ballpen and Semmes–Weinstein Monofilaments (SWM). SWM are used to test light-touch pressure sensation and are recommended for monitoring sensory function and detection of sensory impairment (SI) even at a mild level and at an early stage. Ballpen detects SI at a more advanced level.

SI occurs usually prior to motor impairment but probably post-thermal impairment. In lepromatous leprosy, the dorsal aspect of the limbs is affected first and only later SI occurs on both palmar and plantar aspects.

Kuipers and Schreuder recommended testing on both palmar and dorsal aspects of the hands, and Brandsma proposed the assessment of sensation status on the dorsum of the foot.

However, in training manuals and a number of NFA forms obtained from Hansen’s disease centres around the world (Appendix 1) sensory testing is recommended and recorded on palms and soles only. Both radial and peroneal nerves are assessed for motor function but usually not for their sensory function on the dorsum of the hand and foot, respectively.

The Israel Hansen’s Disease Centre (IHDC) followed the same recommendations until 1995. Based on a clinical observation of repeated dorsal hand injuries, testing of dorsal sensation using graded SWM test was added to routine NFA. This study was designed to describe the magnitude of dorsal SI in hands and feet and to compare the frequency of SI on palms and soles vs. the dorsum of the limbs.

**Methods**

**Study design:** A cross-sectional study of patients tested for light-touch pressure sensation was carried out at the IHDC. Results of sensory testing were collected from the NFA forms in the patients’ files, only one test per patient was used for the study.

**Study sample:** 140 people affected by Hansen’s disease who were registered and followed up at the IHDC during the years 1999–2003 were included. The inclusion criteria comprised of any patient visiting the IHDC on whom a sensory graded test on palmar/plantar and dorsal aspects of limbs was performed, disregarding age, sex and leprosy classification. Tests which were unsuccessfully performed due to lack of cooperation, or concentration were excluded.

**Instrument and procedure:** The SWM test, a reliable and valid graded test of light-touch pressure sensation, was used to assess all patients. Six different filaments (2.83 = 0.05 g, 3.61 = 200 mg, 4.17 = 1 g, 4.31 = 2 g, 4.56 = 4 g, 5.07 = 10 g) were used according to the standard procedure. SI was defined as an inability to feel the 2 g monofilament on both hands and feet. All assessments were performed at the IHDC. The testing was part of a routine procedure for either diagnosis or follow-up and was performed in quiet surroundings by the same tester, a qualified and trained occupational therapist (HM). Ten sites were tested on each palmar and dorsal aspect of the hands, 10 on the soles (heels excluded) and 12 on the dorsum of the feet, regardless of the presence of any skin lesion (Appendix 2). The order of testing limbs, aspects and sites was random. Each site with SI was recorded and counted as one point and summed up for each aspect of each limb.

**Ethical issues**

This study used data which was collected during routine procedures. The analysis was done retrospectively. Confidentiality of patients’ identification was assured. This procedure was
approved by the Hadassah Medical Organisation’s Helsinki Committee of the Hadassah University Hospital.

Statistical analysis

Each limb was used as the unit of analysis. Two outcome measures were used to compare SI on dorsal and palmar/plantar aspects of each limb of the same subject.

Outcome measure 1: Percentage of sites with SI out of the total number of sites tested. The results for the palmar and dorsal aspects were compared using McNemar’s test for matched proportions.

Outcome measure 2: The percentage of limbs with at least two sites with SI out of all limbs tested. These percentages were then compared between palmar/plantar and dorsal results using McNemar’s test for matched proportions.

Results

One hundred and forty people affected by Hansen’s disease were included in the study; 95 (68%) were males and 45 were females, ranging in ages from 14 to 86 (mean 57). A significantly higher frequency of dorsal SI compared to palmar/plantar SI was found. Dorsal SI was detected in 43% of tested sites on the hands and 64% on the feet, whereas SI was detected only in 27% of the palmar and 53% of the plantar aspects (Table 1).

The difference between the frequency of SI on the palmar/plantar aspect and the dorsum was greater on the hands than on the feet. In limbs where no palmar/plantar SI was present, dorsal SI was detected in up to 18% of hands and 6% of feet (Table 2).

Furthermore, SI on the palmar/plantar aspect of limbs was found to be accompanied by dorsal SI in all hands and in 97% of feet (Figure 1).

Discussion

In this study dorsal SI was investigated using two different outcome measures. Both outcome measures showed a high frequency of dorsal SI. Outcome measure 1 found up to 43% of

Table 1. Comparison of % of sites with sensory impairment (SI) on the palmar/plantar aspect of limbs & the % of dorsal SI

<table>
<thead>
<tr>
<th>Limb</th>
<th>Palmar/plantar</th>
<th>Dorsal</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total sites</td>
<td>% impaired</td>
<td>Total sites</td>
</tr>
<tr>
<td></td>
<td>tested#</td>
<td>(95% CI)</td>
<td>tested</td>
</tr>
<tr>
<td>R Hand</td>
<td>1347</td>
<td>349</td>
<td>25.9 (23.6–28.4)</td>
</tr>
<tr>
<td>L Hand</td>
<td>1359</td>
<td>387</td>
<td>28.5 (26.1–31.0)</td>
</tr>
<tr>
<td>R Foot</td>
<td>1334</td>
<td>740</td>
<td>55.5 (52.6–58.2)</td>
</tr>
<tr>
<td>L Foot</td>
<td>1319</td>
<td>749</td>
<td>56.8 (54.1–59.5)</td>
</tr>
</tbody>
</table>

#Missing digits or limbs account for differences in total tested sites.

*McNemar’s test for comparison of paired proportions.

Imp. = impaired sites.
hands and 64% of feet to have dorsal SI, whereas outcome measure 2 detected dorsal SI in 60% of hands and 70% of feet. Similarly, unpublished data of the INFIR study (van Brakel et al., in preparation) found up to 60% SI in the radial cutaneous nerve which innervates part of the dorsum of the hand and up to 69% in the sural nerve which innervates a lateral dorsal area of the foot.

The comparison of SI on both aspects of limbs showed significantly greater frequency of dorsal SI than palmar/plantar SI, as implied by other studies. The INFIR Study detected up to 20% more SI using tests of sensory nerve conduction, latency, amplitude, warm/cold detection and vibration for radial cutaneous nerve than for both ulnar and median nerves which were tested on the palmar aspect only. The same study detected 2–10% more SI for sural nerve than the posterior tibial nerve in testing, warm/cold detection and vibration. Kuipers and Shreuders found 4% more cracks, burns and wounds associated with loss of protective sensation on the dorsum than on the palm of the hand.

### Table 2. Comparison of the frequency of sensory impairment (SI) on palmar/plantar vs. dorsal aspects of limbs according to outcome measure 2§

<table>
<thead>
<tr>
<th>Sensation status</th>
<th>Limb</th>
<th>No SI</th>
<th>Dorsal SI, no palmar/plantar SI</th>
<th>Palmar/plantar SI, no dorsal SI</th>
<th>Both palmar/plantar &amp; dorsal SI</th>
<th>Total (%)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Hand</td>
<td>50</td>
<td>22</td>
<td>0</td>
<td>54</td>
<td>126</td>
<td>(95% CI)</td>
<td>40</td>
</tr>
<tr>
<td>% (95% CI)</td>
<td>40 (31–49)</td>
<td>18 (11–25)</td>
<td>0</td>
<td>43 (34–52)</td>
<td>(100)</td>
<td>&lt;0·0001</td>
<td></td>
</tr>
<tr>
<td>L Hand</td>
<td>52</td>
<td>17</td>
<td>0</td>
<td>59</td>
<td>128</td>
<td>(95% CI)</td>
<td>41</td>
</tr>
<tr>
<td>% (95% CI)</td>
<td>41 (32–50)</td>
<td>13 (8·2–21)</td>
<td>0</td>
<td>46 (37–55)</td>
<td>(100)</td>
<td>&lt;0·0001</td>
<td></td>
</tr>
<tr>
<td>R Foot</td>
<td>34</td>
<td>6</td>
<td>5</td>
<td>86</td>
<td>129</td>
<td>(95% CI)</td>
<td>28</td>
</tr>
<tr>
<td>% (95% CI)</td>
<td>26 (19–35)</td>
<td>4·7 (1·9–10)</td>
<td>3·9 (1·4–9·3)</td>
<td>67 (58–75)</td>
<td>(100)</td>
<td>NS**</td>
<td></td>
</tr>
<tr>
<td>L Foot</td>
<td>37</td>
<td>8</td>
<td>3</td>
<td>84</td>
<td>133</td>
<td>(95% CI)</td>
<td>28</td>
</tr>
<tr>
<td>% (95% CI)</td>
<td>28 (21–36)</td>
<td>6·0 (2·8–12)</td>
<td>2·3 (0·58–7·0)</td>
<td>63 (54–71)</td>
<td>(100)</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

§Outcome measure 2; the % of limbs with at least 2 sites with SI out of all limbs tested.

*McNemar test.

**Non-significant.

Figure 1. Sensory status of limbs comparing palmar/plantar and dorsal aspects.
Dorsal sensory testing of limbs can detect SI which otherwise would go unnoticed. In this study 6% of feet and up to 18% of hands with dorsal SI had no plantar/palmar SI. Using the common practice of testing sensation on palms and soles alone would have missed existing SI.

A sum of sites with SI for each aspect of the limb, regardless of nerve distribution, was used for measuring SI in this study. There are anatomical variations in nerve distribution on the hand and a complex innervation pattern on the dorsum of the foot, which complicates accurate testing and interpretation. Dorsal sensory impairment may also result from local dermal nerve involvement in the area of a skin lesion rather than due to peripheral nerve involvement. The purpose of sensory testing was to detect SI regardless of the associated nerve, similar to the screening performed by Kuipers and Schreuders.

In this study, inability to feel the 2 g SWM was defined as SI on palmar/plantar and dorsal aspects of hands and feet. Other studies have differentiated between thresholds for hands and feet, but none were found to have determined different thresholds for the different aspects of the limbs. There are no conclusive thresholds for normal sensation for either hands or feet. Kets et al. suggest normal reference values for the hands to be 200 mg and 2 g for the feet in Nepali adults, whereas in North America these were found to be 70 mg for hands and 300 mg for the feet. A threshold of normal touch sensation on soles was identified as the ability to perceive the stimuli of 1 g SWM. Our clinical experience would suggest that the normal dorsal sensory threshold is higher than the palmar/plantar threshold, but no evidence was found in the literature to confirm this.

Early detection of nerve function impairment, for the purpose of initiating treatment and preventing disability, requires detection of the lowest level of SI, therefore the 2 g monofilament was used as a cut-off point. It could be argued that this threshold was too close to the normal threshold for the feet and too crude for the hands. In our study this cut-off actually increases the significance of the results for SI on hands.

Early detection and treatment of SI enhances the chances of nerve function recovery. The lack of full information on SI could influence clinical and medical decisions especially at the time of reactional episodes and during follow-up. Testing dorsal sensation, which may be impaired prior to and more frequently than palmar/plantar SI, should therefore be performed routinely as part of nerve function assessment. This has been previously recommended by others, but has not been commonly practised. Although Brand and Fritschi stated that SI in lepromatous leprosy appears on the dorsum first and only later on palms and soles, we have not found evidence that this statement has been interpreted into clinical measures.

Sensory testing on both aspects of limbs is time-consuming and requires patience of both patient and tester, no matter whether ballpen or SWM testing is used. In reality in many settings, it would be difficult to implement dorsal sensory testing in addition to the testing practised at present. The time needed for testing can be reduced by limiting the number of test sites. Therefore, research is needed to determine the minimal number of sites on both aspects of limbs to be tested to detect SI.

Conclusion

SI detected by SWM on dorsum of hands and feet occurs more frequently than SI on palms and soles, it is therefore recommended to include the dorsum of limbs in sensory testing.
Acknowledgements

We are very grateful to Dr. Wim van Brakel for his assistance, patience and support in preparing this paper. We thank The Danish Leprosy Mission for their financial support, The Leprosy Mission International for sponsoring our participation in the scientific paper writing workshop Feb 2007, and Dr. Johan Velema for his encouragement.

References

Appendix 1: NFA forms

1. Watson JM. Preventing disability in Leprosy Patients. Middlesex. TLM 1986; p. 34
3. Manual for the implementation of MDT. Addis Ababa, All Africa Leprosy and Rehabilitation Training Centre 1990
4. Physiotherapy/sensory assessment form. Anandaban Leprosy Hospital Nepal
5. Nerve Functions Assessment Form. TLM, Nigeria.

Appendix 2: Sensory testing sites

Hands

Palmar aspect: 1st, 2nd, 3rd, 4th & 5th distal phalanges
   1st proximal phalanx
   2nd & 5th metacarpal heads
   Thenar & hypothenar eminence
Dorsal aspect: 1st, 2nd, 3rd, 4th & 5th distal phalanges proximal to nails
   1st proximal phalanx
   2nd & 5th metacarpal heads
   Base of 2nd & 5th metacarpals

Feet

Plantar aspect: 1st, 2nd, 3rd, 4th & 5th distal phalanges
   1st, 3rd & 5th metatarsal heads
   1st & 5th metatarsal bases
Dorsal aspect: 1st, 2nd, 3rd, 4th & 5th distal phalanges proximal to nails
   1st, 3rd & 5th metatarsal heads
   Medial & lateral border of foot at the base of 1st & 5th metatarsal bases
   Distal to medial and lateral malleolei