Posterior fossa epidural hematomas in children: clinical experience with 40 cases

Clinical article

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Object. Traumatic posterior fossa epidural hematoma (PFEDH) is rare, but among children it may have a slightly higher incidence. With the widespread use of CT scanning, the diagnosis of PFEDH can be established more accurately, leading to an increased incidence of the lesion and possibly to a better patient prognosis. This study presents 40 pediatric cases with PFEDH.

Methods. The authors assessed the type of trauma, clinical findings on admission, Glasgow Coma Scale scores, CT findings (thickness of the hematoma, bone fracture, compression of the fourth ventricle, and ventricle enlargement), type of treatment, clinical course, and prognosis. Early postoperative CT scans (within the first 6 hours) were obtained and reviewed in all surgical cases.

Results. Twenty-nine patients underwent surgery and 11 patients received conservative therapy and close follow-up. All patients fared well, and there was no surgical mortality or morbidity.

Conclusions. Based on the data in this large series, the authors conclude that PFEDH in children can be treated in experienced centers with excellent outcome, and there is no need to avoid surgery when it is indicated.

(key words) epidural hematoma • posterior fossa • children • surgery • trauma

Traumatic PFEDHs represent a rare clinical entity. Their rate among all epidural hematomas ranges between 1.2% and 15% for all age groups according to various reports. Among children, PFEDHs may have a slightly higher incidence.\(^{7,8,17}\)

With widespread use of CT scanning, the diagnosis of PFEDHs can be established more accurately. Improved diagnostic capability has led to an increased incidence of the lesion and possibly to a better prognosis.\(^{5,7,10,14,15,25}\) In the present study we provide data obtained in 40 pediatric patients with PFEDH treated surgically or conservatively with no mortality or morbidity. We believe this report may be an important contribution to the literature because the literature contains a cumulative number of approximately 100 cases and we provide 40 additional cases.\(^{1,3,7-9,11,19,27}\)

Methods

Of 824 patients with epidural hematomas treated surgically or conservatively at the Department of Neurosurgery Trauma Care Unit, Istanbul School of Medicine, between January 1995 and April 2011, 473 patients were younger than 17 years. Files of those with PFEDHs were retrospectively reviewed. The study group consisted of 40 children with PFEDHs of traumatic origin. There were 22 boys and 18 girls with a male/female ratio of 1:2. Ages ranged from 1 to 17 years (mean 6.7 years). We recorded and evaluated the type of trauma, clinical findings on admission, GCS score, CT findings (thickness of the hematoma, bone fracture, compression of the fourth ventricle, and ventricle enlargement), type of treatment, clinical course, and prognosis. Early postoperative CT scans (within the first 6 hours) were acquired in all surgical cases.

Results

The predominant cause of PFEDH was a fall from a height resulting in a blow to the back of the head in 34 patients (85%). Motor vehicle accidents were the second most frequent cause (4 patients [10%]), and there was an “other” type of injury in 2 patients (5%). Thirty-one patients (77.5%) were admitted within 24 hours of injury, 8 (20%) within 48 hours, and 1 was brought to the hospital within 72 hours.
During admission, the GCS scores were used to assess the level of consciousness of the patients. Thirty-one patients (77.5%) had a GCS score of 15, 4 had a score of 14 (10%), 1 had a score of 13, and 4 patients had GCS scores of 11, 10, 9, and 8.

Symptoms and clinical findings on admission were nausea and vomiting in 23 patients (57.5%), occipital swelling in 17 (42.5%), headache in 15 (37.5%), cerebellar signs in 11 (27.5%), temporary loss of consciousness in 6 (15%), and drowsiness in 2 (5%).

Unenhanced head CT scans including bone window settings were obtained in all patients. An epidural hematoma was present in the posterior cranial fossa in all cases. The thickness of the clot varied between 0.2 and 2.5 cm. A fracture of the occipital bone could be detected in 35 patients (87.5%), and multiple intracranial injuries were present in 9 patients (22.5%). Compression or effacement of the fourth ventricle was encountered in 15 cases (37.5%), and ventricular dilation was observed in 6 cases (15%).

One child with a diagnosis of hemophilia A was admitted to the intensive care unit of our pediatrics department, and another patient had a history of osteogenesis imperfecta diagnosed earlier at another hospital. Both of these patients were followed up conservatively without need of a surgical intervention.

Clinical and radiological features are summarized in Tables 1 and 2. In 28 patients (72.5%), we performed immediate surgery—a suboccipital craniectomy, usually restricted to the side of the hematoma and as wide as necessary to control the active bleeding if present. Figures 1 and 2 show pre- and postoperative CT scans obtained in one of the surgical cases, demonstrating removal of the hematoma and resolution of the fourth ventricle compression. One of the patients underwent surgery 24 hours after admission because the hematoma enlarged and the clinical status worsened. Early postoperative scans acquired in the surgical cases showed no significant residual hematoma and resolution of ventricular dilation if present before surgery. Eleven patients (27.5%) were fully alert at admission and harbored an epidural hematoma. They had no CT-documented mass effect, no compression or displacement of the fourth ventricle, obliteration of perimesencephalic cisterns, or sign of ventricular dilation. These 11 patients were followed conservatively, undergoing clinical neurological examinations and serial CT scanning (at 6, 12, 24, 48, and 72 hours after admission). Figure 3 provides an example of a conservatively managed case in which the admission and 48-hour CT scans reveal no significant change in hematoma thickness and mass effect.

All patients, treated surgically or conservatively, fared well and were discharged with normal neurological status after a mean hospital stay of 6.5 days. The patients were then followed up in the outpatient clinic 1 and 4 weeks after surgery. An additional control CT scan was obtained 4 weeks after discharge. There were no radiological or clinical pathological entities found at the 4-week postdischarge examination.

**Discussion**

Posterior fossa epidural hematoma is rare. It accounts for 9%–20% of all traumatic extradural hematomas in children, whereas in adults the range is much lower, around 2%–11%. Because this is a rare entity, the pediatric cases of traumatic PFEDH published in the literature are limited to case reports and small series. After the introduction of CT scanning, clinical reports on childhood PFEDH have increased, but still they include only small populations. In our institution, which has a busy emergency and traumatology unit, with approximately 1500 cases of head trauma annually, traumatic PFEDHs in children account for 4.9% of all patients and 8.5% of pediatric-age patients with epidural hematomas.

The cause of PFEDHs in children is most commonly a fall, similar to many other forms of craniocerebral trauma in this age group. In 85% of our patients the hematoma was acquired by falling and hitting the occipital region of the skull. Motor vehicle accidents, which are unfortunately a major cause of death and disability in this country, accounted for PFEDHs in 10% of our patients. Posterior fossa epidural hematomas are most often noted in males in the first 3 decades of life. Most studies report higher incidences in the second half of the 1st decade. In our large study group the male/female ratio was 1:2 and the median age was 6.7 years in accordance with data in previous reports.

**TABLE 1: Summary of clinical features of patients with PFEDH**

<table>
<thead>
<tr>
<th>Clinical Features</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>interval btwn trauma &amp; admission</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;24 hrs</td>
<td>31 (77.5)</td>
</tr>
<tr>
<td>24–48 hrs</td>
<td>8 (20)</td>
</tr>
<tr>
<td>48–72 hrs</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>admission GCS score</td>
<td></td>
</tr>
<tr>
<td>&lt;7</td>
<td>0</td>
</tr>
<tr>
<td>8–12</td>
<td>4 (10)</td>
</tr>
<tr>
<td>13–14</td>
<td>5 (12.5)</td>
</tr>
<tr>
<td>15</td>
<td>31 (77.5)</td>
</tr>
<tr>
<td>symptoms &amp; signs</td>
<td></td>
</tr>
<tr>
<td>nausea &amp; vomiting</td>
<td>23 (57.5)</td>
</tr>
<tr>
<td>occipital swelling</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>headache</td>
<td>15 (37.5)</td>
</tr>
<tr>
<td>cerebellar signs</td>
<td>11 (27.5)</td>
</tr>
<tr>
<td>temporary LOC</td>
<td>6 (15)</td>
</tr>
<tr>
<td>asymptomatic</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>drowsiness</td>
<td>2 (5)</td>
</tr>
<tr>
<td>otorrhagia</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>epistaxis</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>trauma type</td>
<td></td>
</tr>
<tr>
<td>fall from a height</td>
<td>34 (85)</td>
</tr>
<tr>
<td>MVA</td>
<td>4 (10)</td>
</tr>
<tr>
<td>bicycle accident</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>hit by a football</td>
<td>1 (2.5)</td>
</tr>
</tbody>
</table>

* LOC = loss of consciousness; MVA = motor vehicle accident.
The clinical picture in PFEDH can be grouped as acute, subacute, and chronic according to the presentation and duration of clinical symptoms. In the acute form the clinical symptoms present within the first 3 days of injury; the acute variety is usually encountered in the young children with diffuse injury.\textsuperscript{7, 20} Our patients most often presented with the acute form of disease and underwent surgery on an emergency basis (when surgery was indicated); however, the age range was relatively wide, with the average age around the middle of the 1st decade. Clinically, the subacute (symptom onset between Days 3 and 14) and chronic (symptom onset after Day 14) forms were not encountered in our patients.

As was also shown in our study, PFEDH may result from mild to moderate head injury and symptoms may be minor, like headache and vomiting, but the clinical picture can progress rapidly.\textsuperscript{3, 7, 8, 11, 13, 15, 17, 19} Therefore, widespread use of CT scanning has facilitated accurate diagnosis and also improved outcome, and we recommend that CT scans be obtained even with the mildest of suspicions. Moreover, the radiological follow-up criteria used in our conservatively treated cases—namely control CT scanning at 6, 12, 24, 48, and 72 hours after admission—may not be considered to be a cost-effective practice, but taking into account the potential for rapid and fatal deterioration, we find it a useful tool.

There are no defined criteria for deciding between conservative and surgical treatment.\textsuperscript{1, 5, 15} Neurological findings, GCS score on admission, the thickness of the blood clot, accompanying compression of the fourth ventricle, and ventricular dilation on the first CT scan are important. Different authors have tried to define indications for surgery such as hematoma volume of no more than 10 \text{cm}^3, hematoma thickness of no more than 15 mm, midline shift of no more 5 mm, and obliteration of perimesencephalic cisterns.\textsuperscript{5} We used thickness instead of volume as a surgical criterion because, on the one hand, an extraaxial hematoma can have much greater volume if it is thin but smeared to the inner layer of the bone, whereas its thickness is much smaller and causes no mass effect. On the other hand, extraaxial hematomas with smaller volumes but significant thickness may cause mass effect or midline shift especially in a narrow space like the posterior fossa. In our 28 patients (70\%) who had signs of neurological deterioration or fourth ventricle compression, cases of ventricular dilation or epidural hematoma with mass effect were immediately treated with surgery. Twelve patients who had normal neurological status and an admission CT scan showing a hematoma without mass effect, with no compression or displacement of the fourth ventricle, perimesencephalic cisterns, and no signs of ventricular dilation, were followed up conservatively with close clinical neurological examinations.

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Retrospective analysis of our data revealed that all patients with a hematoma thickness of less than 5 mm were followed up conservatively. All 29 patients with a hematoma thickness of greater than 5 mm underwent surgery. In 18 patients the hematoma thickness was greater than 15 mm, which has been accepted as a surgical indication. The other 11 patients, in whom the hematoma thickness varied between 5 and 15 mm, had accompanying injuries/conditions (for instance, a contusion, pneumocephalus, or SAH) causing additional mass effect or a GCS score less than 15, so surgical intervention was chosen in their management. Morbidity and mortality rates were found to be higher in former publications. In our study, which to our knowledge represents the largest pediatric PFEDH series to date, we believe the absence of mortality and morbidity might be associated with our surgical criteria. Based on our data and the successful outcomes in our series, we believe a 5-mm-thick hematoma might be a better surgical indication in pediatric cases. Considering the difficulty of assessing of neurological status or administering the GCS in small children, neurosurgeons must be aware of each PFEDH, even those of a relatively “small” size.

An occipital fracture accompanying PFEDH has been widely reported in the literature. We have identified occipital fractures in almost 87.5% of our patients and multiple intracranial injuries in 22.5%. The frequent use of CT is again of utmost importance in cases with multiple injuries. It helps to detect the types of injury and predict the prognosis and outcome in these cases. The literature suggests that the relative incidence of hydrocephalus or ventricular dilation is low in cases of PFEDH. In our series, we observed ventricular dilation in 15% of our patients. In all cases, ventricular dilation was resolved immediately after surgery. Displacement of the fourth ventricle was more common (37.5%) with no associated hydrocephalus or ventricular dilation probably because emergency evacuation of the hematoma was performed in these cases. There was no need for external ventricular drainage insertion, considering that there were no hematomas with mass effect in the conservatively managed group, whereas other hematomas with a mass effect, clinical signs, and symptoms were evacuated immediately. In the postoperative period, ventricular dilation was dissolved and there was no need for external ventricular drainage during the hospital stay or further shunt surgery after discharge in our patient group.

Our clinical protocol for conservatively managed pediatric PFEDHs is based on serial control scans obtained within the first 72 hours of trauma (at 6, 12, 24, 48, and 72 hours postinjury). Enlargement of the hematoma and compression of the fourth ventricle with or without ventricular dilation were evaluated as evidence of mass effect and brainstem compression. One patient (2.5%) underwent surgery 24 hours after admission due to the enlargement of the hematoma and worsening of neurological status. Regarding this data, one may question our serial imaging protocol and the necessity of the extensive investigative protocol, considering that enlargement of the hematoma resulted in delayed surgery in only 1 patient. However, our institution is a tertiary trauma center, which is the oldest and most experienced university clinic in a metropolitan area with an approximate population of 15 million inhabitants. Compared with the data in the literature, our series contains significantly more patients with a delayed admission. Nine (22.5%) of our patients were admitted after the first 24 hours. Most of these patients were referred to our clinic because of hematoma enlargement or clinical deterioration, as the patients were conservatively followed up in small state hospitals or private clinics. The initial CT scan obtained at our institution was actually like a control CT scan for these patients, and in most of the patients surgery was undertaken based on this investigation. This finding indicates that conservative management of pediatric PFEDH is a very dynamic process. Computed tomography scans play a crucial role in the decision-making process because it is known that radiological findings occur before the change in the clinical picture.5,8 We believe that repeat CT scans are important in the follow-up of conservatively treated cases, and although recent reports suggest restriction of CT use in children due to the threat of radiation, early repeat CT scans may be lifesaving in the follow-up of PFEDH in children. Repeat CT scans should not be abandoned until there is more solid evidence of any harmful effects of the radiation dose delivered by CT scanning. Newer protocols for control cranial CT scans with readjustment of doses for children should be considered in the meantime. Our radiology department complies with ALARA principles32,23,24 (recently defined adjustment of imaging protocols to reduce the radiation dose for pediatric patients, also known as “as low as reasonably achievable”) for children but other measures for control cranial CT scans in children can be considered, such as fewer scans of the supratentorial area, just to rule out the development of hydrocephalus.

As with any surgical report, the focus of this paper should at least partly be on the success and outcome of surgery. In this study, 72.5% of the patients received surgical treatment and 27.5% were followed up conservatively. The neurological status in all patients was favorable during admission, and there were no cases of severe head injury. All patients fared well after surgery, which may imply, contrary to the opinion of some authors, that surgery may not add further morbidity or mortality to the existing neurological state. Additionally, other reports with favorable results (also with no mortality or morbidity) have been published, as have other reports of low mortality and morbidity rates, but they all included much smaller patient populations.33,37,11,19,26 We believe that emergency surgery must be undertaken whenever it is deemed necessary, especially considering the rapid and fatal progression of the lesion, although surgery may require other expertise due to anatomical considerations.

Conclusions

This is a relatively large and recent review of data from a university hospital with a busy emergency unit. The favorable outcome may be attributed to the exclusive use of CT scanning in the diagnosis and follow-up of all cases, the improvement of neuroanesthesia and intensive care, and cumulative data from very recent experience, in addition to the mostly favorable admission statuses of the patients.
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Finally, we believe that with the use of modern tools in neuroimaging, surgery, and intensive care, PFEDH in children can be treated safely at experienced centers. There is no need to avoid surgery when it is indicated.

Disclosure
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Sencer, Aras. Acquisition of data: Akcakaya, Sencer, Aras, Goker. Analysis and interpretation of data: Akcakaya, Sencer, Aras, Goker. Drafting the article: Akcakaya, Sencer, Aras. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Akcakaya. Study supervision: Sencer.

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