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THE RELATION OF THE CENTRAL NERVOUS SYSTEM TO THE INCREASE IN SYSTEMIC FLOW PRODUCED BY OCCLUSION OF THE THORACIC AORTA.

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Experiments, previously described [Barcroft, 1931], have shown that complete occlusion of the dog's thoracic aorta has a paradoxical effect on the systemic flow. Occlusion of the thoracic aorta, the greater part of the arterial path, does not diminish the systemic flow, as might be expected, but actually increases it.

Fig. 1 is a sketch of the preparation used for such a demonstration. A mechanical Stromuhr [Barcroft, 1929] was placed in the blood stream so that it made a continuous record of the rate at which the heart supplied blood to the peripheral vascular system, but the stream entering the coronary vessels did so without passing through the instrument. Complete occlusion of the thoracic aorta, at the position shown, typically increased the systemic flow from about 700 c.c. to about 900 c.c. per min. This effect was to be expected after section of the vagi; it only occurred occasionally before section.

A typical tracing, reproduced in Fig. 2, has been selected from an experiment in which the vagi were intact. Fig. 3 is a graph of the systemic flow changes drawn from the tracing. The thoracic aorta occlusion is followed by an increase in the systemic flow.

Complete occlusion of the thoracic aorta causes a large rise in the arterial blood-pressure, and this suggests that the increase in systemic flow which accompanies it might possibly be due to a more efficient pumping prompted by a bigger blood supply to the heart muscle. This

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explanation, however, is untenable for several reasons. First the tracing shows that the initial blood-pressure in the experiment illustrated was fairly normal, namely, 90 mm. of mercury. Secondly the same events have occurred in a similar experiment with an initial blood-pressure of 150 mm. Hg, and lastly, after the occlusion, the right auricular pressure rises. This is to be seen in Fig. 2. The fact that the right auricular pressure rises shows that the increase in systemic flow is to be attributed to increase in inflow and not to improvement in the heart beat.

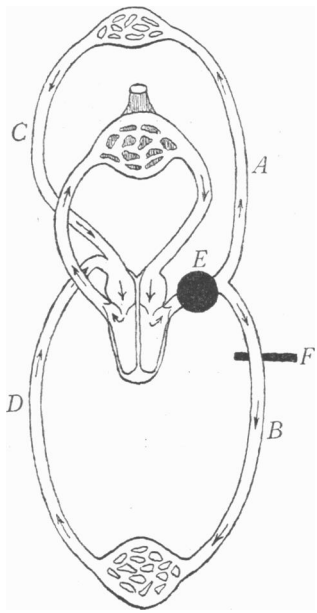

Fig. 1. A diagram of the dog's vascular system showing the position of the mechanical stromuhr and the point at which the thoracic aorta was occluded in these experiments. *A*, brachiocephalic artery. *B*, thoracic aorta. *C*, superior vena cava. *D*, inferior vena cava. *E*, mechanical stromuhr. *F*, the thoracic aorta was occluded here.

Further previous experiments have shown that destruction of the vasomotor centre by an adequate period of acute anæmia has little effect on the events following occlusion of the thoracic aorta [Barcroft, 1931]. For this reason it seemed likely that nervous reflexes were not responsible and that a mechanical explanation must be sought. However, the possibility of spinal vascular reflexes was not excluded. The object of this paper is to describe experiments which show that occlusion of the thoracic aorta increases the systemic flow even after complete physiological

destruction of the whole central nervous system. These experiments show that reflexes involving the central nervous system are not essentially concerned in the phenomenon.

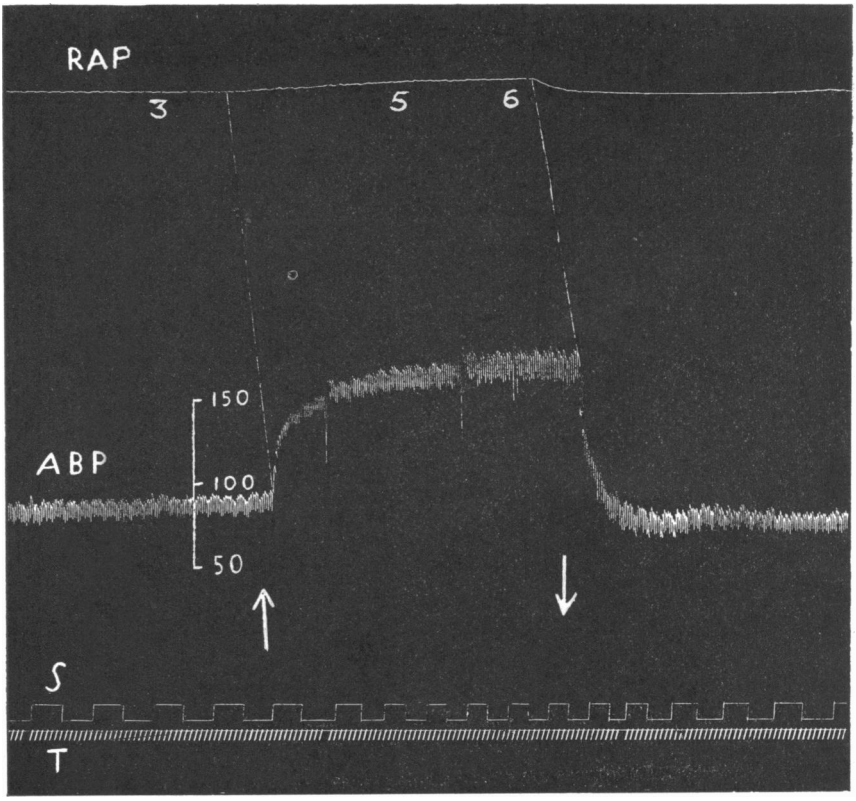

Fig. 2. The effect of occlusion of the thoracic aorta upon the systemic flow, arterial blood-pressure and right auricular pressure in the animal with the vagi intact. *RAP*, right auricular blood-pressure. The figures are readings of the manometer in cm. saline. *ABP*, arterial blood-pressure. Scale mm. of mercury. *S*, stromuhr tracing. 77 c.c. passed through the instrument between successive vertical strokes. *T*, time in seconds. The thoracic aorta was occluded at the first arrow and released at the second.

METHOD.

10 kg. dogs were used. No morphia was given. Anæsthesia was induced with equal parts of chloroform and ether and maintained with ether or chloralose, 0·1 g. per kg. The operation necessary for insertion of the mechanical stromuhr was done as before [Barcroft, 1931]. Chlorazol

fast pink was used as an anticoagulant instead of heparin [Huggett and Rowe, 1933]. In previous experiments injections of anticoagulant, blood, saline, etc., were made through a burette communicating with a cannula in the femoral vein; in these experiments we preserved the femoral vein and tied the burette cannula into the right auricle. The right auricular pressure was taken with a saline manometer and recorded by a piston recorder attached to the top of this manometer. After the operation the systemic flow changes following occlusion of the thoracic aorta were recorded before and after section of the vagi to check the normal behaviour of the animal. The central nervous system was then

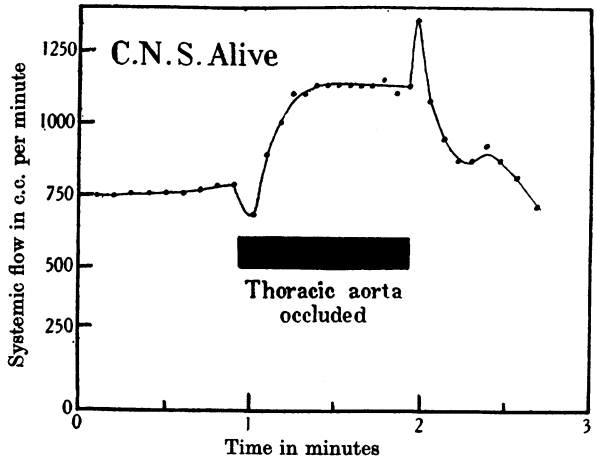

Fig. 3. A graph of the systemic flow changes recorded in the tracing in Fig. 2.

killed by half an hour's aphyxia in the following way. The passage of blood from the heart and stromuhr into the peripheral vascular system was blocked by clamps placed on the great vessels at *A* and *B* (Fig. 4), and the stream was diverted through a fingerstall resistance *F* into reservoir *G* which drained back into the heart through the right auricular appendix. Additional clamps were placed on the great veins at *C* and *D*. In other words the central nervous system was asphyxiated by temporarily turning the preparation into a heart-lung preparation, and so stopping the blood supply to the brain and spinal cord. After half an hour by the clock the blood stream was diverted through the animal's peripheral vascular system again, the temporary external circuit removed and the preparation became once more that shown in Fig. 1. The physiological

activity of the central nervous system was considered to have been destroyed for the following reasons:

(1) The animal no longer made spontaneous movements of any kind.

(2) Acute cerebral anæmia produced by complete occlusion of all arteries to the brain no longer elicited a reflex rise in blood-pressure. This is shown in Fig. 5.

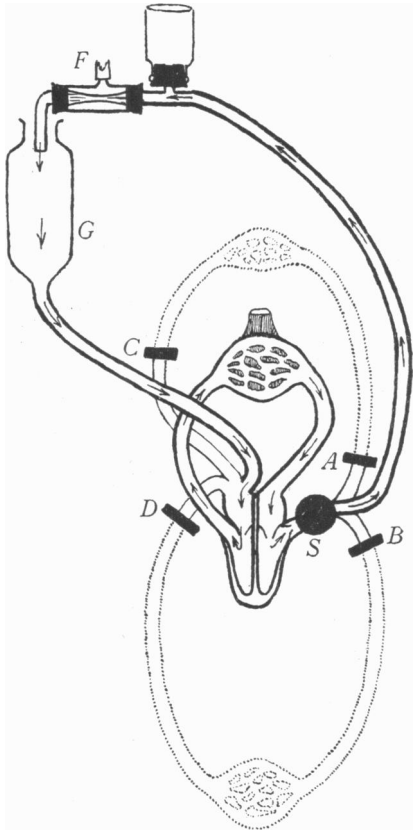

Fig. 4. A diagram of the dog's vascular system to show how the blood supply to the central nervous system was diverted so as to destroy it by asphyxia. *S*, mechanical stromuhr. *A*, *B*, *C*, *D*, clamps on the brachiocephalic artery, thoracic aorta, superior vena cava and inferior vena cava respectively. *F*, fingerstall resistance. The pressure bottle is not shown. *G*, venous reservoir. The heating spiral is not shown.

(3) Stimulation of the central end of the sciatic nerve no longer elicited reflex movements. Stimulation of the peripheral end of the nerve or of muscle still elicited muscular contractions.

After a number of preliminary experiments necessary to establish the technique two satisfactory experiments gave entirely concordant results.

Results.

The sequence of events after occlusion of the thoracic aorta was the same in the normal animal and in the preparation with the central nervous system destroyed. In both instances there was a rise in systemic flow

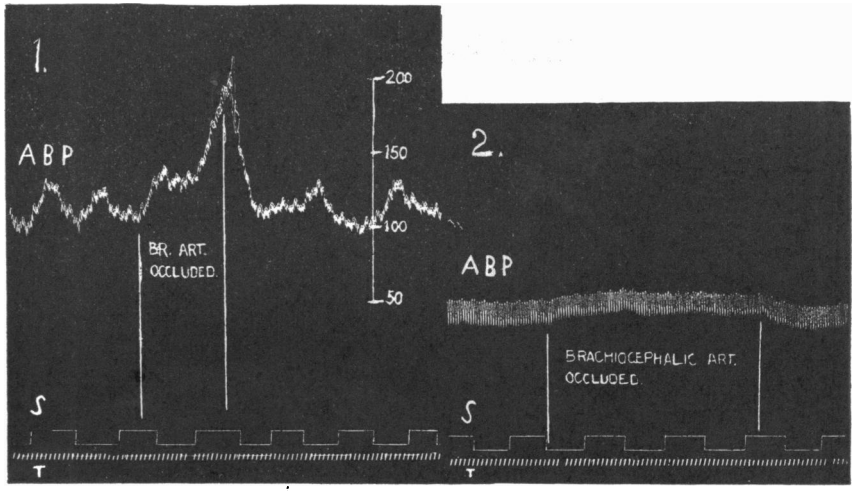

Fig. 5. Tracing 1 shows the reflex rise in the arterial blood-pressure produced by occluding the brachiocephalic artery before destruction of the central nervous system. Tracing 2 shows that after destruction of the central nervous system occlusion of the brachiocephalic artery failed to produce a reflex rise in the blood pressure. *ABP*, arterial blood-pressure tracing. Scale mm. of mercury. The brachiocephalic artery was occluded during the interval between the vertical lines. The left subclavian artery was tied throughout the experiment.

accompanied by an increase in arterial blood-pressure and right auricular pressure. This can be seen in the tracings and curves shown in Figs. 2, 3, 6 and 7. After destruction of the central nervous system the arterial blood-pressure is naturally rather low. Nevertheless, aortic occlusion increased the systemic flow by increasing the inflow and not by improving the action of the heart by raising the coronary blood-pressure. This is proved by the rise in the right auricular pressure.

The increase in systemic flow following occlusion of the thoracic aorta in the dog is therefore not caused by vascular reflexes involving any part of the central nervous system.

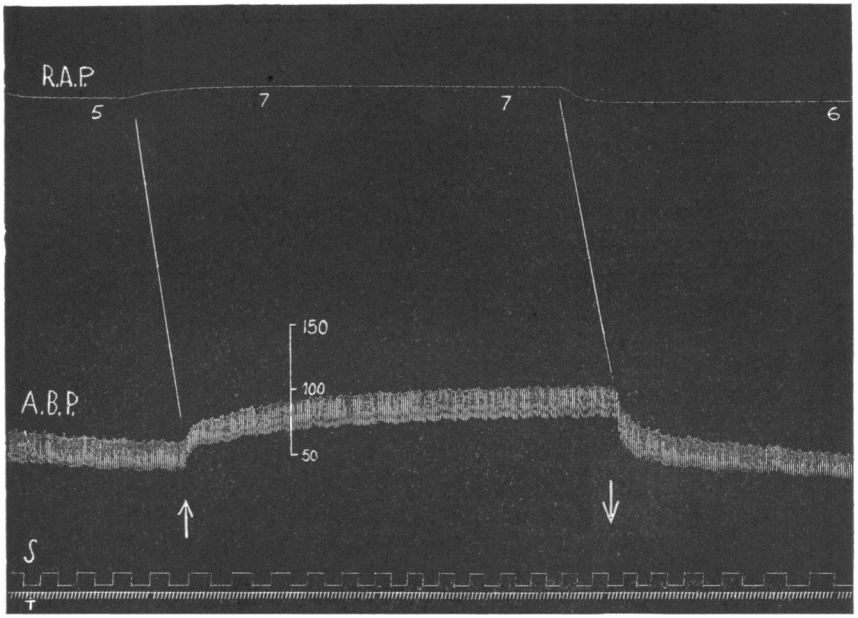

Fig. 6. The effect of occlusion of the thoracic aorta upon the systemic flow, arterial blood pressure and right auricular pressure after destruction of the central nervous system. *RAP*, right auricular blood-pressure. The figures are readings of the manometer in cm. of saline. *ABP*, arterial blood-pressure. Scale mm. of mercury. *S*, stromuhr. 77 c.c. passed through the instrument between successive vertical strokes. *T*, time in seconds. The thoracic aorta was occluded at the first arrow and released at the second.

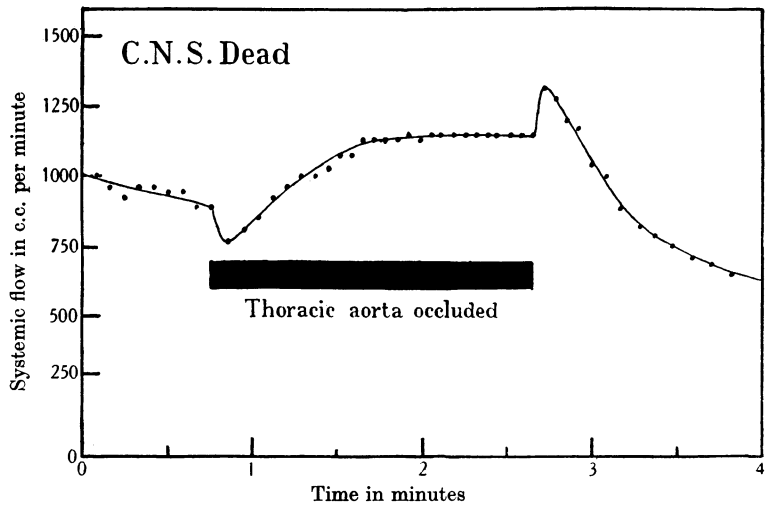

Fig. 7. A graph of the systemic flow changes recorded in the tracing in Fig. 6.

SUMMARY.

1. Occlusion of the thoracic aorta paradoxically increases the systemic flow in the dog.

2. This occurs after the central nervous system has been destroyed by half an hour's asphyxia.

3. Vascular reflexes involving the central nervous system do not play any essential part in the phenomenon.

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