EFFECT OF NORADRENALIN ON REGIONAL CEREBRAL BLOOD FLOW DEPENDING ON INITIAL STATE OF THE MEAN ARTERIAL PRESSURE

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In a moderate hypotension, infusion of noradrenalin reduces the cerebral blood flow. Under conditions of severe hypotension, noradrenalin increases the regional cerebral circulation.

According to data in the literature, noradrenalin may reduce [4], increase [3, 8], or have no effect on [2] the regional cerebral circulation in states of hypotension.

It was decided to study the effect of noradrenalin on the regional cerebral circulation in moderate and severe hypotension.

EXPERIMENTAL METHOD

Dogs were anesthetized with nitrous oxide and oxygen (4:1). Hypotension was produced by bleeding. Noradrenalin was injected intravenously by infusion. The regional cerebral blood flow was determined with the aid of Kr^{85} [5, 7] and correlated with $pCO_2 = 40$ mm Hg [6]. After each measurement of the blood flow, pH and pCO_2 of the arterial blood were determined by means of a micro-Astrup instrument.

*The investigation was conducted in the Laboratory at the University of Glasgow while the author was in Scotland as a WHO Stipendiary.

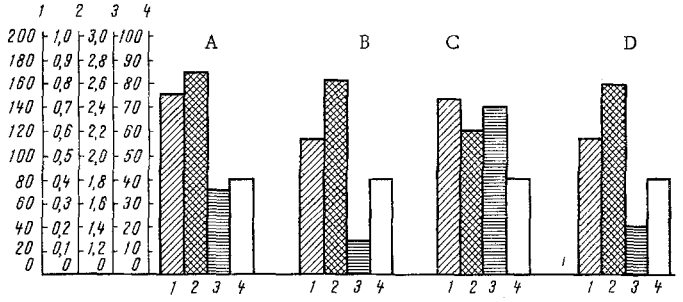

Fig. 1. Effect of noradrenalin on regional cerebral blood flow during moderate hypotension. 1) Mean arterial pressure (in mm Hg); 2) regional cerebral blood flow (in ml/g/min); 3) resistance of cerebral arteries (in mm Hg/ml/100 g/min); 4) arterial pCO_2 (in mm Hg); A) background; B) hypotension; C) infusion of noradrenalin (24 μg/min); D control.

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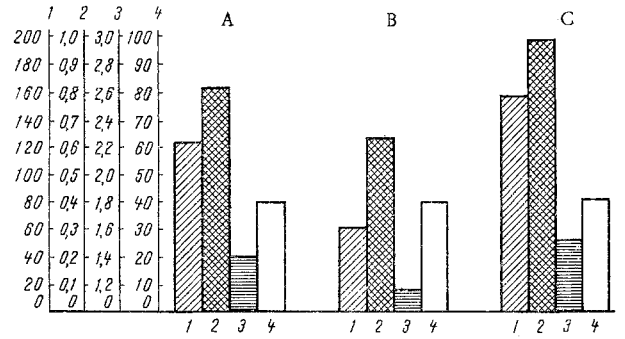

Fig. 2. Effect of noradrenalin on regional cerebral blood flow in severe hyptension. Legend as in Fig. 1.

EXPERIMENTAL RESULTS

The effect of noradrenalin on the regional cerebral blood flow during moderate hypotension is shown in Fig. 1. In the control the mean arterial pressure was 151 ± 5.8 mm Hg, the regional cerebral blood flow 0.85 ± 0.016 ml/g/min, and the resistance of the cerebral arteries 1.7 ± 0.09 mm Hg/ml/100 g/min.

After bleeding, despite marked lowering of the mean arterial pressure (113 ± 2.8 mm Hg; $P < 0.001$), the regional cerebral blood flow remained unchanged (0.83 ± 0.04). Meanwhile a marked decrease in the resistance of the cerebral vessels (1.28 ± 0.009 mm Hg/ml/100 g/min; $P < 0.001$) was observed, evidence of the existence of regulatory mechanisms maintaining the regional cerebral blood flow at a constant level despite the considerable decrease in mean arterial pressure.

Infusion of noradrenalin raised the mean arterial pressure to the control level (Fig. 1). At the same time, the cerebral blood flow was considerably reduced (0.60 ± 0.023 ml/g/min; $P < 0.001$). The resistance of the cerebral arteries was significantly increased (2.4 mm Hg/ml/100 g/min). At the end of infusion of noradrenalin, the above indices had returned to their initial value.

The authors have shown earlier [1] that an increase in pressure (following infusion of noradrenalin under normotensive conditions) does not itself cause changes in the blood flow into the brain. The decrease in blood flow observed in these experiments thus suggests that the increase in resistance of the cerebral arteries was the result of the direct action of noradrenalin on them.

In the next series of experiments the effect of noradrenalin on the cerebral circulation was studied under severe hypotensive conditions.

The results given in Fig. 2 show that bleeding produces a marked decrease in the mean arterial pressure ($P < 0.001$). A marked decrease in the regional cerebral blood flow (from 0.81 ± 0.02 to 0.63 ± 0.04 ml/g/min; $P = 0.01$) and in the vascular resistance (from 1.4 ± 0.05 to 0.8 ± 0.09 mm Hg/ml/100 g/min; $P < 0.01$) also was observed. These results indicate that in severe hypotension the autoregulatory mechanisms are disturbed, leading to a decrease in the cerebral blood flow. This decrease in the cerebral blood flow can be attributed to the inadequate hydrostatic pressure in the maximally dilated vessels. Intravenous infusion of noradreanlin against this background not only raised the mean arterial pressure, but also caused an appreciable increase in the regional cerebral blood flow (from 0.63 ± 0.04 to 0.97 ± 0.005 ml/g/min).

These results show that the character of the action of noradrenalin on the regional cerebral blood flow is largely dependent on the initial value of the mean arterial pressure. Whereas in normotension, in response to injection of noradreanlin the cerebral blood flow remains almost unchanged, in moderate hypotension it is considerably reduced. In severe hypotension, when autoregulatory mechanisms are disturbed, a passive relationship between the pressure and blood flow is observed, and after injection of noradrenalin this is expressed as an increase in the regional cerebral blood flow.

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