A NEW METHOD OF IMPLANTING ELECTRODES IN THE MUSCLES OF THE LIMBS OF DOGS TO RECORD THE ELECTROGRAM UNDER CONDITIONS OF FREE MOVEMENT

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In long- or short-term electromyographic studies on the limb muscles of animals the electrodes are either simple or concentric, and are inserted into the muscle through a puncture in the skin. This method of leading off the electromyogram (EMG) has certain shortcomings: 1) the potentials are not always recorded from the same parts of the muscle, because it is impossible to penetrate the muscle in the identical site every time; 2) the tips of the electrodes often become withdrawn from the muscle into the subcutaneous space, particularly when the animal walks; the effect is due to the movement of the skin with respect to the muscles; 3) for deeply placed electrodes or for muscles lying on the inner surface of joints, needle electrodes cannot be employed; 4) the painful reaction induced by use of stiff electrodes distorts the natural course of the movements.

L. V. Kantorovich [2] and Yu. M. Uflyand [3] have proposed a permanent method of leading off the EMG from limb muscles. In experiments on rabbits they sewed a fine varnished silver wire into a muscle. One end of the wire was scraped free from varnish for a length of 0.7-0.8 cm and was fixed in the depth of the muscle by means of a surgical needle; the other end was brought out onto the surface of the skin. This method of implantation enabled the EMG to be recorded from the muscle for several weeks. T. I. Goryunova [1] implanted electrodes into the diaphragm muscle of rabbits, cats, and dogs. One end of a fine multistrand wire in a chlorvinyl cover terminated in a silver plate fixed to the surface of the diaphragm while the free end was brought out onto the surface of the skin. This method of leading off the EMG made it possible to continue experiments for 1-2 weeks.

Although it is possible to bring out the free ends of the electrodes onto the surface, it is not practicable to do so because then the ends of the leads frequently become broken at the point where they bend, or else they come out under the skin causing infection of the wound. The appropriate shaping of the free ends of the electrodes is an important part of the technique of implantation which has not yet been solved. We have developed a new method of implantation of electrodes for the purpose of recording electrical activity in muscles. The following are the distinctive features: 1) the free ends of the wires leading from the electrodes are made in such a way that they remain beneath the skin; 2) as electrodes wire may be used whose diameter is measured in microns; 3) the EMG recording may be made from an unrestrained undamaged animal.

In our experiments we used 100 μ nichrome wire covered with an insulating varnish (as applied at the factory). One end of the wire was bared for a distance of 10 mm; it was placed in a capsule and fixed to its walls with two or three stitches. The capsule consisted of a length of rubber tube filled with a mixture of an electrically-conducted paste containing fine aluminum filings; it was fixed on both sides with rubber disks. The pieces of rubber tubing and the metal filings were kept in alcohol for 1-1$\frac{1}{2}$ hours.

To implant the electrodes, incisions were made in the skin: one at the point where the electrodes were to be implanted into the muscle, and the other on the neck, or in the thorax, in order to house the capsule. The end of the wire leading from the capsule was fixed with 2-3 stitches in the aponeurosis of the muscle by means of a surgical needle; the last stitch passed through the abdominal muscle in order to submerge the tip of the electrode in the muscle tissue. The tip of the second (bipolar) electrode was submerged at a distance of 1-1.5 cm from the first electrode. The electrodes were implanted either along or across the length of the muscle fibers. The lead had to

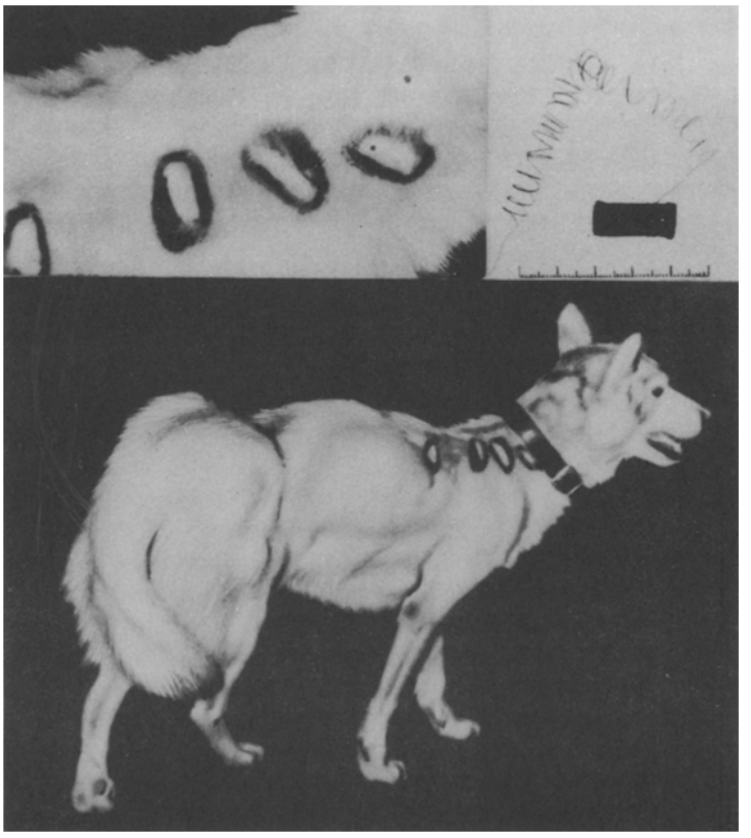

Fig. 1. Dog with electrodes implanting for recording the EMG. Above on the left is shown an enlarged picture of the area of skin beneath which capsules were implanted. Above on the right is shown an electrode whose free end was submerged in the capsule containing the electrically-conducting paste.

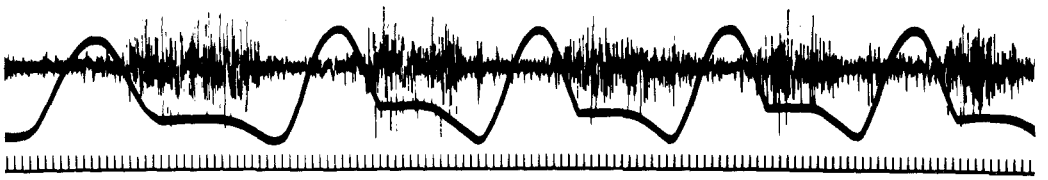

Fig. 2. EMG of a flexor of the right forelimb and trace of the movement of that limb made by a dog while walking. Curves (top to bottom); EMG; trace of movement; flexor of right forelimb at elbow joint (deflection of the line upwards represents flexion); time marker (0.02 seconds).

be sufficiently long so as not to interfere with the movements of the limb. After implantation of the electrode to the flexors and extendors of the front limbs the animal usually walked normally.

Figure 1 shows a dog four months after implantation of electrodes for recording the EMG.

In order to record the EMG through the skin a needle electrode is introduced into the capsule and connected to an amplifier. The skin above the capsule and the needle electrode are treated with alcohol before use.

Figure 2 shows an EMG obtained eight months after the operation. The record of the angular movements at the elbow joint of the forelimb was recorded by M. Ya. Chirskov's method [4]. The EMG and movement record were made while the animal was moving freely (walking).

SUMMARY

A thin nichrome wire served as an electrode for the EMG lead; one end of the wire was introduced into the tissue of the muscle to be investigated, and the other was immersed in a rubber capsule filled with an electrically conducting paste; the capsule remained under the skin of the neck. A needle electrode connected to an amplifier was introduced into the capsule in order to record the EMG through the skin.

LITERATURE CITED

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