FULFORD ORATION

MEASUREMENT OF HEAT PERCEPTION IN SKIN LESIONS OF LEPROSY

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"I often say that when you can measure what you are speaking about and express it in numbers you know something about it, but when you cannot express it in numbers your knowledge is of a meagre and unsatisfactory kind, it may be the beginning of knowledge but you have scarcely in your thoughts advanced to the stage of science, whatever the matter may be."

William Thomson

The words of William Thomson aptly emphasize the importance of measurement in any scientific dialogue. The diagnostic importance of sensory deficit in skin lesions suggestive of leprosy needs no emphasis. Compared with the conventional clinical evaluation, precise sensory tests are generally superior, as can be expected, quantitatively and qualitatively.[1] Based on experiments in sub-human primates, and percutaneous micro-neurography in man, there is considerable advancement in our knowledge of cutaneous sensory function, which today makes the precise sensory tests more meaningful. Modality specific sensibility tests are more physiological than conduction velocity and action potential height in the sense that they are aimed directly at the sensory function of the system.[2] Although individual nerve fibre responds by a all-or-none law, the sensory perception is not an all-or-none phenomenon and can be graded by suitable testing procedures. The subjective nature of all sensory function tests is of course a limitation and make these less objective.

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In the past, many attempts to evaluate touch, pain and thermal sensations have been done. Touch sensations have been quantified using von Frey hairs,[3] two point discrimination[4] or by automated systems.[5] Pain sensations have been graded using graded pressure on pins,[6] pressure algometers[7] and forceps algometer.[8] Thermal sensory perception are generally tested by test tubes containing hot and cold water and are not quantitated. Methods such as heating a body part or immersion in water bath at constant temperatures are not suitable methods in clinical practice. Probes immersed in water at different temperatures have been used and Pasricha has developed an instrument.[6] Another instrument based on Peltier principle using a large stimulator (size 25 mm $\times$ 50 mm) has been used.[9] This instrument is not available indigenously and the large size of probe makes it unsuitable for small lesions of leprosy.

Thermal sensations are probably the earliest to be lost in leprosy. This was the commonest sensory loss detected in routine clinical testing in an epidemiological study.[10] In the protical evolved for assessment of nerve damage in leprosy at a workshop held at Karigiri in 1980, it is mentioned that no suitable method is available for quantitative thermal testing. The need for development of an instrument to measure the loss of heat perception in lesions of leprosy was hence felt.

With the help of Mr. Sidhaya an electronic engineer from Pune, an instrument was fabricated under AFMRC project No 1311/82 and named as *Thermosense*.

THE INSTRUMENT—THERMOSENSE

The instrument consists of a testing probe connected to control unit which can heat the probe to the desired temperature (temp).

(a) The testing probe

It has a hollow metallic tube having thin silver tipped end and covering an insulated heating element. The tip is circular and has a diameter of 5 mm. A thermocouple is placed in contact with the metallic tube adjacent to the tip. Cromel Alumel thermocouple has been used as it gives the best linear reading in the temp range of 0 to 70°C which is the maximum temp to which the probe can be heated.

(b) The control unit

The control unit works on 220 volts mains supplied through a voltage stabiliser. The heating element is fed through a variable resister regulating the current. The desired temp to which the probe is to be heated can be set by pressing the push button on the pannel and turning the knob. A gradual heating is recommended. The control circuit then constantly regulates the current to keep the probe temp constant within ±1°C of the preset temp.

By rotating the control knob the temp of the testing probe can be gradually increased. The instrument is calibrated for operation between 0 to 70°C. The testing of heat sensation is done between room temp and 60°C only.

Capabilities of thermosense

The instrument is used for assessing the heat sensations, indicating the temperature at which the subject feels the tip as hot. No attempt is made to test beyond 60°C due to the fear of damage to the skin. The temp can be raised from room temp to 60°C in 40 seconds.

There is no built-in device to cool the probe. The cooling can however be done by setting the control knob to 0°C and then keeping the probe tip in contact with ice. The thermocouple will then read the temp of the tip so cooled. The same instrument thus can test the cold sensations also.

Method of testing

Starting with room temp, the probe is heated in steps of 1°C and the heated probe is touched at the test site. The contact of the probe at the test site is firm (just sufficient to produce minimal indentation on the skin) and momentary (not lasting more than 2 seconds). The patient is instructed to respond as soon as he can appreciate the heat sensation. The temp at which the patient feels a distinct heat sensation is recorded as minimum temp of heat perception called as thermal sensory threshold (TST).

Precautions while testing

(a) The room temp and relative humidity is recorded.

(b) Before testing the covered areas, the patient is made to expose the test site for at least 20 minutes prior to testing, so that the skin temp remains constant in relation to room temp.

(c) The skin at the test site is kept as dry as possible.

(d) Undue pressure is avoided while testing.

(e) A 10 second interval is given between two contacts with the probe. This was done to ensure that the tip temp remains at the preset level as contact with skin causes dissipation of heat and brings down the tip temp.

(f) Skin temp was recorded at the test site in some cases.

Results

Heat perception was first evaluated in healthy adult males and females in different body regions. It was found that there is considerable difference in different body regions.[11,12] The perception

on palms and back was at higher temperatures as compared to the face and forearm. The perception on non-hairy areas was better than on the hairy area of comparable thickness,[13] while it is well known that moving touch is better perceived on the hairy areas.

The important finding was that the perception in contra-lateral areas was same and testing by different examiners in same individual had reproducible results within limitations. The availability of contralateral uninvolved skin as reference site was very useful in detecting small differences in temperature perception.

Due to the instrumental accuracy being limited to $\pm 1°C$ and allowing for observer differences of 1°C it was found that a difference of more than 2°C in heat perception between contralateral areas could be safely interpreted as significant.[11]

The differences in perception between males and females are marginal. Using the same instrument, co-workers Gupta has found age-related differences in healthy individuals in some body regions. Perception was found to be better in younger age group vis a vis older people above 50 years.[14]

In patients having clinical and histopathological evidence of TT and BT leprosy, it was found that the loss of temperature sensation was not uniform or complete in all lesions. Generally, maximum loss was seen in the centre of lesions, while it was lesser at the periphery. In many cases some sensory deficit could be detected well beyond the margin of a well-defined lesion in areas where no loss of touch sensation was found. The heat perception was almost always lost when touch and pain were lost. The area of sensory deficit as detected using the instrument was greater in majority of the lesions as compared to the area detected by testing touch and pain sensation. Similarly, in neuritic cases also, larger areas were detected to have deficiency in heat perception than touch or pain sensation.[13]

Five lesions in four patients of indeterminate leprosy were similarly tested. TST was higher and variable in all five lesions. While in three cases the histopathology was consistent with the diagnosis, in one case diagnosis was made on a high index of suspicion associated with distinct difference in TST. This patient showed good clinical response to anti-leprosy treatment over a six-month period of follow up.[13] Gupta and Haldar have also used the instrument and treated their cases having lesions suggestive of leprosy and having loss of thermal perception as detected by testing TST. The follow up of these patients on anti-leprosy treatment gave very gratifying result (personal communication).

Heat perception was measured during follow up of leprosy cases. Ten TT/BT lesions in 8 cases were evaluated. It was found over a six-month follow-up, that in six lesions where improvement in sensory perception was significant it was detected earliest with quantitative evaluation of heat perception. The return of sensory perception however was not seen in 4 lesions in two patients.[15] The mechanism of heat transfer between stratum corneum to nerve endings is not known. The possibility that this could affect the heat perception was explored by testing lesions of psoriasis and comparing them with uninvolved contralateral skin. It was found that there was some impairement of heat perception in thick psoriatic plaques.[16] No difference was found in cases of vitiligo. In a well conducted experiment, Dash[17] has demonstrated that sensations can be perceived in anaesthetic areas if the peripheral nerves are simultaneously given antidromic stimulation, even in long-standing cases of leprosy. Testing with thermosense it was found that TST improved if nerve stimulation was given but the improvement lasted only till the stimulation was maintained (personal communication from VD Tiwari).

Quantitative measurement of heat perception is thus found useful in early cases where sensory deficit is not gross. In established cases where sensory loss can be detected by cruder tests also, the instrument is not needed for diagnostic help. It can however be useful for better assessment of the extent of nerve involvement as well as in earlier detection of improvement.

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