Thermographic imaging of cutaneous sensory segment in patients with peripheral nerve injury

Skin-temperature stability between sides of the body

Sumio Uematsu, M.D.
Department of Neurosurgery, The Johns Hopkins University School of Medicine, Baltimore, Maryland

Sensory examination based on the patient's subjective assessment of symptoms may raise difficult questions about whether the individual's expressed complaint is based on organic nerve damage, psychogenic factors, or even malingering. A prototype computerized telethermograph has allowed clinical quantification of peripheral nerve injury. The system makes possible mapping and imaging of the damaged area, as well as skin temperature measurements. In normal persons, the skin temperature difference between sides of the body was only 0.24° ± 0.073°C. In contrast, in patients with peripheral nerve injury, the temperature of the skin innervated by the damaged nerve deviated an average of 1.55°C (p < 0.001). The new technique requires further refinement, but it appears that use of this method may be cost-effective in helping to resolve medicolegal conflicts concerning peripheral nerve injury.

Key Words: thermography · nerve injury · sensory examination · sympathetic nerve · skin temperature

Because the patient's perception and expression of sensation can be influenced by many factors, interpretation of the results of a sensory examination may be difficult. In the past, several attempts have been made to document cutaneous sensory impairment objectively, including the skin resistance test and the starch-sweat test, but, since the methods are cumbersome and their results are not always reproducible, they have not been widely used.

In recent years, a qualitative telethermographic technique has been used for evaluation of the vasomotor function of the skin, particularly in the patient with chronic pain, but criticism of this technique arose because the results lacked quantification. It is known that skin temperature is altered in the field of an impaired peripheral nerve due to sympathetic vasomotor disturbance. Therefore, we reasoned, the sensory segment in the area of an impaired peripheral nerve could be demonstrated as a thermographic image. Accordingly, the prototype equipment used in this study was designed to provide quantitative analysis of thermographic data. We used a new technique that collects and computes the average temperatures in designated areas of the body surface, and provides temperature differences between two designated segments.

Thermography Technique

A color telethermograph with a built-in computer was used in this study. We mapped the skin surface areas to be measured by dividing the body's skin surface into 32 sensory "box" segments that approximate the areas of innervation of the major peripheral nerves (Fig. 1). This mapping is by no means complete: we arbitrarily excluded some areas of innervation because they are not large enough for precise sampling with our present equipment. In addition, we avoided hair-covered areas, such as eyebrows, and moist areas, such as lips and nostrils, because hair and moisture can cause unpredictable temperature changes.

Skin temperature on each sensory segment was measured in 32 healthy subjects, and in 30 patients with peripheral nerve impairment. These individuals ranged in age from 12 to 65 years. The average temperatures in the 32 sensory segments on the normal subjects were determined for both sides of the body. The degree of temperature difference between the sides of the body was determined for the 32 sensory segments in the control subjects (Table 1) and in the patients. The difference in skin temperature (absolute values) between nerve-damaged segments and the opposite cor-