Case Reports and Technical Note
Post-Traumatic Porencephaly in Infancy
A Report of Three Unusual Cases

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A good deal of confusion exists concerning the term porencephaly which was first used by Heschl in his report in 1859. Pseudoporencephaly and ventricular diverticula are but two of the expressions applied to variations in the appearance of these lesions. In an effort to avoid misunderstanding, Drew and Grant entitled their report "Benign Cysts of the Brain." For the purpose of this discussion we have used the term as defined by LeCount and Semarak, "a defect communicating with the ventricles or separated from them by a thin layer of brain tissue and covered on the outside by arachnoid." The etiology of such cysts is diverse and may be broadly classified as developmental or acquired. In his excellent review of the literature, Naeff has noted the changing views concerning the pathogenesis of this condition. Acquired porencephaly is due to destruction of cerebral tissue at any time and from various causes such as trauma, circulatory disturbances, or inflammatory or degenerative processes.

The importance of trauma at birth or in the neonatal period was emphasized by Jaffé in 1929. His case was that of a 20-year-old woman who had suffered severe trauma shortly after birth. Since that time few reports of porencephaly following trauma in infancy have appeared. In the series of Drew and Grant only 1 of the 30 cases fitted into this category, and in 2 other series the incidence was only 2 in 52 and 1 in 32. In the relatively short period of 6 months we have had the opportunity of seeing 3 unusual cases of porencephaly occurring in infancy. Each of these appears to be traumatic in origin, and these cases form the basis of this report.

Case Reports

Case 1. An 18-month-old white female was admitted to the District of Columbia Children's Hospital for repair of a leptomeningeal cyst. The child had been well until the age of 5 months when she was involved in an auto accident. In addition to a fractured femur, she had fractures of the left parietal and right frontal bones, the former depressed, the latter linear.

Twenty-four hours after the accident the depressed parietal fracture was elevated. In the postoperative period the child was irritable and ran a low grade temperature for several days. Lumbar puncture at this time disclosed bloody fluid. The child gradually improved and after 1 week the parietal skin stitches were removed. On the 10th hospital day a soft swelling was noted to the right of the anterior fontanelle. This was felt to be due to the frontal fracture. A pressure dressing was applied with an elastic bandage. Since the child was asymptomatic except for the swelling, she was discharged from the hospital. The mother was instructed in the rewrapping of the pressure dressing.

The child was next seen 1 month later. The swelling had diminished considerably in size. The mother was advised to continue the pressure dressing, but to return in 1 month if the swelling persisted. The child was not seen again for 11 months. When she returned the swelling had increased in size and a large irregular bony defect could be palpated in the area of the anterior fontanelle and to the right extending into the right frontal bone. The swelling measured 3X4 cm. It was soft and did not transilluminate. The child was admitted for excision and repair of what was felt to be a leptomeningeal cyst.

At the time of surgery a coronal incision was made. After the skin had been dissected from the lesion a fine needle was inserted and clear colorless fluid was obtained. The dome of the cyst was then opened and the cavity was seen to have a glistening white lining. Upon opening the ventral aspect of the cavity a large porencephalic cyst was encountered. One could look through the cyst into the foramen of Monro. Along the dorsal margins of the cyst the brain was adherent to the arachnoid and dura. The dural defect was closed with a fascial graft and the scar tissue was imbricated over the defect.

The patient made an uneventful postoperative recovery and was discharged from the hospital on the 8th postoperative day. She returned 11 weeks later; at this time a pneumoencephalogram graphically demonstrated the lesion (Fig. 1).

Follow up through the next 8 months revealed progressive closure of the bony defect with the soft tissue being sunken and firm indicating that the seal was adequate. The patient was bright for her age and talked normally. The only neurological residual was a slight hyperreflexia on the left side.

Comment. This patient appears to have had a laceration of the right frontal cerebrum and its covering membranes at the time of the original injury. The recognition of the severity of the damage was somewhat obscured by the location.
of the lesion as well as by the presence of the depressed left parietal fracture and the fracture of the left femur. The presence of intracranial bleeding was established by the lumbar puncture; however, whether or not a localized hematoma existed is not known. Earlier closure of the dural defect probably would have resulted in a smaller cavity.

Similar cases have been presented and discussed under a variety of titles, including "Growing Skull Fractures of Childhood"\textsuperscript{12} and "Leptomeningeal Cysts . . . ."\textsuperscript{9,13}

Case 2. An 11-day-old white female infant was transferred to District of Columbia Children's Hospital with a diagnosis of hydrocephalus and meningitis. The mother stated that her pregnancy had been unremarkable until 3 weeks prior to delivery when the membranes spontaneously ruptured. Since she was not under medical supervision, no antibiotic therapy was given during this interval. Delivery was uncomplicated.

The birth weight was 4 lb. 13 oz. The head circumference was 29.5 cm., the chest circumference was 29.0 cm. Physical examination shortly after birth was said to be normal. Because of the threat of infection, specimens of blood and urine and a pharyngeal smear were taken for culture and the infant was started on antibiotics. No growth was reported on any of the cultures after 3 days.

The child appeared to be progressing well and after 7 days the antibiotics were discontinued. Two days later the child began vomiting and the fontanelle was noted to be bulging. Cultures were again taken and antibiotics were resumed. Lumbar puncture was unsuccessful. At the time of transfer to the Children's Hospital, the head circumference had increased to 34.5 cm., an increase of 5 cm. in 11 days.

After admission to the Children's Hospital, several attempts were made to perform a lumbar puncture. When these attempts failed, ventricular puncture was performed. A pressure of 300 mm. of water was recorded and xanthochromic fluid was recovered. The protein was 236 mg./100 ml. and sugar was 32 mg./100 ml. No cells were present. Gram and acid fast stains of concentrated smears were negative as was an India ink preparation.

During the next 20 days of her hospitalization, 8 ventricular punctures were performed. Cultures and smears were made from these specimens and fluid was sent to other laboratories in the vicinity for culture. The protein content decreased to 55 mg./100 ml.; however, at no time did the sugar value rise above 32 mg./100 ml. Simultaneous blood sugar values were within normal limits.

Since the circumference of the head continued to increase in spite of removal of fluid, ventriculography was performed on the 30th day after admission (Fig. 2). A porencephalic cyst extended from each frontal horn. These defects seemed to originate at the site of theventricular punctures.

In view of the progressive hydrocephalus, an operation establishing a ventriculo-atrial shunt was performed on the 27th day in the hospital. The shunt functioned well and the child was discharged on the 37th hospital day. She was followed for 10 weeks and appeared to be thriving. She died quite suddenly at home 3 months after discharge. No growth had been obtained on any cultures 2 months after plating. Autopsy was performed at another hospital but no changes other than hydrocephalus were noted on inspection of the brain. The cause of death was never definitely established.

Comment. This patient presented a difficult problem requiring frequent ventricular puncture. The issue of infection within the central nervous system led to delay in the management of the
developing hydrocephalus. The air study was postponed for some time because of the threat of activating an infectious process. The ventriculogram therefore provides reasonable evidence of the consequences of frequent ventricular puncture in this case.

We believe that proper care was exercised in the performance of these punctures, but there is no doubt that considerable destruction of brain tissue may have resulted. Since minimal movement of the needle at the skin puncture site causes the needle tip to move through a considerable arc, serious damage certainly can be produced during ventricular puncture. If the procedure is repeated several times, marked loss of brain tissue may result. The presence of increased pressure probably added to the defect.

It is of some interest that several of the cases in the literature of porencephaly show defects in this same location in children. In the report by Pendergrass and Perryman\textsuperscript{15} 2 cases were comparable. In one the defect was unilateral, in the second bilateral. In the case of Reavis and Kilby\textsuperscript{16} the defect was unilateral. No information concerning ventricular puncture is available in these cases; however, in view of the age of the patients it is likely that this route was chosen at least for the air study. Since the necessary information is not available it cannot be determined whether these cysts might have resulted from an intracerebral hematoma as in our Case 3.

**Case 3.** An 8-month-old white female was admitted to the Children's Hospital with a diagnosis of meningitis. The spinal fluid obtained at lumbar puncture on admission showed a pleocytosis, decreased sugar, elevated protein, and gram negative coccobacilli on smear. She was started on treatment with antibiotics. Within 48 hours hemophilus influenzae was cultured from the blood and spinal fluid.

There was a prompt response to the antibiotics. The temperature dropped from 105°F on admission to 101°F within 24 hours. However, after 5 days of treatment she still had a daily temperature elevation to 101.5°F. The child became irritable and refused food; the fontanelle was bulging.

On the 5th hospital day bilateral subdural punctures

![Fig. 2. Case 2. Anteroposterior view of ventriculogram showing bilateral porencephalic cysts extending from enlarged frontal horns (stippled).](image)

![Fig. 3. Case 3. A large right frontal cavity can be seen with an intracavitory mass which probably represents a solid blood clot. Ventricular displacement and moderate hydrocephalus are also present.](image)
were performed and xanthochromic fluid was recovered, 8 cc. on the right and 5 cc. on the left. Lumbar puncture on the same day showed spinal fluid containing 20 cells and normal values for sugar and protein. Cultures of the subdural and spinal fluid were negative.

There was immediate improvement after the subdural punctures and they were repeated on the 7th day. At the time 8 cc. of fluid were removed from the left. No fluid was obtained on the right side. On the 9th day attempts were made to recover fluid from the subdural space but no fluid could be obtained.

During the next 6 days the patient’s condition appeared to deteriorate. She developed left sided hyperreflexia, hemiparesis, and ankle clonus. A lumbar puncture was performed on the 13th hospital day. With the child relaxed the pressure was measured at 290 mm. of water. No cells were found and the sugar and protein content were normal. Subdural taps on the 14th day were negative.

On the 15th hospital day ventricular puncture was attempted. Upon inserting the needle approximately 1 cm. beneath the cortex on the right, a cavity was entered and 25 cc. of dark liquid blood was obtained. Ventricular puncture yielded clear fluid. X-rays obtained after injection of air (Fig. 3) demonstrated an intracerebral cavity in the right frontal area with deformity and depression of the body and frontal horn of the left lateral ventricle. The left lateral ventricle was tilted laterally. There was a moderate degree of hydrocephalus.

The patient improved after evacuation of the hematoma: however, after 3 days her condition deteriorated and the cavity was again emptied. The fluid obtained at this time appeared to be less viscous than that found initially. Again the patient improved, but measurements showed the head circumference to be increasing steadily. On the 22nd hospital day the cyst was again punctured and the ventriculogram was repeated (Fig. 4). Fluid obtained from the cavity had the same appearance as the ventricular fluid and the sugar and protein determinations were the same. The air studies showed that the dorsal boundary of the cyst was in communication with the subarachnoid space while a ridge of tissue appeared to separate it from the ventricle. The degree of hydrocephalus had increased.

On the 27th hospital day a ventriculo-atrial shunt was performed. The patient was discharged on the 40th day after admission with the shunt working adequately.

This infant was last seen at the age of 18 months at which time her head size was at the 50th percentile and was unchanged in circumference from that at the time the shunt was established. The valve obviously was functioning well. As had been anticipated, she had major neurological deficits with retardation in all spheres of development.

Comment. Subdural puncture is a procedure commonly employed by pediatricians, neurologists and neurosurgeons. While the necessity of this procedure is recognized, the hazards are seldom considered. In this case the intracerebral hematoma probably caused by trauma from a subdural puncture ultimately led to the formation of a porencephalic cyst.

It is of some interest to speculate as to how often this complication may occur and remain.

Fig. 4 Case 3. a. and b. Anteroposterior and lateral brow-up views. c. Hanging head view showing the extent of the right frontal cyst and associated hydrocephalus.
unrecognized. The clinical course of such lesions especially in small hematomas may be such that further investigation is not justified. If a porencephalic cyst should develop at this age, it might easily be asymptomatic. This would be true partly because the cyst involves the frontal lobe and partly because large intracranial lesions occurring in this age group often present only minimal clinical findings.\(^4\)\(^\text{14}\) Whether these defects diminish with age is not known.

**Discussion**

The susceptibility of the immature brain to cavitation has been noted by others.\(^4\)\(^\text{13}\)\(^\text{14}\) Jaffe\(^6\) cites the work of Schwartz\(^7\) who observed, in cases of birth trauma, the progression from areas of cerebral softening and hemorrhage to the development of porencephalic cysts. While this tendency diminishes with age,\(^5\)\(^\text{13}\) it appears to be important throughout infancy. The rapidity with which this process progresses seems to be increased in the presence of hydrocephalus.

Jaffe noted the high incidence of porencephaly associated with prematurity, prolonged labor and instrumental delivery. The possibility that intracerebral hemorrhage may progress to porencephaly suggests that prompt evacuation of the clot may avert further brain damage and diminish the ultimate size of the cyst. If a cyst should form, early establishment of drainage into the subarachnoid or ventricular systems may be important. This procedure appears to be justified in cystic lesions in adults.\(^2\)\(^\text{4}\)\(^\text{7}\) Early creation of adequate drainage may limit cystic expansion, whether the enlargement of the hemorrhagic cyst is by a mechanism similar to that in subdural hematomas or by direct continuity with the ventricle. Although the consequences of large cystic lesions in childhood can be minimal, there is ample evidence that this is not always true.\(^4\)\(^\text{7}\)\(^\text{13}\)\(^\text{14}\)\(^\text{15}\)

We believe that the potential late effects of porencephalic cysts justify more vigorous attempts at early diagnosis and treatment.

The fact that there is normally an open fontanelle in infancy provides at least two hazards related to this discussion. The first hazard concerns the tendency of the ventricular system to "wander" toward areas where loss of brain tissue has occurred, has been noted, and this trend appears to be greater when a bony defect is present.\(^5\)

Pulsations transmitted through the ventricular fluid may promote more rapid formation of cavities in the region of the anterior fontanelle. This explanation, while perhaps having some application to the cases presented in this report, would not apply to the majority of cases of porencephaly since they do not bear any relationship to this opening.

The second hazard presented by an open fontanelle is iatrogenic. While it is not the purpose of this report to alarm those who utilize this opening for diagnostic and therapeutic procedures, a proper appraisal of the risks must be made in each instance. In Case 2 bilateral cysts appeared to follow multiple ventricular punctures. Even when strict attention is given to the mechanics of this procedure, loss of brain substance may result. This loss is probably increased in the presence of hydrocephalus. Case 3 showed one of the hazards of subdural puncture, namely traumatic cortical hemorrhage with resultant intracerebral and even porencephalic cyst formation. Extensive hemorrhage and death are probably rare occurrences; however, lesser degrees of hemorrhage and cortical scarring may be more common. If seizures should occur many years later, as with traumatic porencephalic cysts,\(^4\)\(^\text{6}\) the etiology may not be recognized.

**Summary**

Three unusual cases of porencephaly following trauma in infancy are presented with comments. The possible hazards of therapeutic ventricular and subdural taps are emphasized.

**References**

13. Moore, M. T., and RATNAVALE, D. N. Intra-


