Thermographic presentation of cutaneous sensory and vasomotor activity in the injured peripheral nerve

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Impaired function of cutaneous segments of monkey peripheral nerves experimentally blocked by lidocaine anesthesia was clearly visualized by means of elevated temperature measurements obtained on computerized color telethermography. Mean temperature elevations in the segments of anesthetized primate nerves were 2.40°C at the ulnar segment 17 minutes after nerve block, and 1.20°C at the peroneal nerve at 20 minutes. The vasomotor activity of specific nerves, recorded after local anesthesia and displayed by color telethermographic imaging, corresponded to the distribution of sensory segments identified by more cumbersome means. Telethermography is therefore shown to be a useful tool, both qualitatively and quantitatively, in mapping cutaneous distribution of peripheral nerves and for evaluation of peripheral nerve injuries.

Key Words - thermography - nerve injury - sensory examination - skin temperature - monkey

Changes in skin resistance reflecting variations in sympathetic tone were well documented both quantitatively and qualitatively by Richter in experiments conducted in the 1920's through the 1940's. Richter's early experiments showed that surgical or pharmacological sympathectomy produces a large but transient increase in skin resistance. This increase was attributed to change in sweat gland activity and was shown to last from a few days to several months.

Richter's technique of measuring skin resistance involved moving an electrode over a small area of skin, progressing from affected to unaffected regions. As a normal area was reached, the pointer on the ammeter was deflected on the dial. The electrode was then replaced on the abnormal area and again moved toward normal areas in progressively small steps until the line of demarcation between the areas was sharply delineated. Skin resistance measurements were used for the study of injury and regeneration in the sympathetic nervous system, for sympathetic dermatome mapping, and for the study of peripheral nerve injuries. Despite its possibilities for clinical application in objectively documenting sensory changes, the technique was cumbersome and was not widely adopted.

Telethermography has been developed as an alternative technique for recording the normal and pathological status of nerves with cutaneous distribution. The basis for the method, as in Richter's method, is the fact that the sympathetic distribution closely parallels the somatic sensory distribution of nerves. Skin temperature, which is a function of sympathetic vasomotor (not somatic) control, is known to reflect disturbances in peripheral nerve function. Malfunctioning areas are reliably demonstrated by telethermographic imaging of skin temperature changes.

The technique of computerized telethermography is complex, but the physical principle is readily comprehended. The method relies on measurement of infrared radiation emitted at the body's surface. The infrared rays that radiate from the skin surface are received by the telethermography device. The apparatus does not come in contact with the skin, so that it is possible to record small surface temperature changes without changing the skin's thermal condition. Moreover, the equipment does not apply any form of energy to the subject, and therefore does not cause harm or irritation to the patient, even after the successive uses that are necessary for detailed examination. With direct measurement of skin temperature at segments corresponding to the known distribution of sensory nerves, telethermography allows quantitation of change in, as well as demarcation of, the area affected by peripheral sensory nerve injury.

Description of Telethermography System

The telethermographic equipment consists of a scanning unit, an output amplifier, a computer processor,