A METHOD FOR THE STUDY OF THE CEREBRAL CIRCULATION

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Although a large number of works deal with the roentgenography of the brain, a whole number of features of the technique in animals require to be refined.

We have made x-ray pictures from cats anesthetized with 40 mg/kg chloralose in 1% solution. After exposing the common carotid artery it was ligated, and a glass cannula connected to a mercury manometer was inserted through

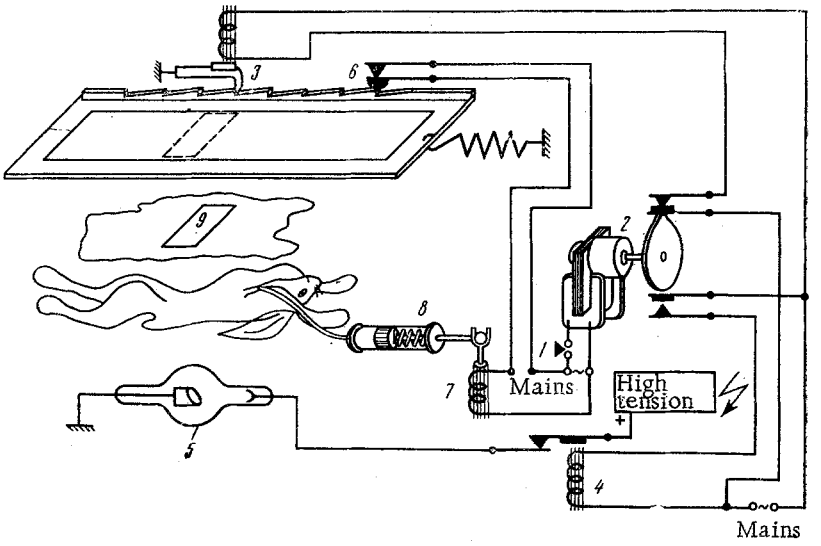

Fig. 1. Diagram of the device for obtaining serial x-ray pictures with the use of an automatic syringe coupled to the x-ray apparatus, for introducing contrast substance at times synchronized to the exposure. The relief button (1) on the control panel completes the circuit of the Warren motor (2) which operates a high-voltage switch (4) on the x-ray tube (5). At the same time the Warren motor completes the circuit of an electromagnet which removes the brake (3) on a cassette-holder which is then enabled to transverse the distance of 10 cm required for exposure of the mixed frame. After the first frame has been exposed the cassette-holder operates the contact (6) which connects the electromagnet (7) whose core releases the catch on the piston of syringe (8). The spring in the syringe, now free to act, pushes the piston and introduces contrast substance throuth this catheter into the blood vessel; 9—aperature for passage of x-rays through the lead shield.

an incision below the ligation, and directed towards the heart. Above the ligation we introduced a polyethylene catheter, and held it in place with a ligature. The free end of the catheter was connected with a thick needle which enabled the catheter to be readily connected either to a syringe containing a contrast substance or to the mercury

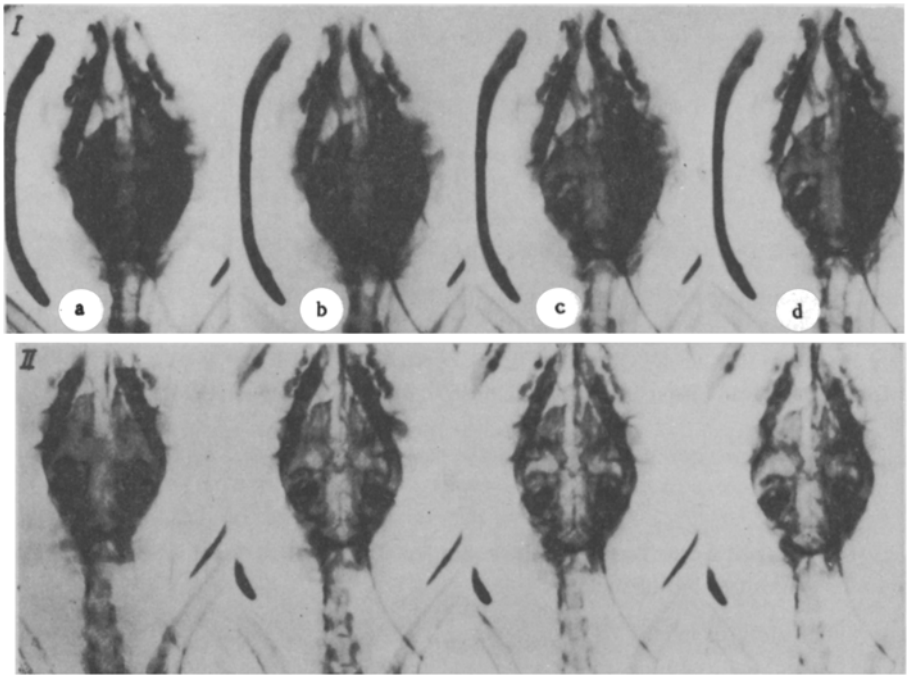

Fig. 2. Two series of cerebral angiograms. I) Before the injection of adrenaline; II) after the injection of adrenaline, a) Control picture of the skull, before the injection of cardiotrast; b) picture taken one sec after injection of cardiotrast; c) taken 2 sec after; d) 3 sec after injection of cardiotrast. Change in calibre and degree of filling by the contrast medium of the arteries of the circle of Willis are well shown after the injection of adrenaline.

manometer for pressure recording. The cannula and catheter were filled with a 1:1 mixture of physiological saline and heparin in order to prevent blood clotting in them.

A series of x-ray pictures were made by means of a simple attachment to a x-ray apparatus [1]. By this means eight x-ray pictures were taken in 8 sec. A further improvement to the attachment was the connection to it of a device which we had developed, and which made possible automatic connection to the blood vessel of the syringe containing the contrast medium. A diagram of the arrangement is shown in Fig. 1.

It is quite evident that for each animal species the smallest concentration of contrast substance required for satisfactory pictures must be determined. The best results were obtained by the injection of 2 ml of a 50% solution of cardiotrast. The animals tolerated this amount without any general disturbance. The use of 70% cardiotrast or an increase in the amount of the 50% solution to above 4 ml caused transient convulsions which occurred 1-2 sec after the injection. Reduction of the cardiotrast concentration below 50% caused deterioration of the pictures.

We must emphasize the importance of accurate regulation of the pressure at which the contrast medium is injected; for the reason that a high pressure causes unwanted side effects. A slow injection is better tolerated, but leads to considerable dilution of the medium. Experimentally we found that the optimal rate was 2ml in 2-3 sec. The spring which moves the piston within the syringe produces in the catheter a pressure 80 mm above the pressure at the peripheral end of the common carotid artery.

We could not confirm that the degree of filling of the cerebral vessels with the contrast medium was inversely proportional to the arterial pressure. In our experiments we obtained a good picture of the vessels of the circle of Willis at an arterial pressure of 120-130 mm; at the same time in many experiments no picture was obtained at a pressure of 75-80 mm.

Figure 2 shows the rate of circulation in the cerebral vessels during the arterial and venous phases. The first picture records the condition before the injection of cardiotrast; the x-rays made after the injection show well the external and internal carotid arteries, external and internal orbital arteries, vessels of the circle of Willis, the basal and even the vertebral arteries, and the jugular vein.

An analysis of the x-ray pictures showed that this method of studying the cerebral circulation can be successfully used in physiological experiments.

SUMMARY

A method of serial angiography of the circle of Willis was used. An attachment of the x-ray unit provided movement of the cassette containing the x-ray film. A syringe automatically injected 2 ml of a contrast substance (50% cardiotrast solution) into the peripheral end of the ligated common carotid artery; the experiments were carried out on 40 cats.

LITERATURE CITED

1. M. M. Popov and P. K. Klimov, Byull. éksper. biol., No. 12, p. 108 (1960).