APPPARATUS FOR MEASURING INTRACRANIAL (CEREBROSPINAL FLUID) PRESSURE AND FOR SUBARACHNOID INJECTION OF ACCURATE DOSES OF RADIOACTIVE ISOTOPES

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UDC 612.824.1-088.2

A simple apparatus designed to avoid a sharp increase in the cerebrospinal fluid pressure during subarachnoid injection of radioactive isotopes is described.

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Injection of dyes and other materials into the cisterna magna by means of a simple syringe and needle creates a transient increase in the intracranial pressure. This manipulation, however it is modified, disturbs the physiological relationship in the subarachnoid space. The apparatus suggested by Purin [1], enabling substances to be injected into the cerebrospinal fluid (CSF) and the intracranial pressure to be recorded simultaneously, was found to be unsuitable for experiments with radioactive substances.

To reduce all fluctuations of CSF pressure to a minimum and to make it possible to study the pathways and velocity of movement of radioactive substances in the subarachnoid space while maintaining constant observation on the CSF pressure in the cisterna magna, a manometric system was devised to provide the following facilities: 1) measurement of the intracranial CSF pressure throughout the experiment, sometimes lasting up to 3-4 h; 2) variation of the CSF pressure in an upward or downward direction and maintenance of a definite, predetermined CSF pressure for the desired time; and 3) injection of solutions of radioactive substances under a certain pressure by the subarachnoid route.

The apparatus consists of a system of vessels and water manometers connected by rubber tubes (Fig. 1).

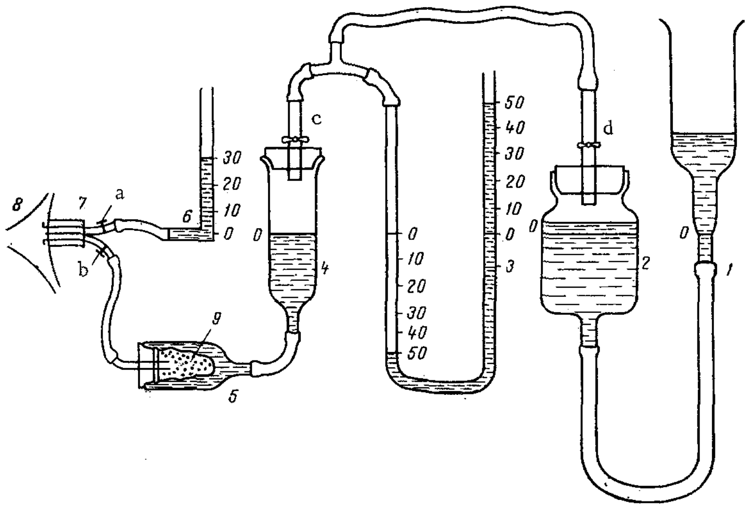

Fig. 1. Scheme of arrangement of vessels in the apparatus. Explanation in text.

Laboratory of Experimental Neurohistology, N. N. Burdenko Institute of Neurosurgery, Academy of Medical Sciences of the USSR, Moscow (Presented by Academician A. I. Arutyunov, Academy of Medical Sciences of the USSR.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 68, No. 7, pp. 118-120, July, 1969. Original article submitted July 25, 1968.

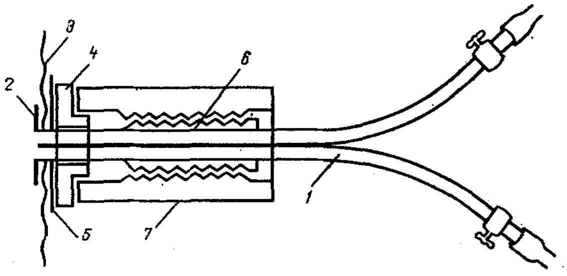

Fig. 2. Design of the needle-fixing device. Explanation in text.

By moving the vessel (1) vertically the height of the column of liquid in vessel (2) can be altered, and this pressure is transmitted via the air into vessel (4) and to the U-shaped manometer (3). Liquid from vessel (4), on being displaced into vessel (5), increases the pressure there, and this is recorded by the U-shaped manometer. A rubber bag (9) containing the solution of the radioactive isotope is firmly secured to the stopper of vessel (5). When the pressure of the water in vessel (5) is increased, the radioactive substances is expressed from the rubber bag (9), through the flexible, thin rubber tube and through the needle (7) (its design is described below), fixed to the dura, into the cisterna magna (8). The pressure in the cisterna is measured automatically by the manometer (6).

Only the rubber bag and the tube with the needle are filled with radioactive isotope. By using this system the amount of radioactive substance used can be considerably reduced and it does not contaminate the main manometric apparatus and the vessels. Protection against ionizing radiation can also be provided easily by screening the vessel (5) with lead.

At the beginning of the experiment the level of the liquid in vessels (1, 2 and 4) and in manometer (3) is set at zero, corrrsponding to the level of the cisterna magna of a dog lying on its side and under general anesthesia. When the needle is connected to the cisterna magna, and the cocks (a, b, c) open and cock (d) opens, the level of liquid in the manometers changes to correspond to the CSF pressure, and fluctuation of the liquid produced by the animal's respiration, with an amplitude of 10-12 mm water, are clearly visible.

To raise the pressure in the cisterna magna, after opening all the cocks the vessel (1) is lifted upward and fixed at a certain height. The water level in the vessel (2) thereupon rises and displaces air, which in turn forces some of the liquid from vessel (4) into vessel (5). Some of the radioactive material then flows along through the needle (7) into the subarachnoid space of the experimental animal, where it may cause the pressure to rise; the pressure in the cisterna magna is measured by the manometer (6).

To lower the pressure in the cisterna magna the vessel (1) is lowered, thereby producing a partial vacuum in the system, so that CSF flows from the cisterna magna through the needle into the bag in vessel (5). The value of this partial vacuum is recorded by the U-shaped manometer and the dynamics of changes in the CSF pressure in the cisterna magna by the manometer (6).

If a simple injection needle is introduced into the cisterna magna there is no guarantee that the CSF–manometer system is airtight. Airtightness is particularly important when the paths of flow of the CSF from the subarachnoid space are to be determined. In these cases even a slight leak of radioactive solution into the region of the cervical muscles may confuse the whole picture of distribution of radioactivity in the tissues of the animal's head. We have designed and made a special needle which ensures airtightness and direct connection of the subarachnoid space with the apparatus described above (Fig. 2). The needle may have one channel or two unconnected channels, one intended only to measure the pressure in the subarachnoid space and the other to change the pressure in the cisterna magna and to administer the radioactive solution. A thin metal plate (2), 3-4 mm in diameter, is soldered to the end of this needle (1). This plate is passed through a hole in the dura (3) and fits up against its inferior surface.

To create a firm and airtight connection between the needle and the subarachnoid space, a freely movable nut made of organic glass or ebonite (4) and a rubber washer (5) are screwed up tight by means of the clamp (7), moving along the screw thread (6). Since a small amount of CSF usually escapes from the hole in the dura when the airtight needle described above is introduced, and its volume cannot be estimated, in order to determine the true CSF pressure at the beginning of the experiment the pressure must be measured by means of a simple injection needle connected to a manometer. After the initial values have been determined, the airtight needle is introduced. The difference between the levels of the CSF pressure is compensated by the manometer.

LITERATURE CITED

1. V. R. Purin, Vopr. Neirokhir., No. 5, 44 (1956).