EFFECT OF CATECHOLAMINES ON BLOOD FLOW VELOCITY IN DIFFERENT PARTS OF THE CIRCULATORY SYSTEM AFTER MUSCARINIC CHOLINERGIC BLOCK

L. I. Abaskulieva

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In 63 experiments on intact and anesthetized dogs, blocking muscarinic cholinergic structures prevented the manifestation of the constrictor response to catecholamines in the pulmonary circulation; in the system of the superior vena cava slowing of the blood flow was observed only after injection of noradrenalin; in the system of the inferior vena cava slowing was observed after injection of adrenalin in intact dogs and of phenylephrine in anesthetized dogs. The velocity of the systemic circulation in intact animals was slowed after injection of adrenalin and phenylephrine, while in anesthetized dogs it was slowed only after phenylephrine.

Previous investigations [1] showed that injection of adrenalin, noradrenalin, and phenylephrine gives rise to responses which differ in different parts of the circulatory system.

At the present time, preoperative preparation of the patient includes administration of atropine [3-5, 8]. Blocking muscarinic cholinergic structures by atropine makes its own impression on the hemodynamic responses of the body [6, 7, 9].

It was therefore decided to study the effect of catecholamines on the velocity of the blood flow in different parts of the circulatory system after muscarinic cholinergic block.

EXPERIMENTAL METHOD

To determine the velocity of the blood flow in different parts of the vascular system simultaneously a method based on changes in the potential of platinum under the influence of hydrogen ions [2] was used. The hydrogen source was a 5% solution of ascorbic acid injected through a catheter into the right atrium. Indicator dilution curves were recorded on a 4-channel type 42B (Elema) instrument with platinum detector electrodes inserted under x-ray control into the left ventricle and into the superior and inferior venae cavae.

The velocity of the blood flow was determined in 63 experiments from intact and anesthetized dogs before and after injection of adrenalin in a dose of 0.025 mg/kg (22 experiments), noradrenalin in a dose of 0.025 mg/kg (21 experiments), and phenylephrine in a dose of 0.25 mg/kg (20 experiments). In all the experiments morphine (10 mg/kg) was used for premedication. After intravenous injection of listhenon (0.05 ml/kg) the animal was intubated and artificial respiration applied with a mixture of ether and oxygen, administered under semiopen conditions. The depth of anesthesia was monitored by the electroencephalogram (EEG) and the degree of oxygen saturation of the blood oxyhemographically.

A preliminary block of the muscarinic cholinergic structures was produced by intravenous injection of 0.1% atropine solution (0.1 mg/kg). Catecholamines were injected 20 min later. Parallel with determination of the blood flow velocity, the arterial and venous pressures in the femoral vessels, the electrocardiogram (ECG), and respiration were recorded. At the height of the hemodynamic effect of the catecholamines, 12-14 mg/kg ascorbic acid was injected into the heart and the dilution curves of the acid were recorded.

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The numerical results were subjected to statistical analysis by the method of direct and indirect differences, using Moldenhauer's constant formula.

EXPERIMENTAL RESULTS

In the intact dogs with muscarinic cholinergic block the time taken for the blood to flow through the pulmonary vessels was 6.2 ± 0.8 sec. After injection of adrenalin, noradrenalin, and phenylephrine the corresponding times for the pulmonary circulation were 5.1 ± 1.17, 5.7 ± 1.65, and 19 ± 0.97 sec ($P > 0.1$). Under endotracheal ether–oxygen anesthesia the time taken for blood to pass through the pulmonary circulation during block was reduced to 3.7 ± 0.78 sec. Administration of catecholamines caused no significant changes in the circulation time, which was 3.3 ± 0.43 sec after injection of adrenalin, 4.2 ± 1.88 sec after noradrenalin, and 3.3 ± 0.69 sec after phenylephrine. Whereas in intact dogs without muscarinic cholinergic block the greatest constrictor effect of the catecholamines is exerted on the pulmonary circulation [1], in the presence of such a block this effect is absent in the pulmonary circulation whether the animal is anesthetized or not.

In the system of the superior vena cava the circulation time in intact dogs was 4.04 ± 0.57 sec. Injection of adrenalin and phenylephrine led to no significant changes in the circulation time in this system, which was 2.9 ± 1.31 sec ($P > 0.1$) and 2.5 ± 0.7 sec ($P > 0.05$) respectively. Injection of noradrenalin led to an increase in the circulation time to 12.0 ± 0.58 sec ($P < 0.01$). In the anesthetized dogs the circulation time in the system of the superior vena cava was 3.7 ± 1.16 sec. Injection of noradrenalin increased the circulation time to 9.6 ± 0.66 sec ($P < 0.01$), phenylephrine increased it to 9.4 ± 2.52 sec ($P > 0.05$), and adrenalin to 6.1 ± 0.98 sec ($P > 0.1$).

The circulation time in the system of the inferior vena cava in intact dogs was 5.1 ± 1.81 sec. After injection of adrenalin it was increased to 11.8 ± 1.37 sec ($P < 0.05$), while the changes in the circulation time produced by noradrenalin and phenylephrine (to 16 ± 4.35 and 11.1 ± 2.4 sec respectively) were not statistically significant. Under endotracheal ether–oxygen anesthesia, the circulation time in the system of the inferior vena cava was 11.3 ± 0.81 sec. Injection of adrenalin and noradrenalin caused no significant change (circulation time 15.8 ± 1.9 sec after injection of adrenalin and 13.1 ± 2.06 sec after injection of noradrenalin). The slowing of the blood flow after injection of phenylephrine was significant: the circulation time rose to 18.1 ± 0.84 sec ($P < 0.05$).

The systemic circulation time during muscarinic cholinergic block in unanesthetized dogs was 11.3 ± 0.96 sec. Injection of catecholamines increased this value to 16.9 ± 1.35 sec in the case of adrenalin ($P < 0.02$) and 18.0 ± 1.61 sec ($P < 0.02$) after injection of phenylephrine. Under anesthesia only phenylephrine caused a significant decrease in the velocity of the systemic circulation (the circulation time was 21.4 ± 0.61 sec compared with an initial value of 15.0 ± 1.28 sec; $P < 0.01$).

The experiments thus showed that muscarinic cholinergic block in intact and anesthetized dogs prevents the manifestation of a constrictor response of the pulmonary circulation to the catecholamines of the blood vessels. In the system of the superior vena cava slowing of the blood flow was observed only after injection of noradrenalin, in the system of the inferior vena cava after injection of adrenalin in intact dogs and of phenylephrine in anesthetized dogs; the velocity of the systemic circulation was slowed after injection of adrenalin and phenylephrine into intact animals, but only after administration of phenylephrine in anesthetized animals.

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