Early recognition of diabetic neuropathy: evaluation of a simple outpatient procedure using thermal perception

V Viswanathan, C Snehalatha, R Seena, A Ramachandran

Objective: To determine the effectiveness of Tip-therm, a temperature discriminator, in making an early diagnosis of distal symmetrical polyneuropathy in diabetic patients and to compare its effectiveness with the Semmes-Weinstein monofilament and biothesiometry, which are established methods of diagnosing neuropathy in diabetic patients.

Patients and methods: From the diabetic subjects who came to the hospital for review, 910 consecutive cases were selected. All were tested with the Semmes-Weinstein monofilament (10 g monofilament) and biothesiometry and also by using the Tip-therm for comparison.

Results: Out of the 241 patients who had no sensation to the monofilament only four (1.7%) felt Tip-therm whereas 237 (98.3%) patients could not feel Tip-therm. Among 298 patients diagnosed as having neuropathy by biothesiometry, only eight (2.7%) patients exhibited sensation with Tip-therm while 290 (97.3%) patients could not feel it.

Conclusion: A simple device, Tip-therm, which tests for temperature discrimination, was compared with two validated methods for detection of neuropathy—a monofilament and biothesiometry. Tip-therm appears to be an inexpensive, highly sensitive, and specific device for detection of diabetic neuropathy when compared with biothesiometry and a monofilament.
neuropathy by biothesiometry, only eight (2.7%) patients exhibited sensation with Tip-therm while 290 (sensitivity 97.3%) patients could not feel it. All 612 (specificity 100%) non-neuropathic patients were able to feel Tip-therm. Table 1 shows the comparison of Tip-therm with biothesiometry. It was interesting to find that the specificity of Tip-therm was 100% when compared with biothesiometry. Sensitivity of Tip-therm for neuropathy was better than that of the monofilament. With the monofilament, 241 out of the 290 neuropathy cases were picked up (sensitivity 83.1%). Among them 237 cases (sensitivity 98.3%) were Tip-therm positive.

**DISCUSSION**

In this study we have compared a simple device, Tip-therm, which tests for temperature discrimination, with a monofilament and biothesiometry, both of which have already been established as validated methods for detection of neuropathy. Tip-therm showed a high specificity and sensitivity when compared with these two devices.

Prospective trials have confirmed the role of both large and small fibre neurological deficit in the pathogenesis of foot ulceration. Small nerve fibre dysfunction usually occurs early and is often present without objective signs or electrophysiological evidence of nerve damage. It is manifested by early symptoms of pain and hyperalgesia in the lower limbs, followed by a loss of thermal sensitivity and reduced light touch and pin prick sensation.

Temperature discrimination threshold is a measure of small fibre function. Warm sensation is mediated by the smallest non-myelinated C fibres and cold sensation by small myelinated Aβ fibres. Temperature discrimination threshold is particularly relevant for a number of reasons. First, temperature sensation may be the first to be affected in diabetic neuropathy. Second, since small fibres also mediate pain sensation it was hypothesised that selective damage may have some relevance to positive painful symptoms of neuropathy. Finally, lack of temperature sensation is of obvious clinical relevance since it may predispose to scalds, burns and other thermal injuries, although the degree of sensory loss required for this is actually quite large, which is approximately 10°C.

Most techniques for the detection of thermal or other temperature discrimination thresholds have used metal elements. They are based on the Peltier principle whereby they might be heated or cooled relatively quickly by changing the direction of flow of electric current through them. Results are often poorly reproducible, especially in disease states, and the equipment required is relatively cumbersome and expensive.

**CONCLUSIONS**

In this study the Tip-therm appears to be an ideal device for temperature testing with a high sensitivity and specificity compared with biothesiometry and a monofilament, which are established methods for the diagnosis of diabetic neuropathy.

**Authors’ affiliations**

V Viswanathan, C Snehalatha, R Seena, A Ramachandran, Diabetes Research Centre, Madras, India

**REFERENCES**


**Table 1** Comparison of Tip-therm with biothesiometry and monofilament

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
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<tbody>
<tr>
<td>Neuropathy by biothesiometry (n=298)</td>
<td>97.3</td>
<td>100</td>
</tr>
<tr>
<td>Loss of sensation by Tip-therm (n=290)</td>
<td>(290/298)</td>
<td>(612/662)</td>
</tr>
<tr>
<td>Loss of sensation by monofilament (n=241)</td>
<td>98.3</td>
<td>92.1</td>
</tr>
<tr>
<td>Loss of sensation by Tip-therm (n=237)</td>
<td>(237/241)</td>
<td>(616/669)</td>
</tr>
</tbody>
</table>

**Key points**

- Tip-therm was used to find out temperature perception in type 2 diabetic subjects without neuropathy and with sensory neuropathy detected by abnormal biothesiometry and a monofilament.
- Tip-therm has high specificity (100%) and sensitivity (97.3%) in diagnosing diabetic neuropathy.
- It is suitable for screening sensation loss in the feet.
- It is a pen-like instrument, easy to use, and is known to give reproducible test results in an ambient temperature of up to 25°C.
- It can be used as an outpatient procedure for detecting foot problems in diabetes.
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