A METHOD OF STUDYING CONDUCTION ANESTHESIA ON THE SCIATIC NERVE OF THE FROG

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As is well known, in order to study the effect of anesthetics under conditions of conduction anesthesia, a method is widely used in which the sciatic nerve of the frog is dissected; the method consists of the following. A strip of wax paper measuring about 5 × 20 mm is placed under the nerve; a wad of cotton moistened with the anesthetic solution is placed on the wax paper. Then, after certain periods of time, the nerve is irritated below the anesthetized portion, and the onset and subsequent disappearance of anesthesia of the nerve is judged by the change in the general motor reaction.

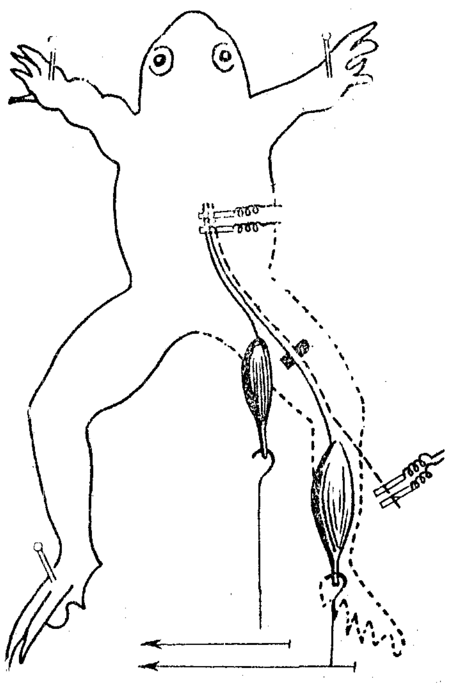

Fig. 1. Diagram for setting up experiment to study conduction anesthesia.

However, this method has a number of disadvantages. First, the graphic recording of the frog's reaction to the irritation is difficult, which naturally reduces the value of the experiment; second, the degree and character of the effect of the anesthetics tested on the production of nerve impulses individually along the sensory fibers and the motor fibers of a mixed nerve in the same animal are not registered. In addition to this, this method does not make it possible to conduct a comparative study of two anesthetics or of a single preparation taken in two concentrations on a single frog.

In an effort to improve this method and eliminate the disadvantages, we suggest that such investigations be carried out in the following manner. The lumbar plexus of a decapitated frog is exposed on the right or the left side, and the central part of the sciatic nerve and the peroneal nerve are separated; the latter is picked up on a ligature and cut. The semitendinosus and gastrocnemius muscles are connected with universal myographs. One of the electrode couples is placed under the lumbar plexus, and the other under the central end of the peroneal nerve. The electrodes are connected through a commutator with an induction apparatus supplied with electrical current from an alkaline battery. When stimulating the peroneal nerve, a current force is usually selected, such that a marked reflex contraction of the semitendinosus muscle is noted. When stimulating the lumbar plexus, the minimal current strength at which the gastrocnemius muscle contracts is used.

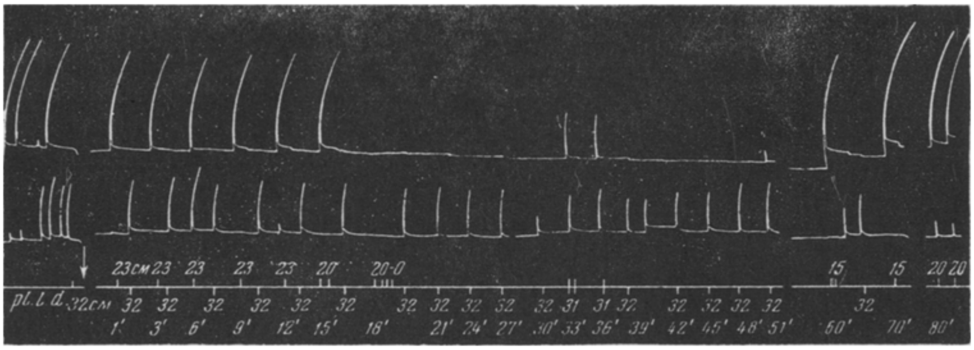

Fig. 2. The effect of a 1% bencaine solution on the conductivity of nerve impulses along sensory and motor fibers of the sciatic nerve of the frog. Significance of curves (from the top down): myogram of the right semitendinosus muscle during stimulation of the right peroneal nerve; myogram of right gastrocnemius muscle during stimulation of the lumbar plexus of the same side; stimulation index, strength of current (distance between induction coils in cm) for stimulating the peroneal nerve (figures above), for stimulating of the motor fibers of the lumbar plexus (figures below); time (in min) from the moment of application of anesthetic solution to nerve.

After the normal contractions of the indicated muscles during stimulation of the nerves with induction current are recorded on the tape of a slowly rotating kymograph, a small celluloid spoon with a small wisp of cotton moistened with the anesthetic solution is placed under the central part of the sciatic nerve; after certain intervals of time (3- or 5-min), the conduction of impulses along the sciatic nerve toward the center during stimulation of the peroneal nerve and toward the periphery, i.e., toward the gastrocnemius muscle, during stimulation of the lumbar plexus is checked (Fig. 1). At the same time, the semitendinosus muscle is the "witness" [1] of the change in conductivity of the sensory fibers of the sciatic nerve, while the gastrocnemius muscle is the "witness" of changes in the conductivity of the motor fibers of the same nerve. The motor nerve which innervates the semitendinosus muscle is not subjected to the action of the anesthetic, since this nerve approaches the muscle before the site of application of the wisp of cotton. The latter circumstance is notable in that it makes it possible to relate all kinds of changes in the reflex contraction of the semitendinosus muscle to changes in the conductivity in the afferent portion of the reflex arch being subjected to the action of the anesthetic.

Figure 2 represents a mechanographic recording of one of the experiments on the determination of the blocking action of the anesthetic, bencaine. The upper myographic curve shows the contractions of the right semitendinosus muscle during stimulation of the right peroneal nerve, while the lower one shows the contractions of the right gastrocnemius muscle during stimulation of the lumbar plexus of the same side. As seen in Fig. 2, after the 15th minute, the semitendinosus muscle did not respond by contracting during the stimulation of the peroneal nerve.

The lower myogram shows that the conductivity of the motor nerve fibers going, as a component of the sciatic nerve, to the gastrocnemius muscle, did not disappear, but only decreased after 30 min. After the removal of the wisp of cotton, it was restored earlier than the conductivity of the sensory nerve fibers. Threshold stimulation for the contraction of the gastrocnemius muscle when the distance of the coils was 32 cm, was subthreshold for the nonreflex contraction of the semitendinosus muscle. Increasing the strength of the current during stimulation of the plexus, which includes motor fibers going to the semitendinosus muscle, caused contraction of the latter, which is what is reflected on the upper myogram corresponding to the 33rd and 36th minutes. This phenomenon is evidence that the disappearance of contractions of the semitendinosus muscle in response to the stimulation of the peroneal nerve does not depend on changes in the efferent part of the reflex arch, but rather on the onset of anesthesia of the sensory fibers of the sciatic nerve.

For the comparative evaluation of the anesthetizing effects of two solutions or two different agents, the design of the experiment is modified as follows. The right and left sciatic nerves are exposed, the peroneal nerves are placed on electrodes, while the corresponding semitendinosus muscles are connected to myographs. Then, one anesthetic solution is applied to the right sciatic nerve, while the other solution is applied to the left sciatic nerve, and observations are made of the character of the changes in conductivity of both nerves. In view of the fact that it is very difficult to observe the changes in conductivity of both narcotized nerves simultaneously (the activity of the reflex apparatus of the frog is found to be extremely inconsistent in this case), it is recommended that the anesthetizing activity of the two solutions selected be compared sequentially with respect to time.

Finally, we should like to point out that many experimenters, regardless of the concentration of the anesthetizing solution employed and time of onset of anesthesia, remove the wisp of cotton moistened with test solution from the nerve after 5 or 10 min following its application to the nerve. With this sort of contact of the nerve with the anesthetic, nonuniform conditions are created for the onset of anesthesia caused by solutions of different concentrations. For example, when testing a 5% solution of novocaine, the nerve is in contact with the anesthetic solution at all times until complete anesthesia is attained; when testing a 0.25% solution, on the other hand, conditions for the restoration of conductivity rather than for its development are created long before the onset of anesthesia, since the wisp of cotton is removed at the 5th or the 10th minute. Therefore, the cotton and lining should be removed after the moment of onset of anesthesia.

Thus, the method of investigation of conduction anesthesia suggested by us makes it possible to use the same subject to simultaneously make observations and objectively record anesthetic-induced changes in the conductivity of impulses along sensory and motor fibers of a mixed nerve, as well as to compare the anesthetizing effects of different solutions on the same animal.

SUMMARY

Many methods used for investigating the local anesthetizing effect of medicinal preparations have a significant drawback, preventing objective recording of the changes occurring during local anesthesia. Such methods give only subjective results, which are not always reliable. A method of assessing conduction anesthesia, suggested by the author, makes it possible to take a separate recording of the changes occurring in the nerve impulse conductivity along the sensory and the motor fibers of frog sciatic nerve, subjected to anesthesia.

LITERATURE CITED

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