

6153

Fibers in Mixed Nerves and Their Dorsal Roots Responsible for Pain.

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It has been shown that fibers which differ in anatomical type, for instance myelinated and unmyelinated fibers, when stimulated, give electrical potentials which differ characteristically (Bishop and Heinbecker¹). The potential picture recorded from a mixed nerve by means of the oscillograph thus serves as an index of the nerve's fiber content. When these potentials are recorded from a nerve still in the body, the correlation between potential record and the response given by the animal as a whole serves to identify the fibers responsible for accomplishing a specific type of activity. The potential record from a nerve, like the electrocardiogram, thus becomes an index of physiological function. We here present data to identify a group of nerve fibers which convey impulses resulting in painful sensations.

Autonomic fibers in mixed nerves can be recognized by the fact that they are slow-acting, and myelinated autonomic fibers can be differentiated from unmyelinated by thresholds and conduction rates. Of somatic fibers, 2 groups can be distinguished, both myelinated, one of which conducts more rapidly than the other. The slower includes the so-called "visceral afferents". There are thus 4 groups recognizable, general somatic, visceral afferent, myelinated autonomic and unmyelinated autonomic. Pain is mediated by fibers of the second group, of which the visceral afferent is the type. Whether pain is also conveyed by unmyelinated fibers in mixed nerves we have been unable to determine so far, since stimulation of the myelinated fibers causes so much pain that an increase of sensation which might result from stimulation of unmyelinated fibers of higher threshold cannot be detected.

A first experiment was conducted in a conscious human. A branch of the saphenous nerve was dissected out after novocaine anesthesia to the skin only. The threshold stimulus required to cause pain was determined. It was found that at this strength of stimulus at least 8 stimuli were required before pain was experienced. With stronger stimulation fewer stimuli were required. Here, as

¹ Bishop, G. H., and Heinbecker, P., *Am. J. Physiol.*, 1930, **94**, 170.

in the study of sympathetic nerve fibers to the eye, (Bishop and Heinbecker²) the number of fiber stimuli rather than the frequency or intensity alone determined the degree of effect. The fiber type which was being stimulated when pain was felt was determined by a potential analysis of a branch of the external popliteal nerve of the same leg (after amputation) of corresponding size and with the same stimulating circuit. It was found that the threshold stimulus required to elicit pain was just adequate to elicit a threshold response of the second potential, from myelinated fibers of the visceral afferent type. These fibers are smaller and more thinly myelinated than the large thickly-myelinated sensory and motor fibers found in a mixed trunk. They include the smallest somatic myelinated fibers. It is important to note that the threshold for reflex muscular responses was the same as the threshold for the sensation of pain.

Experiments were carried out in which an electrode shielded except at the tip was inserted through the skin over a branch of the median cutaneous nerve of the forearm in six conscious humans. The indifferent electrode was placed on the skin 3 or 4 cm. distant and kept moist. The ratio of the threshold for tactile sensations to the threshold required to elicit pain was found to be 1:5 or 1:6. This ratio is of a similar order to that determined for the thresholds of the first and second complexes with fast properties in mixed human nerve trunks. Somewhat similar experiments were carried out in the dog. Here a distal portion of the saphenous nerve was dissected out under general anesthesia. Stimulating and recording electrodes were applied to the nerve trunk after the animal was allowed to recover from the anesthesia. The ratio of thresholds for the first and second potential complexes was found to be 1:5 to 1:6. Pain was again experienced when the stimulus was adequate to elicit the second potential complex. The threshold for muscular reflex response was found the same as the threshold for pain.

Trunks composing the sciatic nerve of the dog and cat with their attached roots were dissected out in order to trace the second potential complex, found to be associated with the sensation of pain, into the spinal cord. On stimulating the nerve trunk, this potential was recorded from the dorsal roots.

The thresholds for motor responses in spinal roots and in nerve trunks are of the same order, and the ratios of stimulus strength for direct motor and reflex responses are the same. Cross sections of

² Bishop, G. H., and Heinbecker, P., *PROC. SOC. EXP. BIOL. AND MED.*, 1931, **28**, 682.

osmicated nerves and roots both show the fibers inferred to correspond to the second potential associated with pain.

Both functional and histological evidence therefore support the conclusion that the impulses giving rise to the sensation of pain are mediated by myelinated fibers coursing *via* the dorsal roots, having the properties of the visceral afferent group.

6154

Observations on "Encystment Cycle" of *Endamoeba histolytica* in a Carrier.

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The stools of a human carrier of *E. histolytica* were studied daily for 215 days to determine (1) the presence of encystment cycle, (2) the development and viability of immature cysts outside of the body, effects of changes in temperature and moisture, (3) the relative proportions of uni-nucleate cysts at various periods of encystment cycle, and (4) correlation, if any, between consistency of stools and number of discharged cysts.

The number of cysts per gram of stool was calculated according to the method previously described¹ and if cysts were very few, according to a modification of Lane's method² for counting hook-worm eggs. All negative findings were verified by Rivas' modification³ of ether-acetic acid concentration method, and also by the culture method recently reported.⁴ Gram iodine solution was used in determining the number of nuclei present in samples of cysts examined.

Observations. 1. *Encystment Cycle.* There was a definite cycle of encystment in *E. histolytica* as has been observed in giardiasis by Boeck,⁵ Kofoid and others⁶ as well as by the author.¹ There was an apparent periodicity in appearance of the maximum number of

¹ Tsuchiya, H., *Am. J. Hyg.*, 1931, **13**, 544.

² Lane, C., *Trans. Roy. Soc. Trop. Med. and Hyg.*, 1924, **17**, 407.

³ Rivas, D., *Am. J. Trop. Med.*, 1928, **8**, 63.

⁴ Tsuchiya, H., *Proc. Soc. Exp. Biol. and Med.*, 1931, **26**, 347.

⁵ Boeck, W. C., *Uni. Col. Pub. Zool.*, 1922, **20**, 199.

⁶ Kofoid, C. A., Boeck, W. C., Minnich, D. E., and Rogers, J. H., *J. Med. Res.*, 1919, **30**, 293.