

THE MECHANISM OF POSTPUNCTURE HEADACHE

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Postpuncture headache occurs in perhaps 20 per cent of patients who have had a diagnostic lumbar puncture. It usually begins within 12 hours of the lumbar puncture. The headache is occipital, or occasionally frontal, and appears within a short time after the patient assumes the erect position. Associated symptoms may be nausea or stiffness of the neck. The headache is very distressing and usually incapacitating but is relieved almost immediately by lying down.

The condition is usually ascribed to a loss of cerebrospinal fluid through the needle puncture wound in the dura which removes the fluid cushion supporting the brain, and allows the brain to settle in the cranial cavity causing traction on the nerves, blood vessels, and dura. The headache appears shortly after the patient assumes the erect posture because with this change in position the lumbar fluid pressure is approximately trebled, thus greatly increasing the rate of fluid loss through the puncture wound.

It is a fact that postpuncture headache is accompanied by a decreased volume of cerebrospinal fluid. This can be proved by measuring the quantity of fluid after removing it and replacing it with air as in encephalography. In patients with a postpuncture headache, the spinal pressure is abnormally low, and the volume of cerebrospinal fluid recoverable at encephalography is always greatly reduced. In some cases I have found it to measure as little as 30 cc. as compared with a normal of perhaps 120 cc. This, however, does not prove that the lost cerebrospinal fluid has escaped through the puncture wound in the dura.

To me the puncture wound of the dura does not appear to be the significant factor, but rather the puncture wound of the arachnoid. The following analogy explains the thesis.

The cerebrospinal fluid is contained within the pia-arachnoid membrane which in turn is closely invested by the dura. This system may be compared to an automobile tire with the air representing the cerebrospinal fluid; the inner tube, the pia-arachnoid; and the tire, the dura. The puncture of an automobile tire does not result in any loss of the contained air, but a puncture of the inner tube will permit the air to escape even though the tire itself is intact.

The pia-arachnoid is a closed system like the automobile inner tube. The brain, spinal cord, blood vessels, and nerves are all really outside the

subarachnoid space, being separated from it by the inner layer of the pia-arachnoid. Therefore, there is no break in the pia-arachnoid system where the spinal nerves and blood vessels leave the spinal canal. The dura, on the other hand, like the automobile tire is not a closed system. Although it provides a cuff for the emerging spinal nerves, nevertheless where this cuff ends an opening in the dura allows the exit of the nerves. The dural sac, therefore, although very much heavier than the pia-arachnoid, cannot be considered a water-tight system. By itself, the flimsy arachnoid could no more support the stresses put upon it than could an inner tube support a car without its investing tire. But backed up by the dense inelastic dura the arachnoid is adequate and water-tight.

From the foregoing analogy it is apparent that the cerebrospinal fluid must first escape through the puncture wound in the arachnoid membrane into the subdural space. From here it may pass through the puncture wound in the dura, but probably the greater portion of it is extruded through the intact dura or through the openings in the dura which transmit the spinal nerves. A postpuncture headache can, therefore, persist even after the puncture wound in the dura has closed.

It is very significant that encephalograms performed in patients who have had a recent spinal puncture, especially if they are the victims of a postpuncture headache, may be unsatisfactory for the reason that the injected air is found to be largely in the subdural space rather than in the subarachnoid space and ventricles. This latter finding suggests the mechanism of postpuncture headache as follows:

When a spinal puncture is performed, the needle perforates both the dura and the arachnoid membrane to reach the subarachnoid space. Since the dura is a dense, heavy membrane, the perforation is more apt to close in it than in the arachnoid which consists of a thin, filmy membrane. The opening in the arachnoid membrane permits the subarachnoid fluid to escape into the subdural space with a consequent partial collapse of the arachnoid sac. If this condition exists, that is, if a subdural collection of fluid occurs after spinal puncture, and if an encephalogram is then performed, a free flow of fluid will be obtained as soon as the needle enters the distended subdural space. Because of the free flow of fluid the operator assumes that the needle is in the subarachnoid space and exchanges the fluid for air. The air, however, is injected into the subdural space as the subsequent films will show.

A similar accident may occur with myelography. Hamby¹ has shown that if a lipiodol myelogram is performed following a recent spinal punc-

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ture, the myelogram films may be unsatisfactory due to the fact that the lipiodol has been injected into the subdural rather than the subarachnoid space. It is, therefore, a fact that after spinal puncture a quantity of cerebrospinal fluid may pass through the perforation in the arachnoid membrane into the subdural space with a consequent collapse of the arachnoid membrane. Nature did not design the dura to serve the purpose of a water-tight barrier. Therefore, if there is a subdural collection of fluid in the lumbar canal and the patient assumes the erect position, the pressure of the fluid in the subdural space is suddenly tripled or quadrupled. This increased head of pressure causes the fluid to be rapidly extruded, probably in large part along the dural cuff of the spinal nerves. With the extrusion of the fluid the brain is permitted to settle in the cranial cavity with resulting traction on the anchoring blood vessels, nerves, and dura causing headache. When the patient lies down, the brain sag is overcome, and the headache soon disappears.

With the lowering of the spinal fluid pressure which occurs when the supine position is assumed, the subdural fluid is no longer extruded so rapidly, and it once more gradually accumulates.

In the sitting position postpuncture headache will continue as long as there is a subdural accumulation of fluid of any consequence. As soon as the perforation in the arachnoid is closed and the subdural accumulation is extruded from the dural sac, the volume of subarachnoid fluid is restored to normal and the postpuncture headache is relieved.

Postpuncture headache does not occur in every patient following lumbar puncture, because in most individuals a subdural collection of fluid does not take place. Usually, the filmy adhesions between the arachnoid and dura prevent the arachnoid from collapsing so that the subdural space remains as nature intended—a potential space only.

REFERENCES

1. Hamby, W. B.: Misplaced spinal lipiodol; analysis of 104 lipiodol spinograms. *Radiology* 37:343-346 (Sept.) 1941.