

Benign extracerebral fluid collections in infancy: clinical presentation and long-term follow-up

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Object. Benign extracerebral fluid collections are common in infants, but there are unanswered questions regarding presentation and long-term outcome. This study was undertaken to establish head size at birth, head size at presentation, head growth over time, history of presentation, indications for surgery, and long-term results.

Methods. Cases of benign extracerebral fluid collections in infancy were retrospectively reviewed. Data pertaining to clinical presentation, progress, and long-term follow-up were evaluated. Patients were divided into two groups on the basis of the presence or absence of increased signal intensity of fluid in the extracerebral space on T1-weighted magnetic resonance images. Group 1 consisted of 39 patients who had benign extracerebral fluid collections without any subdural collections. Group 2 consisted of nine patients who had a chronic subdural hematoma or hygroma without a history of trauma and had generous subarachnoid spaces and/or a history of premature birth. Patients were observed for an average of 49 months.

Results. Group 1 included 39 patients (ages at presentation 3–12 months); the most common presentation in this group was macrocephaly (28 cases). Of those Group 1 cases in which data regarding gestational age at birth were available, 15 births were either severely or mildly premature and 14 were full term. Of those Group 1 patients with adequate data, 14 had an occipitofrontal circumference (OFC) in the 50th to 98th percentile at birth and two had OFCs greater than the 98th percentile. Measurements obtained at 24 months of age were available for 18 Group 1 patients: OFC was at approximately the 98th percentile in eight (all eight born at full term) and more than 1 cm larger than the 98th percentile in 10. Head growth in Group 1 patients continued to decrease, approaching the 98th percentile after 24 months of age. Only three of the 39 patients in Group 1 required shunt placement. Of the 33 Group 1 patients for whom long-term follow-up was available, 30 were developing normally, and three had mild developmental delays.

Group 2 included nine patients (ages at presentation 3–7 months); the most common presentations were large head (three patients) and seizures (three patients). Data concerning gestational age at birth were available in eight Group 2 cases: birth was severely premature in four and gestation was full term in four. Five Group 2 patients were treated surgically—two with subduroperitoneal (SDP) shunt placement, two with subdural punctures, and one with subdural punctures and SDP shunt placement. Adequate follow-up information was available in eight of nine Group 2 cases; all eight patients were found to be developing normally.

Conclusions. Group 1 patients usually had a normal head size at birth, they rarely required shunt placement, their head growth eventually leveled off toward the 98th percentile line, and their outcomes were generally good. Although five of nine Group 2 patients required subdural punctures and/or SDP shunt placement, that group of patients also developed well. Infants with nontraumatic subdural hematomas or hygromas, presumably associated with benign extracerebral fluid collections, can often experience significant resolutions of the hematoma or hygroma within several months without surgical treatment. (DOI: 10.3171/PED-07/08/119)

KEY WORDS • external hydrocephalus • extracerebral fluid collection • pediatric neurosurgery • subarachnoid space

BENIGN extracerebral fluid collection in infancy is also known as external hydrocephalus. Other names for this condition include benign extraaxial collection of infancy,⁷ benign subdural effusions in infants,¹⁶ subdural hygroma,³ pseudohydrocephalus,³⁰ benign communicating hy-

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computed tomography; OFC = occipitofrontal circumference; MR = magnetic resonance; SDP = subduroperitoneal; VP = ventriculoperitoneal.

drocephalus,¹² and extraventricular obstructive hydrocephalus.²³ The disorder is characterized by excess fluid, usually CSF, in the subarachnoid spaces. Unanswered questions related to this condition are investigated in this study. It is known that a large head circumference (> 98th percentile) is observed in most cases, but is it observed in all cases? Was the infant's head abnormally large at birth, or did it become large later and at what age? Some patients have been treated with subdural shunts; what were the reasons for shunt placement? In cases of subdural hematomas involving pa-

tients with no known history or examination findings of trauma, has there been evidence of benign extracerebral fluid collections on neuroimages? What are the long-term results of cases involving infants who present with benign extracerebral fluid collections and how do they compare with those of cases involving infants who have hematomas or hygromas and no evidence of trauma?

Clinical Material and Methods

All cases in my clinical records involving patients who presented between June 1983 and October 2003 were evaluated for inclusion in this study. The records were reviewed for the following terms: benign extraaxial collection of infancy, benign subdural effusion (in infants), subdural hygroma, pseudohydrocephalus, benign communication hydrocephalus, extraventricular obstructive hydrocephalus, and external hydrocephalus. Cases involving patients described as having had an enlarged head without hydrocephalus were also included. Patients who presented before August 2002 were selected based on a review of my clinical records. After August 2002, cases were identified for possible inclusion in the study as the patients presented.

Patients were excluded from the study if they had a known history of physical trauma, if accidental trauma was suspected, or if they had other significant disease. Fifty-eight patients were excluded. Sixteen of the 58 excluded patients had a history of accidental trauma, and another seven had suffered physical trauma through abuse. No patient was excluded solely due to retinal hemorrhages. Hydrocephalus was present in 14 cases, and there was a history of meningitis in four. Three cases were excluded because they involved infants who had been born prematurely and had germinal matrix hemorrhage, and two cases were excluded because of craniosynostosis. Another 12 cases were excluded for the following reasons: inadequate information (two cases); major developmental delays, which were thought to be due to preexisting cerebral atrophy (two cases); and immunodeficiency, previous cranial surgery (two cases), a major metabolic problem, osteogenesis imperfecta, macrocephaly without extracerebral fluid accumulation, DiGeorge syndrome/congenital heart disease, autoimmune enteropathy (one case each).

The remaining cases were divided into two groups. Group 1 included cases involving patients who presented in infancy with an OFC greater than the 98th percentile or in whom a benign extracerebral fluid collection had been diagnosed without any increased signal intensity of fluid on T1-weighted MR images. Imaging criteria for the diagnosis included excess fluid in the bifrontal subarachnoid space as evidenced by a mean distance of more than 4 mm between various frontal gyri and the skull. Group 2 included patients who had presented as infants with a subdural hematoma or hygroma, generous subarachnoid spaces in addition to the subdural hematoma or hygroma or severe prematurity as in one patient (Case 4), and no history of trauma.

Follow-up of Group 1 patients was defined as adequate if 1) the patient was followed up at least once 3 months after the initial diagnosis and was found to be meeting developmental milestones and his or her OFC was not increasing above growth lines or 2) serial imaging studies were performed (usually at 3-month intervals) until the level of extracerebral fluid was found to have stabilized between suc-

cessive images (but not until the fluid collection had resolved). Serial images were not obtained unless the patient's OFC increased further above the growth curve or developmental milestones were not met. Group 2 patients were followed up until MR imaging or CT scanning demonstrated resolution of the hematoma/hygroma. Long-term follow-up of all patients was attempted by telephone.

Results

Thirty-nine patients met the criteria for Group 1 (27 boys and 12 girls). Their age at presentation ranged from 3 to 12 months (median 6.5, mean 7 months). Nine patients (five boys and four girls) met the criteria for Group 2. Their age at presentation ranged from 3 to 7 months (median 5 months, mean 5 months).

The most common sign or symptom in Group 1 was macrocephaly, which was present in 28 cases. Vomiting and fever were each present in four cases. The following were noted as the chief complaints in one case each: seizure, "sick" (mastoiditis), "meningitis or hydrocephalus," twitching, misshaped head, "needs shunt." Signs and symptoms in the Group 2 cases included large head circumference (three cases) and seizures (three cases). Large pupil, vomiting, fussiness, crying, and clogged tear ducts were each present in different individual cases.

Birth had been severely premature (< 35 weeks gestation) in six cases and mildly premature (35–38 weeks gestation) in nine cases in Group 1. Fourteen Group 1 patients were born at full term. Birth was severely premature in four Group 2 cases and full term in four. Information regarding gestational age at birth was not available in 10 Group 1 cases and one Group 2 case. One Group 2 patient had only borderline enlargement of the subarachnoid space (3–4 mm) but was included in the study because of premature birth.

At birth, most Group 1 patients with benign extracerebral fluid collections had an OFC in the 50th to 98th percentile (Figs. 1 and 2). Fourteen infants who were not born prematurely for whom information was available had OFCs at birth in the 50th to 98th percentile, two had OFCs at birth less than the 50th percentile, and one had an OFC greater than the 98th percentile. When patients were evaluated at 24 months of age, approximately half of all those who had not been born prematurely and for whom information was available (eight) had an OFC around the 98th percentile, and the remaining patients in that subgroup (10) had an OFC more than 1 cm larger than the 98th percentile.

In this study, only three of the 39 patients in Group 1 required shunt placement (Table 1). Two patients received SDP shunts—one because of a benign extracerebral fluid collection, a markedly enlarged head, and the development of subdural hematoma/hygroma (Case 1); the other because of an OFC much greater than 98th percentile and some vomiting. One patient received a VP shunt. The patient who received a VP shunt (Case 2) had a markedly increased OFC, a significant benign extracerebral fluid collection, and enlarged ventricles. Five of the nine Group 2 patients were treated surgically: two with SDP shunt placement, two with subdural taps only, and one with SDP shunt placement and subdural taps (Table 1).

A follow-up CT or MR imaging study was obtained in 17 of 39 Group 1 patients, and in eight of nine Group 2.

The most recent information available for most patients

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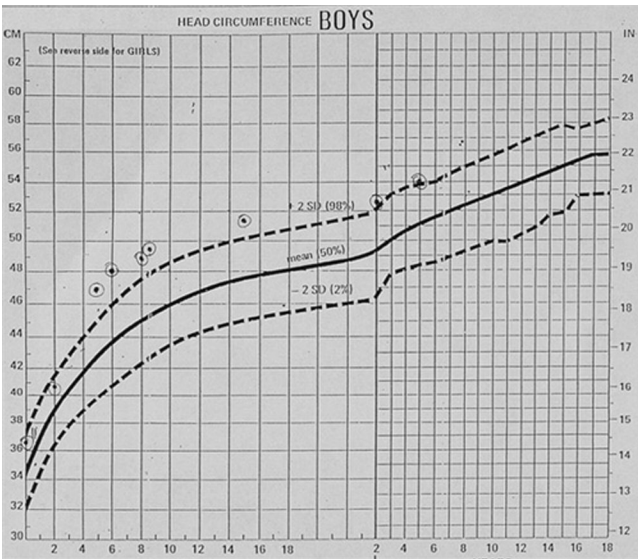


FIG. 1. Head growth chart from a Group 1 case illustrating an OFC between the 50th and 98th percentiles at birth, a finding that was characteristic of 14 infants who were not born prematurely, and an OFC near the 98th percentile at 24 months, characteristic of eight Group 1 children who were not born prematurely.

was obtained by telephone interview with a parent. The long-term outcomes for those patients were very good. Of the Group 1 patients, 33 had adequate follow-up (range 7–129 months after initial diagnosis, mean 49 months, median 36 months). Thirty Group 1 patients displayed development within normal limits. Two were found to have mild delay at 26 and 78 months after diagnosis, and one had speech delay at 7 years of age (Case 1). Eight of the nine Group 2 patients, were found to be developing within normal limits. Follow-up was inadequate in the remaining case (Table 2).

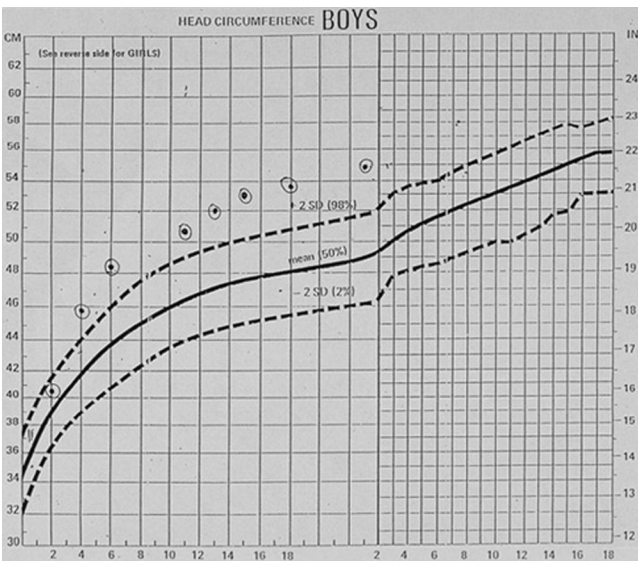


FIG. 2. Head growth chart from a Group 1 case illustrating an OFC at 24 months that was more than 1 cm greater than the 98th percentile, a finding that was characteristic of 10 patients who were not born prematurely.

TABLE 1
Surgical procedures performed

Group No. & Type of Procedure	No. of Patients
Group 1	39
SDP shunt placement	2
VP shunt placement	1
Group 2	9
SDP shunt placement	2
subdural taps	2
subdural taps & SDP shunt placement	1

Initial images obtained in eight Group 2 patients (three of whom were born ≥ 6 weeks prematurely) showed both subdural hematoma/hygroma and benign extracerebral fluid collections. Also, the initial image obtained in one patient (born at 33 weeks' gestation) showed only subdural hematoma/hygroma, with no extracerebral fluid collection. In one Group 1 patient (Case 1), the initial image showed a benign extracerebral fluid collection, and a later image showed subdural hematoma/hygroma. In three of the eight Group 2 cases in which the initial images showed both benign extracerebral fluid collections and subdural hematoma/hygroma, follow-up studies showed an increase in the subdural hematoma/hygroma before successful treatment.

Illustrative Cases

Case 1. This 4.5-month-old Group 1 male infant presented with an enlarging head circumference (OFC 55.5 cm, > 98 th percentile) and no history of trauma. The initial MR images showed benign extracerebral fluid collections (Fig. 3); follow-up images obtained when the child was 12 months old showed significant subdural hematoma/hygroma (Fig. 3C). The hematoma/hygroma was treated with a right SDP shunt. At 40 months of age, the patient's OFC was still above the 98th percentile, but follow-up MR images showed less extracerebral fluid, and the child's OFC had increased only 1 cm in the preceding 2 years. At the most recent follow-up, the child was 7 years of age, developing normally, and attending regular school. He was receiving speech therapy for articulation at school because of what appeared to be a hereditary problem. (His mother and other relatives received speech therapy for the same reason.)

Case 2. This 10-month-old Group 1 male infant had an increased OFC and a benign extracerebral fluid collection was diagnosed. He was born prematurely at 27 weeks of gestational age. A CT scan showed a moderate amount of extracerebral fluid and mild to moderate ventriculomegaly (Fig. 4 left). Over the course of three cranial ultrasound exam-

TABLE 2
*Long-term results in cases in which follow-up was adequate**

Group & Outcome	No. of Patients
Group 1	33
within normal developmental limits	30
speech delay at age 84 mos	1
mild developmental delay at 26 & 78 mos	2
Group 2	8
within normal developmental limits	8

* Follow-up was inadequate in six Group 1 cases and one Group 2 case.

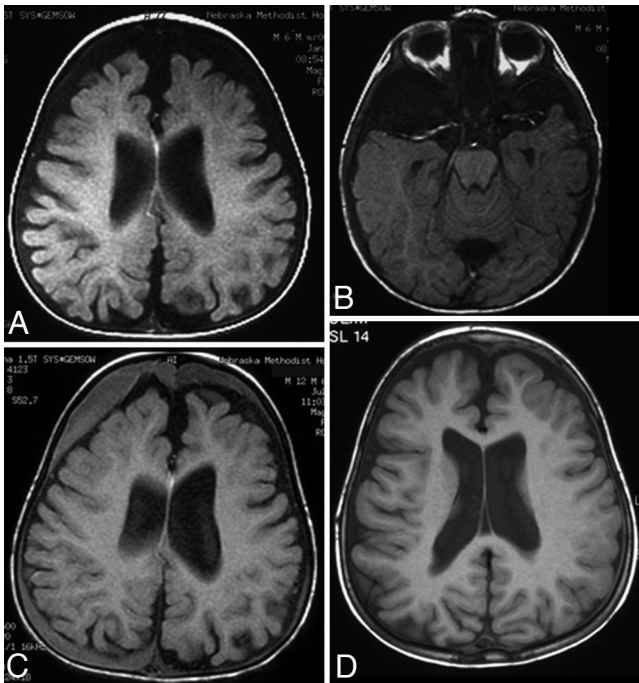


FIG. 3. Case 1. Axial T1-weighted MR images. A: Image obtained at 6 months of age showing wide bifrontal extracerebral spaces. B: Image obtained at 6 months of age; the extracerebral fluid extends down to the anterior temporal areas. C: Image obtained at 1 year of age illustrating significant subdural hematoma/hygroma. D: Image obtained at 40 months of age showing marked resolution of benign extracerebral fluid collection and subdural hematoma/hygroma following SDP shunt placement.

inations, the ventricular measurements were found to have increased slightly. The patient's initial OFC was 53 cm (> 98th percentile), and when he was 14 months old it had increased to 55 cm. At 15 months of age, the patient underwent VP shunt placement because his OFC was continuing to increase. At a follow-up visit when he was 22 months old, his OFC was found to have remained stable since the shunt placement (Fig. 4 right). At that time he was developing well, but he was subsequently lost to follow-up because the family moved across the country.

Case 3. This 6-month-old Group 2 male infant presented with one pupil larger than the other and no other symptoms. The child was born prematurely after 27 weeks of gestation. Ultrasound and MR imaging examinations demonstrated a benign extracerebral fluid collection and a left subdural hematoma/hygroma (Fig. 5A). The MR images showed mild ventriculomegaly and revealed that the ventricle size had increased since the ultrasound examination. The left subdural hematoma was 8 mm in width and covered the middle and superior aspects of the left cerebral hemisphere. The OFC was 40.5 cm when the patient was 6 months of age and 42.5 cm at 7 months of age. The MR images obtained at 7 months of age showed resolution of the subdural hematoma, and the infant did not appear to be experiencing any symptoms at that time (Fig. 5C). The patient was doing well with no intervening therapy at a follow-up visit at 8 months of age and was still developing well at the age of 48 months.

Case 4. This 5-month-old Group 2 female infant, a twin

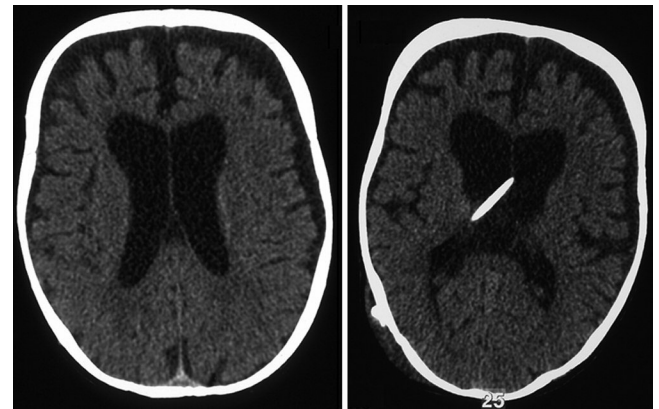


FIG. 4. Case 2. Computed tomography scans. Left: Scan obtained at 10 months of age showing extracerebral fluid and mild to moderate ventriculomegaly. Right: Scan obtained at 15 months of age after placement of VP shunt showing no initial improvement in the amount of bifrontal extracerebral fluid.

who was born after 33 weeks of gestation, had a history of vomiting, fussiness, and crying. The initial MR imaging study showed a bifrontal increased signal, which represented excessive fluid, and the anterior fontanelle was moderately tense (Fig. 6 left). The OFC at 5 months was 42.5 cm. The infant underwent insertion of a right SDP shunt because of persistent vomiting. Microscopically, some red blood cells were noted in the xanthochromic CSF. At 8 months of age, the patient was doing well, and MR images obtained at this time showed a decrease in the fluid volume (Fig. 6 right). When the patient was 16 months old, the OFC was 48 cm, and the anterior fontanelle had decreased to 1 cm in diameter and was flat. There was no evidence of any collection of extracerebral fluid, and the patient was still doing well. At 4 years of age, the patient had completed her 1st year of preschool and was developing normally socially and intellectually. She participated in a study performed by students at a local university in which motor skills were evaluated using a battery of tests (such as stacking blocks), and her performance was above average for her age group.

Discussion

Fukuyama and colleagues¹⁰ reported on the normal CT appearance of the subarachnoid space. It was found that the growth of the brain and skull are virtually parallel until the age of 3 months and that there is barely any subarachnoid space. Throughout the 1st year of life, imbalance was found between the growth of the skull and the brain, but this eventually reached equilibrium after 1 year. The subarachnoid space was considered abnormal if it exceeded 8 mm in width in the 1st year and abnormal in the 2nd year if it exceeded 4 mm. Prassopoulos and coauthors²⁶ reported the maximum frontal CSF compartment width to be 4 mm, with the abnormal range being 6 to 23 mm. Thus opinion differs regarding the criteria for an abnormal accumulation of fluid. Also, there are several ways the measurement can be taken with similar, but not necessarily identical, results. Should the measurement be taken from the frontal gyrus farthest from the skull or should it represent an average distance from various gyri to the skull? In the cases reported in this paper, the latter technique was used.

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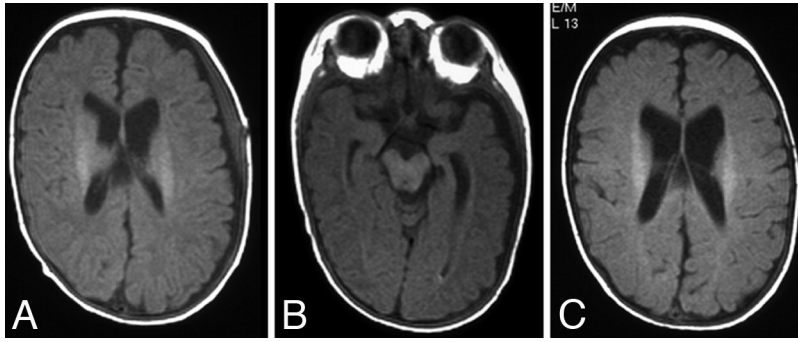


FIG. 5. Case 3. Axial T1-weighted MR images. A: Image obtained at 5 months of age showing extracerebral fluid and left subdural hematoma/hygroma approximately 8 mm in width. B: Image obtained at 5 months of age showing the extracerebral fluid extending down to the anterior temporal region bilaterally. C: Follow-up image obtained at 7 months of age demonstrating spontaneous resolution of the hematoma/hygroma.

The most common physical characteristic of external hydrocephalus is a large head. In the present study, 28 of 39 patients in Group 1 presented with macrocephaly. In Group 2, three of nine patients had enlarged heads. Alvarez et al.² reported a family history of macrocephaly in 88% of idiopathic external hydrocephalus cases. Castro-Gago et al.⁸ identified a history of macrocephaly in one of the progenitors in 38.46% of cases. Nevertheless, Akaboshi et al.¹ reported a case of benign extracerebral fluid collection in a premature infant with autosomal dominant microcephaly. Other characteristics of benign extracerebral fluid collection in infancy include full fontanelles and enlarged ventricles.¹⁶ A wide frontal subarachnoid space is another obvious characteristic of this condition, in contrast to cerebral atrophy, in which the widened subarachnoid space is more generalized. Maytal et al.¹⁴ differentiated external hydrocephalus from cerebral atrophy because cerebral atrophy showed prominent sulci throughout without a disproportionate widening of the bifrontal subarachnoid space. In all the cases reported in this study, the patients had bifrontal and not diffusely prominent sulci.

Andersson et al.³ reported on nine patients with widened subarachnoid spaces. Of these nine, seven underwent craniotomies and two underwent shunt placement. In each of the

patients who underwent craniotomies, a “deep” arachnoid space was found. Three of those seven required a VP shunt to control CSF leakage following their operations. Kapila et al.¹¹ looked at CT scans obtained in infants who had enlarged subarachnoid spaces. They found 16 patients to have associated subdural hematomas, which were documented by CT (seven patients), subdural tap (one patient), or both CT and subdural tap (eight patients). The authors deduced that the enlarged subarachnoid spaces predisposed those infants to subdural hematomas because clinical follow-up showed no evidence of cerebral atrophy. Orrison et al.²¹ described CT findings in six cases of chronic subdural hematoma (effusion) in infancy, but they did not differentiate well between chronic subdural hematoma, chronic subdural effusion, or simple CSF accumulation (as in external hydrocephalus), despite subdural punctures, which should have allowed better definitions of these entities. Current MR imaging techniques permitted differentiation between hematoma/hygroma and CSF in all of the cases reported in the present study.

Infants with benign extracerebral fluid collections can have subdural hematoma/hygroma complications with slight trauma or none. Ravid and Maytal²⁸ suggested that in some infants with benign extracerebral fluid collections, a subdural hematoma may develop with minimal or no trauma due to “stretching of the bridging veins in the unusually widened subarachnoid spaces.” This stretching of the bridging veins leaves the veins without a support system, which predisposes them to bleeding with little or no trauma. Papiasian et al.²² developed a model of the intracranial space that can predict situations in which infants with benign extracerebral fluid collections will develop extraaxial hemorrhage when healthy infants will not. Their equations predict an increased incidence of stretch injuries to veins in the extraaxial space in patients with benign extracerebral fluid collections, findings that correlate with those of Ravid and Maytal.²⁸ Laubscher and colleagues¹³ studied the cases of two infants in whom chronic subdural hematomas developed, one without trauma and the other after a 40-cm fall. These infants had large heads (one in the 90th–97th percentile and the other above the 97th percentile). He also described a third infant in whom a subdural hygroma developed spontaneously at the age of 9 months. A CT scan obtained in this patient showed enlarged subarachnoid spaces. The authors postulated that benign extracerebral fluid collections could predispose in-

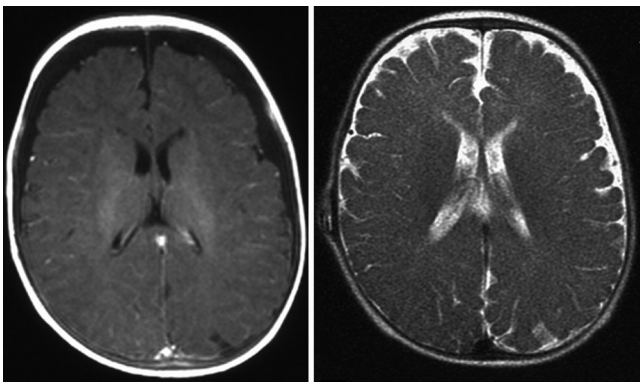


FIG. 6. Case 4. Magnetic resonance images. Left: Axial T1-weighted image obtained at 5 months of age illustrating increased bifrontal extracerebral spaces with slightly increased signal intensity indicating a probable hematoma or hygroma. Right: Axial T2-weighted image obtained at 8 months of age illustrating a decrease in extracerebral fluid following SDP shunt placement.

fants to spontaneous subdural hematoma. They also suggested that benign extracerebral fluid collections in infancy represent a variant of "primitive megalencephaly." Our Group 2 patients were thought to have extracerebral hematoma/hygroma despite a history of slight trauma or none. Imaging studies showed some evidence of benign extracerebral fluid collections along with the hematoma/hygroma in eight of these nine patients. The excellent outcome of eight of the nine cases (one patient was lost to follow-up) is further evidence of the absence of serious trauma in this group. This study does not answer the question regarding whether infants with benign extracerebral fluid collections can have retinal hemorrhages without apparent trauma.

Mori and associates¹⁷ described three infants with extracerebral fluid collections who developed subdural hemorrhages. One of the infants had a fall of 50 cm, and subdural punctures caused another infant's subdural hemorrhage. The third infant did not have a history of trauma. A unilateral subdural hematoma developed in this infant and was treated with bur-hole drainage. One year later, the patient developed a subdural hematoma on the contralateral side. The authors quoted Dr. Rekate as saying that a subdural hematoma can easily develop as a consequence of head shaking in infants who have a subarachnoid fluid collection. Azais and Echenne⁵ found that five of 41 patients in whom "benign enlargement of the subarachnoid spaces" was demonstrated on ultrasonographic examinations and CT studies had "spontaneous" subdural hemorrhage. Pittman²⁵ regarded the presence of a subdural hematoma by itself, in the absence of other evidence of inflicted injury, in a child with external hydrocephalus insufficient to prove abuse.

Premature birth might predispose infants to the development of subarachnoid fluid collections.¹⁷ Fifteen of the Group 1 patients and four of the Group 2 patients were known to have been born prematurely.

With MR imaging technology, it has become easier to diagnose benign extracerebral fluid collections in infancy accurately and to differentiate this condition from subdural hematoma or hygroma than it was previously. DeVries et al.⁹ reported on the differentiation between subdural effusions and external hydrocephalus using ultrasonography and MR imaging. Aoki¹ reported on the role of MR imaging in distinguishing between subdural effusion and subarachnoid space enlargement and stated, "all patients with subdural effusion had fluid that was greater in intensity on at least one sequence using T1-weighted, proton-density, and T2-weighted MRI images. The flow void sign, indicating vessels in the fluid spaces, was not seen in any of these eight patients."

Infantile subdural hematoma/hygroma can decrease without surgical treatment. Hematoma/hygroma can decrease fairly rapidly, within 1 or 2 months. Ravid and Maytal²⁸ stated that the prognosis of patients with external hydrocephalus and subdural hematoma in infancy is usually better than that of other patients with subdural hemorrhage and also stated that in most infants the hematoma will resolve spontaneously. They added three cases of their own, in two of which the hematomas resolved spontaneously and in one of which surgical drainage was performed despite the patient's being asymptomatic. In four of nine of the Group 2 cases in the present study the hematoma/hygroma resolved spontaneously.

Mori and coauthors¹⁶ reported on 20 cases of benign sub-

dural effusion in infants; 20 of the infants developed essentially normally without surgery. Nickel and Gallenstein¹⁸ followed the development of nine infants who had enlarged subarachnoid spaces. None of these infants developed hydrocephalus, and the anomaly had a normal prognosis. Robertson et al.²⁹ observed six infants who had subdural collections of fluid, and in five of the six there were normal long-term prognoses. Ment et al.¹⁵ reported that 11 of 12 infants with enlarged subarachnoid spaces developed normally, and these authors proposed on the basis of the findings of short-term follow-up examinations that benign enlargement of the subarachnoid spaces is rarely associated with neurological dysfunction.

Castro-Gago et al.⁸ conducted a retrospective study involving 39 patients with benign idiopathic external hydrocephalus. Age at diagnosis ranged from 1.33 to 25 months (mean 8.4 months), the mean age at which clinical control was obtained was 3.36 years, and the process was observed to resolve in 14 cases. In five cases, there was motor retardation, and one patient displayed psychomotor retardation. In the present study, there were no cases of moderate or severe developmental delay in either Group 1 or Group 2, perhaps because patients with coexisting disease processes were excluded from the study.

The precise cause of benign extracerebral fluid collections in infancy has not yet been determined although several theories have been proposed. Barlow⁶ stated that the condition is caused by anatomical or functional obstruction of various causes at the level of the arachnoid villi. Mori et al.¹⁶ hypothesized that the dilation of the subarachnoid space may be caused by communicating hydrocephalus due to a distal (high convexity or parasagittal) block. In defining external hydrocephalus, Raimondi²⁷ theorized that there is a free movement of CSF from the subarachnoid space through the membrane into the subdural space in the presence of a pathological accumulation of CSF. Raimondi implied that both compartments contained CSF. Odita²⁰ proposed that the widening of the subarachnoid space in children might be a variation of normal brain development, with a transient accumulation of CSF in the frontal region. Therefore, according to Odita, any child with a rapidly increasing head size may have an "accumulation of this widening."²⁰ The results of the present study showed that a fairly high percentage of patients in Group 1 (15 of 29 for whom information on gestation was available) and in Group 2 (four of eight) were born prematurely and therefore might experience rapid catch-up head growth. Nogueira and Zaglul¹⁹ proposed that cephalocranial disproportion is the basic underlying entity. Piatt²⁴ hypothesized that external hydrocephalus is caused by a developmental disturbance of skull growth—an excessive response of the calvaria signals that link its growth to the growth of the brain. A transient disturbance of CSF circulation, possibly due to delayed maturation of the arachnoid granulations, is commonly accepted as a cause of benign extracerebral fluid collections in infancy.

Conclusions

Both groups of cases in this series generally had good outcomes, and shunt placement was rarely required in Group 1. It is still difficult to differentiate between cases of mild benign extracerebral fluid collections and normal infant head size. Nevertheless, extracerebral fluid collections

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have become easier to diagnose accurately and to differentiate from subdural hematomas and hygromas with advances in MR imaging technology. Patients who have benign extracerebral fluid collections in infancy usually have an OFC in the 50th to 98th percentile at birth, and at 24 months OFC is in the 98th percentile in about half of the cases and more than 1 cm greater than the 98th percentile in the rest. In infants with subdural hematomas or hygromas with no history of trauma, the lesions can decrease within 1 to 2 months without surgical treatment, and infants with benign extracerebral fluid collections can have subdural hematoma/hygroma complications with little or no trauma.

Acknowledgment

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