

Continuing Experience with Subgaleal Shunting

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Abstract

Objective: To evaluate subgaleal shunting — the diversion of cerebrospinal fluid into the subgaleal space for temporary absorption by the membranes of the scalp.

Method: Eighty-one (81) patients were treated over a 20-year period. There were 22 cases of hypertensive hydrocephalus, 52 cases of acute head trauma, and 7 cases of chronic subdural hematoma. The simple surgical technique is described.

Results: Of the eighty-one patients, 33 improved, 27 did not change, and 21 expired within 72 hours. Intracranial pressure was monitored directly in 22 cases and demonstrated that subgaleal shunting provided effective short-term treatment.

Conclusions: This simple, 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.

SUBGALEAL SHUNTING was first described by von Mikulicz (1) in 1896. In 1929, Davidoff (2) reviewed the technique for the relief of hydrocephalus. Chronic postoperative cerebrospinal fluid fistulae were subsequently treated by ventriculosubcutaneous drainage (3, 4) before Perret and Graf (5) 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. Malis (7) advocated the avoidance of exteriorized tubes and receptacles to decrease the risk of infection associated with open ventriculostomy. Drabkin et al. (8) performed a series of 15 ventriculosubgaleal shunts by a frontal approach with patients with ventricular dilatation. The use of ventriculosubgaleal shunting in acute head trauma was first presented to the New York Society of Neurosurgery by Savitz in 1981 and published in 1983 (9). The

purpose of this paper is to review and evaluate continuing experience with subgaleal shunting.

Materials and Methods

Hypertensive Hydrocephalus

Rapid increase in ventricular size, with evidence of periventricular lucencies (10) on computerized tomography, correlated well with increased intracranial pressure (ICP) in 7 patients with hemorrhagic intracranial tumors and 15 patients with subarachnoid and intraventricular hemorrhage (Table 1). After a regular trephine opening in the right 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 intracranial pressure (ICP) was attempted in 30 cases (Table 2) of severe closed head injury treated over a 10-year

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TABLE 1
22 Cases of Hypertensive Hydrocephalus

	number	expired	permanent shunt	rehab center	home
Hemorrhagic tumors	7	-	3	2	5
Subarachnoid/intraventricular hemorrhage	15	8	3	4	3

TABLE 2
30 Cases of Head Trauma without ICP Monitoring

	number	expired	rehab center	home
Grade III	24	1	18	5
Grade IV	6	6	-	-

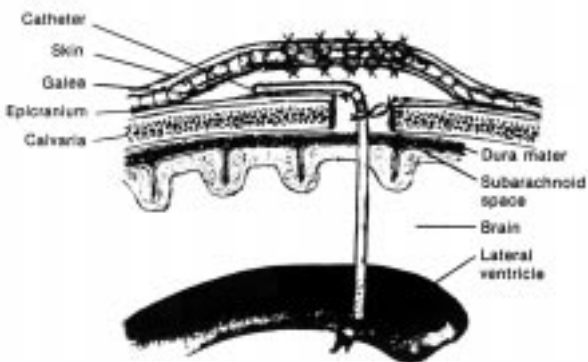


Figure. Artist's drawing of ventriculosubgaleal shunt.

period (12). All of the patients manifested signs of increased ICP and brainstem compression. Cushing's triad (bradycardia, bradypnea, and hypertension) was recorded in each case. There were no focal findings on neurologic examination and no vault fractures on skull x-rays. Dexamethasone 100 mg and 500 mL of 10% mannitol were given intravenously in the emergency room. Immediate intubation facilitated hyperventilation, and further evaluation was carried out by computerized tomography (CT) scan. Neither hematoma nor midline shift was seen in any of the patients. The ventricles were slit-like, and vesicular hemorrhage in white matter or blood in the ventricular system, or subependymal bleeding, was visualized.

The small ventricles were tapped by a right frontal approach just anterior to the coronal suture, which was made with a hand drill. The cerebrospinal fluid obtained under pressure was 10–20 cc in volume and grossly hemorrhagic. A Pudenz ventricular catheter was inserted, 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 available (11), the device was inserted into the left frontal subarachnoid space of 22 patients (Table 3) prior to placement of a ventriculoperitoneal shunt in the right frontal lobe. Initial Glasgow Coma Scale ratings were 3–5. The catheter was removed after 7 days without complications.

Chronic Subdural Collections

Three patients over 50 years of age in Savitz's (10) series presented with an acutely obtunded mental status and were diagnosed as having bilateral subdural hygromas on CT. Because of cerebral atrophy, even in the presence of ventricular enlargement, there was no clear evidence of elevated ICP. Four other patients over 50 years of age, who had undergone drainage of chronic subdural hematomas by limited craniectomy and insertion of a Jackson-Pratt drain, reaccumulated fluid in the subdural space and reversed their neurologic recovery. All 7 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 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 10–14 days without complications (11).

Results

Hypertensive Hydrocephalus

Eight of the 22 patients expired within 72 hours. Temporary drainage of cerebrospinal fluid

TABLE 3
22 Cases of Head Trauma with ICP Monitoring

sex	age	Glasgow Coma scale	complications	initial ICP	post shunt ICP	tracheostomy gastrostomy	outcome
F	23	4	otorrhea	25	0–5	no	home
M	19	4		31	3–10	no	rehab center
M	30	5		26	3–10	no	rehab center
M	32	3	C2 fracture	28	3–10	yes	expired (72 hours)
M	19	5	brachial pl avulsion	31	0–7	yes	rehab center
F	70	3	old left CVA	27	0–4	no	expired (72 hours)
F	44	5	ovarian carcinoma	52	0–8	yes	rehab center
F	16	4	hemothorax	29	2–10	yes	rehab center
M	16	5	rhinorrhea	28	0–8	no	rehab center
F	15	3	rhinorrhea	82	6–18*	yes	expired (72 hours)
F	29	3	otorrhea	52	2–10	no	expired (72 hours)
M	61	5		38	3–10	yes	rehab center
M	50	5		21	0–6	no	rehab center
M	30	5		32	0–8	yes	rehab center
M	22	3	otorrhea	80	4–16*	no	expired (72 hours)
M	18	5		21	2–10	no	home
F	31	5		24	0–6	no	rehab center
M	19	5		28	0–7	no	rehab center
F	17	4		30	2–10	yes	rehab center
F	63	5	otorrhea	77	5–10	no	rehab center
M	40	4		57	0–4	no	expired (72 hours)
M	16	4		40	0–9	no	rehab center

* insertion delayed due to coagulopathy
Adapted from Reference 11.

TABLE 4
7 Cases of Chronic Subdural Hematoma

	number	improved	unimproved
primary bilateral	3	1	2
secondary unilateral	4	4	-

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 pathology. Eight of the 14 patients improved (Table 1). The shorter catheter was easily removed for insertion of a ventriculoperitoneal or ventriculoatrial shunt in 6 cases that had to be converted. There were no complications of wound infection or intraparenchymal hemorrhage.

Acute Head Trauma

In the first 30 cases shunted without a monitor (Table 2), CT evidence of compressed ventri-

cles and cerebral contusion correlated well with increased ICP (13). Six patients categorized as grade IV (no evidence of brain function) in the emergency room did not improve and died within 72 hours. The remaining patients, categorized as grade III (no eye opening, no verbal response, motor response limited to abnormal flexion or extension), were transferred to a rehabilitation center, with the exception of one 16-year-old boy who suffered a fatal pulmonary embolus on his 30th postoperative day. Every patient was tube fed after the third day of hospitalization. In 12 cases, tracheostomy was required. Subgaleal collections of fluid lasted 3–5 days — the period of brain swelling. The reduction in ICP was revealed by immediate improvement in neurological status; hyperventilation, hypertension, and hyperthermia also resolved. Three patients with rhinorrhea stopped leaking cerebrospinal fluid from the nose after shunting.

The initial pressure was over 20 torr (normal < 10 torr) in the 22 cases that were monitored (Table 3). The recorded ICP in 19 cases remained in normal range for the 72 hours of monitoring after a single IV dose of mannitol. Three of the 6 patients who expired had required additional intravenous doses of mannitol in order to maintain the ICP below 20 torr. Eight patients

required tracheostomy and gastrostomy. One patient regained normal cortical function during her hospitalization for multiple trauma. After 2–6 months of rehabilitation and occupational therapy, 15 patients were discharged home to the care of their families. Follow-up CT scans in the 6 cases who met brain death criteria within 3 days showed extensive hemorrhagic infarction rather than resolution and absorption of areas of contusion. Nine patients with basilar skull fractures ceased leaking cerebrospinal fluid after shunting.

Chronic Subdural Collections

Two of the 3 patients presenting with bilateral subdural hygromas on CT had minimal filling of the subgaleal pocket and no neurological improvement. In one patient with chronic bilateral subdural hygromas and in all 4 patients with recurrent subdural hematomas, the subgaleal collection remained tense and resolved over a 10–14 day period; signs of elevated ICP resolved in all 5 cases (Table 4).

Discussion

Perret and Graf (6) did not list any references following their article in 1977; but in a response (14) to a letter to the editor by Ferreira (15), they reviewed the prior neurosurgical literature on subgaleal shunts (1, 3–5). Malis (7), commenting on ventriculosubgaleal shunting and ventriculostomy infections in a paper by Hollaway et al. (16), stated that open drainage was consistently avoided at The Mount Sinai Hospital. This practice had been taught by Professor Jean Michel Gybels of Belgium (17). Hollaway et al. (18), in their response, recognized the advantage of a closed system for ventricular drainage in order to avoid infection, but 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, 6, 8). Inasmuch as high-pressure hydrocephalus was controlled for periods of from 3 weeks up to several months in our series, the membranes of the scalp must have contributed to handling the high volume of cerebrospinal fluid that reduced 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 hypnotics, hyperventilation (hypocarbia), hypothermia, and intermittent mannitol. Which of many

factors, such as normal circulation, choroid plexus formation, transependymal absorption, arachnoid villus transport, and elastance and compliance of the brain, influence cerebrospinal fluid perfusion has not been determined (19).

While attempts to cannulate slit-like ventricles may produce intracerebral bleeding, no post-operative hemorrhages due to shunt placement were seen on follow-up CT scans. The shunts were removed after one 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 (8, 14, 20). Successful treatment of cerebrospinal fluid fistulae by indirect shunting rather than direct repair has been documented in the neurosurgical literature (4, 5).

In the cases requiring shunting of the subdural space, persistence of the subgaleal collection for up to 10–14 days was consistent with increased ICP, while early resolution was diagnostic of a preexisting hygroma. Avoidance of open drains eliminated the sequela of tension pneumocephalus. Perret and Graf (6) described multiple taps of the subgaleal pocket for diagnostic and therapeutic purposes. Absorption and resolution in the 7 patients with chronic subdural collections were monitored only by serial CT scans (11).

Conclusion

Ventriculosubgaleal shunting can act as a safety valve for continuous reduction of elevated ICP in closed head injuries. The subgaleal space is able to provide adequate drainage and absorption of cerebrospinal fluid during the period of traumatic brain swelling. Insertion and removal of catheters may be performed rapidly using minimal anesthesia. Avoidance of the exteriorized tubes and receptacles inherent in more elaborate methods of treating increased ICP lowers the risk of infection and facilitates 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 employing the membranes of the scalp for the temporary relief of elevated ICP has widespread application in acute head trauma, hypertensive hydrocephalus, and chronic subdural collections.

References

1. von Mikulicz J. Beiträge zur Pathologie und Therapie des Hydrocephalus. *Mitt Grenzgeb Med Chir* 1896; 1:264–301.
2. Cushing H. *Studies in intracranial physiology and surgery*. London: Oxford University Press; 1928. pp. 28–29.

3. Davidoff LM. Treatment of hydrocephalus: Historical review and description of a new method. *Arch Surg* 1929; 18:1737–1742.
4. Dardenne G. Le traitement par le drainage ventriculaire sous-cutane des fistules de liquide céphalo-rachidien postopératoires rebelles. *Acta Neurol Belg* 1964; 64:1202–1211.
5. Ferreira NP, Correa J. Derivação liquorica ventriculo-subcutanea na terapeutica cirurgica das fistulas liquoricas post-operatorias rebeldes. *Neurobiologica* 1972; 35:97–104.
6. Perret GE, Graf CJ. Subgaleal shunt for temporary ventricle decompression and subdural drainage. *J Neurosurg* 1977; 47:590–594.
7. Malis LI. Ventriculostomy or subgaleal shunting? [letter]. *J Neurosurg* 1997; 87:486.
8. Drabkin AJ, Levine ME, Yang WC. Ventriculo-subgaleal shunt: Evaluation by computed tomography. *Acta Neurochir (Wien)* 1980; 55:107–115.
9. Savitz MH, Katz SS. Ventriculoperitoneal shunting for acute head trauma. *Crit Care Med* 1983; 11:290–293.
10. Mori K, Murata T, Nakano V, Handa H. Periventricular lucency in hydrocephalus on computerized tomography. *Surg Neurol* 1977; 8:337–340.
11. Savitz MH. Another look at ventriculosubgaleal shunting. *Mt Sinai J Med* 1997; 64:189–193.
12. Savitz MH. Ventriculosubgaleal shunting for acute head trauma. 10 years' experience. *J Neurol Orthop Med Surg* 1991; 12:205–208.
13. Tabaddor K, Danziger A, Wisoff HS. Estimation of intracranial pressure by CT closed head trauma. *Surg Neurol* 1982; 18:212–215.
14. Perret GE, Graf CJ. Subgaleal shunt for ventricular and subdural drainage [letter]. *J Neurosurg* 1978; 49:474–475.
15. Ferreira NP. Subgaleal shunt for ventricular and subdural drainage [letter]. *J Neurosurg* 1978; 49:474.
16. Holloway KL, Barnes T, Choi SC, et al. Ventriculostomy infections: The effect of monitoring duration and catheter exchange in 584 patients. *J Neurosurg* 1996; 85:419–424.
17. Malis LI. *Acoustic neuroma*. Amsterdam, The Netherlands: Elsevier Science; 1998.
18. Hollaway K, Bullock R, Marmarou A. Ventriculostomy or subgaleal shunting? [letter]. *J Neurosurg* 1997; 87:486.
19. Pappenheimer JR, Heisey SR, Jordan EF, et al. Perfusion of the cerebral ventricular system in unanesthetized goats. *Am J Physiol* 1962; 203:763–774.
20. Verbeke L, Calliauw L. Cerebrospinal fluid oedema: A rare complication of the ventriculo-subgaleal shunt. *Neurochirurgia (Stuttgart)* 1987; 30:99–101.