Telemetric ICP monitoring after surgery for posterior fossa and third ventricular tumors

Technical note

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After surgery for posterior fossa or third ventricular tumors, hydrocephalus may persist or evolve. Proper management of this complication requires timely detection. Temporary external ventricular drainage has been suggested by some authors as an adjunct to clinical observations and radiographic studies for unshunted patients. As an alternative, the authors have used a telemetric method of pressure monitoring in association with a ventricular catheter and subcutaneous reservoir. This has been found useful in eight patients without the disadvantages inherent in other methods of management.

Key Words • telemetry • intracranial pressure • cerebrospinal fluid • intracranial tumor • shunt

Obstructive hydrocephalus is commonly associated with tumors of the posterior fossa and third ventricle, and its management is usually of concern in the surgical treatment of these neoplasms. In such cases, shunting may be necessary prior to definitive tumor surgery in order to reduce dangerously elevated intracranial pressure (ICP) and improve the patient's general condition. This tactic has encouraged some surgeons to routinely place preoperative shunts in an effort to reduce overall management morbidity and mortality.1,7 Others have suggested preoperative external ventricular drainage as an alternative.6,8 Less attention has been given to the systematic management of persistent or evolving postoperative hydrocephalus, which can represent an unpredictable and troublesome problem in unshunted patients. A short period of external ventricular drainage may help to identify those patients who will require cerebrospinal fluid (CSF) diversion. One must otherwise rely on clinical observation or serial radiographic studies.

As an alternative we have recently begun to use telemetric ICP monitoring to facilitate the postoperative management of selected patients who are at risk for developing hydrocephalus. The purpose of this report is to describe the technique and summarize our experience to date.

Materials and Methods

The telemetric monitoring system employed here represents an adaptation of that which we have previously described for use in shunt systems.3 The device is 20 mm in diameter and 3 mm thick. It houses a chamber which communicates with ventricular CSF by a connection between its entrance tube and a ventricular catheter (Fig. 1). Its upper surface is a diaphragm which bulges outward against the overlying scalp when CSF pressure in the chamber increases above zero atmospheric pressure. There is a passive resonant circuit in the base of the chamber and a tuning element on the diaphragm, so that a bulge in the diaphragm causes a change in the resonant frequency of the circuit. By means of an external radiofrequency detection circuit and antenna, the telesensor can be continuously interrogated to detect its resonant frequency and, thus, determine changes in the CSF pressure within the chamber.

Cardiac-related ICP variations on these recordings confirm that the ventricular catheter is unobstructed. The telesensor is also designed so that pressure applied to the diaphragm through the intact scalp will force the diaphragm down to a reproducible null or zero point, which represents its position at zero pressure within the chamber. Thus, by applying a known graded external pressure to the scalp, the telesensor can be zeroed at any desired point and continuously monitored to detect changes in the CSF pressure within the chamber.
counterpressure to the diaphragm, one can both determine the zero baseline of the sensor at any time (that is, automatically compensate for drift and barometric changes) and measure the pressure in the chamber. The counterpressure required to bring the diaphragm to its zero position is equal to the CSF pressure in the sensor. In practice, counterpressure is applied by means of an inflatable cuff attached to the antenna. Accuracy of the telemetric ICP measurements was assessed by comparison with simultaneous direct pressure measurements via the reservoir (Fig. 2). Linear regression analysis shows a correlation coefficient (r) of 0.97 (p < 0.001) between the telemetric and direct ICP measurements.

In the present context, we use the device and its associated reservoir in conjunction with a standard ventricular catheter. The apparatus is placed near the burr hole site beneath the scalp in an accessible location (Fig. 1 lower). Placement is planned in such a way that distal tubing can easily be added to convert it to a conventional shunt.

**Summary of Cases**

We have used this method of postoperative ICP monitoring in seven patients with tumors of the third ventricle or posterior fossa. In each case we were reluctant to place a shunt at the time of craniotomy, either because the tumor was potentially disseminating (germinoma, medulloblastoma) or because the surgical decompression of CSF pathways seemed adequate. Two patients required subsequent shunting, both 8 days following craniotomy. After partial removal of a large pineal germinoma, we were able to closely monitor ICP while early radiotherapy was begun. A shunt was avoided as the tumor responded promptly to treatment. In an eighth case, the device was used to monitor pressure and administer chemotherapy to a patient with carcinomatous meningitis and early hydrocephalus. Shunting was not required. There were no complications attendant to using the technique in these eight patients.

**Discussion**

After craniotomy for third ventricular or posterior fossa tumors, obstructive hydrocephalus is a potential problem. It may occur as an early or late postoperative phenomenon. Albright and Reigel found that eight of 47 children undergoing posterior fossa tumor surgery required a shunt before leaving the hospital. Another nine children were shunted within a year after surgery. Papo, et al., reported a 25% incidence of permanent postoperative shunts, most of these being required 3 to 5 weeks after posterior fossa surgery. The experience of others is similar, with 19% to 23% of patients requiring a shunt for hydrocephalus following tumor surgery. Regular shunt placement, either before or at the time of tumor surgery, is one way of dealing with this issue. Routine shunting to facilitate perioperative management is a topic that has been debated elsewhere. From the standpoint of postoperative care, we believe it is desirable to avoid shunts in those patients whose hydrocephalus has been effectively relieved by tumor removal. In addition, one would like to avoid an unnecessary shunt in the case of potentially disseminating tumors, such as medulloblastomas and pineal germ-cell neoplasms. Finally, preoperative ventricular decompression by shunting or external ventricular drainage...
Postoperative telemetric ICP monitoring

has been associated with severe hemorrhage within posterior fossa tumors.\textsuperscript{2,10}

The occurrence of postoperative hydrocephalus cannot be reliably predicted on the basis of the extent of surgery. If one chooses not to place shunts routinely in such patients, then some means of postoperative monitoring is desirable. The use of external ventricular drainage has been mentioned. A major disadvantage of this technique is that it can only be used for a limited period postoperatively. This is pertinent in that a substantial percentage of patients will require shunting well beyond the time it is discontinued.\textsuperscript{1,6} Two of our own patients needed shunts 8 days postoperatively. Although the rate of infection complicating external ventricular drainage may be as low as 1\% to 2\%,\textsuperscript{6,9} this method does require a consistently meticulous technique for prevention.

Most of our experience with the telemetric sensor described here has been gained from its use in shunt systems.\textsuperscript{2} To date, 40 devices have been placed in connection with conventional shunts. There have been three mechanical failures, and the remainder have functioned satisfactorily for periods as long as 6 years. The application of this technique has been helpful as an adjunct in the postoperative management of patients who are at risk to develop obstructive hydrocephalus. In contrast to external ventricular drainage, this device allows accurate noninvasive ICP monitoring for an indefinite period of time, up to years if necessary. There is no restriction of patient mobility during the immediate postoperative period. The attached reservoir allows fluid sampling or withdrawal to lower the ICP acutely. The device is easily converted to a shunt if necessary, as occurred in two of our cases.

Acknowledgment

We wish to thank Ms. Ann Duggan for her assistance in preparation of this manuscript.

References


Manuscript received July 27, 1983.
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