Surgical treatment of subdural empyema

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Abstract. Subdural empyemas are rare intracranial pyogenic infections with a mortality rate of 14-28 percent. Inflammation of paranasal cavities, otitis, injuries and osteomyelitis, typical for the age of under to 30 years are among the most frequent infection sources. This study includes several clinical cases of subdural empyema, which have undergone different treatment with different results. According to the literature survey, early diagnosis and opportune operative management have an essential practical bearing on the final outcome. Also, some prognostic factors are outlined, such as changes in consciousness at the time of operation, as having important practical implications on the choice of surgical tactics. The advantages and drawbacks of the treatment using trephination burr holes or craniotomy are discussed.

Key words: Subdural empyema, burr hole drainage, craniotomy.

Subdural empyema (SE) is a rare disease spanning over 13-29% of intracranial pyogenic infections [1-4]. The annual incidence even at larger neurosurgical and neurological clinics rarely exceeds 3 to 4 cases a year [2,4]. This low incidence may be the reason why the disease remains unsuspected for a long time, thus leading to its late diagnosis, delayed surgical treatment, and unfavorable outcome.

Despite the substantial diagnostic potential of computed tomography (CT) and magnetic resonance imaging (MRI), and the improvements in surgical treatment and antibiotics therapy, the mortality rate over the last years has stayed relatively high as 14-28% [1,4-8]. Although conservative treatment has proved successful in a number of cases [3,8], SE treatment is surgical for most of the cases. The operative techniques applied are still subject to discussion and contradiction [1,3,5,6,9-11].

By presenting 11 cases from our practice, treated in different ways and with different outcome, we aim at attracting the attention of neurologists, neurosurgeons, otorhinologists and other physicians to this rare but grave disease and, based on the existing literature, to highlight several factors influencing the outcome.

Materials and methods

Eleven patients with subdural empyemas were retrospectively identified at the Department of Neurosurgery, Military Medical Academy, Sofia for a period of eight years (between 1999 and 2006). The patients with parenchymal abscesses or cerebritis were excluded from the study. SE is defined as an infectious process, collection of pus which occupies the space between dura mater and arachnoid surrounding the brain. The diagnosis of empyema is confirmed by: Computerized Tomography (CT); microorganisms isolated from the pus and/or cerebrospinal fluid cultures; intracranial suppuration observed during surgery or histopathological examination. Patients were considered having mixed infections, provided at least two bacterial organisms were isolated from the initial cultures. Patients who were initially treated at other hospitals but transferred to our hospital for further therapy were also included in the study, with the clinical data collected from those hospitals.

Those patients who had developed SE as a consequence of neurosurgical procedures were classified as postneurosurgical (postoperative) forms. The patients, who had not undergone invasive procedures, were respectively classified as spontaneous forms.

Surgical treatment (SE evacuation) and antibiotic therapy was the mainstay of our treatment. Appropriate antibiotic therapy was administered after the antimicrobial tests and according to the antibiotic capability of passing through the blood-brain barrier in adequate amounts. The surgical treatment consisted of a burr hole or craniotomy. An external drainage was inserted in 9 cases and removed after 48–72 hours.
Results

Eleven patients (8 males and 3 females) were included (aged 26 to 73 years). The interval between onset of symptoms and detection of intracranial suppuration ranged between 7 and 32 days (average 12 days). At a follow-up of 6 months, 7 had good outcomes, 1 was satisfactory, while the other 3 died.

The epidemiological data, clinical features, treatment and outcome are listed in Table 1.

Table 1. Analysis of the epidemiological data, clinical features, treatment and outcome

<table>
<thead>
<tr>
<th>No</th>
<th>F/M/age*</th>
<th>Epidemiology</th>
<th>Clinical features</th>
<th>Treatment</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/28</td>
<td>Paranasal sinusitis</td>
<td>Altered consciousness, seizures, hemiparesis</td>
<td>Burr hole drainage</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>M/26</td>
<td>Head trauma</td>
<td>Altered consciousness, seizures, fever</td>
<td>Craniotomy</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>M/43</td>
<td>Postneurosurgical infection</td>
<td>Seizures, hemiparesis, fever</td>
<td>Craniotomy</td>
<td>Excellent</td>
</tr>
<tr>
<td>4</td>
<td>M/73</td>
<td>Postneurosurgical infection</td>
<td>Altered consciousness, hemiparesis, fever</td>
<td>Burr hole craniotomy</td>
<td>Exitus</td>
</tr>
<tr>
<td>5</td>
<td>F/30</td>
<td>Unknown</td>
<td>Altered consciousness, seizures, fever</td>
<td>Burr hole drainage</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>M/29</td>
<td>Meningitis</td>
<td>Altered consciousness, seizures, neck stiffness</td>
<td>Burr hole drainage</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>F/31</td>
<td>Otopenic infection</td>
<td>Altered consciousness, neck stiffness, fever</td>
<td>Burr hole drainage</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>M/49</td>
<td>Unknown</td>
<td>Altered consciousness, Septic shock, fever, hemiparesis</td>
<td>Burr hole drainage</td>
<td>Exitus</td>
</tr>
<tr>
<td>9</td>
<td>M/35</td>
<td>Paranasal sinusitis</td>
<td>Seizures, fever, hemiparesis</td>
<td>Burr hole drainage</td>
<td>Good</td>
</tr>
<tr>
<td>10</td>
<td>M/48</td>
<td>Head trauma</td>
<td>Altered consciousness (coma), fever</td>
<td>Craniotomy</td>
<td>Exitus</td>
</tr>
<tr>
<td>11</td>
<td>F/61</td>
<td>Head trauma</td>
<td>Altered consciousness, hemiparesis, fever</td>
<td>Craniotomy</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>

F= female; M= male; * years

The route of infection in 11 cases of SE included: postoperative empyema after evacuation of chronic subdural hematoma in 2 patients; postoperative SE - 3 (head injury, open depressed skull fracture - 2, and brain tumor - 1); complication of meningitis - 1; otogenic origin - 1, paranasal sinusitis - 2 and unknown - 2. The most often clinical features found in those 11 patients included fever, disturbed consciousness and seizures (Table 1).

The microbiological analysis of subdural pus revealed: *Staphylococci* – 3 cases (2 patients with head trauma, 1 patient after neurosurgical operation); aerobic and anaerobic *Streptococci* – in 3 cases with otorhinogenic SDE and 1 patient with leptomenigitis; mixed infection (multiple organisms) – *Serratia marcescens* and *Klebsiella Pneumoniae* - 1 patient after brain tumor extirpation; and negative culture in 3 (27.3%).

CT scans of the head were performed in all patients. The location of all subdural suppurations was supratentorial: over the cerebral convexity - 7 patients, and/or around the interhemispheric tissue - 4 cases. Additionally, intraparenchymal inflammatory lesions (cerebritis, brain abscess) were detected in 4 cases. The radiological findings, in contrast, enhanced CT scans included low-density extra-axial collections with rim enhancements surrounded by edema in 7 patients (Figure 1) and areas of low attenuation without enhancement in 4 patients (Figure 2). Mass effect on the cerebral hemisphere which is out of proportion to the small size of the extra-axial collections (SE) is presented on CT images.

In all 11 patients treated for subdural empyemas both surgical and antibiotic therapies were administered. Among these patients, 7 (63.6%) underwent burr hole drainage, one of them required craniotomy because of reaccumulation of SE. Another 4 patients (36.4%) were treated by craniotomy, as they had already previous neurosurgical operation (craniotomy for head injury or brain tumor).
Figure 1. A case of interhemispheric SE. Contrast CT demonstrating parasagital (parafalcine) empyema (a), sagital (b) and coronal (c) CT reconstructions show that the interhemispheric suppuration extends backward over the tentorium and below the left occipital lobe. Postoperative control CT - 1st day (d) and follow-up CT 3 months later: (e), (f).

Figure 2. A case of convexity SE. Non-contrast CT of the brain demonstrating convexity empyema on the left side (a) due to orbital and paranasal sinus inflammatory disease (b). Note the inflammation extending to the left orbit (c). Follow-up CT 6 months later: hydrocephalus (d) and cure of paranasal sinusitis (e) and orbital inflammation (f).
In total, 8 patients out of 11 survived (72.7%), and mortality rate was 27.3%. Among the 8 surviving patients, 2 resumed normal lives, despite minor deficits (excellent results), 5 had neurological deficits or epilepsy, “disabled but independent” - good results, and 1 patient had severe disability, dependent on daily support (satisfactory result).

Discussion

SE is an important form of intracranial suppuration, accounting for 15–25% of pyogenic intracranial infections [1,4,10,12,13]. In older children and adults, SE is most often a complication of otorhinologic infection [2,3,5-7,12,14-19]. Paranasal sinusitis is identified as source of SE in 35-74% of the cases. Less frequent are the otogenic infection (otitis) (4-21%). SE may also occur as a result of a head trauma (4-31%), osteomyelitis of the skull (5-6%), or bacteriemic spread from a distant focus of infection in some isolated cases [1-3, 7,12,14,16,17]. In contrast to previous studies, our study found out that otogenic infection and paranasal sinusitis were causes of SE in 33% of the cases. SE is a rare complication following cranial surgery (11), but the postoperative infections have become an increasingly important etiology (10). Nearly 86% of the treated patients were young people under the age of 30 [2,3,5,8,18,20-22]. The mean age of our patients was 41 years.

SE pathophysiology has been discussed in detail by Courville, 1944 [20]. The infection may spread in the subdural space directly by erosion of the posterior bony wall of the frontal sinus with further erosion of the underlying dura mater, and indirectly by retrograde thrombophlebitis of the veins connecting the extra- and intracranial venous systems (emissary veins) [20,23]. Once spread in the subdural space, the infection may involve the convexity of the cerebral hemisphere, and may communicate with the contralateral side via the inferior free margin of the falx. The subdural fluid accumulating between the falx and arachnoid is known as parasagittal, interhemispheric, or parafalcine empyema and is usually secondary to surface subdural collections, but rarely may be primary [1].

Generally, patients have a nonspecific illness for a few days - few weeks prior to presentation to the hospital as acutely ill [5,12,17,24-27]. However, if the infection is a result of head trauma or surgery, the symptoms might be milder, hence present subacutely [19,26-29].

Diffuse neurological signs, such as disturbed consciousness, papilledema and seizures are a result of increased intracranial pressure (ICP). Their progres-

sion may cause herniation syndrome and death [4,5,30]. Focal neurological abnormalities, such as hemiparesis or seizures, aphasia or dysphasia, and cranial neuropathies, may be secondary to local pressure on the underlying cortex by the SE, and may be precipitated by cortical venous thrombosis, brain inflammation and infarction [11,31-33]. The most common symptoms and signs are headache, fever, neurological deficit and stiff neck [2,3,5,9,20,21,23,27], but these cardinal features are not specific for SE. Our SE patients typically presented with progressively altered consciousness, fever, seizures and focal neurological signs.

Acute or subacute worsening of consciousness, seizures, focal neurological deficits are all considered substantial reasons to suspect SE, especially if the patients are young (under 30 years of age) and have history of paranasal sinusitis. In some cases, the dynamics of process is rapid - from a couple of hours to 1-2 days. These are the so-called fulminant forms which, despite the surgical treatment, have lethal outcome [1,5]. Such forms are the presented case No 8 and No 10 with their swift development into a coma state, large subdural pyogenic collection "from pole to pole" and malignant brain swelling diagnosed intraoperatively, as well as the puss found out during the pathoanatomical dissection.

When SE is suspected, further diagnostic research should be carried out immediately. Quality medical care including the timely diagnosing and dispatch of patients is of paramount importance in this respect, too. Diagnosing SE is difficult in a number of cases, especially in the absence of local infections. The most informative examinations over the last years have been CT and MRI. CT shows a classic extra-cerebral (extra-axial) hypodensity area compared to brain parenchyma, almost isodense compared to cerebral spinal fluid. This subdural collection can be localized around the hemisphere convexity or interhemispherically. Contrast enhanced CT increases conspicuity of the collections and leads to finer delineation of the SE [15,17,19]. Additionally, gyral enhancement subjacent to an extra-axial empyema on contrast CT is a frequent finding, indicative of meningitis, cerebritis, and/or venous thrombosis. Extensive mass effect on the ipsilateral cerebral hemisphere which is out of proportion to the small size of the extra-axial collection is invariably present and it is manifested as ventricular compression and midline shift. It is important to examine the paranasal sinuses, middle ear cavity and orbits for inflammation, which may reflect the origin and extent of the intracranial abnormalities [24,27]. MRI provides much better sensitivity and specificity as compared to CT: better
visualization of SE, precise localization, differentiation of SE from other noninfected subdural effusions and hygromas [34-36].

The clinical suspicion of SE requires immediate institution of parenteral antibiotic therapy. When SE is diagnosed by CT or MRI, the surgical drainage of empyema is imperative, and the immediate operative treatment is mandatory. Most authors have acknowledged the importance of timely intervention to reducing mortality [1,4,7,21,31,37]. There is a disagreement concerning the optimal mode of surgery. The comparative efficacy of burr holes drainage versus craniotomy is complicated by clinical factors which may affect the outcome. Several reports advocate craniotomy over burr hole drainage, citing increased survival in the group treated by craniotomy [2,3,5,15,16,31,32]. The advantage of craniotomy is considered to be related to wide exposure, adequate exploration, and more thorough evacuation of pus (purulent material) [6,8,31]. Few investigators however have considered the level of patient’s consciousness when evaluating mortality rate. The advantages of a burr hole procedure are: the drainage and accurate detection of collection by CT are possible, easy to perform and may be repeated, and complications such as postoperative edema, cerebral infarct or hemorrhage, and osteomyelitis can be avoided [1,6,8,9,11]. Regardless of the initial surgical approach (multiple burr holes versus craniotomy), several studies report a number of patients requiring reoperation [2,3,15,16]. In our study, the surgical technique had no influence on the therapeutic outcome, but the numbers of cases were too few to lead to definitive conclusions. Based on the CT results, we were able to drain the SE by burr-holes, and found out that the technique was quick and efficient, and also very easy to repeat. The open craniotomy should be restricted only too hard to reach localizations and chronic SE that cannot be drained well by burr-hole.

The result of SE treatment largely depends on the antibiotics therapy. The microbiological study indicated an increased occurrence of anaerobic infections and mixed forms, such as Streptococcus and Gram negative bacteria. The later inflicts fulminating infections [1,3,5,8,38] and calls for adequate adaptation of the antibiotics therapy. In our study the initial empirical antibiotics included beta lactamase stable penicillin, third generation cephalosporin, and metronidazole. The therapy for seizure prophylaxis included Depakin® and Tegretol® or Trileptal®. Mannitol® and steroids were used to decrease the intracranial pressure. The results of our treatment of SE (excellent and good results, morbidity and mortality) are comparable to others authors results.

Conclusion

CT and MRI make a perfect match in diagnosing and follow-up of SE. The changes in consciousness by the time of performing the operation are the leading factors in deciding on operative tactics. Burr-hole drainage is to be preferred, whereas open craniotomy should be restricted to some isolated cases. Early diagnosis and timely operative treatment combined with adequate antibiotics therapy are essential for the good therapeutic results.

References
