SOME REFLEXES OF THE LESSER CIRCULATION*

(UDC 612.148:612.833.148+612.833.148)

V. S. Kupriyanov

Department of Normal Physiology (Head, Professor V. V. Petrovskii),
Bashkir Medical Institute, Ufa

Presented by Active Member AMN SSSR V. V. Parin
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 59, No. 5,
pp. 22-25, May, 1965
Original article submitted December 12, 1963

Recently, several works have appeared describing the involvement of the sinocarotid and aortic reflexogeneous zones in regulation of the blood flow through the lesser circulation [5-7, 11, 12, 20, and others].

We have established the presence of reflex influences originating in the vessels of the portal system and influencing the tone of the pulmonary vessels [2].

It can be seen that reflexes from the greater circulation are concerned in the regulation of the flow through the lesser circulation. However, despite numerous investigations [9, 10, 13, 17, 22] the problem of the autoregulation of the pulmonary circulation cannot be considered as settled.

The object of the present work has been to study the nature of the reflex changes in the tone of the pulmonary vessels in response to changes of pressure in them.

EXPERIMENTAL METHOD

The experiments were carried out on cats. Anesthesia was induced with ether, and then after the change-over to artificial respiration it was maintained with urethane. Access to both lungs was gained by bilateral extirpation of the 5th rib. The posterior lobe of the left lung was isolated humorally. In order to preserve the innervation of the vessels of this lobe as completely as possible, in places where the afferent cannula was introduced into the pulmonary artery and where the efferent cannula was introduced into one of the pulmonary veins, the adventitia was carefully separated and preserved. The vessels of this lobe were perfused with Locke's solution at 37-38°; in many of the experiments the Locke's solution was mixed with heparinized feline blood maintained at a constant pressure of from 5-12 cm water. We used the perfusion method because the humoral isolation vessels produced by this means eliminates the mechanical transmission of pressure from the right ventricle and from the left atrium to the perfused pulmonary vessels, an effect which has been pointed out by many authors [6, 8, 11, 12, and 15]. Furthermore this method enables very small variations in vascular tone to be observed [1]. The arterial pressure was recorded by a mercury manometer from the common carotid artery. The experiments were discontinued as soon as there was any edema of the perfused lobe. The perfusion was not continuous for more than 10-30 min in the different experiments. Because the contraction of the muscles of the diaphragm or of the abdominal wall or larynx may mechanically influence the pulmonary circulation [6, 11], in some of the experiments we divided the phrenic and recurrent laryngeal nerves. Altogether in 50 experiments we reduced and lowered the pressure in the vessels of the right and left lungs 501 times.

EXPERIMENTAL RESULTS

Reduction of the pressure in the vessels of the right lung brought about by compression of the branch of the pulmonary artery led to a constriction of the perfused vessels of the left lung and to an increase in arterial pressure (Fig. 1).

The change in the tone of the perfused vessels occurred after a latent period of from 1-5 sec. Evidence of the

* Read at the 50th Summary Scientific of Bashkir Medical Institute on April 4, 1963.

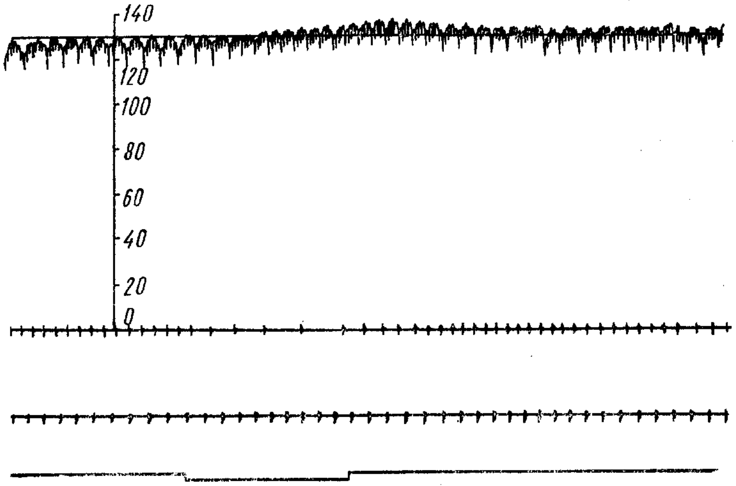

Fig. 1. Change in the tone of humorally isolated vessels of the left lung and of the general arterial pressure in response to compression of an arterial branch of the right lung. Curves, top to bottom: blood pressure in common carotid; number of drops of perfusate passing through vessels of the posterior lobe of the left lung; time marker (2 sec); marker indicating fall in pressure in right lung.

reflex nature of the increase in pulmonary tone was afforded by experiments in which after division of the nerves and adventitia of the vessels passing through the root of the perfused lobe of the left lung compression of the same artery of the right lung failed to bring about constriction of the perfused left-lung lobe. However, the reflex of the right-lung vessels influencing the vessels of the greater circulation was maintained. If the nerves were cooled only a small amount, when they were heated again the vessels of the left lung once more constricted. In 233 out of 264 cases reduction in pressure in the pulmonary vessels led to an increased tone of the perfused vessels; in 12 there was a drop in pressure, in 13 the reaction was mixed, and in 6 cases there was no reaction.

Increase in pressure in the vessels of the right lung resulting from compression of one of its veins caused a reflex dilatation of the vessels of the left-lung lobe. From Fig. 2 it is clear that the reflex change in the tone of the vessels of the left lung was also associated with a reflex depression of arterial pressure in the greater circulation [3, 4, 19].

The reflex reduction in tone of the vessels of one lung and the reduction in the general arterial pressure was directly proportional to the extent to which the pressure was raised in the vessels of the other lung (Fig. 2A, B). As a rule, maximum reduction in tone of the perfused vessels occurred towards the end of the period of interference, and was maintained for some time after the interference had ceased (Fig. 2C). In 220 out of the 237 cases increase in pressure in the pulmonary vessels was associated with a dilatation of the humorally isolated pulmonary vessels, in 5 cases the vessels were constricted, in 7 there was no reaction, and in 5 cases the reaction was mixed.

From these results it follows that a change in the pressure of the pulmonary vessels exerts a marked influence on their tone and on the tone of the vessels of the greater circulation, and the 2 changes are in the same direction. A similar coincidence in the reactions of the vessels of the greater and lesser circulations has been observed when the pressure in the pulmonary vessels was raised [4], when the receptors of the carotid sinus and of the aortic nerve were stimulated [6, 12, 16, 18, and 21], when muscular work was undertaken, and during respiration [15].

Compression of the branches of the pulmonary vessels may apparently be associated with some increase in pressure in the right atrium and venae cavae. There is, therefore, reason to suppose that the changes which we observed in the vascular system during compression of the pulmonary vessels have their origin in reflexes originating not in pulmonary receptors but in the heart. However, if this was the case, compression of the arteries and veins of the lungs would be associated with only one effect on the vascular system, because changes of pressure in the heart would then be of the same type. However, we have observed that during compression of a pulmonary artery and vein the actions on the vessels of the greater and lesser circulations are opposed. For the same reasons the idea that during compression of the pulmonary vessels reflexes originated from their chemoreceptors as a result of hypoxia of the pulmonary

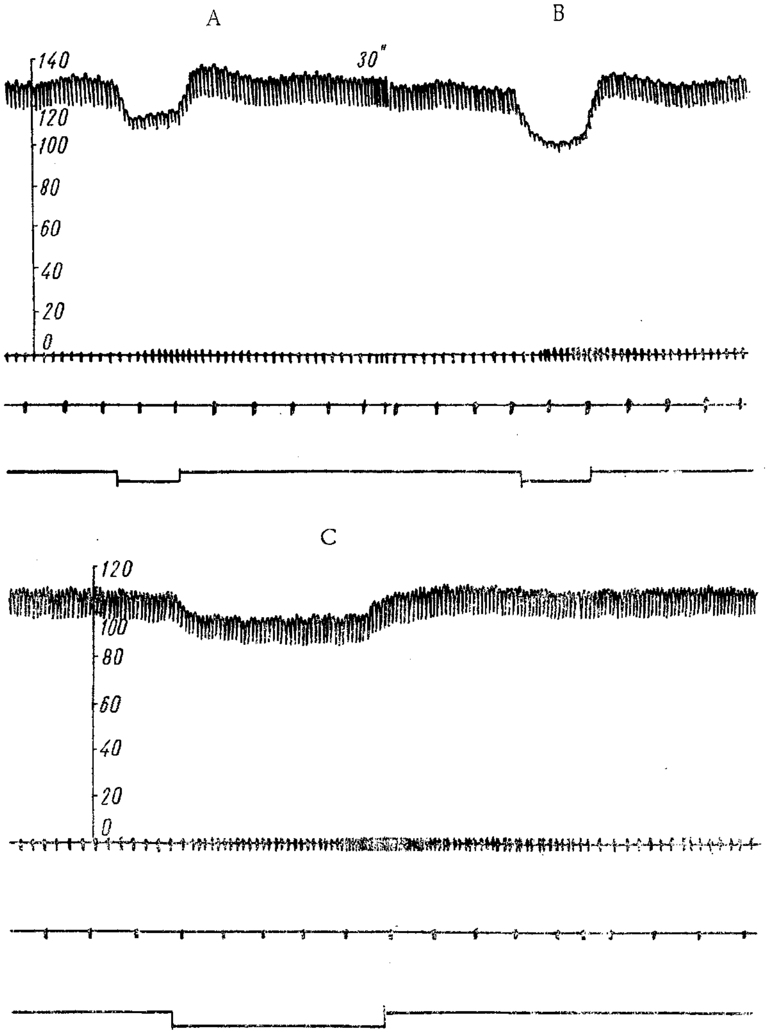

Fig. 2. Change in the tone of vessels of the posterior lobe of the left lung, and of the general arterial pressure in response to (A) partial, (B) complete compression of the vein of the right lung for 25 sec. Curves, top to bottom: blood pressure in the common carotid; number of drops of perfusate passing through vessels of the posterior lobe of the left lung; time marker (6 sec); marker indicating increase in pressure in right lung.

tissue is at variance with our results. Further opposing evidence is the existence of a marked interrelationship between the pulmonary and the bronchial blood supplies.

The results of our work give reason to suppose that when the blood pressure in the pulmonary vessels rises, the subsequent fall may be brought about not only by reflex dilatation of the vessels of the greater circulation [4] but also very likely through the simultaneous reduction of tone in the vessels of the lesser circulation itself. The opposite process may occur when the pressure in the vessels of the smaller circulation falls.

SUMMARY

Experiments have shown that reflex changes occur in the tone of pulmonary vessels if pressure is changed within them. A decrease in pressure causes the vessels to constrict and induces an increase of general pressure. The opposite effect is observed when the pressure in the pulmonary vessels rises.

LITERATURE CITED

1. G. N. Kotova, V. V. Petrovskii, and D. I. Smirnov, Fiziol. zh. SSSR, No. 2 (1961), p. 237.

2. V. S. Kupriyanov, Fiziol. zh. SSSR, No. 8 (1963), p. 961.
3. V. V. Parin (1939). Quoted by V. V. Parin and F. Z. Meerson, An outline of the clinical physiology of the circulation [in Russian], Moscow (1960), p. 21.
4. V. V. Parin, The role of the pulmonary vessels in reflex regulation of the circulation, [in Russian], Moscow (1946).
5. A. I. Khomazyuk, Experimental studies of receptors and of the lesser circulation, Dissertation for Doctorate, Kiev (1961).
6. E. Agostoni, I. E. Chinnock, Daly M. de Burgh, J. Physiol. (London), 137 (1957, p. 447.
7. D. M. Aviado, Jr., A. H. Niden, and C. F. Schmidt, Fed. Proc., 15, No. 1, Pt. 1 (1956), p. 5.
8. I. L. Berry, Daly I. De Burgh, Proc. roy. Soc. B., 109 (1931), p. 319.
9. A. van Bogaert et al., Arch. Mal. Coeur, 46 (1953), p. 289.
10. B. L. Brofman et al., J. thorac. Sug. 34 (1957), p. 206.
11. Daly I. de Burgh and Daly M. de Burgh, J. Physiol. (London), 137 (1957), p. 427.
12. Daly M. de Burgh and A. Schweitzer, Ibid, 131 (1956), p. 220.
13. H. Denolin, P. Courtoy, and A. Dumont, Arch. Mal. Coeur, 50 (1957), p. 1011.
14. U. S. Euler and G. Liljestrand, Acta physiol. scand., 12 (1946), p. 301.
15. W. F. Hamilton, R. A. Woodbury, and E. Vogt, Am. J. Physiol, 125 (1939), p. 130.
16. G. Logaras, Acta physiol. scand., 14 (1947), p. 120.
17. F. Robicsek, Acta med. Acad. Sci. hung, 9 (1956), p. 1.
18. E. S. Schafer, Quart. J. exp. Physiol. 12 (1920), p. 373.
19. H. Schwiegk, Pflüg. Arch. ges. Physiol. 236 (1935), p. 206.
20. Stewart, Leusen et al. (1954). Cited by U. S. Euler and G. Liljestrand.
21. A. Tournade and I. Malmejae (1932). Cited by D. M. Aviado, Jr. et al.
22. P. Weil, P. F. Salisbury, and D. State, Am. J. Physiol., 191 (1957), p. 453.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.