External ventricular drainage for control of posthemorrhagic hydrocephalus in premature infants

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Over a 3-year period, 11 premature infants with intraventricular hemorrhage and posthemorrhagic hydrocephalus were managed initially with prolonged external ventricular drainage via a subcutaneously tunneled catheter. The mean duration of drainage for this group was 20.7 days. Although two patients died before shunting was considered, no morbidity or mortality was observed to result from this technique. Seven patients required a shunt after stabilization of their medical problems. Two patients, followed for 24 and 40 months, have not required shunting procedures. External ventricular drainage via a subcutaneously tunneled catheter has been found to be a safe and reliable initial method of treating posthemorrhagic hydrocephalus in premature infants.

KEY WORDS: intraventricular hemorrhage • posthemorrhagic hydrocephalus • prematurity • ventriculostomy

Intraventricular hemorrhage (IVH) is the most common neuropathological entity found in premature infants. Although IVH is associated with a high mortality rate, many of these infants will survive the acute event. Of the survivors, at least 80% have been found to develop posthemorrhagic hydrocephalus (PHH). Unfortunately, IVH is invariably associated with other serious medical problems, and the initial management of these severely compromised neonates is controversial.

Experience has shown that the initial management of these patients should be directed toward control of intracranial pressure (ICP) and prevention of hydrocephalus. Although these goals could be achieved by a functioning internalized shunt, such a procedure may be hazardous in these premature infants. Because of our satisfactory experience with prolonged ventricular drainage via a subcutaneously tunneled external drain, it was thought that this technique might offer these infants the advantages of shunting without the attendant disadvantages. We report our experience with 11 premature infants with IVH and acute PHH.

Summary of Cases

Clinical Material

During the 3-year period from August, 1977, through August, 1980, we participated in the management of 11 premature infants with IVH and PHH. The IVH was categorized as Grades III and IV. Gestational age ranged from 25 to 35 weeks, with a mean of 30 weeks. Birth weight ranged from 880 to 1900 gm, with a mean of 1323 gm. There were 10 male infants and one female. In all infants, the diagnosis of IVH and PHH was made by computerized tomography (CT) brain scans.

In addition to IVH and PHH, 10 of the 11 patients (91%) had respiratory dysfunction secondary to respiratory distress syndrome, or Group B beta hemolytic streptococcal pneumonia. Seven (64%) had pneumothorax and/or pneumomediastinum. Intracerebral hemorrhage extending beyond the subependymal area was found in five patients (45%), and 10 patients (91%) had seizures. Other associated medical problems included systemic sepsis, congestive heart failure, and renal failure. Two patients died of cardiovascular...
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TABLE 1
Summary of clinical data for 11 premature infants in this series

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<tr>
<th>Case No.</th>
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* Total days of external drainage were 228; mean 20.7 days.

failure. A summary of the patient profiles is found in Table 1.

Operative Technique

With the infant restrained in a supine position, the forehead is aseptically prepared and draped. A point at the hairline above the right midpupillary line is infiltrated with local anesthetic (1% xylocaine). Care is taken to anesthetize the pericranium. The anesthetic agent is then infiltrated across the forehead.

Through a small transverse incision, a right frontal twist-drill hole is made. A metal trocar (Fig. 1) is used to puncture the dura and pia arachnoid. The frontal horn of the right lateral ventricle is then catheterized. The ventricular catheter is radiopaque Silastic, 38 cm long, 3 mm in outer diameter, and 1 mm in inner diameter, with a metal stylet (Fig. 1). The catheter, with the stylet in place, is introduced into the ventricle, and the cerebrospinal fluid (CSF) pulsation is easily seen through the tubing. The catheter is then advanced about 2 cm further as the stylet is removed. The free end of the catheter is then attached to the trocar, which has a reversed flanged end to hold the catheter securely. The sharp end of the trocar is inserted into the wound and tunneled subcutaneously across the forehead before being brought out through the skin. Extra tubing is then drawn through the tunnel until none protrudes from the initial incision. The catheter is anchored by a stitch at the exit site, and the free end is connected to a medium-pressure Hakim valve which is in turn connected to a sterile collection bag.* Catheter placement is illustrated in Fig. 2. All connections are secured with 0 silk ligatures, and an antibiotic ointment is applied at the exit site. The incision is closed with a single layer of 4-0 prolene suture. No dressings are used.

* Ventricular catheter and collection bag manufactured by Extracorporeal Medical Specialties, Inc., Royal and Rose Roads, King of Prussia, Pennsylvania.

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and ICP was not recorded or used to determine shunt dependence.

Results

Ventricular size was monitored by repeat CT brain scan and was found to be reduced in all patients who survived following ventriculostomy. The duration of drainage ranged from 2 to 41 days, with a mean of 20.7 days.

Of the 11 patients, two (Cases 5 and 10) died. Ventricular drainage of grossly bloody CSF was carried out for 2 days in Case 5. Postmortem examination in that patient revealed evidence of renal failure and severe cardiopulmonary disease, as well as IVH and PHH. Death was attributed to cardiovascular collapse secondary to the above disorders. Cultures of CSF, before and after death, were negative.

In Case 10, adequate ventricular drainage was never established because of a clot and debris in the catheter. Drainage was discontinued after 3 days, and the infant subsequently died with Acinetobacter anitratus septicemia, apnea, and cardiovascular collapse. A CT scan revealed a massive left hemisphere infarction. Permission for postmortem examination was denied.

Of the nine survivors, two (22%) were found to be independent of ventricular drainage, and did not require a shunt. These two patients have been followed for 40 and 24 months, and continue to be shunt-independent as determined by clinical examination and CT scan. The other seven surviving patients required VP shunts for control of hydrocephalus.

No morbidity or mortality was observed with this technique in these patients. No patients were noted to have epidural, subdural, or intracerebral hemorrhages associated with passage of the ventricular catheter. One positive bacterial culture, a Klebsiella species, was obtained from the collection bag in Case 1. However, the patient showed no clinical evidence of ventriculitis, and simultaneous cultures drawn from the aspiration port in the tubing were sterile. We believe this was a contaminant.

In one patient (Case 3), CSF was noted to leak from the exit site in the forehead following removal of the ventricular drain. A single stitch was placed half-way between the forehead incision and the exit site, encircling the subcutaneous tunnel. No further leak was observed.

All patients who required shunts tolerated the procedure well under general anesthesia after stabilization of their medical problems. One patient (Case 9) developed a Staphylococcus epidermidis infection of his VP shunt, which necessitated removal of the shunt and reinstitution of external drainage. All CSF cultures before his shunting procedure had been sterile. Although it is likely that the shunt was contaminated at the time of placement, a subclinical infection during external drainage cannot be excluded, despite negative cultures. We believe it would have been prudent...
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to remove the drain 2 to 3 days before shunt placement.

Discussion

Neonatal IVH occurs primarily as a result of hemorrhage in the germinal matrix of premature infants during the first 3 postpartum days.\textsuperscript{1,2,9,16-18} Hydrocephalus has been noted in 80% to 85% of infants after IVH,\textsuperscript{6,18} although a tense fontanel, spread sutures, or increasing head circumference may not be present for days to weeks following the hemorrhage.\textsuperscript{1,5,18,19} As more premature infants survive with intensive neonatal care, the problem of PHH becomes more prevalent.\textsuperscript{8,10}

Clinical and experimental evidence suggests that prompt treatment of PHH would benefit these infants.\textsuperscript{3,8,11-13,17-19} However, IVH is invariably associated with other problems of prematurity, particularly respiratory distress syndrome,\textsuperscript{2} and definitive surgical therapy is often delayed until the infant is better able to undergo operation.\textsuperscript{6,18,19} Prompt treatment to decrease ICP and reduce ventriculomegaly in premature infants may be even more important than experimental evidence indicates. Impaired autoregulation in stressed neonates may result in hypoxic brain injury with any decrease in cerebral perfusion pressure,\textsuperscript{7,5,17,18} and the effects of hydrocephalus on the still dividing cell population of the periventricular germinal matrix are unknown. The poor prognosis associated with IVH of Grades III and IV may be due in part to delay in treating PHH.\textsuperscript{19}

An ideal method of treatment should pose minimal risks for the infant while providing continuous control of ventriculomegaly and ICP. Removal of blood and elevated protein may also be important in preventing permanent shunt dependence.\textsuperscript{10} Although a well functioning internalized shunt meets these criteria, we believe that our approach offers some advantages not available with an internalized shunt. Functional integrity of this system is easily determined by monitoring CSF flow and valve filling, and occult shunt malfunction is avoided. Ventriculostomy is easily performed under local anesthesia in the neonatal intensive care unit, and the problems of scalp necrosis and distal catheter obstruction are not encountered. Shunt dependence is determined before placement of an internalized shunt; and, if such a procedure is needed, it can be performed under optimal conditions after stabilization of the patient's medical problems, without compromising early treatment.

The disadvantages of external drainage have been sepsis and catheter dislodgement.\textsuperscript{14,20} However, Saunders and Lyons\textsuperscript{14} showed that with a subcutaneously tunneled catheter, these risks could be reduced. Friedman and Vries\textsuperscript{4} had similar results with modification of this technique. In this series, the mean duration of drainage was 20.7 days, without dislodgement or sepsis.

The effect of external ventricular drainage on permanent shunt dependence is unknown. Removing blood and protein from the CSF might reduce the number of infants requiring permanent shunts. Conversely, an alternative pathway for CSF flow might lead to aqueductal changes, producing an obstructive hydrocephalus. We can draw no conclusions as to the effect of ventricular drainage on shunt dependence. We believe however, that drainage should not be continued indefinitely in the hope of eventual shunt independence. If the infant is medically stable, has clear CSF, and requires ventricular drainage for control of hydrocephalus, a shunt should be placed. Hospital stay was not lengthened by this approach, as the infants so treated required continued care for other medical problems.

In the final analysis, the value of this method of treatment will be determined by the quality of life of surviving infants. A follow-up study of these patients will be undertaken.

Conclusions

1. Premature infants with intraventricular hemorrhage and posthemorrhagic hydrocephalus (PHH) may benefit from prompt intervention for control of PHH.

2. External ventricular drainage via a subcutaneously tunneled catheter is a safe and reliable method for initial control of PHH.

3. The effects of external ventricular drainage on eventual shunt dependence and neurological development are not known.

References


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