Subgaleal shunting: A 20-year experience

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Object. The authors undertook a retrospective study to evaluate the effectiveness of diverting intracranial fluid into the subgaleal space for temporary absorption by the membranes of the scalp.

Methods. Eighty-one patients were treated over a 20-year period. There were 22 cases of hypertensive hydrocephalus, 52 cases of acute head trauma, and seven cases of chronic subdural hematoma. The simple surgical technique is described.

Subgaleal shunting provided effective short-term treatment of hydrocephalus and increased intracranial pressure, which was monitored directly in 22 cases of cerebral contusion and edema.

Conclusions. The closed method for drainage of cerebrospinal fluid avoids the complications of open ventriculostomy or open drainage of the subdural space.

KEY WORDS • closed head injury • intracranial pressure • cerebral contusion • hydrocephalus • subdural hematoma

In 1896, von Mikulicz²¹ described a procedure for diverting intracranial fluid into the subgaleal space. The procedure was reviewed by Cushing¹ in 1928 and Davidoff³ in 1929 for the relief of hydrocephalus. Chronic post-operative CSF fistulas were subsequently treated by ventriculosubcutaneous drainage^{2,6} before Perret and Graf¹³ in 1977 reported a method of temporarily decompressing the ventricular system enlarged by tumors and of treating recurrent subdural hematomas by diverting fluid into the parietal subgaleal space. One of the present authors (L.I.M.)⁹ taught his residents to avoid the use of exteriorized tubes and receptacles to decrease the risk of infection associated with open ventriculostomy. During his training with the author at The Mount Sinai School of Medicine, H. J. Drabkin placed 15 ventriculosubgaleal shunts via a frontal approach in patients with ventricular dilation.⁴ Insertion of a ventriculosubgaleal shunt in acute head trauma was first reported to the New York Society of Neurosurgery by the second author (M.H.S.) in 1981.¹⁸ The purpose of this paper is to review and evaluate experience with subgaleal shunting over a 20-year period.

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computerized tomography; ICP = intracranial pressure.

CLINICAL MATERIAL AND METHODS

Hypertensive Hydrocephalus

Rapid increase in ventricular size with evidence of periventricular lucencies¹¹ observed on CT scanning correlated well with increased ICP in seven patients with hemorrhagic intracranial tumors and 15 patients with subarachnoid and intraventricular hemorrhage (Table 1). After a regular trephine opening in the right-sided parietal area, a ventricular catheter was passed into the lateral ventricle, and the proximal end was left in a previously dissected pouch in the subgaleal space. Accurate two-layer closure of the galea and skin was performed with fine sutures to prevent leakage (Fig. 1).

Acute Head Trauma

No direct measurement of ICP was attempted in 30 cases (Table 2) of severe closed head injury over a 10-year period.¹⁷ In all 30 patients signs of increased ICP and brainstem compression were demonstrated. Cushing's triad (bradycardia, bradypnea, and hypertension) was recorded in each case. There were no focal findings on neurological examination, and no vault fractures were demonstrated on skull x-ray films. Dexamethasone (100 mg) and mannitol 10% (500 ml) were given intravenously in the

TABLE 1

Data obtained in 22 cases of hypertensive hydrocephalus

Patient Diagnosis	Outcome/Discharge			
	Died	Permanent Shunt	Rehab Center	Home
hemorrhagic tumors (7 patients)	0	3	2	5
subarachnoid/intraventricular hemorrhage (15 patients)	8	3	4	3

emergency room. Immediate intubation facilitated hyperventilation, and further evaluation was performed by CT scanning. Neither hematoma nor midline shift was seen in any of the patients. The ventricles were slitlike (Fig. 2 *left*), and vesicular hemorrhage in white matter or blood in the ventricular system or subependymal bleeding was visualized (Fig. 2 *center*).

Using a hand drill, the small ventricles were tapped via a right-sided frontal approach just anterior to the coronal suture. The CSF, obtained under pressure, was 10 to 20 ml in volume and grossly hemorrhagic. A Pudenz ventricular catheter was inserted (Fig. 2 *right*), and 4 cm of tubing was tucked into an 8-cm pocket created above the periosteum by dissecting the loose areolar subgaleal tissue. Prophylactic methicillin was administered intravenously every 6 hours. When the Camino ICP monitor became available¹⁵ the device was inserted into the left frontal subarachnoid space in an additional 22 patients (Table 3) prior to placement of a ventriculoperitoneal shunt on the right side (Fig. 3). Initial Glasgow Coma Scale scores were 3 to 5. The catheter was removed after 7 days without complications.

Chronic Subdural Collections

Three patients over 50 years of age presented with an acutely obtunded mental status; CT-demonstrated diagnosis of subdural hygromas was made. Because of cerebral atrophy, even in the presence of ventricular enlargement, there was no clear evidence of elevated ICP. In four other patients over 50 years of age in whom chronic subdural hematomas were treated by limited craniectomy and in-

TABLE 2

Data obtained in 30 cases of head trauma without ICP monitoring

Grade*	Outcome/Discharge		
	Died	Rehab Center	Home
Grade III (24 patients)	1	18	5
Grade IV (6 patients)	6	0	0

* Grading scale presented by L. I. Malis.⁹

section of a Jackson–Pratt drain, the reaccumulation of fluid in the subdural space reversed their neurological recovery. All seven patients (Table 4) were treated by placing a Pudenz ventricular catheter in the subdural space. When no craniectomy site was available, a single burr hole was made in the right-sided parietal area with a hand drill. About 4 cm of tubing was tucked into an 8-cm subgaleal pocket created above the pericranium. The shunts were removed after 10 to 14 days without complications.¹⁵

RESULTS

Hypertensive Hydrocephalus

Eight of the 22 patients died within 72 hours. Temporary drainage of CSF for several weeks provided emergency decompression of the ventricular system with no syphon effect in the other 14 patients. Fibrotic processes progressively stopped the absorption after longer periods. While the subgaleal pocket was soft and fluctuant, simple palpation demonstrated that the ICP was low. If the collection became tense, the galeal and periosteal membranes were no longer able to handle the underlying uncorrected disease. Eight of the 14 patients improved (Table 1). The shorter-length catheter was easily removed for insertion of a ventriculoperitoneal or ventriculoatrial shunt in six cases that had to be converted. There were no complications of wound infection or intraparenchymal hemorrhage.

Acute Head Trauma

In the first 30 cases in which a shunt was inserted without a monitor (Table 2) as presented by L.I.M.,⁹ CT evidence of compressed ventricles and cerebral contusion correlated well with increased ICP.¹⁹ Six patients categorized as having a Grade IV (no evidence of brain function) in the emergency room did not improve and died within 72 hours. The remaining patients had Grade III function (no eye opening, no verbal response, and motor response limited to abnormal flexion or extension) and were transferred to a rehabilitation center; the exception was a 16-year-old boy who suffered a fatal pulmonary embolus on the 30th postoperative day. Each patient was fed via a tube after 3 days of hospitalization. In 12 cases, tracheostomy was required. Subgaleal collections of fluid persisted for 3 to 5 days—the period of brain swelling. The reduction in ICP was evident by immediate improvement in neurological status; hyperventilation, hypertension, and hyperther-

Fig. 1. Artist's drawing showing the ventriculosubgaleal shunt.

Fig. 2. Computerized tomography scans obtained in patients with acute head trauma. *Left:* Narrowing of ventricular system can be seen. *Center:* Note the blood in relation to left lateral ventricle. *Right:* The catheter is properly positioned. Note the small high-density foci representing areas of cerebral contusion.

mia resolved. In three patients with rhinorrhea CSF stopped leaking from the nose after shunting.

The initial pressure was over 20 mm Hg (normal < 10 mm Hg) in the 22 patients who were monitored (Table 3). The recorded ICP in 19 cases remained within normal range for the 72 hours of monitoring after a single intravenous dose of mannitol. Three of the six patients who died had required additional intravenous doses of mannitol to maintain the ICP below 20 mm Hg. Eight patients required tracheostomy and gastrostomy. One patient regained normal cortical function during her hospitalization for multiple trauma. After 2 to 6 months of rehabilitation and occupational therapy, 15 patients were discharged

home in the care of their families. Follow-up CT scans in the six cases in whom brain death was diagnosed within 3 days revealed extensive hemorrhagic infarction (Fig. 4 *left*) rather than resolution and absorption of areas of contusion (Fig. 4 *right*). In nine patients with basilar skull fractures CSF ceased leaking after shunting.

Chronic Subdural Collections

Two of the three patients in whom bilateral subdural hygromas were demonstrated on admission on CT scans had minimal filling of the subgaleal pocket and no neurological improvement. In one of these patients and in all four patients with recurrent subdural hematomas, the sub-

TABLE 3
Data obtained in 22 cases of head trauma with ICP monitoring

Age (yrs), Sex	GCS Score	Complication	ICP (mm Hg)		Tracheostomy, Gastrostomy	Outcome/ Discharge
			Initial	Postshunt		
23, F	4	otorrhea	25	0–5	no	home
30, M	5		26	3–10	no	rehab center
32, M	3	C-2 fracture	28	3–10	yes	died (72 hrs)
19, M	5	brachial plexus avulsion	31	0–7	yes	rehab center
70, F	3	prior left CVA	27	0–4	no	died (72 hrs)
44, F	5	ovarian carcinoma	52	0–8	yes	rehab center
16, F	4	hemothorax	29	2–10	yes	rehab center
16, M	5	rhinorrhea	28	0–8	no	rehab center
15, F	3	rhinorrhea	82	6–18*	yes	died (72 hrs)
29, F	3	otorrhea	52	2–10	no	died (72 hrs)
61, M	5		38	3–10	yes	rehab center
50, M	5		21	0–6	no	rehab center
30, M	5		32	0–8	yes	rehab center
22, M	3	otorrhea	80	4–16*	no	died (72 hrs)
18, M	5		21	2–10	no	rehab center
31, F	5		24	0–6	no	rehab center
19, M	5		28	0–7	no	rehab center
17, F	4		30	2–10	yes	rehab center
63, F	5	otorrhea	77	5–10	no	rehab center
15, M	4		30	0–7	no	rehab center
40, M	4		57	0–4	no	died (72 hrs)
16, M	4		40	0–9	no	rehab center

* Insertion delayed due to coagulopathy. Abbreviations: CVA = cerebrovascular accident; GCS = Glasgow coma scale.

Fig. 3. Artist's drawing showing the ICP monitor in the left frontal area and right subgaleal shunt.

galeal collection remained tense and resolved over a 10 to 14-day period; signs of elevated ICP resolved in all five cases (Table 4).

DISCUSSION

Perret and Graf¹³ did not list any references following their article in 1977; but in a response¹⁴ to a letter to the editor written by Ferreira,⁵ they reviewed the prior neurosurgical literature on subgaleal shunts.^{2,3,6,21} Malis,¹⁰ commenting on ventriculosubgaleal shunting and ventriculostomy-related infections in a paper by Holloway, et al.,⁷ indicated that open drainage was consistently avoided at The Mount Sinai Hospital over a 25-year period. This practice had been taught by Professor Jean Michel Gybels of Belgium (see Malis⁹). In their response, Holloway et al.,⁸ while recognizing the advantage of a closed system for ventricular drainage to avoid infection, raised the question of efficacy and the potential for back pressure once the subgaleal pocket had filled.

The absorptive capacity of the subgaleal space has been well documented.^{3,4,13} Inasmuch as high-pressure hydrocephalus was controlled for periods of 3 weeks up to several months, the membranes of the scalp contributed to handling high volume and reducing CSF pressure to normal range. In other patients with intracranial hematomas, midline shifts, and extensive cerebral contusion, leakage into the subgaleal space following decompressive craniectomy could not decrease elevated ICP even with hypnotic, hyperventilation (hypocarbica), hypothermia, and intermittent mannitol therapies. Which of the many factors,

such as normal circulation (choroid plexus formation, transependymal absorption, arachnoid villus transport, and elastance) and compliance of the brain, influenced CSF perfusion cannot be determined.¹²

Although attempts to cannulate slitlike ventricles may induce intracerebral bleeding,¹⁶ no postoperative shunt placement-related hemorrhages were demonstrated on follow-up CT scans. The shunts were removed after 1 week to avoid formation of a subdural hygroma; tracking of fluid around the tubing may occur with or without obstruction of catheters left in place.^{4,14,20} Successful treatment of CSF fistulas by indirect shunting rather than direct repair has been documented in the neurosurgical literature.^{2,6}

In the cases requiring shunting of the subdural space, persistence of the subgaleal collection up to 10 to 14 days was consistent with increased ICP, whereas early resolution was diagnostic of a preexisting hygroma. Avoidance of open draining systems eliminated the sequela of tension

Fig. 4. Computerized tomography scans. *Left:* Areas of diffuse contusion have coalesced into multiple intracerebral hematomas. *Right:* The ventricles have returned to normal size and configuration. Note the resolution of contusion.

TABLE 4

Outcome in seven cases of chronic subdural hematoma after shunting

Shunt Placement	Improved	Unimproved
primary bilateral (3 patients)	1	2
secondary unilateral (4 patients)	4	0

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pneumocephalus. Perret and Graf¹³ described the use of multiple taps of the subgaleal pocket for diagnostic and therapeutic purposes. Absorption and resolution in the seven patients with chronic subdural collections were monitored only by serial CT scans.¹⁵

Ventriculosubgaleal shunting can act as a safety valve for continuous reduction of elevated ICP in patients with closed head injuries. The subgaleal space is able to provide adequate drainage and absorption of CSF during the period of traumatic brain swelling. Insertion and removal of the device may be performed rapidly after induction of minimal anesthesia. Avoidance of the exteriorized tubes and receptacles necessary in more elaborate methods of treating increased ICP significantly lowers the risk of infection and can be readily incorporated into the intensive nursing care of comatose patients. Certainly, ICP monitoring over a 72-hour period lends credence to the efficacy of such shunting. The simple method of using the membranes of the scalp for the temporary relief of elevated ICP has broad application in acute head trauma, hypertensive hydrocephalus, and chronic subdural fluid collections.

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Manuscript received September 12, 2000.

Accepted in final form October 4, 2000.

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