Conservative Management of Supratentorial Extradural Hematomas in Children

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Abstract

Background: Acute Extradural Hematoma (EDH) is less common in children compared to adults, which can be explained by the relative flexibility of skull bones at this age which make fractures less frequent than in adults. Furthermore, EDH at this age is characterized by non-specific clinical presentation and inability of very young children to communicate. However, the management guidelines of EDH in children are ill-defined.

Objective: The aim of this study is to assess the safety and efficiency of Bullock et al guidelines for conservative management of EDH in Children.

Patients and Methods: This was a prospective study conducted in Al-Manial university hospital, Kasr Al-Aini Medical School, Cairo University, over a period of one year duration. The study included children (<15 years old) with Glasgow Coma Scale (9-15) suffering from supratentorial EDH (thickness <15mm, volume <30cc and midline shift <5mm) without any focal neurological deficits according to Bullock et al., guidelines.

Results: 18 children (13 boys and 5 girls) matched these criteria and underwent conservative treatment. The most common mode of trauma was fall from height (usually 1.5 meters) (72%), while the most common sites of hematoma were frontal and parietal (33.3% and 27.8% respectively). Early follow-up computed tomography (CT) scan revealed enlargement of seven cases (38.8%), six of them continued the conservative management. While one case exceeded the required parameters for continued conservative treatment and was evacuated successfully. Thus the success rate of conservative management of EDH was (94.4%). There was no mortality and all patients had good outcome.

Conclusion: Conservative management of EDH in children is safe and effective if the guidelines of Bullock et al., were followed. However, if conservative treatment of EDH is considered, it is mandatory to secure adequate neurological monitoring and the possibility of urgent evacuation at any time especially in borderline cases.

Key Words: Bullock guidelines – Conservative management of extra dural hematoma – Head trauma in children.

Introduction

The incidence of extradural haematoma (EDH) constitute approximately 2.7-4% of traumatic brain injury in children [1-3]. This incidence is even rarer among open head infants and young children. Unlike EDH in adults, EDH in children may follow a trivial head injury, the symptoms are subtle, the course is more insidious and associated skull fissure is less frequent [4]. Recently thanks to the widespread availability of computed tomography (CT) scan, a larger number of EDH is diagnosed with stable neurological status or mild symptoms especially in children and infants [5-6].

Regarding the guidelines for surgical management of acute epidural haematomas, after meta-analysis of selected 18 published studies, Bullock and his co-workers recommended that patients without any focal neurological deficits and Glasgow coma scale (GCS) between [9-15], EDH volume less than 30cc, thickness less than 15mm and midline shift (MLS) less than 5mm can be managed conservatively with close clinical and radiological follow-up [7]. Unfortunately, the guidelines regarding the appropriate management of EDH in children were not specified in this study. The aim of this study is to assess the safety and efficiency of Bullock et al., guidelines for conservative management of EDH in Children.

Patients and Methods

This was a prospective study conducted in Al-Manial university hospital, Kasr Al-Aini Medical School, Cairo University, Egypt over a period of one year duration (between October 2012 and September 2013) with minimum 4m follow-up. A selected group of children who had post traumatic EDH according to specific selection criteria were initially managed conservatively. All patients were subjected to meticulous general and neurological examination and initial brain CT scan.
The selection criteria followed Bullock et al., guidelines for management of EDH [7].

**Inclusion criteria:**
- All patients under 15 years old, GCS [9-15] without any focal neurological deficits.
- EDH thickness <15mm.
- MLS (measured at the level of septum pellucidum) <5mm.
- EDH volume <30cc (the volume of EDH was calculated using the equation \( \text{Volume} = 0.5 \times \text{height} \times \text{length} \times \text{depth} \) [8].

**Exclusion criteria:**
- Patients with GCS 8 or with focal neurological deficit.
- Patients with associated compound fractures or significant associated intra-cranial lesions.

*NB:* Association of fracture base of skull, fissure or simple depressed fractures not requiring surgery were not considered as exclusion criteria.

The interval between the time of trauma and initial plain brain CT was documented. The level of Consciousness was closely monitored and urgent brain CT scan was planned in case of any deterioration. Urgent surgical evacuation would be performed if the EDH parameters exceeded the above mentioned values.

The first follow-up CT scan was done within 12 hours from the initial CT scan if the initial CT scan was performed within 6 hours of trauma; and within 24 hours for patients having their initial CT scan later than 6 hours from trauma. Second follow-up CT scan was performed one day after the first follow-up CT scan; and then subsequent CT scans were ordered every other day in the first six days after the trauma.

The criteria for hospital discharge included fully conscious patients with hematoma volume, thickness and MIS less than 30cc, 15mm and 5mm respectively, after duration of at least 6 days from the time of trauma.

On discharge; all patients’ relatives were instructed to come back if they noted any deterioration of consciousness, repeated vomiting, or persistent headache. The patients were followed-up at the outpatient clinic regularly every 2 weeks for one month, then every month for the following 3 months. It is worth mentioning that follow-up CT scans were not routinely performed unless the patient has significant symptoms.

### Statistical analysis:

Data were statistically described in terms of mean±standard deviation (±SD), and range.

### Results

From 37 children with post traumatic EDH who were admitted to the neurosurgical emergency and trauma unit; 18 children (48.6%) matched the inclusion criteria for conservative management (Table 1). There was an evident male predominance with a male-to-female ratio (M/F) of 13/5 (2.6). The mean age of patients at diagnosis was 5.8y (±3.6y SD), ranging from 4 months to 14.8 years. The mode of trauma varied from fall from height (usually less than 1.5 meters) in 13 cases (72.2%), road traffic accidents in 3 patients or assault by heavy object in the remaining 2 cases. On admission, 9 children were fully conscious (GCS 15), 7 children had GCS 14, while only 2 children had GCS 13. The time interval between trauma and the initial CT scan was variable ranging from one hour to three days. Most of the cases had their initial CT scan within 6 hours following trauma (Fig. 1).

![Time interval between the onset of trauma and the initial CT](image_url)
Comparing the initial CT scan with the first follow-up CT scan revealed increase in EDH parameters in 7 cases (38.8%); 5 cases within 12h (of trauma), and 2 cases within 24h according to the follow-up CT protocol. All these 7 patients continued their conservative management of EDH except only one patient who had the follow-up CT scan exceeding the required parameters for continued conservative treatment and reaching volume 42cc, thickness of 20mm and MLS of 2mm. (Fig. 2). The number of CT scans performed for each patient ranged between 4-7 scans (except the operated case). It is noteworthy that no enlargement of EDH parameters was noted after 24h in any case.

The mean hospital stay was 7.4±1.6 days (range 6-11 days). The mean follow up period was 4.7±0.7 months. There was had no mortality and all patients had good Glasgow outcome scale.

![Fig. (2): Patient N.18, the only patient who underwent surgical evacuation. A- Initial CT scan showing EDH of 13mm thickness, 1mm midline shift (MLS) and 29cc volume; B- At the first CT scan follow-up after 12h, the EDH enlarged with thickness 18mm, MLS 2mm and volume 42cc.](image-url)

<table>
<thead>
<tr>
<th>Patient N</th>
<th>Sex</th>
<th>Age</th>
<th>GCS</th>
<th>Site</th>
<th>Initial CT</th>
<th>F/U CT</th>
<th>Associated fissure</th>
<th>Need for surgery</th>
<th>GOS</th>
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<tr>
<td>1</td>
<td>♂</td>
<td>4m</td>
<td>15</td>
<td>Lt F</td>
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<td>Fissure</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>♂</td>
<td>11y</td>
<td>15</td>
<td>Lt O</td>
<td>6cc, 5mm, 0</td>
<td>Same</td>
<td>–</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>♂</td>
<td>3y</td>
<td>14</td>
<td>Rt F</td>
<td>6cc, 5mm, 0</td>
<td>Same</td>
<td>Fissure</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>♂</td>
<td>8.5y</td>
<td>15</td>
<td>Rt F</td>
<td>7cc, 5mm, 0</td>
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<td>Fissure</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>♂</td>
<td>2.5y</td>
<td>14</td>
<td>Rt P</td>
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<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>♂</td>
<td>5y</td>
<td>15</td>
<td>Rt PT</td>
<td>8cc, 6mm, 0</td>
<td>18cc-1 1mm-1mm</td>
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<tr>
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<td>♂</td>
<td>5y</td>
<td>15</td>
<td>Rt P</td>
<td>8cc, 5mm, 0</td>
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<td>–</td>
<td>–</td>
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<tr>
<td>8</td>
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<td>8y</td>
<td>15</td>
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<td>9cc, 4mm, 0</td>
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<td>2y</td>
<td>15</td>
<td>Lt FP</td>
<td>9cc, 5mm, 1mm</td>
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<td>Lt O</td>
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<tr>
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<tr>
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<td>13</td>
<td>Lt P</td>
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<td>–</td>
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<tr>
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<td>15cc, 9mm, 1mm</td>
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<td>14</td>
<td>Rt FP</td>
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<td>–</td>
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</tr>
<tr>
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<td>14</td>
<td>Rt F</td>
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<td>Fissure</td>
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<td>Good</td>
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<tr>
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<td>7y</td>
<td>14</td>
<td>Rt FP</td>
<td>22cc, 9mm, 0</td>
<td>Same</td>
<td>Fissure</td>
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<tr>
<td>17</td>
<td>♂</td>
<td>4.5y</td>
<td>13</td>
<td>Lt PT</td>
<td>25cc, 11mm, 1mm</td>
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<td>–</td>
<td>–</td>
<td>Good</td>
</tr>
<tr>
<td>18</td>
<td>♂</td>
<td>6y</td>
<td>15</td>
<td>Lt PT</td>
<td>(29cc), 13mm, 1mm</td>
<td>42cc-18mm-2mm</td>
<td>Surgery</td>
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</table>
Discussion

Acute EDH is less common in children compared to adults, representing approximately 3% of pediatric patients admitted due to head trauma [5,9-12]. This can be explained by the relative flexibility of skull bones at this age which make fractures less frequent than in adults [13]. Furthermore, EDH at this age is characterized by non-specific clinical presentation and inability of very young children to communicate [5,14]. The mechanism of injury at this age group was fall from height followed by traffic related accident or assault by heavy object [5,12,15]. This coincides with results in this study as fall from height was the most common mechanism and the only one in age below five years. It should be noted that the height is usually less than 1.5 meter which explain the mild injurious effect in these cases.

The most common location of EDH in children was parieto-temporal in many studies, which differ from the results of this study as the frontal location was the commonest [14,16,17]. This may be related to the inclusion criteria where only conservative cases were selected not all cases. Pure temporal location is rare in infant and young children because the middle meningeal artery is not grooved as compared to adults in temporal bone, hence less exposed to injury [5,14].

There is a controversy regarding the actual incidence of associated skull fractures or fissures in EDH in children which varies greatly among reported studies from 40% to 80% [2,4,5,11-14,17-19]. Few studies explained the low incidence of associated skull fractures or fissures in children with EDH by different elasticity coefficients between the inner table of skull and the dura mater which result in detachment of the dura from bone and development of EDH without fissure or fractures at this young age group [20]. Conversely, other reports argued that fissures may be missed radiologically as a result of the thinness of bone in infant and young children [17]. In this work, associated fissure fracture was noticed in about 72.2% of cases.

Conservative management of EDH in children was reported to be successful in many series because children tolerate more increase of intracranial tension due to open fontanel (in young children 2y), wide sutures and large basal cisterns [19,21,22]. Furthermore, the source of EDH at young age is commonly venous which make the volume less than that in adults in which the arterial bleeding are more reported [19]. Most of studies about conservative strategy are retrospective without specific guidelines for patient selection; however most of them concluded that GCS and EDH parameters in CT scan are the most important factor for decision making.

Bejjani et al., reported extradural haematoma in 33 children, 20 patient underwent surgery and 13 patient treated conservatively [6]. Multivariate logistic regression analysis revealed that MLS, hematoma thickness, and volume, as well as temporal location of the hematoma were related to surgery. Hematoma volume and MLS were 41 cm³ and 8 cm³, and 4 mm and 0.5 mm, for the surgical and conservative groups, respectively.

Many studies reported a higher incidence of EDH enlargement in patients diagnosed within 6-8 hours after trauma [14,23,24]. In the current study, all patients were closely observed for their level of consciousness to detect any deterioration due to hematoma enlargement which should be evacuated urgently. Routine follow-up CT scan was done for all cases even if they are neurologically stable. The first follow-up CT scan was planned within 12 hours (for patients with initial CT scan within 6 hours from trauma) or within 12 hours (for patients with initial CT scan later than 6 hours from trauma) from initial CT scan. The subsequent follow-up films were done one day later, then every other day.

In this study, the number of follow-up CT scans ranged between 4 and 7 scans which is higher than some studies [28]. Enlargement of EDH parameters were noticed in the first follow-up CT scan in seven cases (38.8%); however, significant increase occurred in a single case (5.6%) (Fig. 1) which was evacuated surgically. The patient, who had significant increase of the EDH size, was still fully conscious without neurological deficit. It is noteworthy that the CT parameters of this patient on admission were 29 cc volume, 13 mm thickness and 2 ml MLS, which means that borderline cases should be subjected to more attention.

The results regarding enlargement of (7/18=38.8%) EDH within 24h from the initial CT scan is consistent with the results of Sullivan et al., who observed that the mean interval between EDH enlargement and initial CT scan or trauma was 5.3h and 8.2 hours respectively [26]. Enlargement of EDH occurred within 12 hours from initial CT Scan in 95% of their patients with no enlargement observed later than 36 hour from trauma.
On the other hand, Knuckey et al., reported that the average interval between admission and surgery was 2.7 days in seven patients with EDH [22]. Also, Pang and his colleague [19] operated upon two of their patients 6–8 days following trauma and Balmer et al., operated upon one of thirteen children five days after trauma [18].

The high success rate of conservative management of EDH in the current study of 18 children (17/18=94.4%) with only one patient was managed surgically with good outcome and no mortality is consistent with the study of Balmer et al., who reported successful conservative treatment of EDH in 12/13 of children (92.3%) [18].

There is no firm consensus in the literature regarding the required length of hospital stay for conservative management of EDH. The reported average hospital stay ranges from seven to ten days in many studies [27]. Consistent with these studies, the mean hospital stay in this study was 7.4 days (range from 6 days to 11 days). In contrast, other studies allowed discharge only after two weeks of hospitalization [28]. The zero mortality in this study is similar to that reported in many other articles for conservative treatment of EDH [13,18,19,21,25], which confirms the safety of conservative management of EDH if Bullock et al., guidelines were followed under meticulous clinical and radiological monitoring.

**Conclusion:**

Conservative management of EDH in children is safe and effective if the guidelines of Bullock et al., were followed. However, if conservative treatment of EDH is considered, it is mandatory to secure adequate neurological monitoring and the possibility of urgent evacuation at any time especially in borderline cases.

**References**


