Postmeningitic Subdural Effusions: The Syndrome and its Management

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Although subdural effusions have been recognized since 1950 as a complication of purulent meningitis in infants, the precise role of these fluid collections and associated membranes on the course and sequelae of the meningitis is not clear. Effusions have been implicated as a cause of seizures, persistent fever, focal neurological deficits, a poor or relapsing clinical course, and increased intracranial pressure. However, in as many as 50% of cases of meningitis without such manifestations, “routine” subdural taps may reveal fluid accumulations, and, conversely, effusions may be absent when clinically suspected.

There is a divergence of opinion as to the optimal management of postmeningitic effusions. Since many effusions following meningitis are encapsulated and resemble infantile subdural hematomas, techniques already in vogue for treating the latter have been applied to the former. Ingraham and his associates have popularized the concept that craniotomy for stripping of subdural membranes is essential for achieving the best results. However, this notion has not gone unchallenged. Recently, some neurosurgeons, no longer convinced that removal of subdural membranes is necessary for successful treatment, have proposed various operations to shunt subdural fluid to other body cavities. Pediatricians, who have had the most experience in treating and following infants with meningitis and its complications, generally favor nonoperative management of subdural effusions and refer only recalcitrant cases for neurosurgical treatment.

This is a study of 30 selected cases of postmeningitic subdural effusions treated by repeated taps which were often followed by burr holes and craniotomy. Our analysis has failed to show a consistent causal relationship between the effusion and its mode of treatment and the clinical course and subsequent outcome. An appraisal of our results and those reported previously suggests that a more conservative approach to the treatment of postmeningitic subdural effusions can be justified.

Clinical Material

A review was made of the clinical records of 42 infants with postmeningitic subdural effusions cared for in the Riley Hospital for Children at the Indiana University Medical Center during the past decade. Twelve of these cases were excluded because of confusing factors such as trauma, failure to obtain fluid or positive bacterial diagnosis, severe hydrocephalus, and brain abscess.

Of the 30 representative patients selected for further review, 19 were male and 11 female. Their ages ranged from 1 to 32 months, all but one being under 18 months. The patients were admitted and initially managed on the pediatric service; however, all but three cases were subsequently evaluated or treated by the neurosurgical staff.

Hemophilus influenza type B was the etiologic organism in 19 cases, pneumococcus in four, and Neisseria meningococcus in two. In many instances the meningitis had been partially or inadequately treated with antibiotics prior to admission, and in five such patients no organism could be identified.

Inquiries and examinations were made to obtain follow-up data. The average follow-up for all patients was 26 months. Four patients followed for less than 6 months and one lost to follow-up were neurologically normal and progressing satisfactorily at the time of discharge.

Analysis of the Acute Syndrome

The stage of the illness during which the initial diagnostic subdural tap was done var-
ied considerably. Effusions were first discovered within a day to several weeks after the onset of meningitis, with about two-thirds being noted between the 3rd and 14th day of illness.

Indications for diagnostic subdural taps included a poor clinical course or persistent fever during medical treatment, suspected increased intracranial pressure, generalized or focal seizures, and focal neurological deficits. In some instances more than one indication was present, while in several the taps appeared to have been performed as routine procedures. However, there was no consistent clinical picture. For the most part, it was impossible to separate the toxic and inflammatory features of the meningitis and associated cerebral damage from any specific effects of the effusions or membranes. A number of infants who had tense fontanels, high fever, dehydration, and convulsions upon admission showed remarkable improvement after several days of medical therapy. Twenty-two infants in this series were already improving on antibiotic and supportive therapy when effusions were diagnosed.

*Eight of the patients appeared to have been gravely ill when the first subdural tap was performed.* With this group it seemed particularly appropriate to inquire into a possible cause and effect relationship between repeated subdural taps and clinical improvement. Rapid clinical improvement was noted in three severely ill infants who were tapped on the day of admission because of either a tense fontanel, seizures, or a hemiparesis. However, in the infant with the tense fontanel, a total of only 6 ml of fluid was removed by multiple taps during the first 6 days of hospitalization. In the infant with seizures, only 5 ml were obtained in the first 4 days. The improvement specifically attributable to removal of these small amounts of fluid is certainly questionable. The hemiparetic infant had bilateral taps upon admission because the right side of the head transilluminated. An unrecorded amount of fluid was withdrawn from the right subdural space during the next 4 days with lessening of left-sided weakness. Decompression may have been helpful in this instance.

A fourth severely ill infant with a hemiparesis was not tapped until the third hospital day. Bilateral subdural punctures revealed only 8 ml of subdural fluid located ipsilateral to the hemiparesis; by this time the weakness had already begun to improve. Subdural taps were performed on two other sick infants 3 and 4 days after admission because of seizures. In the first infant, 36 ml were obtained over 7 days; in the second infant, 84 ml were collected over 11 days. In spite of the taps, seizures persisted in the first infant; he later manifested signs of severe brain damage. The second patient gradually improved after the subdural spaces were tapped dry.

A seventh case, seriously ill with H. influenza meningitis, had 3 ml of fluid removed from the right subdural space 1 day after admission. Three days later the taps were repeated, and only a few drops of blood could be obtained from each side. The infant made a good recovery, and antibiotics were discontinued on the 10th day. Two days later, because of an abnormal electroencephalogram, a unilateral effusion was discovered. There was subsequently a prolonged period of subdural taps and eventually a craniotomy. The eighth such case also had a smouldering course in association with H. influenza meningitis; 210 ml of subdural fluid were withdrawn over 12 days while the patient was receiving high doses of specific antibiotics, and he gradually improved during this period.

**Analysis of Treatment and Results**

*Criteria.* When seen in follow-up, patients were considered normal if they were without neurological deficit and had reached a level of development appropriate for their age. Patients were classified as mildly impaired if they had a slight residual hemiparesis, occasional seizures, or possible slowness of motor development. Those with major neurological deficits or obvious psychomotor retardation were considered severely impaired or defective. No deaths occurred in this series during the period of follow-up.

*Summary of Treatments Used.* The 30 cases reviewed have been divided into four treatment groups (Table 1). In 13 infants (Group 1) the effusions resolved with taps through the fontanel and no other procedures were done. Three patients (Group 2)
TABLE 1

Thirty cases of postmeningitic subdural effusions: Results of treatment

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Type of Treatment</th>
<th>No. of Cases</th>
<th>Results of Treatment</th>
<th>Average Follow-up (mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Taps</td>
<td>13</td>
<td>Normal 9, Mildly Impaired 4, Severely Impaired 0</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Burr holes</td>
<td>3</td>
<td>Normal 2, Mildly Impaired 0, Severely Impaired 1</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>Membrane stripping</td>
<td>12</td>
<td>Normal 6, Mildly Impaired 5, Severely Impaired 1</td>
<td>33.5</td>
</tr>
<tr>
<td>4</td>
<td>No taps (direct surgical)</td>
<td>2</td>
<td>Normal 2, Mildly Impaired 0, Severely Impaired 0</td>
<td>14*</td>
</tr>
</tbody>
</table>

* 1 case lost to follow-up.

with persistent effusions underwent burr-hole drainage but received no additional surgical therapy. Craniotomy for stripping of membranes was performed in 12 infants (Group 3) whose effusions failed to clear with repeated taps. Two patients (Group 4) who were older and had closed fontanels were not tapped. The type of meningitis and the interval from its onset to diagnosis of the effusion did not appear to be related to the treatment selected.

Fontanel Taps. Effusions in 13 infants were tapped near the coronal suture on one or both sides until dry, over intervals varying from several days to 4 weeks. The frequency of taps and the amount of fluid withdrawn bilaterally averaged 3.7 ml per day over the period during which the taps were performed. Taps were usually abandoned when punctures on several separate occasions failed to yield fluid. The presence or absence of membranes was not established. Nine patients (69%) in this group appeared to be normal upon discharge. Six of these who have been followed for longer than 6 months have continued to develop normally. The four other infants (31%) treated by taps alone remained mildly impaired.

Burr Holes. Burr holes were performed as definitive treatment in three patients whose effusions persisted after 2 to 3 weeks of tapping. The total volume of fluid removed from both sides averaged 8.2 ml per day. Two of these infants appear to be developing normally; at operation a membrane was present in one and absent in the other. The clinical course of the third patient, who had meningococcal meningitis, was not noticeably changed by taps or burr hole drainage, and the patient now shows psychomotor retardation; a “cast” of purulent material which could not be separated from the underlying cortex was noted at operation.

Craniotomy. Stripping of membranes was performed in 12 patients in whom persistent effusions did not resolve with subdural punctures. These infants had been tapped over periods ranging from 1 to 6 weeks (average 2.7 weeks). During this period up to 35 ml were removed per day. However, in nine infants an average of less than 10 ml per day was obtained from bilateral subdural taps. Although some infants were sicker than others when their effusions were diagnosed, by the time of craniotomy, in spite of persistent effusions and membranes, most were playful, eating well, and exhibited stability of head size.

The presence of membranes was usually established by burr holes. Membrane stripping was then performed through a standard craniotomy. In three such cases no appreciable fluid was found at operation. In some infants the entire membrane was thin and translucent, but in others it varied in thickness from place to place. At times it was adherent to thickened, whitish pia arachnoid. In one case, as an unusually thick outer membrane (6 to 8 mm) was being removed, bleeding and extensive cerebral swelling occurred which resulted in a permanent hemiparesis. There were no other operative complications. Preoperative neurological deficits were not observed to have improved as a direct result of the surgical procedure.

Subdural punctures were performed in only two cases following craniotomy. Taps in one infant yielded 25 ml of fluid on the 7th and 14th postoperative days and in another infant 8 ml on the 15th postoperative
day. The former patient made an excellent recovery without further therapy, while the latter continued to have unilateral seizures.

Of the 12 patients who underwent membrane stripping, half are developing normally, the average follow-up being 33.5 months. Five infants in this group have mild residuals and one is severely impaired. Generally, an infant with a larger effusion had an increased chance of being subjected to membrane stripping. However, the size of the effusions in this operated group varied considerably, and there was no correlation between the apparent volume of the preoperative accumulation and the ultimate result.

**Direct Surgery Without Fontanel Taps.**

The fourth treatment category included the two patients with increased intracranial pressure who did not have subdural taps because of closed fontanels. One 16-month-old infant had bilateral effusions and membranes diagnosed during ventriculography; a bilateral craniotomy was performed and the membranes removed. This patient was progressing satisfactorily at the time of discharge but was lost to follow-up. Spread sutures were noted in another 32-month-old child with partially treated H. influenza meningitis. Large bilateral effusions were evacuated through burr holes, but the thick membranes were not removed. The child slowly improved and appeared to be developing normally without evidence of increased intracranial pressure when last seen 6 weeks after operation.

**Comment**

After diagnosing and successfully treating their first case in 1950, McKay, et al., Subsequently performed subdural taps on "all patients with meningitis due to H. influenza whose clinical course was judged to be unsatisfactory, on the basis of either general clinical impression or the presence of any of the following: fever after 48 to 72 hours of treatment; positive cerebrospinal fluid cultures after 48 hours of treatment; convulsions after apparent subsidence of infection; focal convulsions at any time; vomiting after apparent subsidence of infection; and any gross neurologic abnormality during the immediate convalescent period."

These indications for performing subdural taps in infants with meningitis have been frequently restated, implying a cause and effect relationship between the effusions and the clinical manifestations. The present data as well as that of other authors suggest that this is not always the case. Although it cannot be denied that an effusion can produce increased intracranial pressure or possibly a hemiparesis, the relationship of the effusion and its membrane to the course of the meningitis and completeness of recovery is not clear. "Routine" taps in the absence of the usual indications have revealed effusions in close to 50% of cases of infantile meningitis. Using accepted indications for performing subdural taps, Platou and his associates found effusions in 55 infants with meningitis, but, employing the same criteria, they were unable to find suspected fluid accumulations in 33 additional patients.

Fever, seizures, altered consciousness, and irritability are so common with meningitis in infants, that it is difficult to implicate subdural effusions as the cause. Although these clinical findings may lead to the diagnosis of an effusion, subdural decompression is not regularly associated with their disappearance. Contrary to the observations of McKay and his associates and of Smith, it has been our experience, like that reported by Dodge and Swartz, that no patient with a postmeningitic effusion had dramatic improvement that could be directly attributed to a subdural puncture. Cerebral damage from the inflammatory process is more likely to be responsible for convulsions, focal deficits, and psychomotor retardation than is an encapsulated effusion, particularly when increased intracranial pressure is not a factor. Comparing late results of pyogenic meningitis with and without an effusion, Benson and his colleagues found no significant difference in the amount of residual brain damage in the two groups.

Opinions differ as to the best treatment of postmeningitic effusions, and a randomized study would be desirable. McKay and his neurosurgical colleagues, who included Ingraham and Matson, when reporting the first cases of these effusions, recommended the same approach they had been advocating for the treatment of traumatic infantile subdural hematomas. Subdural taps were to be performed every day or so until the patient's condition improved. If membranes were then
shown to be present by exploratory burr holes, their removal was felt to be mandatory to "prevent reaccumulation of fluid and to permit normal re-expansion and growth of the brain." Supported by impressions and data from various clinics, this plan of treatment is still widely accepted and undoubtedly influenced the decision to remove membranes at this medical center.

However, a change in our viewpoint has evolved in retrospect. Membrane stripping is not a reliable technique for preventing the reaccumulation of fluid. If subdural taps are performed postoperatively, recurrent collections are commonly found. In two of our cases, we found post-craniotomy subdural effusions comparable in size to those noted preoperatively. It is reasonable to assume that all the operation accomplished in these two patients was the partial removal of a thin membrane. Furthermore, although not verified in these particular cases, the formation of new membranes has been demonstrated when subdural effusions persist or recur after craniotomy.

The postulated constriction of the growing brain by post-inflammtory membranes remains unproven. Theoretically, subdural membranes, which in this series were usually thin and translucent, should be less constrictive than the enveloping dura and calvarium which normally do not hamper growth of the brain. Elective craniotomy in the infants under study was delayed until their condition had stabilized. Those infants already doing well preoperatively continued to do well postoperatively. Removal of subdural membranes did not result in any immediate lessening of preoperative deficits or in any conspicuous change in the rate of improvement.

Some neurosurgeons, questioning the necessity of removing subdural hematoma membranes, have shunted persistent effusions into the pleural or peritoneal cavities. Although shunts were not used in infants with postmeningitic effusions in this series, exploratory burr holes, performed at varying intervals after such shunts, have shown membranes to become thinner and even resolve provided the subdural fluid has been effectively drained or resorbed.

The hypothetical benefits derived from removing the membrane must also be weighed against the potential morbidity of the operative procedure. Stripping of membranes may be a relatively safe operation, but the risks of anesthesia and craniotomy in young infants cannot be ignored. No surgical mortality occurred in this group of patients, but the operation was responsible for a hemiparesis in one infant.

Pediatricians, who as a group probably have had the greatest experience in managing and following cases of postmeningitic subdural effusions, appear to be less aggressive in their approach. In addition to being unconvinced about the necessity of removing membranes, it is generally their opinion that most effusions will eventually clear by repeated taps. Dodge and Swartz believe that these effusions can resolve spontaneously with subsequent normal development and even question the need of repeated taps under most circumstances.

Several observations in the present review tend to support these contentions. The average volume of fluid evacuated from the subdural space per day over the period during which the taps were performed was quite small. When the total surface area of the cerebral convexities is considered, this is not an impressive layer of subdural fluid, and it is not surprising that no dramatic improvement followed the taps. Burr-hole drainage in three infants did not yield much more fluid than was already being obtained with daily punctures, and the advantage of the former procedure over the latter must be questioned. Also, by the time infants in Group 3 underwent operations to remove membranes, many of the effusions had become quite small, and in three infants no appreciable fluid was found.

In our series we have found no significant difference in the subsequent outcome of those patients with persistent effusions eventually subjected to membrane stripping as compared to those treated by repeated taps or burr-hole drainage. As in most retrospective studies, however, the patients are not entirely comparable since the infants operated upon generally, but not invariably, had larger, more persistent effusions, and the presence of membranes was not proven in cases treated by taps alone. Recent surveys report major neurological residuals in 5% to 20% of cases of purulent meningitis in this age group. Therefore, at present, the over-
all results in this series with both conservative and major operative treatment must be considered quite good, since only two infants in this entire series remain severely impaired.

Summary and Conclusions

This analysis of 30 cases of postmeningeitic subdural effusions has failed to show a consistent relationship between the course and result of the illness and the specific treatment of the effusion. The results of treatment have been as good in infants managed solely by repeated subdural (fontanel) taps as in those subsequently subjected to burr-hole drainage and craniotomy for stripping of membranes.

Meningitic subdural effusions can cause increased intracranial pressure and possibly focal neurological deficits. However, the most critical factor determining the outcome of infantile meningitis is cerebral damage inflicted by the inflammatory process itself. The clinical effect of effusions has probably been overemphasized. Many effusions go unrecognized and cause no obvious symptoms. The supposed constrictive effect of membranes and the value of removing them to prevent recurrent accumulations has never, in our opinion, been convincingly established. Moreover, good results have been achieved without membrane removal.

It would be premature to advocate complete abandonment of long-established neurosurgical principles and techniques. However, this appraisal of past experience suggests that a trial of extended conservative management is justified. We believe that subdural taps should still be performed for diagnosis and to relieve signs and symptoms of increased intracranial pressure. But if an infant with a persistent effusion seems clinically well and has a stable head size and soft fontanel, it also seems to us that it would be reasonable and safe to withhold further taps or operation, provided his course is carefully followed. Furthermore, in an infant without increased pressure who is severely impaired from the inflammatory process itself, treatment of the effusion and membranes should not be expected to alter his neurological status appreciably.

References