ROLE OF AFFERENT INFLUENCES IN HEMODYNAMIC CHANGES AFTER COMPRESSION OF THE ABDOMINAL AORTA

M. V. Kon

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Changes in some indices of the hemodynamics and gas exchange following compression of the aorta were studied in rabbits with the spinal cord divided at the level D_{7-8} and in rabbits with the arterial pressure maintained unchanged (by means of a stabilizer). In the experiments with stabilization of the arterial pressure the blood flow in the upper half of the trunk was not significantly changed during compression of the abdominal aorta. The experiments with division of the spinal cord failed to establish that afferent influences from the lower, ischemic half of the trunk are reflected in the minute volume of the blood flow.

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Previous experiments showed that in intact rabbits and in rabbits with denervation of the aortic and carotid sinus reflexogenic zones the total oxygen demand and the arterial venous oxygen difference are reduced during compression of the abdominal aorta, the minute volume of the heart (MVH) remains constant, and the blood flow above the point of compression is considerably increased. The only difference between the two groups is that in the denervated animals the arterial pressure (AP) increased much more during compression of the aorta than in the intact animals while the heart rate was not reduced, in contrast to the intact animals.

In the present investigation changes in the blood flow during compression of the abdominal aorta were studied with the AP maintained constant and the effect of removal of afferent influences from the lower ischemic half of the trunk on the hemodynamics was examined.

EXPERIMENTAL METHOD

Experiments were carried out on rabbits of both sexes weighing from 2.5-4 kg anesthetized with urethane. The oxygen consumption was determined continuously throughout the experiment by means of a closed system. The mean AP was recorded in the carotid artery. The MVH was calculated by Fick's method. The aorta was compressed between the superior mesenteric and celiac arteries, by drawing on a ligature brought outside through a tourniquet. In the experiments of series I the AP was stabilized by means of an apparatus consisting of a glass flask, a mercury manometer, and a reservoir containing physiological saline, connected through a tube with the vascular system. The catheter of the stabilizer was introduced into the carotid artery or the aorta (through the superior mesenteric artery) as far as the level of the diaphragm. In the latter case the lumen of the aorta was constricted to the thickness of the introduced catheter. By squeezing on a bulb with a valve, air was forced into the system, establishing it to a pressure corresponding to the AP as previously measured in the rabbit. In the experiments of series II the spinal cord was divided at the level D_{7-8} after irrigation of the point of division with 2% procaine solution. The experiments began 1 h after division.

EXPERIMENTAL RESULTS AND DISCUSSION

Compression of the Abdominal Aorta in Rabbits with Stabilization of AP

In the experiments using a stabilizer, the AP remained unchanged after compression of the aorta (15 experiments), its greatest increase being 5-7 mm (in the experiments without stabilization the level of the AP rose on the average by 28 mm during compression of the aorta). The oxygen consumption and pulmonary ventilation were reduced in these experiments just as in the experiments without AP stabilization.

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TABLE 1. Changes in Hemodynamics and Gas Exchange in Rabbits in Experiments with AP Stabilization during Compression of Abdominal Aorta

Index studied	Before compression of aorta	During compression of aorta	P
Oxygen consumption (in ml/min)	21.9±1.4	13.7±1.3	<0.01
Arteriovenous oxygen difference (in vols. %)	4.1±0.26	4.18±0.27	≈0.5
MVH (in ml/min/kg)	188.8±17	111.6±12	<0.01
Pulmonary ventilation (in ml/min)	615.6±56	467.1±49	<0.01
AP (in mm Hg)	90±3	95±2.5	
Heart rate	264±8	257±7	≈0.05
Systolic volume (in ml)	2.2±0.3	1.4±0.2	<0.01

TABLE 2. Changes in Hemodynamics and Gas Exchange during Compression of Abdominal Aorta in Rabbits with Divided Spinal Cord

Index studied	Before compression of aorta	During compression of aorta	P
Oxygen consumption (in ml/min)	24.5±1.2	16.2±1.5	<0.01
Arteriovenous oxygen difference (in vols. %)	4.4±0.3	2.8±0.3	<0.01
MVH (in ml/min/kg)	187±16	198±29	≈0.6
Pulmonary ventilation (in ml/min)	54.1±1.9	91.4±2.7	<0.01
AP (in mm Hg)	674±55	560±46	<0.05
Heart rate	269±17	262±16	<0.05
Systolic volume (in ml)	2.5±0.2	3.1±0.4	≈0.1

The heart rate was unchanged. The oxygen concentration in samples of mixed venous blood taken during compression of the aorta was almost indistinguishable on the average from the original level. The MVH under these conditions was reduced (Table 1).

It is important to emphasize, therefore, that in contrast to the experiments without AP stabilization, in which the AP was always increased after compression of the aorta but the MVH remained almost unchanged, in the experiments with stabilization the MVH fell sharply. This decrease in MVH was proportional to the decrease in oxygen consumption, as revealed by the unchanged arteriovenous oxygen difference. Consequently, in the experiments without stabilization of the AP, the blood flow in the upper half of the trunk was increased (as shown by the decreased arteriovenous difference), while in the experiments with AP stabilization the blood flow remained normal after compression of the aorta (arteriovenous difference unchanged).

Compression of the Aorta in Rabbits with Divided Spinal Cord

In this series (10 experiments) the intension was to abolish some of the afferent influences on the cardiovascular system probably arising under the influence of compression of the aorta from the lower, ischemic half of the trunk.

After division of the spinal cord at the level D_{7-8} the AP fell considerably despite the fact that the remaining indices of the hemodynamics and gas exchange were identical with the initial indices in the other series of experiments (Table 2).

Compression of the aorta under these conditions was accompanied by a decrease in oxygen consumption and in the arteriovenous oxygen difference. The mean value of the MVH was increased, but not by a statistically significant degree. The shape of the curve of increase in AP during compression of the aorta was the same as that for intact rabbits.

Hence, in the animals with a divided spinal cord, compression of the abdominal aorta produced the same changes in the circulation (AP, MVH) as in intact rabbits.

To sum up the results of this investigation, it will be recognized that in neither series of experiments could any reflex influences be demonstrated from the lower half of the trunk on the circulation in the upper half. In fact, in the experiments of series I with AP stabilization the MVH remained relatively constant and adequate to the oxygen consumption, despite the ischemia in the lower half of the trunk. In the experiments of series II, division of the spinal cord had no significant effect on changes in the circulation in the upper half of the trunk consequent to compression of the abdominal aorta. The suggestion which has been made, that the blood flow in the upper half of the trunk is increased during compression of the aorta through reflex stimulation of receptors in the lower, ischemic half, was not therefore confirmed by this investigation.