

Diagnostic method for the vibration syndrome with special reference to finger skin temperature and vibratory sense threshold

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NIIOKA T, KOJIMA Y, KAJI H, SAITO K. Diagnostic method for the vibration syndrome with special reference to finger skin temperature and vibratory sense threshold. *Scand J Work Environ Health* 12 (1986) 251–253. The skin temperature and vibratory sense threshold of 34 chain-saw operators, ten of whom were diagnosed as suffering from vibration syndrome, and nine healthy students were measured before and immediately, 5, 10, and 15 min after 10 min of cold provocation of the left hand in water at a temperature of 10°C. Scattergrams of these parameters at the five points in time were drawn, and a boundary line for discrimination between the study groups was obtained at each of the five points in time. With the use of the boundary line for 5, 10, or 15 min after the provocation, it was possible to discriminate between the patients and the other subjects with more than 90 % accuracy. Considering the severe pain caused by the conventional 5°C cold provocation test, the 10°C test can be recommended for the screening and diagnosis of vibration syndrome.

Key terms: chain saws, correlation, cold provocation test, cold provocation test at 10°C, discriminant analysis, medical diagnosis, scattergram.

Measurements of finger skin temperature, vibratory sense threshold, hyperemia time (using the nail compression test), and pain sense threshold have been customarily employed in Japan as items of the special health examination for vibration hazards (4). These examinations have been widely performed after a 10-min cold provocation in which the hand is immersed in cold water at 5°C (3, 4). Immersion in 5°C water, however, causes subjects severe pain (1). We have investigated the possibility of using a temperature of 10°C, which causes much less pain than the 5°C test (6). It is the purpose of this communication to give a detailed report of the procedure and its usefulness and reliability for the diagnosis of the vibration syndrome.

Subjects and methods

Thirty-four male chain-saw operators, ten of whom were patients with vibration syndrome, and nine healthy male students 25–28 years of age were examined. Nine of the ten patients aged 37–55 years had a history of Raynaud's phenomenon. The mean

length of chain-saw use of the ten patients was 4 467 h. The other 24 operators, age-matched with the patients and between the ages of 40 and 54 years, had no complaints or medical signs, and the mean of their chain-saw use was 3 800 h.

A thermistor thermometer (Takara model PZL-64) was applied to the palmar surface of the middle phalanx of the middle finger of the left hand for the recording of skin temperature. The vibratory sense threshold of the fingertip was measured at 125 Hz with a vibratory sensation meter (Rion model AU-02). The skin temperature and vibratory sense threshold of the middle finger were measured before immersion and immediately, 5, 10, and 15 min after immersion of the left hand for 10 min in water at a temperature of 10°C.

The procedures of these examination methods were essentially in accordance with those recommended by the Japanese Ministry of Labour (4).

Results

The skin temperature of the patients was relatively low after the cold provocation as compared with that of the other subjects, although no statistically significant difference between them was observed at any of the five points in time. The vibratory sense threshold of the patients was markedly higher than that of the other subjects at all the five points in time.

Negative correlations between skin temperature and vibratory sense threshold were observed after the cold provocation. In some cases, a linear combination of two correlated variables provides a better discriminator than uncorrelated ones (5). Scattergrams of these parameters at the five measurement times were drawn

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for further analyses. There were some difficulties in making a discrimination between the patients and the other subjects in the scattergrams of the parameters before and immediately after the cold provocation. On the other hand, there was a tendency to differentiate the patients from the other subjects 5, 10, and 15 min after the cold provocation.

It could also be seen that subjects having a lower skin temperature showed a higher vibratory sense threshold and vice versa when the skin temperatures were below 20–25°C. However, the relation could not be observed when the skin temperatures were over 25°C.

Five minutes after the cold provocation a boundary line for discrimination between the patients and the other subjects could be drawn as shown in figure 1. The boundary was expressed by a linear combination of skin temperature and vibratory sense threshold when the skin temperature was below 25°C, although a discrimination could be made only on the basis of vibratory sense threshold when the skin temperature exceeded 25°C. With the use of this boundary line, it was possible to discriminate between the patients and the healthy operators with a false discrimination of 6 %, a sensitivity of 80 %, and a specificity of 100 %. A similar discrimination was obtained with the boundary line drawn 10 min after the cold provocation, where the false discrimination was 9 %, the sensitivity 80 %, and the specificity 96 %. Fifteen minutes after the cold provocation the false discrimination was 9 %, the sensitivity 70 %, and the specificity 100 %.

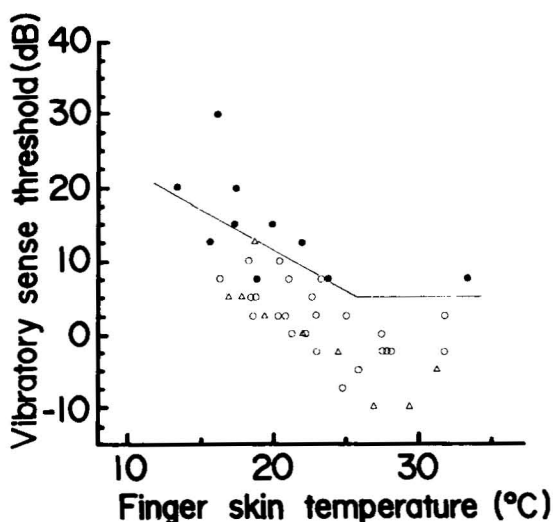


Figure 1. Scattergram of skin temperature on the palmar surface of the left middle finger and vibratory sense threshold of the fingertip of nine healthy students (Δ), 24 healthy chain-saw operators ($\circ$), and ten patients with vibration syndrome ($\bullet$) 5 min after immersion of the left hand in water at a temperature of 10°C for 10 min. The line shows the boundary for discrimination between the patients and the other subjects.

Discussion

On the basis of the analyses using scattergrams of skin temperature and vibratory sense threshold, it appears that the patients with vibration syndrome could be detected effectively in the 10°C cold provocation test. This result shows that the 10°C test is as useful as the conventional 5°C test. With the values measured immediately after the cold provocation, however, discrimination with a high degree of accuracy was impossible. This result was considered to be due to overlapping distributions of the vibratory sense thresholds in all the groups and to very narrow distributions of the skin temperatures in the region of 11°C (10–13°C).

The vibratory sense thresholds after the cold provocation increased remarkably in all the groups as compared with those before the provocation. As the skin temperatures returned to their original levels after the cold provocation, the vibratory sense thresholds decreased. The mean rate of the decrease in relation to the increase in skin temperature in the three groups was about 1.5 dB/°C when the skin temperatures were below 25°C. Weitz (7) pointed out a similar relation between vibratory sense and skin temperature. Inman & Peruzzi (2) reported that amplitude and the rate of rise of the receptor potential of mesenteric pacinian corpuscles, considered as vibratory receptors, in the cat decreased on cooling. Hence, it is considered that the increase in vibratory sense threshold after cold provocation in the present experiments was closely connected with the decrease in skin temperature.

In the present experiments, correlations between skin temperature and vibratory sense threshold were often observed after the cold provocation, and the linear combination of the two provided a better discrimination between the patients with vibration syndrome and the other subjects. This result illustrates that discrimination without the use of a linear combination of vibratory sense threshold and skin temperature would not be adequate. When skin temperature is higher than 25°C, discrimination is probably adequate only on the basis of vibratory sense threshold, because the vibratory sense threshold was almost independent of the skin temperature.

A boundary line for discrimination between the patients with vibration syndrome and the other subjects should be defined carefully because it varies with the subjects tested and it also depends on whether weight is given to the specificity or the sensitivity.

The vibration syndrome of the patients in the present experiments was not serious. Although both a prolonged rewarming of skin temperature and a prolonged recovery of vibratory sense threshold were observed in a patient who had been diagnosed as having the greatest severity of vibration syndrome among the patients tested, there was no clear relationship in general between the degree of severity of the syndrome and the location of data points in the scattergram. Further investigation is needed to clarify this point.

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