Pseudotumor Cerebri Patients with Shunts from the Cisterna Magna: Clinical Course and Telemetric Intracranial Pressure Data

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OBJECTIVE: Shunting of cerebrospinal fluid (CSF) to an extracranial site is the mainstay of treatment of absorptive hydrocephalus and pseudotumor cerebri. On occasion, both lateral ventricles and the lumbar space become unsuitable for placement of a functioning CSF drainage catheter. We have encountered several such patients and describe our strategy of shunting from the cisterna magna to the pleural space or cardiac atrium.

METHODS: We report a retrospective review of the clinical course of five patients with cisternal shunts and intracranial pressure telemonitoring devices.

RESULTS: Cisternal shunting was able to successfully drain CSF to a normal pressure in all five patients. CSF pressure data collected from those patients indicate that the CSF pressure dynamics in cisternal shunts is similar to that of ventricular shunts. However, the cisternal shunting and subsequent high revision rate did result in a significant number of complications and two shunt infections.

CONCLUSION: Shunting CSF from the cisterna magna in the absence of another suitable drainage site does result in acceptable reduction of elevated intracranial pressure. However, the technique is associated with a high complication rate that may reflect the population of patients in whom this technique is required.

KEY WORDS: Cisterna magna shunt, Pseudotumor cerebri, TeleSensor

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Pseudotumor cerebri (PTC) is a syndrome characterized by an increased intracranial pressure (ICP) with normal cerebrospinal fluid (CSF) chemistries, papilledema, and normal or small ventricles. Symptoms may include headaches, nausea, visual disturbances, and cranial nerve deficits. Although the pathogenesis of PTC remains controversial, this syndrome has been associated with a variety of endocrine and metabolic disturbances. In addition to the medical management of these comorbid disorders, treatment is centered on reduction of symptoms and management of ICP.

Medical management of increased ICP caused by absorptive hydrocephalus or PTC includes the use of diuretics (usually a carbonic anhydrase inhibitor) and repeated lumbar punctures. Surgical treatment centers around CSF diversion (2, 13, 17, 23). Recipient sites for the CSF diversion may include the peritoneum, pleura, cardiac atrium, and gall bladder, among others. Sites of drainage have generally been limited to the ventricular system or the lumbar subarachnoid space.

PTC patients, in particular, can be difficult to treat. Shunting from a variety of locations has been attempted. This includes the use of ventricular (20), lumbar (13, 16, 20, 22, 24), and cervical shunts (2). However, there is a subset of patients requiring CSF diversion in whom the use of the ventricular system or lumbar subarachnoid space is not possible: small ventricles may cause repeated catheter occlusion and underdrainage; repeated lumbar punctures and lumbar catheter revisions may lead to scarring of the lumbar thecal space. It is in this group of patients that alternative methods of CSF diversion may be necessary. As an alternative CSF drainage site, the cisterna magna has been reported in approximately 20 patients from three different institutions (12, 16, 21). A review of the reported cisternal shunting is presented (*Table 1*). We have revis-

TABLE 1. A review of previously reported cisternal shunting[a]

Series (ref. no.)	Type of shunt	No. of patients with PTC	No. of revisions
Johnston and Sheridan, 1993 (12)	10 cisternoatrial	11	11 revisions: 5 infections, 2 obstructions, 3 low-pressure symptoms, 1 wound breakdown
	3 cisternopleural		
Spetzler et al., 1977 (21)	6 cisternoatrial	N/A	1 proximal obstruction
	3 ventriculocisternal		
	1 cisternal reservoir		
	1 cyst-cisternal		
Lundar and Nornes, 1990 (16)	2 cisternoatrial	6	N/A
	1 cisternoperitoneal		
Lee (present study)	5 cisternopleural	5	11 revisions: 2 infections, 1 obstruction, 2 cranial nerve symptoms, 4 valve changes, 2 distal drainage malabsorption, 2 explorations

[a] PTC, pseudotumor cerebri; N/A, not available.

ited the technique of shunting from the cisterna magna by assessing clinical usefulness as well as observing the CSF pressure dynamics in five patients with PTC by telemetric monitoring.

PATIENTS AND METHODS

Five consecutive patients were evaluated retrospectively after placement of cisternal shunts. There were four women and one man (age range, 23–43 yr). Each patient had a diagnosis of PTC, funduscopic examinations demonstrating papilledema, and lumbar punctures revealing ICP greater than 30 cm H_2O. In addition, each patient underwent both medical and surgical treatment. Before placement of the cisternal shunt, all five patients had undergone multiple unsuccessful attempts at either lumbar shunting or ventricular shunting (*Table 2*).

Technique of Cisterna Magna Shunt Placement

Under general anesthesia, the patients are placed in the prone position in head-pin fixation. The neck is flexed, and a

TABLE 2. Patients and shunting attempts[a]

Patient no.	Sex/age (yr)	Signs/symptoms	Revisions before cisternal shunt
1	F/43	PTC	LPS with multiple revisions and infections at another institution; slit ventricles
2	F/38	PTC	VPS with multiple revisions at another institution; prior lumbar fusion surgery
3	M/34	PTC	LPS with 2 revisions; slit ventricles
4	F/35	PTC	VPS with 4 revisions; intractable overdrainage symptoms with lumbar drainage
5	F/23	PTC	LPS with 6 revisions after multiple revisions at an outside hospital; small ventricles

[a] PTC, pseudotumor cerebri; LPS, lumboperitoneal shunt; VPS, ventriculoperitoneal shunt.

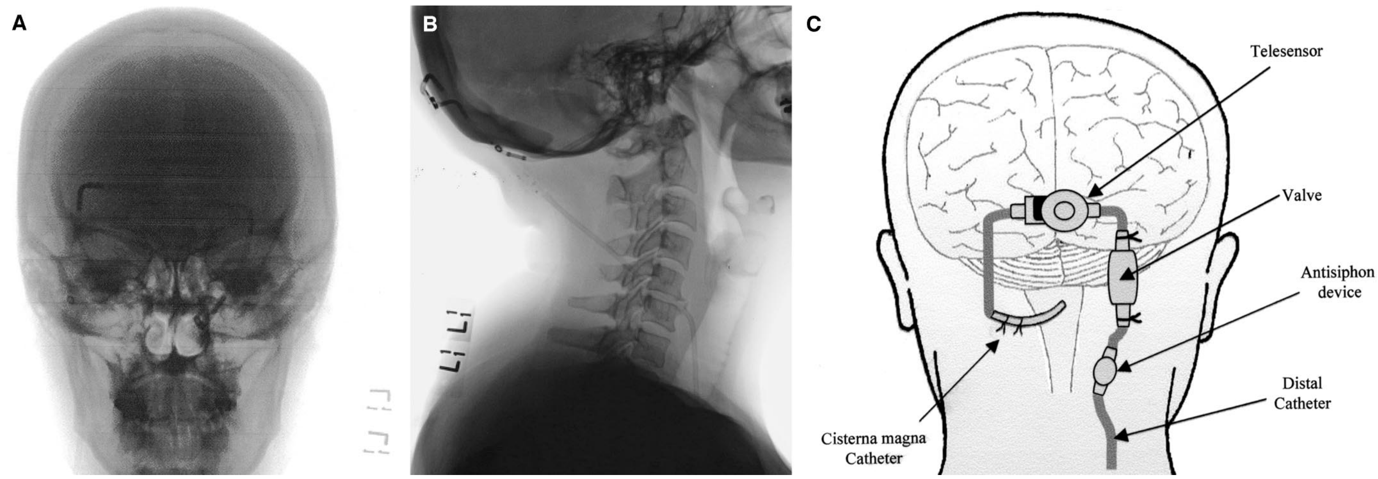

FIGURE 1. *Anteroposterior (A) and lateral (B) x-rays of the cranium demonstrating the connection of the cisternal catheter to the TeleSensor, valve, antisiphon device, and distal catheter (Patient 1) and graphical depiction of those components within the shunt system (C).*

midline incision is made from the inion to the foramen magnum and an incision over the fifth rib approximately 5 cm away from midline. The soft tissue and muscle on the left are dissected off the bone, whereas the muscle on the right is kept in contact with the bone. After a subgaleal dissection is performed superiorly and on the right, a right angle connector and TeleSensor (Radionics, Burlington, MA) are placed superiorly. After a second right angle connector is placed, a programmable valve and distal tubing (with or without antisiphon device) is tunneled from the right of the incision to the pleural access incision.

A burr hole craniectomy is made in the left-side occipital bone near the foramen magnum. A duratomy is made, and a catheter is placed through the craniectomy and under the arachnoid of the cisterna magna under direct vision. The catheter is advanced minimally into the paramedullary gutter or the upper cervical subarachnoid space. Proximal flow is verified, and the catheter is connected to the proximal right angle connector. Distal flow is then verified, the distal catheter is placed into the pleural space, and the incisions are closed. In one patient, because of bilateral pleural CSF malabsorption, the catheter was accessed in the neck posteriorly and redirected into the cardiac atrium via the internal jugular vein. X-rays and a graphical representation showing the cranial components of the shunting system are displayed in *Figure 1, A* and *B*.

Measurements of ICP

ICP measurements were performed as described (10, 19) using the Radionics TeleSensor (4–6). This Radionics TeleSensor required the cooperation of the patient, because a radiofrequency telemetric unit is placed over the coil of the TeleSensor until registry of an analog output of ICP. Measurements were performed with the patient in the supine position and at various head elevation levels (0, 15, 30, 45, 60, 75, and 90 degrees), as is our clinical practice. No differences greater than 1 cm H_2O were seen among multiple measurements performed at any one time; therefore, results were plotted using the mean value of these measurements. Intraventricular pressures are expressed in centimeters of water, as calibrated on the Radionics ICP-M4 or ICP-M3 telemonitor system, measured at the site of the TeleSensor above the inion.

Analog ICP is displayed on the ICP-M4 or ICP-M3. Negative ICP is unable to be detected. In addition, because the TeleSensor is in line with the shunt, signal output is dependent on a patent ventricular catheter.

RESULTS

Five patients underwent cisternal shunting (*Table 3*). After those five insertions, all patients had at least one revision (11

TABLE 3. Cisternal shunting[a]

Patient no.	Valve	Distal drainage site
1	VPV	Pleural, revised to atrial
2	VPV with antisiphon device	Pleural
3	VPV with siphon-limiting device	Pleural
4	VPV, revised to add siphon-limiting device	Pleural
5	VPV with “siphon-guard” device	Pleural

[a] VPV, variable pressure valve (Codman-Medos; Codman/Johnson & Johnson, Raynham, MA).

revisions total; mean, 2.2 per patient). Of the 11 revisions, two were explorations; three revisions involved the proximal catheter (one for occlusion and two for repositioning of the proximal catheter because of pressure effects causing a trigeminal neuralgia syndrome in one patient and facial nerve weakness in a second); two were to change the distal drainage site because of malabsorption in the pleural space; four operations involved changing the valve or adding an antisiphon device; and two were for removal because of infection.

There were two major and three minor complications. Patient 1 had a transient pleural effusion, which recurred after catheter repositioning in the contralateral pleura and was finally alleviated through repositioning into the cardiac atrium. In addition, this patient had left-sided facial pain and numbness, which was attributed to the proximal catheter location in the cerebellopontine angle and was relieved by catheter repositioning. Patient 5 developed a facial nerve palsy attributed to the proximal catheter resting on the floor of the fourth ventricle. Patients 4 and 5 developed shunt infection, presumably because of multiple closely spaced revisions necessitating removal of the shunt system. Patients 1, 2, and 3 retain shunts from the cisterna magna, with supine CSF pressures less than 15 cm H_2O. Although symptoms of headaches were improved with a functioning shunt, all three patients continued to require medical pain management or diuretic treatment in addition to the CSF diversion.

CSF Pressure Dynamics

Postural pressure dynamics of patients who received shunts to the pleural space are shown in *Figure 2*. Patients 2, 4, and 5 were found to have pressures that never exceeded zero, even in the supine position, as has been reported previously in ventriculopleural shunting (19). Patients 1 and 3 had dynamic CSF pressure values similar to those previously reported in antisiphoning shunt systems in the pleura or differential valve systems draining to the cardiac atrium (10).

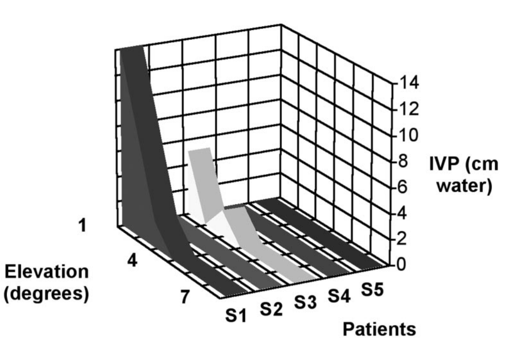

FIGURE 2. *Three-dimensional graph showing postural pressure dynamics in five patients with shunts to the pleural space. Pressure, in centimeters of water, is plotted versus elevation of the head, in degrees. Patient numbers correspond with Tables* 2 and 3.

DISCUSSION

There is an extensive history of the use of the CSF cisterns in various shunting procedures. Torkildsen shunts (1, 9) and third ventriculocisternostomies use the cisterns as a reservoir to bypass ventricular obstruction. Drainage of syrinx cavities into the subarachnoid or cisternal spaces is also common (18). Shunting from the cisterna magna has also been reported in a small number of patients, with a moderate degree of success (12, 16, 21).

We report our experience with shunts from the cisterna magna in five patients. In all five patients, there was adequate drainage of CSF and functioning shunts. In addition, we demonstrate that ICP is lowered with cisternoatrial and cisternopleural shunts in a manner similar to that seen with ventricular shunts. Specifically, the telemetric CSF dynamic pressures in cisternal shunts without antisiphon components were very similar to those seen in ventriculopleural shunts without antisiphon devices in which CSF pressure does not exceed zero. With antisiphon devices, the dynamic CSF pressure curves are similar to antisiphoning pleural shunts (19). The cisternoatrial shunt with a differential valve (*Fig. 2*, Patient 1) displayed dynamics identical to similar ventricular shunts without an antisiphoning component (10).

CSF drainage with a unidirectional shunt valve is dependent on the valve characteristics and the pressure gradient proximal and distal to the valve. While the patient is supine, the intracranial and lumbar pressures may be equal. When the patient is upright, however, siphoning of CSF into the spinal thecal sac may decrease ICP while increasing lumbar subarachnoid pressure. This pressure differential may be balanced at the cisterna magna. Thus, although upright positioning may decrease shunting of CSF from the ventricle and cisterns because of a decreased pressure gradient, continued siphoning of CSF may occur with lumbar drainage. Although the CSF pressure dynamics of lumboperitoneal shunting has never been reported, the tendency to overdrain and other flow-related complications (e.g., secondary Chiari malformation) predict that cisternal shunting pressure dynamics are different from that of lumbar shunting.

Complications of cisternal catheterization may include vertebral artery/brainstem puncture (14, 21) or damage to cranial nerves that can result from poor placement of the posterior fossa catheter (15). Our patients experienced two temporary cranial nerve palsies from placement of the cisternal catheter. One approach to reducing this complication in the future is use of more flexible lumbar catheter tubing rather than standard ventricular catheters in the cisternal area (H Rekate, personal communication). In addition, greater exposure and placement of the cisternal catheter with more visualization may decrease this complication rate. With the larger exposure provided during Torkildsen shunting, this cranial nerve palsy may have been seen less frequently.

In addition, our patients experienced two shunt infections. The two shunt infections were attributed to multiple successive revisions (8, 11). The frequency of shunt revisions in this population might have been predicted through failure of shunting from the ventricular or lumbar spaces (3, 7).

CONCLUSION

Although ventriculoperitoneal or lumboperitoneal shunting remains the mainstay of treatment for hydrocephalus and PTC, small ventricles may be difficult to access, and intermittent blockage of the proximal catheter is frequent; lumboperitoneal shunting may be fraught with catheter kinks along with proximal catheter obstruction (13, 20). We have placed cisterna magna shunts in five patients who previously had unsuccessful results with multiple attempts at shunting from other sites. Despite the high complication and infection rates, this approach does provide another option for a CSF drainage site when the more traditional sites are unavailable or unsuitable and adequate CSF drainage cannot otherwise be achieved. In addition, the CSF pressure dynamics of this type of shunt closely resemble that of ventricular shunting, predicting a use for cisternal shunting when ventriculoperitoneal shunt pressure dynamics are needed but the ventricles are unavailable for shunting.

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COMMENTS

The authors present an acceptable, although somewhat higher-risk, alternative to lumboperitoneal or ventriculoperitoneal shunting in patients with pseudotumor cerebri. These are all patients in whom more traditional methods of shunting have failed. They have added the very useful information gained by including a telemetric device to monitor the pressure in the proximal catheter. Although this may not be quite as reliable as a pressure-monitoring device that is separate from the shunting system, it does provide very useful information about intracranial pressure and any change with alteration in the patient's head position. This technique should be kept in mind as an alternative in these often challenging patients.

William F. Chandler
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As emphasized by this report, the surgical treatment of pseudotumor cerebri has long been problematic. Preferred treatment consists of a ventriculoperitoneal shunt using a programmable valve and antisiphon device. This is a comparatively simple procedure that usually produces good short-term results, although problems may be encountered in implanting or maintaining the shunt in slit-like ventricles. Lumboperitoneal shunting, once the procedure of choice, has been abandoned by many neurosurgeons because of difficulties in controlling shunt overdrainage, orthostatic symptoms, and acquired tonsillar herniation. When all else fails, bilateral subtemporal decompression can be considered.

In this study, the authors used a cisterna magna shunt in five patients in whom multiple attempts at shunting from either the cerebral ventricles or the lumbar theca had been unsuccessful. Obvious advantages of the cisterna magna are its generous size and accessibility and physiological features that minimize hydrostatic changes related to posture. Although cisternal shunting is not new, the detailed telemetric pressure data provided by this study are of considerable interest. The major problem with cisterna magna shunts is their high rate of complications, some of which are quite serious. As the authors point out, cisternal shunting for pseudotumor cerebri should be considered only when the cerebral ventricles or lumbar theca is unavailable or otherwise unsuitable for shunting.

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In this article, the authors present five patients who underwent cisterna magna shunting for relief of normal-pressure hydrocephalus or pseudotumor cerebri. The intracranial pressure was assessed by a telemetric intracranial pressure-monitoring device, and the data are presented in *Figure 2*. These data are interesting in two respects. First, although this is not the largest series describing cisternal shunting, the patients had a 100% complication rate! Thus, the data presented constitute a strong deterrent to the use of this form of shunting. Second, *Figure 2* represents telemetric data on long-term intracranial pressure in these five patients, and this is novel and important. However, there are several disturbing things in this article.

In the abstract, it is stated that "cisternal shunting was able to successfully drain [cerebrospinal fluid] to a normal pressure in all five patients." Yet in *Figure 2*, the data shown for three of the five patients show an intracranial pressure of 0 without any fluctuation, regardless of head position and presumably independent of the relatively long duration of monitoring. This suggests that the telemetric sensor is, in fact, malfunctioning, because numerous studies have shown that intracranial pressure will vary with physiological behavioral changes and with body position. This lowers confidence in the data presented here and suggests that the telemetric method is inaccurate, and unless the authors can show that there is fluctuation or a calibration response of some kind, then the data are suspect for at least three of the five patients.

These five patients needed 11 revisions and had two major and three minor complications, including new cranial nerve palsies in two. The only three patients in whom cisternal shunts were left in situ still needed pain medication for their headaches. I thus conclude, in contrast to the authors, that this method of cerebrospinal fluid diversion is to be strongly avoided.

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Shunting from any subarachnoid space to any cavity in the body has been described before, but the use of the telemetric pressure monitoring device in pseudotumor patients is new. The main interesting findings in this article are that the cisterna magna pressures do not change with various positions of the head and body, and that, in three of the five patients with pleural shunts, pressure never exceeded zero. Unfortunately, the device used here cannot measure negative pressures, so we do not know how much below zero the pressures actually are, and we are not much wiser now. However, this study has highlighted to me, again, how miserable the results of shunting are for the treatment of headaches in pseudotumor cerebri, and it has strengthened my firm belief that only visual problems, but not headaches, are an indication for shunt placement in these patients: A total of 5 initial procedures plus 11 revisions were performed in five patients, who together had probably already undergone more than 23 procedures before the cisternopleural shunting, while lasting relief of the headaches was really accomplished in none of the patients! Moreover, the use of programmable valves (as in this study) leads to further overconsumption of medical resources in this particular group of patients: several patients like these present to the emergency room almost weekly, demanding that my residents adjust the opening pressure (no easy task in and by itself!), alleging that slight over- or underdrainage is causing their headaches to become unbearable. Thus, I am willing to place a shunt (usually ventriculoperitoneal) in a patient who is threatened with visual loss, but I emphasize that I will not perform any revisions or adjustments for headaches alone. By pretending that neurosurgeons can help these patients' headaches with shunts, we delay the development of more effective treatments, such as endovascular balloon dilation of stenosed intracranial sinuses.

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