THORACOLUMBAR SYMPATHECTOMIES EXAMINED WITH THE ELECTRICAL SKIN RESISTANCE METHOD*

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(Received for publication September 21, 1945)

It has been found that areas of skin denervated by sympatheetomy can be quickly and accurately outlined by means of the electrical skin resistance method, using a small portable dermometer. Thus far this method has been used only for upper thoracic and lumbar sympathectomies, both of them performed most frequently in the treatment of peripheral vascular diseases. In this study it was used on thoracolumbar sympathectomies (removal of ganglia from T-9 to L-1 inclusive) performed in the treatment of hypertension.

In the previous studies it was found that the electrical skin resistance method made it possible to follow the distribution of sympathetic nerves far beyond where they have been traced by anatomical dissecting methods. Thus, it was demonstrated that the sympathetic nerves are distributed in regular segmental dermatomes, both on the head and on the lower part of the trunk and legs.

The knowledge of the distribution of the sympathetic nerves as obtained from skin resistance measurements has been used clinically by neurosurgeons (1) preoperatively, to decide which ganglia must be removed to denervate certain affected areas of skin and (2) postoperatively, to determine whether the affected areas of skin have actually been denervated, that is, whether the neurosurgeons actually removed all of the ganglia that they had intended to.

In the present study we used this method in the examination of thoracolumbar sympathectomies to determine: (1) the extent of the areas of skin that are denervated by the operation; (2) how these areas agree with our present knowledge of the distribution of the sympathetic and sensory nerves in this part of the body; (3) whether the denervated areas can be used to indicate the surgical and clinical success of the operation; and, finally (4) whether regeneration of the sympathetic nerves can be detected by this method.

METHODS

For the full understanding of the use of the electrical skin resistance method it is important to know: (1) that the resistance offered to the passage

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* Carried out under a grant from the John and Mary R. Markle Foundation and under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and The Johns Hopkins University.
of a minute, imperceptible current through the body is localized almost entirely in the skin; and (2) that this resistance is controlled largely through the sympathetic nervous system; thus removal of the sympathetic nervous system or sympathetic paralysis greatly increases skin resistance, while stimulation of the sympathetic nerves greatly decreases skin resistance.

The small portable dermometer used for these experiments has been described in detail in previous papers. It will suffice to state here that it consists of a microammeter, a 4½-volt battery, a 1000-ohm potential divider, a telephone socket and plug, and two electrodes and connecting wires. One electrode, made of a strip of silver-plated phosphor-bronze, has the shape of a clip. By means of a specially devised clasp it can be firmly fastened to the lobe of the ear in such a way that the disc of the electrode rests directly over the front surface of the ear lobe. A paste made of kaolin and saturated zinc sulphate solution establishes contact between the electrode and the skin. A puncture made previously through the skin with a fine hypodermic needle eliminates the resistance of the skin under this electrode. This electrode remains fixed to the ear throughout the examination. The other electrode consists of a small silver-plated phosphor-bronze disc which is built into the end of an insulated wooden handle. This electrode is held in the hand of the examiner, thus making it possible to bring its flat, smooth surface into contact with the skin on any part of the body. No paste is used with this electrode. As a result of the elimination of the resistance under the ear electrode, all of the remaining resistance offered by the body is localized in the skin under this movable electrode.

With one electrode attached to the ear lobe and the other in contact with the skin, the amount of current from the battery that flows through the circuit is indicated by the excursion of the needle of the microammeter. The extent of the excursion varies directly with the resistance offered by the skin under the hand electrode. When this resistance is high the needle will not move, indicating that no current is flowing, while when it is low the needle will move quickly entirely across the dial, indicating that a large amount of current is flowing. The instrument can be adjusted so that when the hand electrode is placed over a normally innervated area of skin the needle will move sharply and entirely across the dial, while when it is placed over a denervated area it will not move at all.

The sharpness of the outlines of the denervated areas depends on the difference in level that exists between the resistance of the denervated areas and the surrounding areas of normally innervated skin. Factors that promote sweating reduce the resistance on the normally innervated skin but have little or no effect on parts that have been denervated. Thus, to sharpen the outlines, the patients may be heated for a few minutes in a hot-air cabinet or under a heat cradle. Hypertensive patients rarely require much heating since in their weakened condition even the slight effort involved in sitting up in bed is apt to produce sweating on all normally innervated areas. Hence, many patients can be adequately examined in their beds on the wards. In all instances, however, in which diffuse or doubtful outlines are obtained the patients must be heated in a heat cabinet or under a heat cradle for a few minutes. Because the patients are frequently in a weakened condition for the first few days after the operation, the examinations are not usually made before the 6th to 10th postoperative day.

The mapping of the areas that have been denervated by thoracolumbar sympathectomy involves the following steps:

(1) The patient is placed in a hot-air cabinet and is heated for a few minutes. Whenever possible the areas of high electrical skin resistance are outlined before the patient leaves the cabinet. This reduces the complications in the records that may arise from sudden cooling. If the patient is too weak to sit up in the cabinet, he is allowed to lie down in bed and is then kept as warm as possible with blankets.

(2) The fixed electrode is attached to the ear lobe, and the dermometer is placed so that the dial of the microammeter is readily visible at all times.