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Original Article

Subdural empyema in children — 20-year experience in a medical center

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Background and Purpose: Subdural empyema (SDE) is a serious neurological condition in children and adults. Although otorhinolaryngeal infections are regarded as the most important predisposing factors in the literature, this has not been our expeience. This study reviewed clinical data on pediatric patients with SDE at our institution over the last 20 years.

Methods: Charts of children hospitalized in Mackay Memorial Hospital from 1985 to 2005, with a final diagnosis of SDE were reviewed. Gender, predisposing factors, symptoms and signs, bacteriologic data, diagnostic work-up, treatment procedures, and outcome were collected and analyzed.

Results: In total, 31 patients were enrolled. Twenty seven of them (87.1%) were below the age of one year. The male-to-female ratio was 1.21. Only 3 patients (9.7%) had prior otorhinolaryngeal infections; 6 patients (19.4%) had SDE following head trauma or surgery. The leading clinical manifestations were fever (96.8%), seizure (70.1%), and focal neurological signs (58.1%). The most common pathogens included *Streptococcus pneumoniae* (16.1%), group B *Streptococcus* (12.9%), *Haemophilus influenzae* type b (12.9%), *Salmonella* spp. (12.9%), *Escherichia coli* (9.7%) and *Pseudomonas aeruginosa* (9.7%). Cerebrospinal fluid leukocyte counts and protein levels were usually high and the glucose levels were usually low. SDE was first suspected or found via brain sonography in 9 infants. Nine patients (29.0%) received only medical treatment for SDE. Three patients (9.7%) died — all were infected by *S. pneumoniae*. Twelve patients (38.7%) recovered without neurological sequelae.

Conclusions: In the past 20 years, most of our cases of pediatric SDE occurred in infancy, and only one-tenth of them had prior otorhinolaryngeal infections. Brain sonography could be a helpful tool for early diagnosis of SDE in infancy.

Key words: Empyema, subdural; Meningitis; Otitis media; Sinusitis; Ultrasonography

Introduction

Subdural empyema (SDE) is a serious central nervous system infection which can cause neurological sequelae and mortality [1-3]. The incidence of SDE in children is lower than in adults [2]. Otorhinolaryngeal infection, especially paranasal sinusitis, was the most important predisposing factor in previous studies [1-6]. However, our experience with SDE suggests that many of our patients did not have this association. Therefore, we performed this retrospective study to evaluate the predisposing factors, clinical presentation, diagnostic work-ups, management, and outcomes in children with SDE hospitalized at our hospital during the past 20 years.

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Methods

The charts of all patients younger than 18 years who were hospitalized to the Department of Pediatrics, Mackay Memorial Hospital with the final diagnosis of SDE during the period from January 1985 through December 2005 were reviewed. Patients were included in this study only if their computed tomography (CT) findings revealed subdural pus collection or surgical approaches (subdural tapping and/or craniotomy) identified frank pus in the subdural spaces.

The following data were collected during the chart review: (1) demographic characteristics; (2) predisposing factors that might have a relationship with SDE; (3) signs and symptoms at admission and during hospitalization; (4) microbiological studies, including bacterial cultures and antigen detection; (5) routine laboratory results and cerebrospinal fluid (CSF) findings; (6) timing and implications of imaging studies (brain sonography and CT); (7) patient management; and (8) outcomes.

Organisms detected from subdural pus were regarded as the pathogens. In those cases where no pus was obtained directly from the subdural space, organisms found from CSF or blood were considered to be the pathogens. Patients received spinal tap only when their intracranial pressure was acceptable. The prognosis of the patients was noted from chart record and telephone contact and classified as favorable or unfavorable. Children with no neurological deficits were defined as having favorable prognosis, and the remainder as unfavorable.

We used two-sample *t* test to compare risk factors between favorable and unfavorable groups.

Results

Thirty seven patients were included according to the diagnosis. Six patients were excluded due to insufficient data being available: four only had brief summary records left, one had transferred to our hospital after SDE had been treated for two weeks in another hospital, and one was transferred to another hospital soon after admission due to family request. Thus, 31 patients were enrolled into this study.

Age and gender

Patients were aged between 7 days and 16 years, with a mean age of 17.7 ± 42.9 months. Twenty patients (64.5%) were younger than 6 months. Twenty seven patients (87.1%) were younger than one year. Only 4 patients (12.9%) were older than one year (Fig. 1). Seventeen patients (54.8%) were male. The male-to-female ratio was 1.21.

Predisposing factors

Otorhinolaryngeal infections prior to SDE were found in only 3 patients (9.7%), including sinusitis in 1 patient and otitis media in 2 patients. SDE following head trauma or surgery was found in 6 patients (19.4%), including head injury in 2 patients and previous head surgery in 4 patients. The duration of previous neurosurgery for symptoms of SDE was 107 days, 38 days, 14 days and 47 days, respectively.

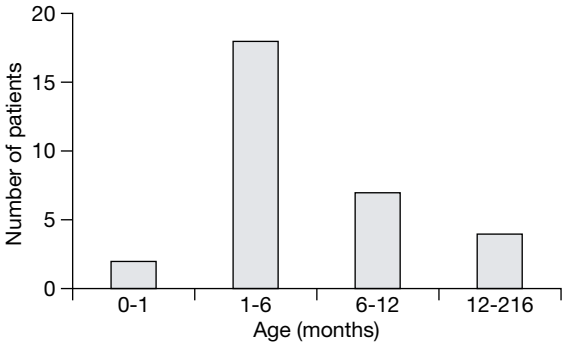

Fig. 1. Age distribution of 31 children with subdural empyema.

Signs and symptoms

Fever (96.8%), seizure (70.1%), and focal neurological signs (58.1%) were the most common clinical manifestations (Table 1). The mean duration between fever onset and diagnosis of SDE was 12.5 ± 10.6 days (range, 1 to 51 days). The mean duration of fever after susceptible antibiotic treatment was 9.1 ± 7.7 days. Among the 22 patients with seizure, 16 (72.7%) had focal seizure. Eighteen patients (58.1%) had focal neurological signs, including focal seizure (16 patients), anisocoric pupil (2 patients), hemiparesis (2 patients) and facial palsy (1 patient).

Bacteriology

In four patients (12.9%), the causative pathogen could not be found (Table 2). The others had organisms detected by pus or CSF cultures, except one detected by pus and urine *Haemophilus influenzae* type b antigen (Wellcogen® Bacterial Antigen Kit; Murex Diagnostics Inc., IL, USA). Ten episodes (32.3%) were caused by Gram-positive organisms and 16 (51.6%) by

Table 1. Clinical presentation of 31 children with subdural empyema

Symptoms	Number of patients (%)
Fever	30 (96.8)
Seizure	22 (70.1)
Focal neurological signs[a]	18 (58.1)
Vomiting	12 (38.7)
Bulging fontanelle	10 (27.0)
Neck rigidity	6 (19.3)
Headache	3 (9.7)

[a]Focal neurological signs included focal seizure (16 patients), anisocoric pupil (2 patients), hemiparesis (2 patients) and facial palsy (1 patient).

Table 2. Pathogens of 31 children with subdural empyema

Pathogen	Number of patients (%)
Streptococcus pneumoniae	5 (16.1)
Group B *Streptococcus*	4 (12.9)
Methicillin-sensitive *Staphylococcus aureus*	1 (3.2)
Haemophilus influenzae type b	4 (12.9)
Salmonella spp.	4 (12.9)
Escherichia coli	3 (9.7)
Pseudomonas aeruginosa	3 (9.7)
Haemophilus parainfluenzae	1 (3.2)
Enterobacter cloacae	1 (3.2)
Unknown	4 (12.9)

Gram-negative organisms. *Streptococcus pneumoniae* was the most common pathogen (5 patients, 16.1%), followed by group B *Streptococcus*, *H. influenzae* type b and *Salmonella* spp. [4 patients (12.9%) each].

Two patients had acute otitis media caused by *H. influenzae* type b and *Pseudomonas aeruginosa*. In the 2 patients with head injury, the pathogens were *Escherichia coli* and *S. pneumoniae*. Among the 4 patients with previous head surgery history, one had no isolated organism and the others were caused by *P. aureginosa*, methicillin-susceptible *Staphylococcus aureus* and *Salmonella,* respectively.

Laboratory data

The CSF examination revealed elevated leukocyte counts (mean, 4213 ± 1061/μL; range, 4 to 55,500/μL) [Table 3]. The majority of the patients' (96.3%) CSF leukocyte counts were >50/μL. The mean CSF protein level was 481 ± 632 mg/dL (range, 82 to 2697 mg/dL). CSF protein levels were more than 100 mg/dL in 81.8% of patients, and were more than 200 mg/dL in 58.3%. The mean CSF glucose level was 18.8 ± 25.6 mg/dL (range, 0 to 98 mg/dL). CSF glucose levels were <20 mg/dL in 73.1% of patients, and the CSF-to-blood glucose ratio was less than 0.67 in 96.0% of patients.

The mean blood leukocyte count was 11,564 ± 7415/μL (range, 2210 to 30,160/μL). Blood leukocyte count was >15,000/μL in 51.6% of patients. Elevated C-reactive protein was found in 21 of 23 patients (91.3%) and elevated erythrocyte sedimentation rate was found in 19 of 24 patients (79.2%).

Diagnostic imaging

All patients except one had brain CT findings compatible with SDE. SDE was suspected or found at first by brain sonography in 9 infants. One of them was diagnosed by brain sonography only, without CT re-confirmation due to quick deterioration of the clinical condition, but he had pus found via subdural tapping. Eight infants had brain CT performed before brain sonography; their brain sonographies were performed to follow up the intracranial condition.

Unilateral SDE was found in 15 patients (48.4%). Frontal lobe involvement was found in 25 patients (80.6%). Temporal lobe and parietal lobe involvement were each detected in 20 patients (66.7%), and occipital lobe involvement was detected only in one patient.

Therapy

Nine patients (29.0%) received antibiotic treatment without surgical intervention for SDE. Among them, surgery was suggested but refused by the family in one patient, while surgery was performed later in two patients (one subduroperitoneal shunting and the other ventriculoperitoneal shunting), due to complications. One patient with bilateral otitis media who had SDE at the junction of the superior portion of the right petrous bone and squamous portion of right temporal bone, received myringotomy. Two infants received subdural tapping and antibiotic treatment. Nineteen patients (61.3%) received craniotomy, debridement and external drainage. In three of them, ventriculoperitoneal shunting was performed later, due to hydrocephalus. The mean duration of antibiotic therapy was 36.8 ± 14.2 days (range, 9 to 56 days).

Table 3. Laboratory findings of cerebrospinal fluid in children with subdural empyema

Variable	Number of patients (%)
Leukocyte count (/μL) [n = 27]	
40-50	1 (3.7)
50-100	3 (11.1)
100-500	6 (22.2)
500-1000	3 (11.1)
1000-5000	9 (33.3)
5000-10,000	3 (44.4)
>10,000	2 (7.4)
Protein (mg/dL) [n = 26]	
50-100	5 (19.2)
100-200	7 (26.9)
200-500	6 (23.1)
>500	8 (30.8)
Glucose (mg/dL) [n = 26]	
0-20	19 (73.1)
20-40	3 (11.5)
40-60	2 (7.7)
60-80	1 (3.8)
>80	1 (3.8)

Table 4. Comparison of some clinical variables between children with subdural empyema having favorable and unfavorable outcomes

Risk factor	Favorable group (n = 12)	Unfavorable group (n = 19)	*p*
Age (months) [mean ± SD]	20.0 ± 54.8	16.4 ± 35.1	0.32
Duration of fever before diagnosis (days) [mean ± SD]	12.0 ± 6.8	10 ± 8.8	0.54
Duration of fever after received susceptible antibiotics (days) [mean ± SD]	7.4 ± 7.2	9.8 ± 8.3	0.49
Seizure (n)	8	14	0.67
Focal neurological signs (n)	8	10	0.69
CSF leukocyte count (/μL) [mean ± SD]	2540 ± 3162	7838 ± 1702	0.36
CSF protein level (mg/dL) [mean ± SD]	234.0 ± 197	838 ± 908	0.07
CSF glucose (mg/dL) [mean ± SD]	22.0 ± 23.8	15.6 ± 31.3	0.61
Unilateral involvement (n)	6	9	0.43
No initial surgical treatment (n)	3	6	0.63

Abbreviations: SD = standard deviation; CSF = cerebrospinal fluid

Outcomes

Three patients (9.7%) died; all were infected by *S. pneumoniae*. Among the survivors, 12 patients (38.7%) recovered without neurological sequelae (favorable group) and 16 patients (51.6%) had neurological deficits left. Thus, 19 patients were enrolled into the unfavorable group.

None of the factors examined (including age, duration of fever before diagnosis, duration of fever after susceptible antibiotic therapy, seizure, focal neurological signs, CSF leukocyte count, CSF protein level, CSF glucose level, location of empyema and initial treatment method) was significantly different between the favorable and unfavorable groups (Table 4).

Discussion

SDE was reported to affect most commonly male adolescents and young adults in most series [1-3]. Around 40 to 70% of the reported SDE originated from otorhinolaryngeal infections, including paranasal sinusitis, otitis media and mastoiditis; around 6 to 30% were related to head injury or neurosurgery [1-3,6-8]. Neurosurgery with mastoidectomy or epidural catheter insertion has also been reported [9,10]. Others have noted that predisposing factors include diabetes mellitus, alcoholism, chest infection, sepsis, etc [2,3]. However, approximately 80% of our patients were infants and only 10% of episodes were related to otorhinolaryngeal infection. These findings are quite different from other reports. We speculate that frequent use of broad-spectrum antibiotics in our local otorhinolaryngeal clinic might have some relevance to this situation. Further studies are needed in order to detect the exact reason for discrepancy between our findings and those of other reports.

Early diagnosis and treatment are important requirements if reductions in morbidity and mortality are to be achieved [11]. Since meningitis, otorhinolaryngeal infection, head trauma or neurosurgery are all predisposing conditions for SDE, clinicians should be alert to the possibility of SDE in patients with these conditions. When a patient has any of the above conditions and develops a prolonged fever, seizure, focal neurological signs or altered sensorium, SDE must be considered. The mean duration from fever onset to diagnosis was 12.5 days in our patients. Approximately 70% of our patients had seizure attack and most of them (72.7%) were diagnosed with focal seizure by clinical presentation or electroencephalography. Focal neurological signs are also a clue for the detection of SDE, and was present in almost 60% of our patients.

In children, SDE is commonly secondary to *H. influenzae* or *S. pneumoniae* meningitis [12]. SDE associated with *Salmonella, Neisseria meningitidis* and neurotuberculosis has also been reported [13-18]. Patients in this study with group B *Streptococcus* SDE were all younger than 4 months; this organism is rare in previous reports. SDE secondary to paranasal sinusitis is usually caused by aerobic and microaerophilic streptococci, which were not found in our patients. CSF leukocyte counts and biochemical data in this study mostly revealed moderate to severe meningeal inflammation, indicating that most of our patients had concomitant meningitis.

Brain CT or magnetic resonance imaging with enhancement is suggested as the diagnostic tool of choice [19-21]. Nevertheless, our experience suggests that brain sonography could be a helpful examination in infants.

Nine of 27 infants (33.3%) in our study were first suspected to have SDE from brain sonography findings. Although CT re-confirmation is usually necessary, brain sonography can not only be performed easily at the bedside at the outset, but also used to assess the amount of empyema after treatment.

The goal of treatment is evacuation of pus and eradication of the source of infection. Medical treatment may be adequate in some situations [22]. Craniotomy is comparable or superior to burr hole [2,23,24]. In our patients, whether medical treatment alone or surgery was used did not affect the outcome significantly. Our choice of management was related to the clinical condition. A surgical approach was suggested in those patients who did not respond well to medical treatment or in those who had massive subdural pus accumulation. In infants whose anterior fontanelles are still wide open, transcutaneous subdural tapping may be another option, but it must be performed with great caution.

The reported mortality rates of SDE have ranged from 0 to 12% [1-4]. Age, level of consciousness, timing and aggressiveness of treatment, and the rapidity of disease progression have been found to influence outcome [25,26]. Our mortality rate was 9.7% and all three deaths were from pneumococcal meningitis and occurred more than 10 years ago. We could not find a reliable factor to predict the outcome of SDE in this study.

Although the number of patients in this study is relatively small, it is one of the largest case series of children with SDE. Our report reveals that meningitis is the most important predisposing factor for SDE in childhood in our community, and that brain sonography can be a helpful tool for early diagnosis of SDE in infancy.

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