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Active singling out of shunt independence

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Abstract The availability of telemetric devices for intracranial pressure (ICP) measurements in line with a multipurpose valve (MPV) was shown to be the ideal condition for safe investigation of the problem of shunt independence in 21 patients. After percutaneous closure of the shunt, all but 4 patients developed some degree of intracranial hypertension. The time lapse between blockade of the MPV and appearance of the morphology, in the tracing, that suggests ICP is different for each patient and could reflect individual conditions such as the residual pathways of CSF, ventricular size and complicance of the system.

Key words Hydrocephalus
Intracranial pressure

Introduction

In the past, contrasting opinions have been expressed on the problem of shunt independence. Some workers have ruled out its occurrence thus suggesting that a shunt operation is an irreversible lifelong choice, while others maintain that 1 out of 5 shunted patients could have their shunts removed [1–3]. In a previous study we tried to investigate the tracings of intracranial pressure (ICP) in shunted hydrocephalic patients after percutaneous closure of MPVs; in all but four cases pathological, progressive intracranial hypertension developed [4]. With the introduction of telemetric devices for measuring ICP in line with the shunting system the harmful maneuvers involved in puncturing the reservoir could be avoided; therefore, we returned to active examination for shunt independence in a new series of patients.

Materials and methods

Since 1985 we have acquired ICP telemetric devices, and we used these in line with the MPV in 21 patients submitted to shunting operations. Such a system does not provide true conventional monitoring of ICP single instantaneous measurements, which meant we had to plot each value for ICP manually versus the time lapse since percutance blockade of the valve.

More recently we coupled our telemetric ICP detector to a chart recorder either for graphic visualization of the morphology of the ICP waves (Fig. 1) or to obtain a gross evaluation of the trend of ICP developing in the patient (Fig. 2). In each case, functioning of the shunt was previously ascertained according to the method described elsewhere [5]. Briefly, patients remain 15 min in the supine position, after which a first telemetric evaluation of ICP is made. The patient's head is then elevated progressively until the ICP becomes negative. This is called zero point and is expressed by the angle of tilt of the foldable bed at which the ICP becomes negative. An angle ranging between 15° and 30° is a reliable sign of well-functioning shunt. The MPV is then closed, and a telemetric evaluation of ICP is recorded every 15 min in the first 2 h and subsequently every 30 min. Each value is entered in a graphic, which gives an idea of the trend of ICP during the test. The valve is opened again as soon as headache or disturbances of consciousness occur or when the ICP reaches three times the basal value.

Results

The mean duration of the test was 7.5 (1–12) h. After closure of the MPV early intracranial hypertension (4 h) arose in 8 patients while values were evident within 12 h

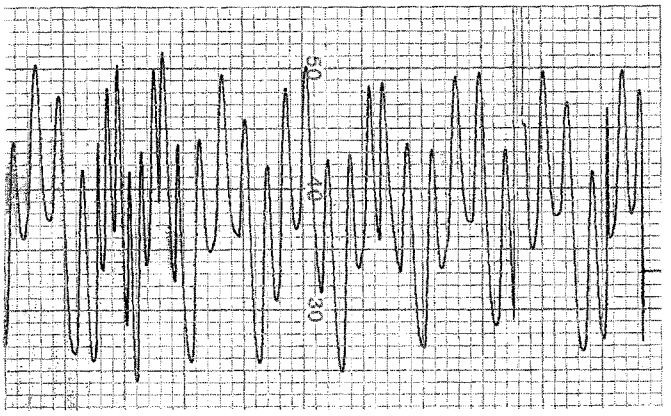

Fig. 1 Chart recording telemetric intracranial pressure (ICP) morphology of single cerebral pulsations at ICP of 25 cmH_2O

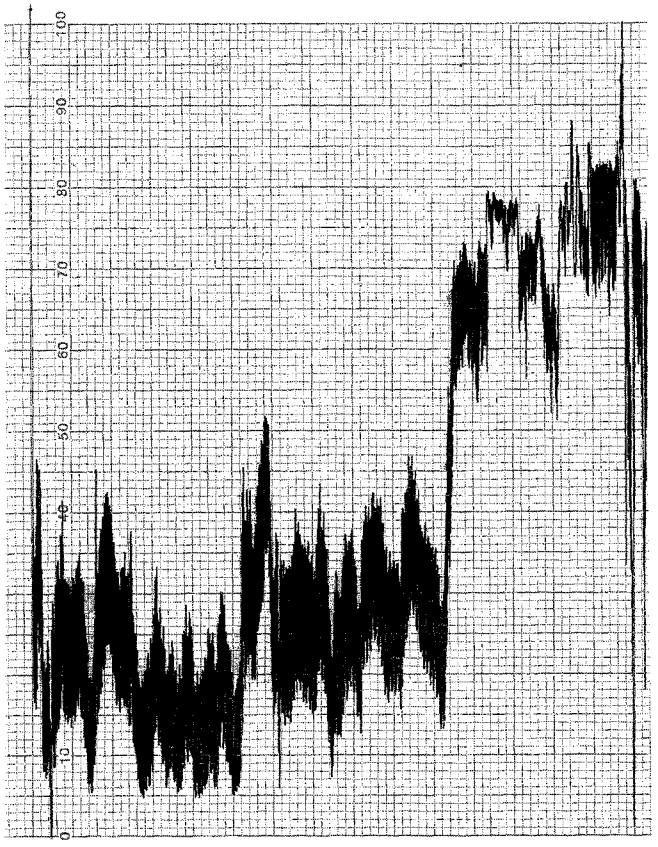

Fig. 2 The wand containing the antenna is maintained on the ICP transducer. Variations in ICP can be observed. The absolute value remains unknown, but the morphology suggests a plateau wave

in a further 6. In 4 cases there were no significant changes. In the remaining patients the ICP rose and stabilized at values between 20 and 40 cmH_2O without causing any symptoms (Fig. 3). Symptoms of intracranial hypertension occurred in 5 of the 21 patients.

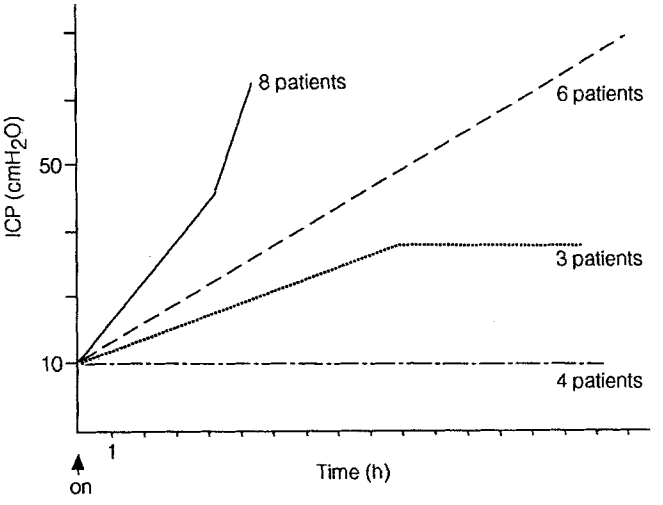

Fig. 3 Diagrammatic representation of the most common patterns of ICP after closure of the multipurpose valve

Although some recordings seem show plateau waves, pathologic A and B waves were never clearly demonstrated. Conversely, the morphological aspects of each wave proved to be graphically well defined, but they were available only in a minority of cases.

Discussion

In 1982 we reviewed our series of 415 treated hydrocephalic patients, but only in 5 cases did we occasionally observe the situation of a blocked shunt in the absence of signs of intracranial hypertension. We did not remove any of the shunts, but 6 years later 1 child developed intracranial hypertension and needed revision of the shunt. An important point was that all the reported cases of shunt independence were in patients whose shunts had spontaneously closed. We then argued that a group of patients with unnecessary but well-functioning shunts could probably be singled out in a similar manner. One way of assessing whether a shunt is still necessary is to verify what happens to the ICP once the shunt has been temporarily blocked. This was easily achieved by monitoring ICP directly from the reservoir of the MPV after the on/off device had been closed percutaneously. The aim of the test and its ethical justification did not rest in the possible, hypothetical removal of the shunt, but rather on the evaluation of the degree of shunt dependence. It was reasoned that this test with percutaneous closure of the valve and ICP monitoring could have some clinical relevance for follow-up of the patients, giving the neurosurgeon and the relatives some reliable data on what could happen in case of a malfunctioning shunt. That study allowed us further observations: the latency

time (i.e., the time lapse from the blockade of the shunt to the occurrence of pathologic ICP values) varied from a few minutes to 7 h; there was no correlation with either the type of hydrocephalus (communicating or blocked) or with ventricular dilatation. Out of 41 children tested, 37 developed pathologic ICP; the 4 who did not had previously had a tumor removed [4].

The results of the present study with telemetry confirm the previous conclusions, although with different figures; indeed, only 14 of 21 patients developed an unequivocal intracranial hypertension after closure of the MPV. These patients should be considered strictly shunt-dependent, but flat tracings or mild elevations of ICP are not sufficient criteria for shunt independence. Perhaps longer monitoring of ICP with blocked shunt is needed for definitive conclusions [6].

Finally, as to the interpretation of the test results we think that closure of the shunt leaves the patient with his or her own residual CSF resorption pathways, and the physiological CSF production of 0.3 ml/min must match the residual resorption pathways. If these are insufficient, intracranial hypertension will ensue. The true interpretation of the test is then that of an autoinfusion of CSF, with some resemblance to the infusion test after Katzman. These suggestions are not definitive, but a safe evaluation of the CSF resorptive capacity could be an interesting way of following up the biological history of impaired CSF circulation in hydrocephalic patients.

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