PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

THE SIGNIFICANCE OF INTEROCEPTORS IN THE REGULATION OF THE SATURATION OF ARTERIAL BLOOD WITH OXYGEN

COMMUNICATION 2. THE ROLE OF THE SPLEEN AND SINOCAROTID ZONES IN THE REGULATION OF THE SATURATION OF THE ARTERIAL BLOOD WITH OXYGEN DURING HYPOXIC STATES

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In a previous communication [2] we showed that the sinocarotid interoceptive zones play a substantial role in the processes regulating the extent and dynamics of the saturation with oxygen of the arterial blood during hypoxic states.

It is important to investigate the possible role of other organs possessing interoceptive zones in the regulation of the saturation of arterial blood with oxygen. It is known that during oxygen deprivation the spleen assures the rapid mobilization of erythrocytes and an increase in the hemoglobin present in the blood stream. This process has a reflex character [1].

The aim of the present study was an investigation of the role played by the interoceptive zones of the spleen and the sinocarotid zones in the regulation of the saturation of the arterial blood with oxygen during hypoxic states.

EXPERIMENTAL METHODS

The studies were undertaken on 7 cats which, 4 months previously, had been subjected to a splenic denervation and on 9 more cats of which 5 were first subjected to a splenic denervation and then, 4 $\frac{1}{2}$ to 5 months later had a denervation of the sinocarotid zones; the other 4 cats had the same operation but in reverse order. The studies were conducted by the use of the same methods and observance of the same conditions as already described in our first communication [2]. In all, 44 experiments were performed.

EXPERIMENTAL RESULTS

In the animals with denervated spleens, at the start of the experiments the oxygen saturation of the arterial blood varied between 96 and 92 %. As the atmospheric pressure fell ("climbing to the heights") there took place a gradual, relatively steady decrease in the degree of arterial blood saturation with oxygen. When a "height" of 7500 meters was attained the oxygen saturation leveled off at saturations of 54-62 %; in 3 animals during the period of exposure on the "heights" the oxygen saturation remained almost unaltered while in the other four after 8-10 minutes a gradual increase was observed. After the restoration of normal atmospheric pressure, the oxygen saturation returned to base levels in 5 animals while in 2 it remained below normal.

The graph of Fig. 1 describes an experiment in which the saturation on climbing dropped to 62-65 % rising by the 12-15th minute on the "heights" to 72 %. Upon the return to normal conditions the oxygen saturation re-

turned to base levels. The extent and dynamics of oxygen saturation of the blood in the cat with a denervated spleen did not in any way differ from the results obtained with the control animals. Among those animals in whom the oxygen saturation of the blood did not rise while remaining on the height", the alterations of this indicator took about the same course as after denervation of the sinocarotid zones. However, in these instances also the decrease in the degree of saturation was less shaprly expressed and after the return to normal conditions, saturation approached base levels.

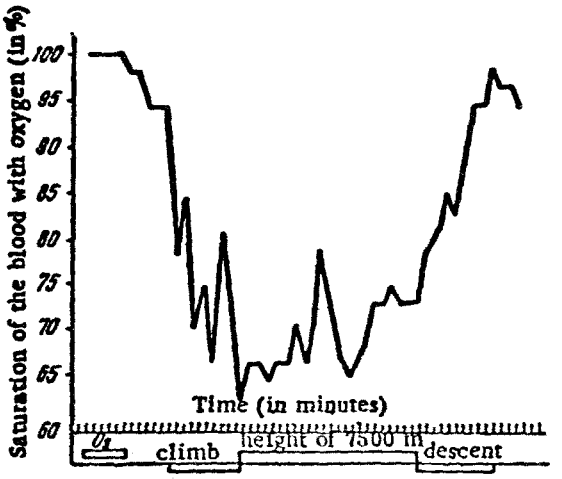

Fig. 1. Dynamics of saturation of the arterial blood with oxygen in cat No. 28 which had had a preliminary splenic denervation.
O_2) Arrangement of apparatus for 100 % saturation by respiring pure oxygen; climb) the moment of "climbing" to 7500 meters; height of 7500 meters) exposure at the "height" of 7500 meters for 20 minutes; descent) return to the usual environment.

Thus it appears that splenic denervation exerted no marked influence upon the extent and dynamics of the oxygen saturation of the arterial blood during hypoxic states and, in any case, the influence it did exert was materially less than the effect of excluding the sinocarotid zones.

During the period of the "climbs" it was demostrated that animals who had had the second operation (sinocarotid zone denervations) after the preliminary splenic denervation developed a much greater decrease in the arterial oxygen saturation than they did after splenic denervation alone. This is to be compared with the animals who had been subjected to the sinocarotid denervation first and in whom the additional splenic denervation effected no marked alterations in the dynamics and degree of saturation when "climbing to the heights" (see Table).

The first group consisted of animals who had splenic denervations after a preliminary deafferentation of the sinocarotid zones; while the second group consisted of those animals which had denervation of the carotid sinuses performed after the splenic denervation.

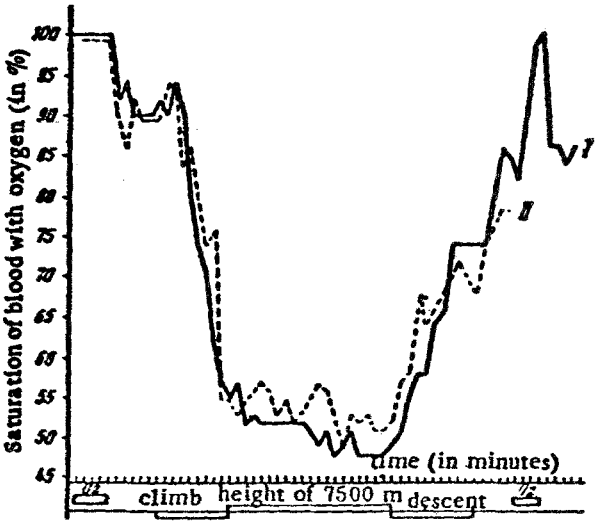

Fig. 2. Dynamics of saturation of the arterial blood with oxygen in cat No. 16.
I) After splenic denervation; II) against the background of previous studies following denervation of sinocarotid zones. The markings are the same as in Fig. 1. O_2[at right]) at the moment of observation of the inhalation of pure oxygen during the experiment following the second operation.

Degree of Saturation of the Arterial Blood with Oxygen During Climbs to 7500 Meter Heights in Animals with Denervated Sinocarotid Zones and Denervated Spleens

Number of animals	O_2 saturation of blood before "climbing"		At a height of 7500 meters												After the descent	
			1st minute		5th minute		10th minute		15th minute		20th minute		25th minute			
	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument	%	Measurements by calibrations of the instrument
I Group																
14	98	98	64	81	70	84	64	81	68	83	70	84	—	—	90	94
16	92	95	55	75	52	73	51	72	51	72	49	71	—	—	86	92
17	96	97	60	79	62	80	62	80	58	78	56	76	—	—	86	92
22	96	97	72	85	74	86	66	82	70	84	68	83	—	—	88	93
Average	95.5	—	62.7	—	64.5	—	60.7	—	61.7	—	60.7	—	—	—	87.5	—
II Group																
4	94	96	52	73	51	72	51	72	49	71	49	71	—	—	94	96
6	90	94	56	76	51	72	48	70	49	71	48	70	—	—	84	91
7	94	96	60	79	56	76	57	77	55	75	56	76	—	—	86	92
9	94	96	60	79	57	77	56	76	52	73	57	77	—	—	94	96
28	88	93	48	70	49	71	51	72	51	72	51	72	—	—	80	89
Average	92	—	55.4	—	52.8	—	52.6	—	51.2	—	52.2	—	—	—	87.6	—

When the experimental results are compared it becomes evident that denervation of the sinocarotid zones produces in the animals with preliminary splenic denervations a much greater lowering of the sturation than is caused by splenic denervation alone. These studies were undertaken after each of the operations so that it is possible to compare the results of both experimental series in the majority of the animals.

From Fig. 2 it is evident that denervating the spleen did not affect the changes arising as a result of denervation of the sinocarotid zones.

Fig. 3 shows the changes in the oxygen saturation of the blood when the operations were performed in the reverse order. In this series it is quite easy to see the difference in the depression and dynamics of the oxygen saturation of the blood arising as a consequence of the second operation which was the denervation of the sinocarotid zones. While in the "climbs" after splenic denervation only the degree of sturation fell to 55-57 %, after the sinocarotid denervation this value was 48-51 %.

In addition, it should be noted that while in the first study the degree of saturation rose to 58-62 %, by the 10th minute of being on the "heights", in the second study there was observed an actual slight greater fall, while after the return to the normal environment the arterial blood saturation did not revert to base levels during the 5 minutes of observations.*

* On breathing pure oxygen there was 100% saturation at beginning of experiment.

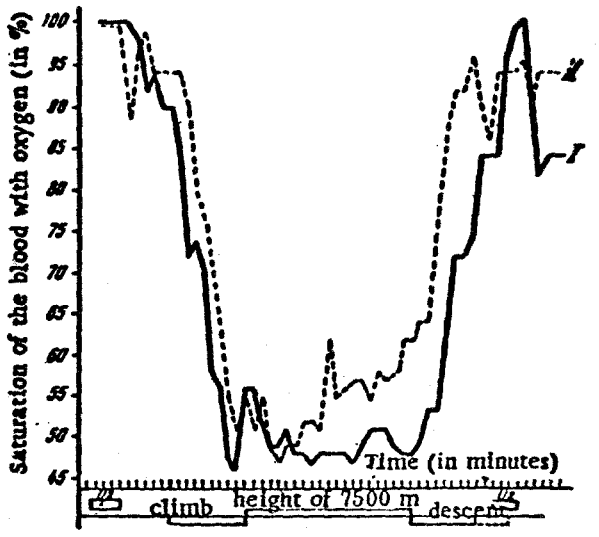

Fig. 3. Dynamics of the saturation with oxygen of the arterial blood in cat No. 6.
I) After denervation of the sinocarotid zones;
II) against a background of previous splenic denervation. The markings are the same as in Fig. 1.

Thus, denervation of the sinocarotid zones after a preliminary splenic denervation produced during "climbs to the heights" further alterations lowering the degree of the oxygen saturation of the arterial blood. Denervation of the spleen in animals who had had the denervation of the sinocarotid zones first did not produce additional substantial changes in the dynamics of the saturation with oxygen of the arterial blood when these animals were subjected to hypoxic stress.

The results obtained indicate that oxygen saturation of the arterial blood in hypoxic states is much more dependent on the normal functioning of the sinocarotid zones than on the influence of the spleen which seems to be inconstant and much weaker.

The significance of the carotid sinuses in respiratory regulation is generally well known. The role of the sinocarotid zones in hypoxic states is clearly evident [3], while the spleen, even though it may be an important interoceptive zone, has a much less marked role in regulation of respiration.

Denervation of the carotid sinuses produced profound alterations in the arterialization of the blood in hypoxic states while following splenic denervation the changes were inconstant and much less marked. In addition we showed that animals having denervated carotid sinuses and subjected to hypoxia suffered no changes in the process of the erythrocyte increase and hemoglobin rise. Conversely, in animals subjected to splenic denervation, at times when they were subjected to hypoxia, the number of erthyrocytes did not rise and the hemoglobin percentage did not increase.

We come to the conclusion from our accumulated data that the oxygen saturation of the arterial blood in hypoxic states is more dependent on respiratory alterations than on the hemoglobin content of the blood.

SUMMARY

It was experimentally demonstrated that the interoceptive zone of the spleen plays a less important part in regulation of oxygen saturation of arterial blood than the zones of the carotid sinuses.

LITERATURE CITED

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[2] N. N. Beller, Biull. Eksptl. Biol. i Med. 43, 6, 12, (1957).**

[3] D. Cordier and G. Cordier. La medecine Aeronautique, 4, 1, 49 (1949).

* Russian translation.
** Original Russian pagination. See C.B. Translation.