

A STUDY OF THE EFFECT OF NOVOCAIN BLOCKADE ON INTACT MUSCLE BY MEANS OF VITAL STAINING

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(Received May 16, 1958. Presented by Active Member of the AMN SSSR V. N. Chernigovskii)

Lumbar paravertebral block with novocain is widely used in medical practice. The nature of the effect of this block on the muscles has not, however, been adequately explained. Striated muscles must be the most reactive, for their functional activity is under the constant influence of the nervous system. The effect of this is shown, as was pointed out by I. S. Beritov [2], by the high excitation of the denervated muscle in the region of the nerve endings. Novocain acts on the different organs through the means of nerve conductors. I. N. Kantorovich pointed out [7], for instance, that novocain causes a sharp reduction in the functional lability of muscle, and direct stimulation of the muscle produces a normal contraction even when the action of novocain is far advanced. L. G. Vol'fenzon [4] studied the action of novocain on the cells of different tissues, especially muscles, using the method of vital staining. This worker showed that novocain, in doses causing necrosis, produces a contraction of the rectus abdominis muscle of the frog, but this effect is not observed on the sartorius muscle.

Our object was to discover the effect of lumbar novocain block on the skeletal muscles of the hindlimbs in mammals.

EXPERIMENTAL METHOD

Experiments were carried out on white mice of both sexes, weighing on the average 20-22 g. We used the method of vital staining with neutral red. The method is described in detail in our previous paper [5]. An injection of 0.2 cm³ of a 0.25% solution of novocain was given into the left sympathetic trunk in its lumbar division. To test the specificity of the action of novocain block, another group of animals was injected with the same volume of physiological saline. In response to a single injection of adrenalin we studied the sorptive power on the day of injection and the following 3 days; if the injections were given 2 and 4 times in the course of 2 days, the sorptive power was determined during the next 2 days; when four daily injections were given the mice were taken for study of the sorptive power on the last day of the injections. Altogether 88 mice were used in the experiments.

EXPERIMENTAL RESULTS

No fundamental differences were found in the reaction of the mice to injection of novocain or physiological saline into the sympathetic trunk. How may the fact that all the reactions were of the same type be explained? The workers who introduced the method of novocain block [3] emphasized the nonspecific nature of its action. In this connection attention is drawn to the findings of G. A. Ionkin [6], who demonstrated the increased lability of cardiovascular tone as a result of novocain block, and showed that similar changes appeared also after injection of hypertonic saline or of physiological saline. The common feature in the action of these solutions, in this worker's opinion, is the mechanical pressure of the injected fluid on the tissue and the change in osmotic pressure. I. N. Bel'gova [1] gave repeated injections of novocain and observed a considerable increase in the sensitivity of the heart. Prolonged action of Ringer's solution on the heart also increased its sensitivity to novocain.

TABLE 1

Values of the Sorptive Power of Muscles After Injection into the Sympathetic Trunk of Novocain Solution and of Physiological Saline, Expressed as Percent of Controls Which are Taken as 100% (experiments on females)*

Date	Control	Novocain (right limb)	Novocain (left limb)	Physiolo- gical sa- line (right limb)	Physiolo- gical sa- line (left limb)	Notes
1955	A. After a single injection					
6/IX	100	71	67	53	67	Injections 5/IX on — —
7/IX	100	67	59	125	111	
8/IX	100	77	77	83	71	
19/IX	100	77	71	—	—	Sorption studied on the 4th day after in- jection of novocain
	100	62	62	—	—	
26/X	100	91	91	—	—	Sorption studied on the day of injection
	100	83	83	—	—	
B. After two injections at 48 hr interval						
9/IX	100	77	67	90	83	Injections given on 5/IX 8/IX — —
	100	90	90	67	67	
	100	77	77	100	83	
10/IX	100	83	71	90	100	
C. After 4 daily injections						
28/X	100	77	86	83	91	Injections given on 25/X, 26/X, 27/X, 28/X
	100	71	77	53	55	
D. After four injections at 48 hr intervals						
26/IX	100	83	83	71	71	Injections given on 23/IX 24/IX, 25/IX & 26/IX
27/IX	100	59	59	59	67	

*Sorption of the right calf muscles was compared with that in the right calf muscles of control animals, and sorption of the left with that in their left calf muscles. The values for the control animals were taken as 100%.

In our experiments physiological saline is a weak stimulating agent. Injection of a volume of 0.2 cm³ of this solution cannot be regarded as indifferent for so small an animal as a mouse. It must be pointed out that although the left sympathetic trunk was stimulated, corresponding changes were observed in both right and left muscles. This may possibly be explained by transmission of the stimulus from the sympathetic ganglia of the left trunk through the central nervous system to the ganglia of the right sympathetic trunk. The connection between the sympathetic ganglia and the central nervous system through receptors, particularly via the peripheral processes of the neurones of the intervertebral ganglia, was demonstrated by E. S. Levitskaya [9].

Our observations revealed essential differences in the reaction of the calf muscles to stimulation of the sympathetic trunk as observed in females and males. As seen from Table 1, in females a fall in the sorptive

TABLE 2

Values of the Sorptive Power of Muscles After Injection into the Sympathetic Trunk of Novocain Solution and of Physiological Saline, Expressed as Percent of Controls Which are Taken as 100% (experiments on males)*

Date	Control	Novocain (right limb)	Novocain (left limb)	Physio- logical saline (right limb)	Physio- logical saline (left limb)	Notes
1955	A. After a single injection					
22/IX	100	91	83	—	—	Sorption studied on the day of injection of novocain solution
	100	71	83	—	—	
26/X	100	91	100	—	—	
	100	57	57	—	—	
6/IX	100	182	200	167	—	Injection on 5/IX
7/IX	100	167	182	143	143	
8/IX	100	100	133	100	100	
	B. After two injections at 48 hr interval					
29/X	100	100	125	83	100	Injection given on 5/X & 8/X
	100	91	125	91	100	
	C. After 4 daily injections					
28/X	100	77	100	77	91	Injection given on 25/X (X, 27/X & 28/X
	100	91	100	71	91	
	D. After four injections at 48 hr intervals					
16/X	100	143	143	154	—	Injection given on 6/X, 9/X, 12/X & 15/X
	100	125	125	15	—	
17/X	100	143	143	133	167	

*Sorption of the right calf muscles was compared with that in the right calf muscles of control animals, and sorption of the left with that in their left calf muscles. The values for the control animals were taken as 100%.

power of the calf muscles was observed in all cases.

In males the sorptive power fell immediately after the injection; after a few hours and for the next 3 days increased sorption over that of the controls was observed (Table 2, section A). A reduced sorptive power was found after four daily injections and, in isolated cases, after two injections in 48 hours (see Table 2, sections B and C). After 4 injections at intervals of 48 hours, an increase of sorption was observed in all cases (see Table 2, section D).

Some figures, reflecting changes in sorption as a result of the block, are only insignificant variations from the controls. Within these limits variations are observed in the sorptive power of muscles in the control animals (of the order of 10%). These cannot be regarded as variations in the sorption of muscles of different animals, since a definite tendency is observed in the changes in sorptive power of the experimental animals' muscles towards either a decrease or an increase of sorption.

Thus in the first place we succeeded in revealing sexual differences in the reactions of the calf muscles during lumbar novocain block. In the majority of males we observed an increase in the sorptive power of the

muscles during the action of the block. In the first few hours after the block we observed that the sorptive power was lower than in the control; on the next day we found an increase of sorption, which lasted until the 3rd or 4th day after the injection. In some cases sorption increased after multiple injections and in others it decreased. In females we observed only one type of reaction, namely a decrease in sorption. Hence a phasic type of reaction is observed in the muscles of the males: a phase of decreased sorption alternates with a phase of increased sorption.

The phasic nature of the response of living matter to an external agency was pointed out by S. N. Romanov [10, 11]. Sexual variations in the reaction of the epithelium of Descemet's membrane in rodents to strychnine were discovered by V. L. Levin [8], who also used the method of vital staining as a criterion of the sensitivity of the epithelium. Tissue from males not only showed itself to be more susceptible to injury by large doses, but also responded more rapidly to the action of minimal concentrations of strychnine.

The fact that in females only a phase of decreased sorption was observed in response to all the variants of the injection technique used, in contrast to the character of the reactions of the muscles in males, may be evidence of a considerably smaller degree of lability of the muscles in females.

SUMMARY

The sorptive properties of gastrocnemius was studied in mice (by vital staining with neutral red) in injection of 0.2 cc of 0.25% novocain solution into the lumbar portion of the left sympathetic trunk.

A decrease of the sorptive function of the muscles was observed in females. In males, after a short decrease of the sorption, this function was intensified on the next day after the injection. This increase was still present on the 3rd and the 4th day.

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