

MORPHOLOGY

EFFECT OF PHRENICOTOMY ON THE INTERNAL ARTERIES OF THE DIAPHRAGM IN DOGS

I. N. Preobrazhenskaya

From the Dept. of Normal Anatomy (Chairman: Prof. M. G. Prives). I. P. Pavlov First Leningrad
Medical Institute (Director: Docent A. I. Ivanov).

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A number of authors [1, 3, and others] who have studied the effects of the nervous on the vascular system have observed that lesions of nerve trunks caused diminished elasticity of blood vessels, with thickening of their walls, and obliteration of the lumen, as long term effects of denervation of the affected part. Other effects recorded are lowered resistivity of the walls of the vessels, increase in their permeability after sympathectomy, and dilatation of arteries supplying muscle, skin, and large blood vessels after deafferentation.

Most of these studies are based on histological data, and are related to research on the action of peripheral nerves on blood vessels in general. We have found no direct references in the literature to morphological studies (with the application of microscopy) of the action of the nervous system on the internal blood supply of muscles, and, in particular, of the diaphragm.

EXPERIMENTAL METHODS

Unilateral or bilateral phrenicotomy was performed on 8 dogs, which were killed with chloroform at various times after the operation. The arterial system was infused with a contrast substance within 24 hours of death, by M. G. Prives' procedure, and the diaphragm was dissected out and x-rayed. Time after operation is shown in the following table:

Time Elapsing After Operation

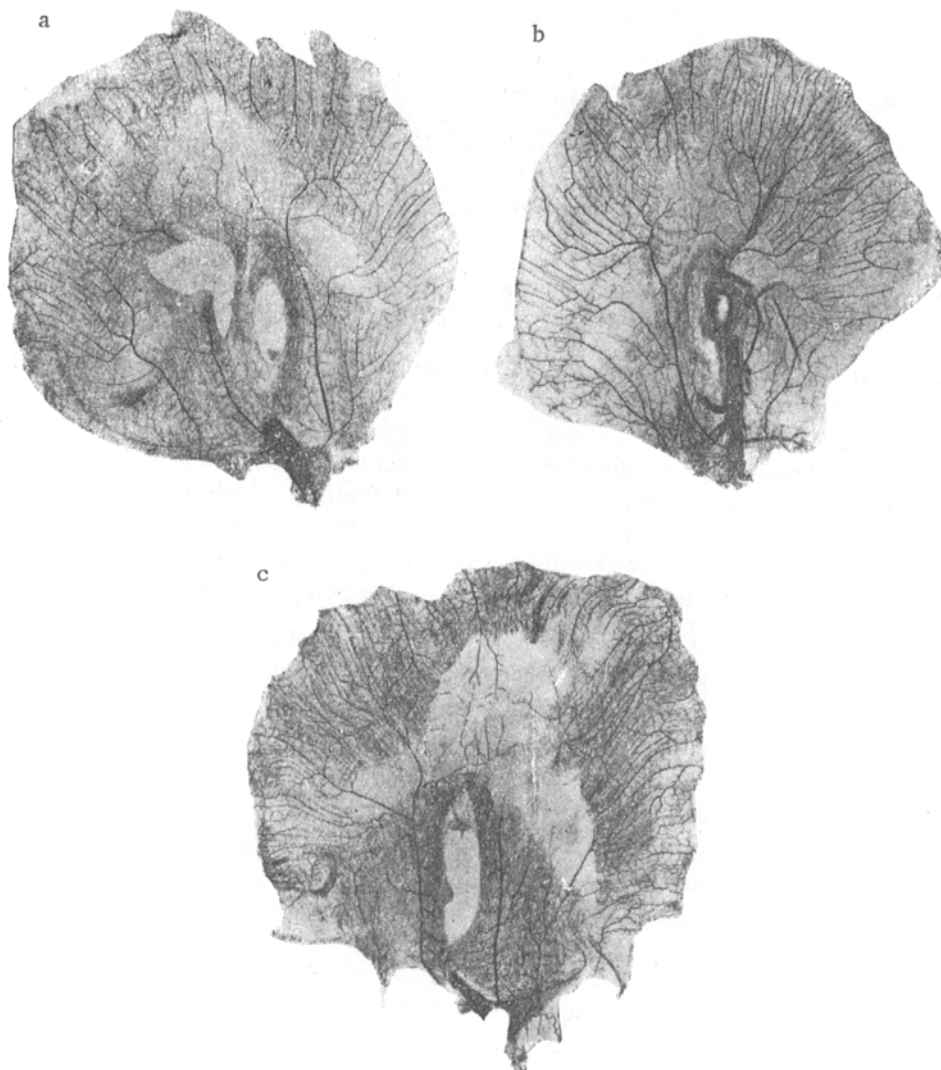
Left phrenicotomy	2 weeks
Right "	3 "
Left "	4 "
Bilateral "	6 "
Left "	10 "
Bilateral "	12 "
" "	20 "
" "	24 "

Four unoperated dogs were taken as controls; the arterial blood supply of their diaphragm was studied as for the test animals.

EXPERIMENTAL RESULTS

Branching of the arteries entering the vertebral, costas, and sternal parts of the diaphragm was observed 2-6 weeks after phrenicotomy. The ramifications are arteries of the 2nd, 3rd, 4th, or higher order, and most of

them run parallel with the muscle bundles, viz., radially through the greater part of the muscle, in a circle at the esophageal opening, and longitudinally in the crura (see Figure, a). All the branches anastomize freely, forming arterial arcs and loops. The diameter of arteries of the 1st order, i.e., of arteries entering the muscle, varies from 0.1 to 1 mm. Arteries of the 2nd and higher orders pursue a tortuous course. All these observations also apply to unoperated dogs.



Diaphragmatic arteries of dogs at various times after phrenicotomy. a) 6 weeks after bilateral phrenicotomy. b) 10 weeks after left phrenicotomy. c) 24 weeks after bilateral phrenicotomy.

No differences ascribable to the operation could be seen between the right and the left sides of the diaphragm 2, 3, 4, and 6 weeks after left or right phrenicotomy, nor did the arterial systems of such diaphragms differ macroscopically from those of control dogs. It follows that the short time elapsing since the operation (up to 10 weeks in this case) was insufficient for the development of such morphological changes as would become evident by the application of our technique of injection followed by x-ray examination.

The arteries of the right side of the diaphragm of dogs killed 10 weeks after left phrenicotomy are more tortuous than of the left side (see Figure, b).

The arteries of the diaphragm of two other dogs, killed 12 and 20 weeks after bilateral phrenicotomy, are straight, on both sides.

Thus morphological changes in the diaphragmatic arteries are to be observed 10 weeks after the operation; the arteries become less tortuous. This change may be ascribed to abolition of activity of the denervated muscle, which remains in a resting condition, and therefore requires less blood. This demonstrates the unity of diaphragmatic function with its structure and its vascular supply. The straightening out of the arteries is evidently connected with loss of tonus of the diaphragmatic muscles and their relaxed state (without entering into consideration of changes in the innervation of the vessels themselves).

Numerous extravasations are evident in the diaphragm 24 weeks after phrenicotomy (see Figure, c), showing that in later postoperative stages the permeability of the arterial walls increases, allowing lead salts to pass through them. This is evidence of more permanent changes in the structure of the arterial walls.

It may hence be concluded that the phrenic nerves affect the intradiaphragmatic arteries.

According to E. K. Evzerova, E. S. Sanovich, and S. Yu. Minskin [1] heightened permeability of the vascular walls is already evident 2 weeks after interference with the nerve supply of a given region (these authors studied the parts of main arteries within organs).

Permeability to plasma may develop earlier than to lead salts (these authors did not inject the vessels of dead animals; they studied the degree of edema in the denervated parts of the living animal).

I. L. Khlopina also found heightened permeability of the walls of intramuscular arteries after denervation, together with thickening of the walls and almost complete obliteration of the lumen; the latter effect was seen by this author only after long post-operative periods.

We did not observe narrowing of the lumen of the arteries, probably because of the relatively short time elapsing between operation and death of the animals (not more than 24 weeks).

We conclude from our experiments that section of the phrenic nerves affects the morphology of the intradiaphragmatic arteries of dogs. The arteries become straighter, and the permeability of their walls rises after some time.

LITERATURE CITED

- [1] E. K. Evzerova, E. S. Sanovich, and S. Yu. Minskin, *Soviet Psychoneurology*, 1941, 2, 37-41.
- [2] P. M. Zalkan, *Collected Papers of the Dermatological-Venereal Institute*, (Moscow, 1941) Vol. 8, 185-197.
- [3] G. P. Konradi, *Bull. Exptl. Biol. Med.*, 17, 6, 41-44 (1944).