Abnormal Patterns of Cerebrospinal Fluid Flow and Absorption after Head Injuries; Diagnosis by Isotope Cisternography

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Summary. RIHSA cisternography was performed in 47 patients after head injuries. Five patterns of abnormal C.S.F. flow and absorption were distinguished: 1. Complete obstruction of the subarachnoid space over both cerebral convexities, with ventricular filling; 2. Partial obstruction of the subarachnoid space over both cerebral convexities, with transient or persistent ventricular filling; 3. Obstruction of the subarachnoid space over one brain convexity, with transient or persistent ventricular filling; 4. Obstruction of the subarachnoid space over one convexity without ventricular filling; 5. Delayed absorption of C.S.F. with a normal pattern of C.S.F. pathways. Patterns 2-5 are considered to be intermediary stages in the development or regression of hydrocephalus, which if progressive causes the final result observed in pattern 1.

In the abnormal scintigrams the subarachnoid space over one or both cerebral convexities is obstructed, the normal flow of C.S.F. to the absorption areas around the superior sagittal sinus is disturbed, and alternative mechanisms of absorption through the walls of the cerebral ventricles come into play. These abnormal C.S.F. dynamics are reversible. The significance of these observations in the context of possible ventriculo-atrial shunting is discussed.

Isotope cisternography is a very useful method for the study of cerebrospinal fluid flow and absorption [7, 8, 11, 13, 14]. It is important not only in the diagnosis of hydrocephalus but also in deciding whether a shunting procedure is indicated. However, the publications dealing with isotope cisternography have mostly been confined to the diagnostic question of whether or not hydrocephalus is present [3, 4, 6, 17, 18, 23]. It is our purpose in this paper to describe certain abnormalities of C.S.F. flow and absorption which can be seen in scintigrams, and to suggest explanations for them. A study of patients with head injuries has drawn our attention to certain abnormal patterns of flow which in our opinion provide a model for the development of hydrocephalus as shown in isotope cisternography.

Material and Methods

Isotope cisternography was performed in 47 patients with head injuries. The indications for the investigation were suspected post traumatic non resorptive hydrocephalus and suspected C.F.S. rhinorrhea. Clinical examination and plain skull radiographs were made in all patients. Pneumoencephalography and angiography were performed in part of the patients only.

Radioiodinated human serum albumin (RIHSA) was used. Routinely 100 μCi is injected into the lumbar theca. The RIHSA is freshly prepared and of high specific activity (1 mg albumin per 100 μCi). The thyroid gland is blocked by three drops of Lugol's iodine daily for nine days, starting one day before the investigation. Each study is performed both by a scintillation gamma camera (Pho Gamma III, Nuclear Chicago) and by a rectilinear scanner (Pho Dot Nuclear Chicago). There are several reasons for this. A preliminary study with the gamma camera gives a quick general orientation, and suggests whether it is necessary to use views and positions other than the routine anterior and lateral views. The rectilinear scanner
gives a somewhat better resolution in the plane of the collimator, compared with the gamma camera. Every patient is studied at 4, 24 and 48 hours after injection. Later studies are usually performed as well when the ventricles have filled with the radiopharmaceutical.

Results

Out of 47 diagnostic cisternographies, no abnormalities were found in the distribution of the radiopharmaceutical or the flow dynamics in 20. The patterns of C.S.F. flow in these patients corresponded to those we have described in normal controls [11]. The abnormal cases were grouped according to the patterns of flow and absorption.

Group 1: Complete obstruction of the subarachnoid space over both cerebral convexities, with ventricular filling (the pattern of communicating non resorptive hydrocephalus).

The isotope cisternograms in these cases show early ventricular filling with the radiopharmaceutical in the 4 hour scintigrams. The radiopharmaceutical is absorbed only slowly from the ventricles, which remain visible for 48 hours or more. At no stage of the investigations is the radiopharmaceutical found in the subarachnoid space over the brain convexities. The distribution pattern of the radiopharmaceutical is practically the same in the 4, 24 and 48 hour scintigrams.

Illustrative case:

An 18-year-old man sustained a severe head injury in a car accident. He was comatose, and was found to have bilateral pyramidal signs. The right pupil was dilated, and neither pupil reacted to light. A right carotid angiogram was normal. Plain radiographs of the skull showed fractures of the petrous bones on both sides. Over a period of weeks he improved to some extent, and the coma changed to a state of akinetic mutism. RIHSA cisternography was performed. The 4 hour pictures (Fig. 1) showed ventricular filling, which was still seen at the 48 hour study. No radioactivity was recorded over the brain convexities. Three patients belonged to this group.

Group 2. Partial obstruction of the subarachnoid space over both cerebral convexities and transient or persistent ventricular filling.

This pattern is characterized by partial filling of the subarachnoid spaces over the cerebral convexities, but the region of the superior sagittal sinus shows no radioactivity. There is always a transient or persistent filling of the ventricles. The degree of filling defect over the convexities and the visualization of the ventricles depend on the degree of ventricular enlargement and of hindrance of C.S.F. flow over the convexities. In the

![Fig. 1a](image1a) ![Fig. 1b](image1b)

Fig. 1. Non resorptive communicating hydrocephalus following head injury: RIHSA cisternography in the case illustrating group 1. a) and b): anterior and lateral views at 24 h. The radiopharmaceutical fills the ventricles but is not seen in the subarachnoid space over the brain convexities or along the superior sagittal sinus

more advanced cases of absorption defect the ventricular filling persists in the later stages of the investigation.

Illustrative cases:

A 66-year-old man sustained a severe head injury in a road accident. He was comatose for about a month. He then improved slowly but remained in a state of akinetic mutism. Right carotid angiography, performed two months after the accident, showed moderate widening of the lateral ventricles. This was confirmed by pneumoencephalography which also showed enlargement of the lateral and the third ventricles. Air was found in the basal cisterns, sylvian fissures and pericallosal sulcus, but not over the brain convexities. RIHSA cisternography (Fig. 2) demonstrated early and persistent ventricular filling. The radiopharmaceutical outlined the sylvian fissures but did not reach the superior sagittal sinus.

In another case we were able to observe, on subsequent cisternography, spontaneous restoration of normal C.S.F. flow.

A 27-year-old woman was admitted to hospital after a scooter accident, in a comatose state with a left hemiparesis. Right carotid angiography demonstrated a subdural haematoma which was evacuated. She remained unconscious for three weeks and then slowly recovered.