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Management of Subarachnoid Fluid Collection in Infants Based on a Long-Term Follow-up Study

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Summary

We report the natural history and management of subarachnoid fluid collections in infants and their management based on a long-term follow-up study in 20 cases.

These subarachnoid fluid collections were resolved spontaneously in 17 of 20 patients and only 3 by surgical intervention at the age of 2.

In our 20 patients the natural history of subarachnoid fluid collection in infants was benign unless the patients sustained head trauma. Surgical treatment was performed in the cases where a subarachnoid fluid collection developed into a subdural haematoma. Head trauma may precipitate subdural haematoma in patients with subarachnoid fluid collection.

All patients except one who underwent the placement of subdural-peritoneal shunt, attained normal psychomotor development in time. During the follow-up period of 3 to 10 years after resolution of the fluid collection, no patient has had a recurrence once it resolved.

Keywords: Subarachnoid fluid collection; subdural fluid collection; subdural haematoma; infant.

Introduction

A subarachnoid fluid collection is regarded as a benign lesion in infants who do not have underlying conditions such as infection, anoxia, intracranial haemorrhage, perinatal problems, and congenital anomalies [8, 33]. As this condition is age-related and self-limiting, spontaneous resolution can be expected in most cases by 2 to 3 years of age [32]. However, a subarachnoid fluid collection may complicate subdural fluid collection. Most subdural fluid collections may resolve spontaneously, while some may continue to develop and expand.

Although extra-cerebral fluid collections in infants may resemble cortical atrophy [6, 13, 17], the diagnosis of this condition was simplified by the advent of computed tomography (CT) scanning [9]. We studied patients with extra-cerebral fluid collection by CT scanning and reported the study under the title: "Benign subdural effusion in infants" [26, 27]. We also found that subarachnoid fluid collections may complicate subdural haematoma [28].

In this manuscript we present a study on the natural history of this condition in infants and on its management based on 20 patients who have been followed for a long term.

Subjects and Methods

Most patients were brought for medical attention because of slightly delayed development and signs of increased intracranial pressure such as head enlargement or tense anterior fontanelle. A few patients presented with seizures. A review of the prenatal, perinatal and postnatal histories of the patients showed no definitive causes for these symptoms and signs.

Patients with underlying conditions such as infection, anoxia, intracranial haematoma, perinatal problems, and congenital anomalies, were excluded because these conditions can cause primary brain damage and might confuse findings related to infantile extra-cerebral fluid collection.

CT scans were significant for low-density areas over the frontal lobes, interhemispheric and Sylvian fissures that mimicked cortical atrophy. During an 8-year period from 1982 to 1989, we evaluated 20 patients with infantile extra-cerebral fluid collections by CT scanning or magnetic resonance imaging (MRI) every three months until the fluid collection disappeared, which include 14 males and 6 females from 2 to 30 months in age on the first examination, with a mean age of 9 months. All patients were followed up for 3 to 10 years after the fluid collection disappeared. Seventeen of 20 cases had no surgical procedure. Three had surgical interventions for sizable subdural haematomas complicating the original subarachnoid fluid collection.

Results

Slight ventricular dilatation was noted on the CT scans of some patients with subarachnoid fluid collections, but progressive dilatation of the ventricles did not occur. Peripheral low density over the frontal lobes disappeared by 2 years of age (Fig. 1), and all patients did well. Signs of increased intracranial pressure disappeared and head circumference returned to normal limits. All patients except one who underwent the placement of a subdural-peritoneal shunt, had normal development.

Three of 5 patients studied by MR imaging demonstrated subarachnoid fluid collection complicated by subdural haematoma.

One 5-month-old patient had fallen from a height of 50 centimeters and sustained head trauma. MR image taken 3 weeks after the head trauma demonstrated the haematoma in the left subdural space (Fig. 2). Burr hole and irrigation was performed and approximately 40 milliliters of fluid haematoma was evacuated. The second patient, 6 months old, had a large volume of extra-cerebral fluid and was treated with repeated subdural taps, this was followed by the development of a subdural haematoma. The haematoma was treated by placement of a subdural-peritoneal shunt. The third patient, 20 months old, developed a subdural haematoma of unknown aetiology on the right side. The haematoma had been treated by burr hole and irrigation, but follow-up MR images taken one year later showed development of a subdural haematoma on the opposite side. The haematoma was treated again by burr hole and irrigation. Thereafter, the patient had no further subdural haematoma.

Mild retardation of psychomotor development was noticed in 4 patients, but this improved with time, except in the one patient who underwent placement of a subdural-peritoneal shunt.

In summary, 17 of 20 patients improved without any invasive procedure and 3 required surgical intervention because of additional subdural haematoma. No patient has had recurrence of the fluid collection during the follow-up period of 3 to 10 years after its resolution.

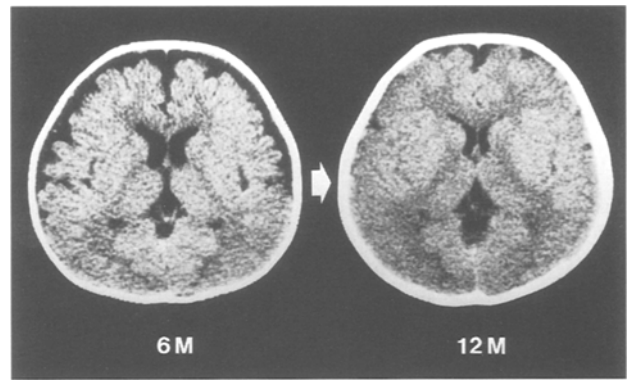

Fig. 1. CT scans demonstrating improvement of a subarachnoid fluid collection in a male infant. Left: CT scan at 6 months of age shows enlargement of the frontal and interhemispheric subarachnoid spaces with slight enlargement of the lateral ventricles. Right: CT scan at 12 months of age shows the disappearance of the fluid collection

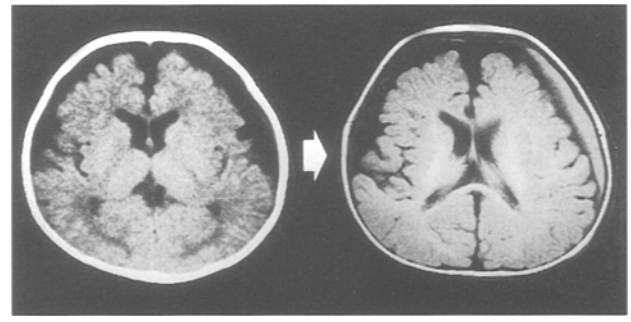

Fig. 2. CT scan and MR image demonstrating a subarachnoid fluid collection complicated by a traumatic subdural haematoma in a 5-month-old male infant. Left: CT scan immediately after head trauma. Right: T_1 weighted axial MRI 3 weeks after head trauma shows an outer high intense region and an inner low intense component with the same density as CSF

Discussion

1. Terminology

Various terms have been proposed to describe the condition of extra-cerebral fluid collection, including "fluid accumulation on the brain surface in children in the first year of life" [30], "benign subdural collections of infancy"[8, 33], "external hydrocephalus" [1, 2, 11, 23, 34], "pseudohydrocephalus-megalocephaly" [35], "benign subdural effusion in infants" [26, 27], "subdural hygroma" [23], "benign communicating hydrocephalus in children" [19], "hypodense extracerebral fluid collections" [25], "subdural effusion with ruptured subarachnoid effusion" [38], "extracerebral fluid collection in infancy" [8], "benign extraaxial collection of infancy" [10], "benign enlargement of the subarachnoid spaces in the infant" [24, 29], "hypodense extracerebral images in children" [31], and "reversible enlargement of the bifrontal subarachnoid space" [40]. All terms proposed in the literature refer to dilatation of the subarachnoid space in infants without severe dilatation of the ventricles.

MR imaging can differentiate between subarachnoid and subdural fluid collections [40], allowing specification of the actual location and nature of the extra-cerebral fluid collection. A two-layered fluid collection on an MR image is termed a subarachnoid fluid collection associated with subdural haematoma. The fluid in the extra-cerebral spaces (effusion) has a

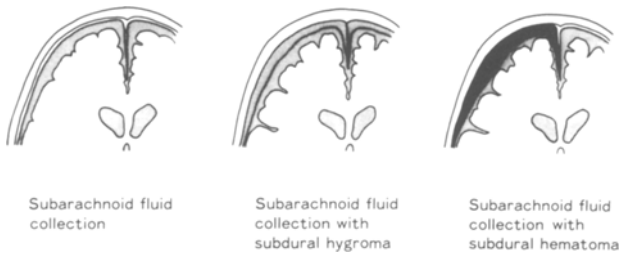

Fig. 3. Different types of extracerebral fluid collection in infants

wide spectrum ranging: from cerebrospinal fluid (CSF) (hygroma) to xanthochromic to bloody fluid (haematoma) (Fig. 3).

2. Pathogenesis

The pathological state characterized by excessive CSF accumulation over the cerebral surface was first termed "external hydrocephalus" by Dandy and Blackfan [12], and was thought to be a rather rare conditon at the time. But as CT became more widely used, it proved more common [8, 33].

Although many reports have speculated as to the pathogenesis of infantile subarachnoid fluid collections over the frontal convexities, there is still no definitive theory. Trauma in the prenatal and perinatal periods may be responsible in some cases, and prematurity might predispose to the development of this condition [29]. Although the subarachnoid spaces in infants have normal variations in size [20], the spaces over the frontal convexities observed by CT scan or MR image in normal infants are usually less than 0.5 millimeters in width. Enlarged subarachnoid spaces can be caused by a number of factors, including adenocorticotropic hormone (ACTH) and corticosteroid therapy [6, 17, 18]. In patients with subarachnoid fluid collections, cisternography has demonstrated prolonged stasis of radionuclide over the cerebral convexities [8].

Consequently, the enlarged subarachnoid spaces may result from a delayed maturation of the arachnoid villi [5]. External hydrocephalus or hydrocephalus due to a distal CSF space block may cause dilatation of the subarachnoid spaces. Subarachnoid dilatation may, therefore, represent an early finding in hydrocephalus. Although the patients with hydrocephalus eventually develop dilated ventricles, infants with a subarachnoid fluid collection do not exhibit progressive dilatation of the ventricles.

3. Clinical Course

Patients with a subarachnoid fluid collection who were managed conservatively, eventually resolved the low-density area over the frontal lobes seen on CT scan. Almost all patients attained normal developmental milestones with time, and head growth tended to stabilize along a curve parallel to the 95th percentile by 2 years of age [32].

We have observed the development of sizable subdural haematoma or effusion in 3 of 20 patients with subarachnoid fluid collection [28], which suggested that infants with enlarged subarachnoid spaces may be susceptible to subdural haematoma or effusion [3, 22]. Craniocerebral disproportion of any form may favour brain displacement, thereby predisposing to the development of subdural haematoma or effusion due to arachnoid rupture or tearing of the bridging vein by rotation of the brain during blunt head injury [7]. The association of arachnoid cysts (local subarachnoid fluid collection) with subdural haematomas may be explained by the same mechanism.

It has been established that head shaking in battered child syndrome often results in a subdural haematoma. This may occur because subarachnoid fluid collections are more common in infants, and infants with a subarachnoid fluid collection may be more prone to develop a subdural haematoma after head shaking (H.L. Rekate, personal communication).

4. Radiologic Diagnosis

Subarachnoid fluid collection in infants mimicks cortical atrophy on CT scan. However, in most cases the fluid collection findings could be distinguished from those seen in cerebral atrophy [6, 17]. Cases of cerebral atrophy exhibit prominent sulci without disproportionate bifrontal widening of the subarachnoid space [23].

Although subarachnoid and subdural fluid collections cannot always be differentiated by CT scan [37], especially bilateral chronic low-density subdural haematomas, MR images easily demonstrate the nature and site of the extra-cerebral fluid [15] (Fig. 4). Different types of extra-cerebral fluid can also be differentiated on MR images [14, 36]. Since methaemoglobin formation in subacute or chronic haemorrhage displays high intensity [16], MR is better than CT in defining extra-cerebral fluid collections, and may therefore play an important role in management. A subarachnoid fluid collection is displayed as a single-layer collection with the same intensity as CSF on

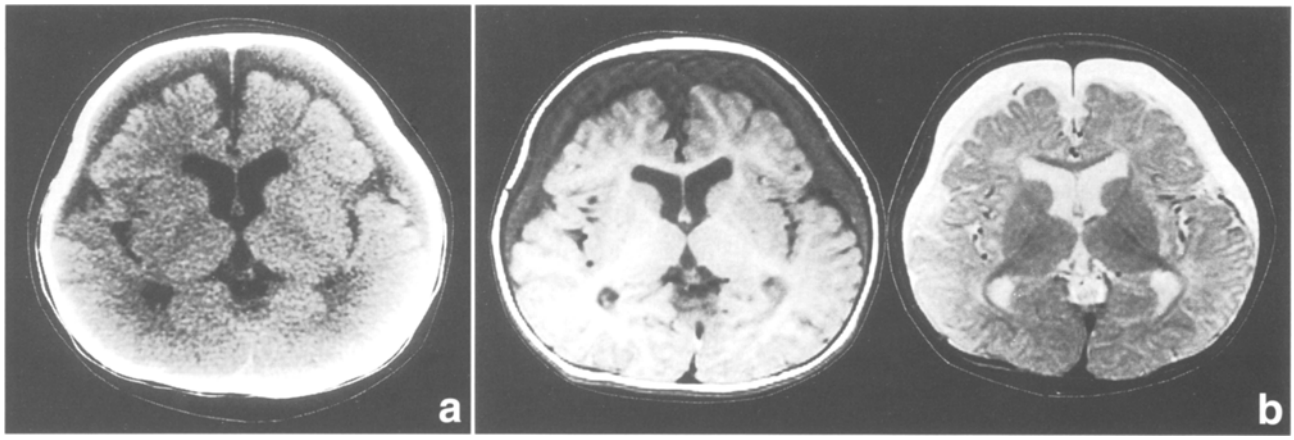

Fig. 4. (a) CT scan demonstrating an extra-cerebral fluid collection in an 8-month-old girl. (b) Axial MR images showing a subarachnoid fluid collection associated with bilateral chronic subdural haematomas in the same patient. Left: T_1 weighted MR image showing a thick low intense fluid collection over both hemispheres. The intensity of the outer collection is slightly more intense than the inner collection which has the same density as CSF. Right: T_2 weighted MR image showing the high intense fluid collection. The intensity of the outer collection is slightly higher than the inner collection

MR image. It has no apparent encapsulating membrane. When a subarachnoid fluid collection is complicated by a subdural fluid collection, the fluid collection displays two layers or compartments, with a hyperintense outer layer and an inner layer with the same intensity as CSF [40]. The fluid collection may show an encapsulating membrane in the chronic stage.

5. Management

During the course of this condition, most subarachnoid fluid collections resolve spontaneously and surgical intervention is not required (Fig. 5). No recurrence of the fluid collection has been encountered. The condition is therefore benign in nature. However, surgical treatment should be considered when the subarachnoid collection is complicated by a sizable or

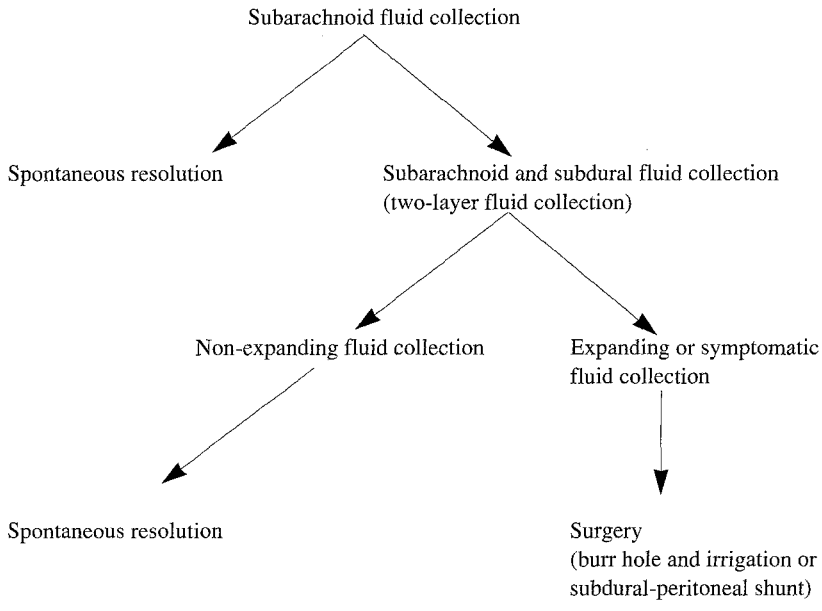

Fig. 5. Management of subarachnoid fluid collections in infants

symptomatic subdural haematoma due to damage of the arachnoid membrane or tearing of the bridging vein by brain displacement secondary to head trauma. Subdural effusion associated with subarachnoid fluid collection may need surgical intervention if it is expanding or symptomatic. Therefore, all patients with infantile subarachnoid fluid collection should be followed carefully until the fluid collection disappears. Subdural taps may also result in subdural effusion due to traumatic subarachnoid rupture.

For patients whose course is complicated by an expanding or symptomatic subdural fluid collection, we usually make burr holes and irrigate, but if the clinical symptoms do not improve and the fluid collection does not decrease in size, we insert a unilateral subdural-peritoneal shunt [4, 21, 39]. The shunt does not necessarily need to be removed after resolution of the fluid collection.

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