THE DIFFUSION OF SUBSTANCES IN THE SUBARACHNOID SPACES*

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The diffusion of particulate suspensions introduced into the subarachnoid spaces has been studied by several authors after Quincke. Among the most noteworthy contributions to the subject are some recent papers of Brierley. In the last of these papers Brierley (1950) has shown that particles of indian ink, suspended in saline, and introduced into the cisterna magna of the rabbit (using an adequate technique in order to avoid any modification of the pressure of the cerebrospinal fluid) are arrested at the medial border of the spinal ganglion. Here he suggests the presence of an arachnoid "cul de sac" and not of a fissure, as claimed by Hassin. This cul de sac, according to Brierley, would open into the periradicular spaces.

Brierley showed that as far as the brain is concerned, indian ink particles would accumulate 24 to 48 hours after the injection in the perivascular spaces, particularly in the hippocampal region. Brierley claims that these findings conflict with the generally accepted opinion of Weed (1914), Schaltenbrand and Bailey (1927), and Kubie (1928), who support the view of an outward movement of the perivascular fluid from the perivascular to the subarachnoid spaces; and Brierley, in the absence of passive transport of the particles by phagocytes, declares that he himself is at a loss to explain these findings. But the views of Weed, Schaltenbrand, and Kubie that the subarachnoid system would represent a large lymphatic space, where the lymph, coming from the Virchow-Robin spaces, is diluted into the fluid secreted by the choroid plexuses, and finally reabsorbed into the large venous sinuses through the arachnoid villi, are well supported by clinical findings (Belloni, 1949). It will be shown in the present paper that Brierley's findings do not conflict with the latter views, and can be explained, if we take into account

that the hydraulic conditions of the cerebrospinal fluid and of the perivascular lymph are *not static*, but, instead, are continually subjected to pressure variations due to the pulsations of the vascular system. Such pressure variations must give rise to counter-currents in the perivascular fluid which might send up, against the stream, as it were, along the perivascular spaces, substances introduced in the subarachnoid system, in spite of the existence of a basal, slow, and most probably intermittent, lymphatic flow in the opposite direction.

* A preliminary communication was given at a meeting of the Società Italiana di Neurologia at the Veneto-Emiliana branch on October 25, 1950.

Figs 2 and 3

To test such a hypothesis, the model shown in Figs. 1, 2, and 3 was used. The 400 ml. vessel A is filled with an indian ink suspension from the funnel H, after which water is allowed to run in, always from H, until all the side tubes G and C have been completely freed from indian ink ; at this moment tube B is closed.

Under these conditions it was found that in 24 to 48 hours the indian ink had diffused from A up the tube C for a distance of 3 to 4 cm. (Fig. 1).

Then, if the outlet tube B is partially opened so that 3 or 4 drops run out per minute (the fluid level in H being kept practically constant by adding from time to time some tap water), it will be found that not only does the diffusion of the indian ink up the tube C progress no further, but that, on the contrary, the indian ink, which had already diffused, is slowly pushed back from C towards vessel A until the limit between the water and suspension reaches the final constant level shown in Fig. 2.

It appears therefore that this very slow stream of water from H into A is sufficient to oppose the diffusion of indian ink into the fluid contained in C.

While this inlet stream of water is being continued, the rubber balloon F is rhythmically compressed so that the closed end rubber tube D (which is in connexion with the balloon) will rhythmically pulsate in order to imitate the pulsation of an artery. It will then be found that, as a result, diffusion of indian ink will immediately begin in C into the clear fluid which surrounds the rubber tube D and which may be taken to represent a perivascular space (Fig. 3).

It is clear therefore that Brierley's findings, i.e. the diffusion of indian ink particles from the sub-arachnoid spaces into the Virchow-Robin perivascular spaces, do not necessarily disprove the generally accepted view of a movement of the lymph, in the perivascular spaces, in the opposite direction, i.e. towards the subarachnoid spaces.

REFERENCES

- Belloni, G. B. (1949). Atti del X° Congresso della Società Italiana di Neurologia, p. 211.
Brierley, J. B. (1950). *Journal of Neurology, Neurosurgery, and Psychiatry*, 13, 203.