Epidural Hematomas in Children

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Study objective: To describe the presentation, management, and outcome of children with traumatic epidural hematoma.

Design: Retrospective chart review.

Type of participants: Fifty-three children diagnosed with traumatic epidural hematoma on computed tomography scan who were treated at Children's Hospital in Boston between 1980 and 1990.

Main results: Twenty-four of 53 children developed an epidural hematoma after a fall of less than 5 ft. At the time of diagnosis, 51 of 53 children had one or more symptoms of vomiting, headache, or lethargy. Twenty-six patients were alert, 21 were responsive to verbal or painful stimuli, and five were unresponsive or posturing. Twenty-one (40%) had acute neurologic deterioration before surgery; however, 20 (38%) were alert with normal vital signs and neurologic examinations at diagnosis. All patients survived, and at the time of discharge 45 had normal examinations and eight had neurologic abnormalities; at follow-up only four of these eight had persistent (although mild) abnormalities.

Conclusion: Although often dramatic in presentation, epidural hematoma may occur after relatively minor head trauma and in alert children with nonfocal neurologic examinations. In our study, incidence of neurologic sequelae increased if abnormal neurologic examination or depressed mental status was present at diagnosis. The outcome of children in this study is improved from that of previous studies, perhaps due to increased use of computed tomography and higher incidence of low- or moderate-impact trauma in this series.

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INTRODUCTION

Head injuries in children are common; they account for approximately 600,000 emergency department visits annually. Although many of these injuries are minor, head trauma causes significant pediatric morbidity and mortality.[1,2] A major goal for the emergency physician is to identify and treat any potentially life-threatening head injuries. Epidural hematoma is one such complication of head trauma. Although studies of children with epidural hematoma have been reported, most involved patients treated before the use of computed tomography (CT) and showed that many children died or were left with major sequelae.[3,4] Because CT has enabled the clinician to detect intracranial abnormalities promptly and more accurately, children diagnosed with the use of CT may differ in symptomatology, clinical course, and outcome from those diagnosed before the use of this modality.

With this in mind, we undertook a retrospective study of children diagnosed with epidural hematoma with the use of CT. An understanding of the range of clinical presentation may enable the clinician to improve early recognition and predict outcome of children with epidural hematoma.

MATERIALS AND METHODS

Charts were reviewed retrospectively of children who were diagnosed with traumatic epidural hematoma on CT scan, less than 19 years old, and treated at Children's Hospital in Boston between November 1980 and December 1990. These patients were identified from medical record discharge codes, computerized discharge summaries, and neurosurgical operative logs. Children who suffered in-hospital trauma and those with underlying central nervous system abnormalities were excluded.

Historical information, physical findings, operative descriptions, hospital course, and follow-up were abstracted from the chart. Time of diagnosis was considered the time at which the CT scan was obtained, and findings at diagnosis were those noted in the ED evaluation at diagnosis (or the ED evaluation after the diagnosis if the patient was referred). Levels of consciousness were recorded as alert, responsive to verbal stimuli, responsive to painful stimuli, or unresponsive or posturing based on the physician and nurse notes. Neurologic examination was considered focal or nonfocal based on the findings noted in the chart; children with an isolated Babinski reflex that was withdrawal or inconsistent between examiners were not considered to have a focal deficit.

Patients were categorized as having bradycardia or tachycardia if heart rates were documented below or above, respectively, the age-appropriate normal range at any time prior to surgery or hospital admission.[5] Hypertension or hypotension were considered present if a blood pressure above the 95th percentile or below the 5th percentile norm for age, respectively, occurred at any time before surgery or hospital admission.[5] Hypertension or hypotension was considered to be present if blood pressure was above the 95th percentile or below the 5th percentile norm for age, respectively, at any time before surgery.

Acute neurologic deterioration was considered to have occurred if the patient required intubation in the ED, or if a sudden decrease in the level of consciousness occurred in association with a neurologic abnormality. All patients underwent cranial CT. At the time of this study, reports on all scans were noted in the charts, and 40 CT scans were available for detailed review by two neuroradiologists; the remaining 13 CT scans were at referring institutions and thus were unavailable for review. Epidural hematoma location, intradural abnormalities, amount of midline shift (in mm), and presence of skull fractures were noted. A relative epidural hematoma size was calculated as the product of the maximum sagittal, transverse, and vertical dimensions of the hematoma; the volume reported (in cm^3), therefore, is not the true volume of the hematoma,

Table 1.
Mechanism of injury in 53 children with epidural hematoma

Injury	No. of Patients	%
Fall (height)	31	58
< 5 ft	24	
5 to 10 ft	5	
> 10 ft	2	
Bicycle	12	23
Motor Vehicle Accident	3	6
Pedestrian	2	
Passenger	1	
Blow	3	6
Skateboard	2	4
Other	2	4

Table 2.
Post-traumatic time to presentation, diagnosis, and surgery

Hours	Time to Initial Presentation (N = 53)	Time to Diagnosis (N =53)	Time to Surgery (N = 44)
0 to 6	40	25	13
6 to 12	4	6	7
12 to 24	6	9	10
24 to 48	2	5	6
> 48	1	8	8

but rather a relative size. Children who did not have skull radiographs obtained and had no fracture noted on CT or on the operative report were considered to have no fracture.

Continuous data were analyzed using the two-tailed Student's *t*-test, and categorical variables were analyzed by χ^2, Fisher's exact test, and Mann-Whitney analysis. Values are given as mean ± SD. $P < .05$ was considered significant.

RESULTS

Fifty-three patients with epidural hematomas were identified. Twenty-three patients underwent primary evaluation at Children's Hospital, and 30 were transferred to Children's Hospital after initial evaluation at other facilities. Their ages ranged from 3 months to 18 years and 11 months (mean age, 7.1 ± 5.8 years; median age, 5.3 years), with 13 children 2 years old or less, 13 children 2 to 5 years old, and 27 children 5 to 18 years old. The group included 35 male patients and 18 female patients.

Overall, falls caused the majority of the injuries (Table 1). The mechanism of injury differed by age with every child less than 5 years old sustaining head injury due to a fall and only five of 27 children more than 5 years old sustaining an injury due to a fall. Immediate post-traumatic loss of consciousness occurred in ten patients (duration was more than five minutes in only three), was unknown in 12 patients, and did not occur in 31 patients. Two children had post-traumatic seizures (one immediately and one three hours after the trauma). Thirty-five patients (66%) were diagnosed with epidural hematoma at the initial hospital visit, four (8%) were admitted for observation and subsequently diagnosed during hospitalization, and 14 (26%) were not diagnosed until a return hospital visit. Fifty patients came to the hospital within 24 hours of the head injury; however, only 40 were diagnosed with epidural hematoma within 24 hours (Table 2).

Symptoms of headache, vomiting, or lethargy were common, with 51 of 53 patients having at least one of these three (Figure). The two asymptomatic patients (ages 3 and 8 months) had CT scans done because of localized head swelling. The majority of children had normal vital

Table 3.
Findings at diagnosis in 53 children with epidural hematoma

Finding	No. of Patients
Vital Signs	
Normal	31
Abnormal	22
Low heart rate	13
Low heart rate, high blood pressure	5
High heart rate	1
High blood pressure	2
High heart rate, high blood pressure	1
Mental Status	
Alert	26
Responsive-verbal	9
Responsive-painful	13
Unresponsive	5
Pupillary Size	
Normal	41
Abnormal	12
One pupil dilated	11
Two pupils dilated	1
Optic Discs	
Normal	15
Abnormal	6
Unknown	32
Neurologic Examination	
Normal	31
Abnormal	22
Cranial nerve	7
Hemiplegia	2
Cranial nerve + hemiplegia	6
Abnormal Babinski	3
Other	4
Basilar Skull Fracture Sign	
Present	5
Absent	46
Unknown	2
Multisystem Injury	
Absent	49
Present	4
Rib fracture	1
Clavicle fracture	1
Partial avulsion foot	1
Multisystem injury	1

Table 4.
Findings in children with and without surgery

Finding	No Surgery (N = 9)	Surgery (N = 44)
Mean Age (yr)	9.9±7.3	6.5±5.3
Acute Deterioration*	0	21 (47%)
Mental Status at Diagnosis*		
Alert	9	17 (39%)
Depressed	0	27 (61%)
Neurologic Examination at Diagnosis*		
Normal	8 (89%)	23 (52%)
Abnormal	1 (11%)†	21 (48%)
CT Findings*	(N = 8)	(N = 32)
Epidural size (cm^3)	20±1 (2 to 56)	115±83 (2 to 315)
% With midline shift	13	84
% Midline shift ≥ 5 mm	0	56
Neurologic Examination at Discharge		
Normal	9	36
Abnormal	0	8

*$P < .05$.
†Isolated upgoing toe.

signs, normal pupillary size and reactivity, nonfocal neurologic examinations, and normal level of consciousness, with each sign considered independently (Table 3). Twenty patients (38%) were alert with normal vital signs and normal neurologic examinations.

Twenty-one children with epidural hematomas had acute neurologic deterioration, which occurred within 24 hours of the head trauma in 20 of 21 patients. Although these children presented to the hospital sooner after their injuries ($P < .05$), they did not differ from those without acute deterioration with regard to age, sex, type of trauma, incidence of immediate post-traumatic loss of consciousness, or symptoms of vomiting or headache.

Skull fractures were present in 36 patients and absent in 17. The 40 CT scans available for review showed the epidural hematoma location to be frontal in six, temporal in 19, temporoparietal in ten, and other in five; epidural hematoma size ranged from 2 to 315 cm^3 (mean, 97 ± 84 cm^3; median, 63 cm^3). Midline shift was present in 28 of 40 and ranged from 1 to 27 mm (mean, 5.1 ± 5.7 mm; median, 4 mm), with 18 of 40 having shift of 5 mm or more. There were no associated intradural hemorrhages in 33 patients. CT showed cerebral contusions in four, cerebellar hemorrhage in one, and questionable cerebral contusions in two patients.

Forty-four patients underwent surgical evacuation of the epidural hematoma (Table 4). The nine patients who did not undergo evacuation of the epidural hematoma were alert with nonfocal neurologic examinations (except one child with an isolated upgoing toe), tended to have smaller hematomas and small or nonexistent midline shift, and had uneventful hospital courses.

All 53 patients survived, and at the time of discharge from the hospital, eight had abnormal neurologic examinations. Thirty-one of the 45 patients who were normal at hospital discharge had follow-up examinations in the neurosurgery clinic noted in the chart; all were normal.

Figure.
Symptoms of vomiting, headache, or lethargy

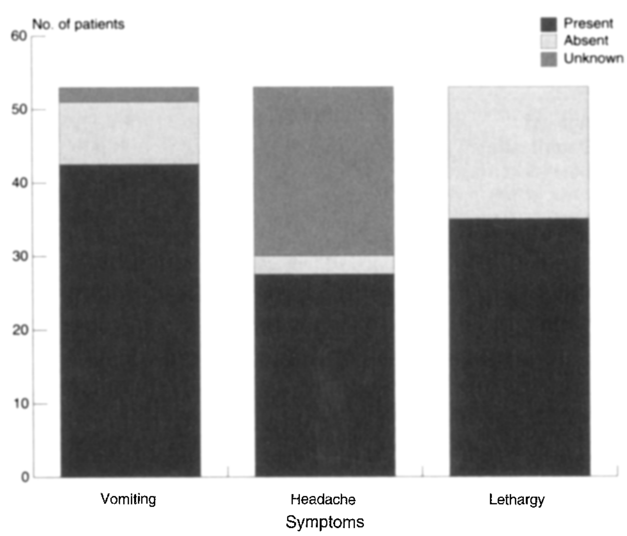

Table 5.
Neurologic abnormalities at discharge and follow-up (N=8)

Patient	Abnormality at discharge	Follow-up
1	Right cranial nerve 6 palsy Right weakness	Right cranial nerve 6 palsy Right weakness
2	Right cranial nerves 6 and 7 palsy	Right cranial nerves 6 and 7 palsy
3	Right cranial nerve 3 palsy Left weakness Trunkal ataxia	Slight left leg weakness
4	Left weakness Ataxia Impaired verbal communication	Clumsy (? mild ataxia) (on the honor role)
5	Right cranial nerve 3 palsy Left hand weakness	Normal
6	Mild left weakness	Normal
7	Left cranial nerve 7 palsy Left upgoing toe	Normal
8	Mild left weakness	No official follow-up ("normal" at later surgery)

Table 6.
Signs and symptoms of children diagnosed at first and return visits

Finding	Group Initially Discharged (N = 14) First Visit	Group Initially Discharged (N = 14) Return Visit	Group Initially Admitted (N = 39)
Vomiting			
Yes	4	13	30
No	10	1	7
Unknown			2
Lethargy			
Yes	2	9	25
No	12	5	14
Mental Status			
Alert	14	8	18
Verbal response	0	4	5
Pain response	0	1	12
Unresponsive	0	1	4
Pupils			
Normal	14	11	30
Abnormal	0	3	9
Neurologic Examination			
Normal	14	9	22
Abnormal	0	5	17

The eight children with abnormal neurologic examinations at discharge did not differ significantly from those with normal discharge examinations with regard to incidence of loss of consciousness or symptoms. They did differ with regard to type of trauma and findings at diagnosis. Only 6% (two of 31) of children who suffered falls were abnormal at discharge compared with 33% (four of 12) of those involved in bicycle accidents ($P = .03$). The eight children abnormal at discharge also had a significantly higher incidence of mental status depression (seven of eight, with four unresponsive or posturing) and abnormal neurologic examination at diagnosis (eight of eight) ($P < .05$).

No patient with a normal examination at diagnosis had an abnormal examination at discharge from the hospital, whereas eight of 22 with abnormalities at diagnosis were abnormal at discharge ($P < .01$). An abnormal neurologic examination at discharge also was more likely with progressive depression of mental status at diagnosis; only one of 25 who presented alert had abnormalities at discharge compared with four of five who were initially unresponsive or posturing. Although eight children had neurologic abnormalities at the time of hospital discharge, all could walk and talk except a 10-month-old infant who had a mild left hemiplegia and had not yet achieved these developmental milestones before the head trauma. Follow-up of these eight patients showed that four had persistent but mild abnormalities and three had normal neurologic examinations. One had no official neurosurgical follow-up noted in the chart but at later elective surgery was noted to be "normal" (Table 5).

Fourteen of the 15 patients (26%) with epidural hematoma were diagnosed at a return visit after having been evaluated for the head trauma and discharged from a medical facility. None of these patients underwent cranial CT at the initial visit. Six of 14 had skull radiographs at the first visit, and three of six showed skull fractures. Compared with the group that was diagnosed with epidural hematoma or hospitalized at the initial visit, there was no difference in age, mechanism of injury, history of loss of consciousness, or time to initial presentation. However, these patients had a higher level of consciousness and fewer neurologic abnormalities; all 14 patients were alert and nonfocal neurologically at initial discharge (Table 6).

Time to return visit was less than 24 hours in eight patients, 24 to 48 hours in one, and more than 48 hours in five. The reasons for returning included one or more symptoms of vomiting, headache, or lethargy in 11; neurologic deterioration in two; and localized head swelling in one. At return visit, this group had significantly more vomiting, lethargy, mental status depression, and neurologic abnormalities ($P < .05$) compared with their initial presentations (Table 6), and at this point they did not differ significantly from the group diagnosed at first visit. Twelve of 14 underwent surgery, and at hospital discharge, 13 of 14 had normal neurologic examinations. Thus, management and outcome of this group were similar to those of the group diagnosed without delay.

DISCUSSION

Epidural hematomas are a relatively uncommon complication of head injury, occurring in fewer than 3% of patients who are hospitalized with head trauma.[3,6] However, epidural hematomas are critical to identify because they are life-threatening and readily treated surgically. Clinicians routinely consider the diagnosis in any child who experiences significant head trauma and has an altered level of consciousness or neurologic deterioration. We found that epidural hematoma may also be more subtle in presentation. Many children presented to the hospital after relatively minor trauma (45% after falls of less than 5 ft). All except two patients had symptoms of headache, vomiting, or lethargy, and more than half had signs that clearly pointed to the diagnosis. However, almost 40% were alert with nonfocal neurologic examinations.

Previous studies of patients with head trauma also have demonstrated that serious intracranial injury may occur after minor head trauma in alert patients. Studies of both adults and children found a 1% to 3% incidence of intracranial hemorrhage in patients who were alert after apparently minor-to-moderate head trauma.[7,8] Miller et al reported that 183 patients with intracranial hemorrhage after "minor" head injury arrived alert with a Glasgow Coma Scale (GCS) score of 15; 57% had no clinical signs.[9] Likewise, Cook et al reported that among 100 patients with traumatic epidural hematoma and GCS of 14 or 15, 40% had nausea or vomiting but no focal neurologic signs.[10]

In a study of children with epidural hematoma, Singounas and Volikas[11] noted "in 9 of 17, the injuries were absolutely trivial to such an extent that on exam ... some of the residents were wondering whether these children should be admitted or not," although specific GCS and neurologic findings were not noted. This "new" population of patients with intracranial hemorrhage and little symptomatology probably is being identified due to the current widespread use of CT. The clinician must now include the alert, relatively well-appearing child as a possible presentation of epidural hematoma. Despite apparent stability, children with epidural hematoma harbor a potentially life-threatening injury and can deteriorate abruptly.

The 14 patients in this series who were not diagnosed until a return visit were alert with nonfocal neurologic examinations at the first presentation but returned with significantly more symptomatology. Because none had CT scans at the initial evaluation, it is impossible to say if a hemorrhage was present at that time or the epidural hematoma onset was delayed.[12] The experience of this group highlights the importance of clear instructions for follow-up and raises the issue of when to obtain a CT scan. It may not always be possible to differentiate clinically between the child with simple head trauma and one with an intracranial injury. It is neither practical, reasonable, nor cost-effective to obtain a CT scan on every child with head trauma, yet the clinician must maintain a low threshold for performing this test in a child with suggestive symptomatology as epidural hematoma can occur after minor trauma and be subtle in presentation. Obtaining skull radiographs in individuals with head trauma is a controversial issue,[13-17] and although we are not advocating routine skull films in this situation, if radiographs are obtained and reveal a skull fracture, the clinician should strongly consider obtaining a CT scan, particularly if the fracture crosses the path of a major vascular structure (eg, middle meningeal artery). However, a normal skull radiograph does not preclude the presence of an epidural hematoma.

In this series, the likelihood of neurologic sequelae increased if the child had acute deterioration, neurologic abnormalities, or a depressed level of consciousness. Seven of 21 children who had acute deterioration had abnormalities at discharge compared with one of 32 who had not deteriorated ($P < .01$). Because the children who deteriorated did not differ from the others with regard to age, loss of consciousness, or symptoms of vomiting or headache, it is difficult to predict who will decompensate. However, once deterioration occurred, the child was much more likely to have neurologic sequelae.

The outcome of children in this series was encouraging. Despite potentially life-threatening intracranial hemorrhages, there were no deaths and relatively low morbidity; no children were in a vegetative state, and only 15% had nonincapacitating neurologic abnormalities at hospital discharge (almost half of whom were normal at follow-up). Because formal clinical follow-up was not done for all patients, it is unknown whether other survivors had subtle abnormalities or learning difficulties.

The outcome for patients in this series was much better than that reported in previous studies. Of 104 children with epidural hematoma reported by Choux et al in 1975, 18 died and 17 had residual neurologic abnormalities (overall, 33% had a poor outcome).[3] In a study of 144 children with epidural hematoma, Dhellemmes et al reported in 1985 that only 97 had a complete recovery.[4]

Studies of patients with epidural hematoma diagnosed with CT have demonstrated improved outcomes;[6,10,18] however, most have included adults in their population. Although advances in anesthesia, surgery, and postoperative care may have contributed to the improved outcome of patients, the use of CT to diagnose epidural hematoma in minimally symptomatic individuals (in some cases before clinical deterioration) probably is the factor most responsible for improved outcomes. In previous years, minimally symptomatic patients either would have deteriorated and been diagnosed at that point or would have done well without intervention and never have been diagnosed. Patients with epidural hematoma who are minimally symptomatic fare better than those neurologically compromised; therefore, early detection may lead to improved outcomes. Another factor that may account for the good outcome of children in this series is the high incidence of relatively low-impact trauma (eg, many short falls and few motor vehicle accidents).

A prospective study to compare children with epidural hematoma with those sustaining head trauma without intracranial hemorrhage might further help the clinician determine signs and symptoms that are more specific for this complication.

CONCLUSION

Although often epidural hematoma is dramatic in presentation, it may occur after relatively minor head trauma and in alert children with nonfocal neurologic examinations. In this series, there was an increased likelihood of sequelae if abnormal neurologic examination or depressed mental status was present at diagnosis. Also, the outcome of children in this study is relatively good compared with those of earlier studies, perhaps due to the increased use of CT and the higher incidence of low- or moderate-impact trauma in this series. Because early recognition may improve outcome, heightened sensitivity to the range of presentation is warranted.

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