

## Review

# Extradural haematoma—To evacuate or not? Revisiting treatment guidelines



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## ABSTRACT

**Background:** We describe three cases of extradural haematomas (EDHs) and their management, focusing on operative and non-operative treatment. We also review the available literature from the past three decades as well as the guidelines for the management of EDH. An algorithm is formulated based on different factors, including the clinical course of the patients and their CT findings.

**Methods:** The first patient presented to us after sustaining a fall with a GCS of 15/15 and a large parieto-occipital EDH with a volume of 90 cm<sup>3</sup>. He was treated non-operatively. Follow-up CT showed good resolution of the haematoma. The second patient presented with a GCS of 7/15, a posterior fossa EDH with a volume of 30 cm<sup>3</sup>, and obstructive hydrocephalus. Emergency craniotomy and evacuation of the EDH, which was converted to a VP shunt. The third case was a patient presenting with a large hemispheric EDH, which was 130 cm<sup>3</sup> in volume. The GCS at presentation was 14/15 but dropped to 6/15, following which he underwent craniotomy and evacuation of the EDH.

**Results:** The Glasgow Outcome Scale (GOS) at three months was five for the first two cases and three for the third case with a dense right hemiplegia.

**Conclusion:** EDH, both supratentorial and in the posterior fossa, can be managed non-operatively. A large volume EDH (>30 cm<sup>3</sup>) can be managed non-operatively provided the GCS at presentation and follow up remains the same with symptomatic improvement. Prompt treatment of a large volume EDH may still result in a poor outcome.

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## Contents

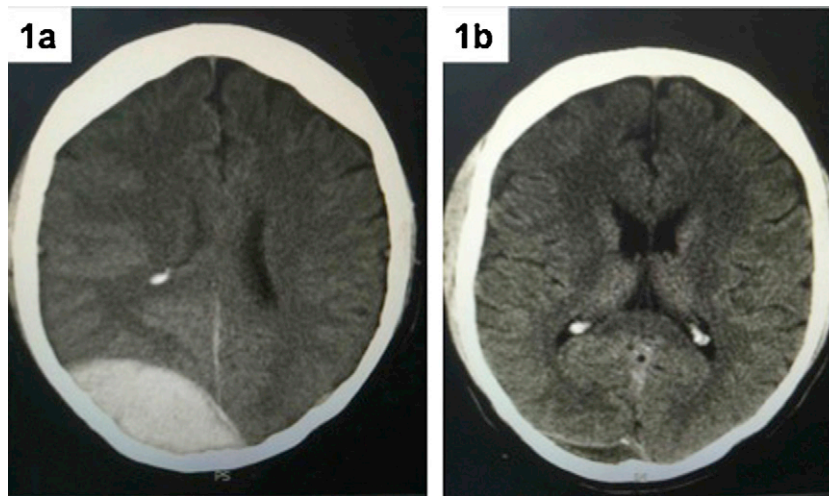
1. Introduction.....	1201
2. Case description.....	1202
2.1. Case 1.....	1202
2.2. Case 2.....	1202
2.3. Case 3.....	1203
3. Discussion.....	1203
4. Conclusion.....	1205
Conflict of interests.....	1205
Acknowledgments.....	1205
References.....	1205

## 1. Introduction

Extradural haematoma (EDH) is a neurosurgical emergency as it may cause an acute increase in intra cranial pressure (ICP) following trauma requiring rapid emergency treatment [1–3]. Early

treatment is necessary to reduce morbidity and mortality [4]. The Brain Trauma Foundation (BTF) [5] has recommended that any EDH greater than 30 cm<sup>3</sup> should be surgically evacuated regardless of the patient's Glasgow Coma Scale (GCS) score. The recommendations also suggest a follow-up computed tomography scan (CT) in non-operative patients within 6–8 h of the initial injury. CT brain without contrast is the standard radiological imaging used for the diagnosis and evaluation of EDH [1,6,7]. Dubey et al. [8] described that patients who were managed conservatively had a

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**Fig. 1.** Three cases of extradural haematomas (EDHs) and their management, focusing on operative and non-operative treatment (a) Non-contrast CT brain in Case 1 demonstrating large right parieto-occipital EDH. (b) Non-contrast CT brain at eight weeks after the injury showed a very small amount of low-density blood remained, but overall, the EDH had resolved.

better outcome than surgically managed patients with an EDH volume (EDHV) of less than  $30\text{ cm}^3$ , and several institutions worldwide follow the guideline for better clinical outcomes. We described three cases of EDH; all were managed differently based on their GCS at presentation, whether the EDH was supratentorial or in the posterior fossa, volume of EDH and degree of midline shift (MLS) on CT scan. We also reviewed the current literature over the past 28 years emphasising conservative treatment or non-operative interventions for EDH and found an acceptable management strategy and outcome for these patients. Lastly, we summarise and formulate an algorithm for the overall management of intracranial EDH including supratentorial and PFEDH.

## 2. Case description

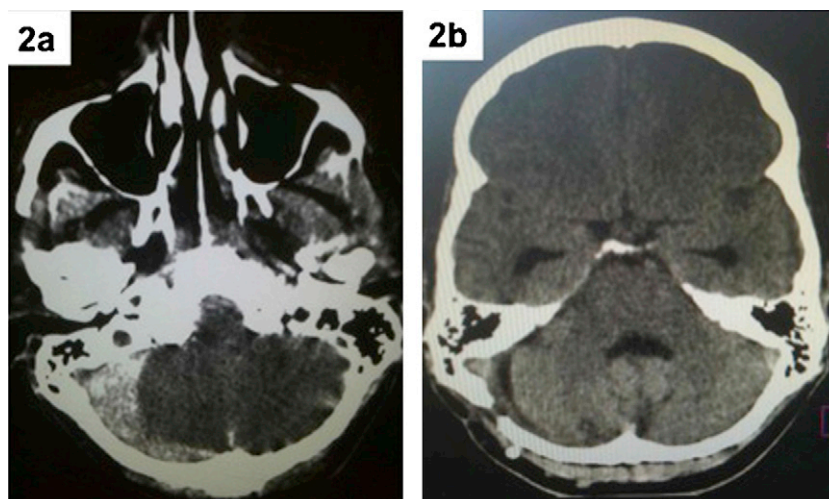
### 2.1. Case 1

A 28-year-old male presented to us after sustaining a fall of 3 m from a ladder. He had two episodes of headache associated with vomiting. On examination, his pupils were equal and reactive. Neurological examination was normal. CT scan showed a large EDH in the right parieto-occipital region with a MLS of 5 mm (Fig. 1a). Small temporal contusions were also noted on the scan. The blood volume

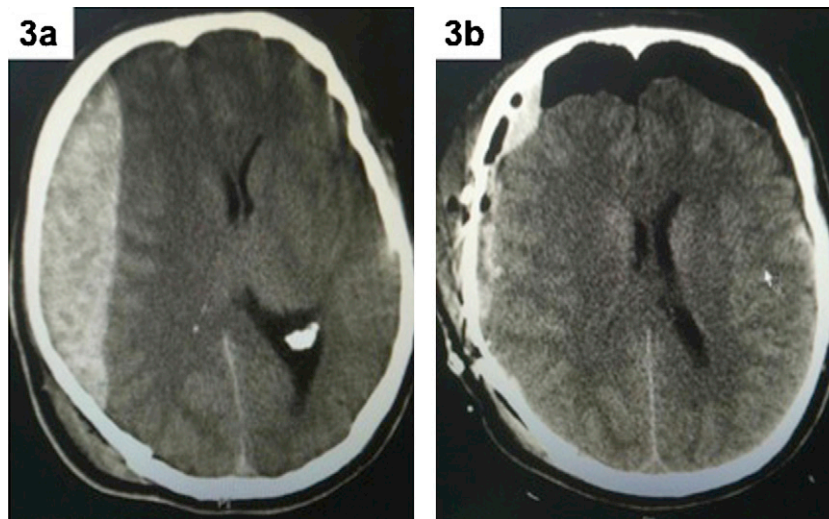
was  $90\text{ cm}^3$ . He was admitted for neurologic observation and analgesics were administered. After a few hours, his symptoms receded, and 24 h later he remained well. A repeat CT scan showed no change in the features of the EDH. He was discharged home after 48 h with instructions for care after a head injury. Follow-up outpatient clinic with repeat CT scan at 8 weeks (Fig. 1b) showed that a very small, low-density amount of blood remained, but overall, the EDH had resolved. He remained well and was discharged from our service.

### 2.2. Case 2

A 56-year-old male presented to our service after falling down stairs. His GCS at presentation was 7/15 with midsize, fixed pupils. He was subsequently intubated and ventilated and an urgent CT scan (Fig. 2a) was performed that revealed a large posterior fossa extradural haematoma (PFEDH) with obstructive hydrocephalus and a fracture of the occipital bone. The clot overlaid the transverse sinus with volume of  $30\text{ cm}^3$ . Emergency ventriculostomy was performed. The patient was extubated 2 days later, and his GCS returned to 15. The ventriculostomy was challenged by raising the height of drain. The patient did not tolerate this, and subsequently, a VP shunt was performed. He was discharged to the referring hospital for rehabilitation. He was seen back in the clinic with complete



**Fig. 2.** (a) Non-contrast CT brain in Case 2 showed a right posterior fossa EDH with a blood volume of  $30\text{ cm}^3$ . (b) Non-contrast CT brain at 8 weeks after a VP shunt operation showed an overall resolution of the EDH.



**Fig. 3.** (a) CT brain in Case 3 demonstrating large right hemispheric EDH. (b) Postoperative CT brain showing good resolution of the haematoma.

recovery. Follow up CT (Fig. 2b) at 8 weeks showed good resolution of the haematoma with a good position of the VP shunt. He was discharged from our service.

### 2.3. Case 3

A 52-year-old male presented to us with a history of collapse in the street and was brought in to the emergency department with a GCS of 14/15. His GCS dropped to 6/15 over a period of 45 min, and he was intubated and underwent a CT brain (Fig. 3a). This revealed a large EDH in the right hemispheric region with an estimated EDHV of 130 cm<sup>3</sup>. There was a fronto-parietal fracture noted with a MLS of 1 cm. His pupils became fixed and dilated. Emergency craniotomy was performed and the EDH was evacuated. Post-operative

CT scan showed resolution of the MLS and satisfactory evacuation of the EDH (Fig. 3b). Two days later, he showed some signs of improvement but was left with a dense weakness on the right side suggestive of Kernohan's notch phenomenon. At three months, his GCS remains 13/15 with a dense right-sided hemiplegia.

### 3. Discussion

These three cases illustrate the varied presentations of EDH with different clinical management strategies. Early recognition and diagnosis of EDH is the key to management of this neurosurgical emergency. Patients with EDH can 'talk and die' due to rapid expansion of the haematoma. In surgically treated patients, a haematoma volume greater than 50 cm<sup>3</sup> is significantly related

**Table 1**  
Surgical management of Acute Extradural Haematoma.

Recommendations – Brain Trauma Foundation guidelines [5]

#### Indications for Surgery

- An extradural haematoma (EDH) greater than 30 cm<sup>3</sup> should be surgically evacuated regardless of the patient's Glasgow Coma Scale (GCS) score.
- An EDH less than 30 cm<sup>3</sup> and with less than a 15-mm thickness and with less than a 5-mm midline shift (MLS) in patients with a GCS score greater than 8 without focal deficit can be managed non-operatively with serial computed tomographic (CT) scanning and close neurological observation in a neurosurgical centre.

#### Timing

- It is strongly recommended that patients with an acute EDH in coma (GCS score <9) with anisocoria undergo surgical evacuation as soon as possible.

#### Methods

- There are insufficient data to support one surgical treatment method. However, craniotomy provides a more complete evacuation of the haematoma.

**Table 2**  
Literature review comparing conservative vs. surgical treatment in patients with extradural haematoma.

Author (year)	Cases (no)	Age group	Sex	GCS	VEDH	Operated	Cx	Favourable outcome
Roka et al. [4] (2008)	43	Adult	M > F	>50% 13/15	<10 ml	33	10	O (PF)
Cheung et al. [1] (2007)	89	Adult	M > F	>50% 13/15	Small	30	59	Cx
Offner et al. [2] (2006)	84	Adult	M > F	GCS > 12	<12 mm*	37	47	Cx
Babu et al. [14] (2005)	300	Both	M > F	NA	Small	247	53	NA
Dubey et al. [8] 2004	203	Adult	M > F	>10	<40 ml	156	47	Cx
Bezircioğlu et al. [10] (1996)	270	Both	M > F	GCS > 8	<40 ml	197	75	NA
Wong [7] (1994)	25	Both	M > F	NA	<10 ml	20	5	O = Cx (PF)
Chen et al. [11] (1993)	74	Both	M > F	GCS > 12	<30 ml	12	62	Cx
Cucciniello et al. [12] (1993)	144	Both	M > F	GCS > 10	<40 ml	87	57	Cx
Tuncer et al. [3] (1993)	15	Both	M > F	GCS > 5	<20 ml	–	15	Cx
Kawakami et al. [9] (1990)	2	Paeds	M	GCS > 12	Small	–	2	Cx (PF)
Bullock et al. [13] (1985)	123	Both	M > F	GCS > 12	<38 ml	111	12	Cx
Pang et al. [20] (1983)	11	Paeds	M > F	GCS > 12	Medium to large	2	9	Cx

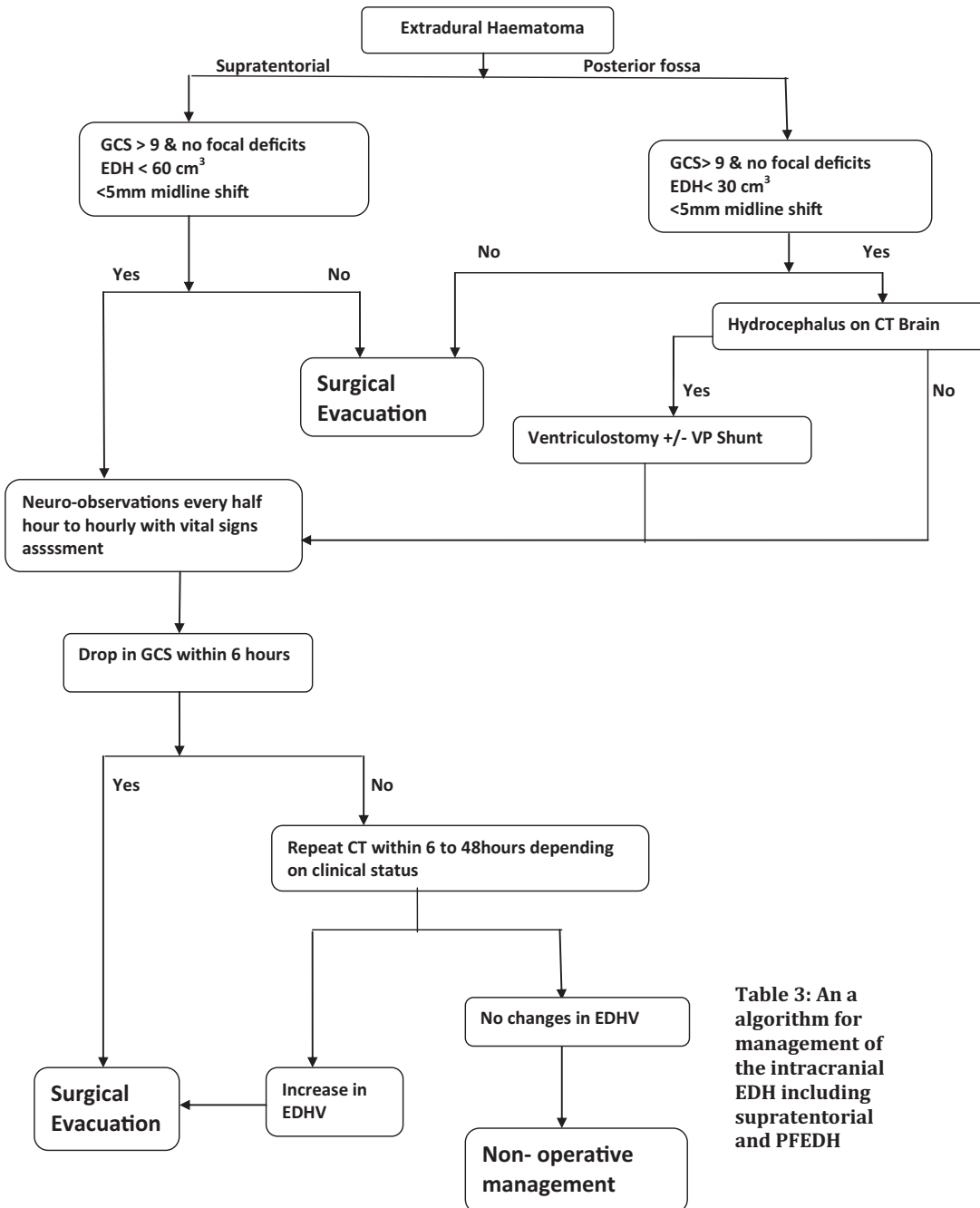
M: male; F: female; VEDH: volume of extradural haematoma treated conservatively; GCS: Glasgow coma score at presentation; Cx: conservative management; O: operated; NA: not available; PF: posterior fossa; asterisk \*: CT finding based on thickness of EDH.

to higher mortality and unfavourable functional outcome [6]. However, BTF guidelines indicate that an EDH less than 30 cm<sup>3</sup> and with a thickness less than 15 mm and with less than a 5 mm MLS in patients with a GCS score greater than 8 without focal deficits can be managed non-operatively (Table 1). Therefore, it is crucial to determine the treatment plan at an earlier stage.

Conservative treatment or non-operative interventions have been described in the literature for EDH. Table 2 summarises the articles published in the past 28 years. The literature to date has focused on clinical outcomes following operative vs. non-operative management for EDH with a follow-up of up to one year. The lowest GCS that was treated conservatively was nine [11], and the largest volume EDH was 40 ml. A few authors have documented

small volume EDHs, which we believe were less than 30 ml. Chen et al. [11], Cucciniello et al. [12] and Bullock et al. [13] had successful outcomes in non-operative management of patients with a GCS score of more than 10 and an EDHV of less than 40 ml. Offner et al. [2] however, used the thickness of the EDH (<12 mm) as predictor for the success of non-operative management, and also had successful outcomes. He did not support the contention that failed non-operative intervention resulting in delayed evacuation of the haematoma may compromise patient outcomes [6]. The pathological effects of EDH can cause compression of the underlying brain and lead to an increase in intracranial pressure (ICP) [14]. Tuncer et al. [3] used intracranial epidural pressure monitoring in treating EDH without evacuation of the haematoma. They achieved good outcomes by monitoring ICPs and treating of raised ICPs. The

**Table 3**  
An algorithm for management of the intracranial EDH including supratentorial and PFEDH.



**Table 3:** An algorithm for management of the intracranial EDH including supratentorial and PFEDH



literature also favoured non-operative interventions in the management of EDH in selected groups of patients [1,14].

The articles above have focused on supratentorial EDH. PFEDH has an incidence of 4–7% [4]. A recent article by Roka et al. [4] recommended that an EDHV of more than 10 ml should be removed surgically. Their results showed a better outcome in the surgical management group, with 27 of the 33 cases that underwent operation (81%) making a full recovery versus 7 of the 10 cases in the conservatively managed group (70%). Wong [7] used the same criteria but concluded that conservative treatment achieved similar outcomes to those who underwent surgery. Kawakami et al. [9] described two patients younger than 10 years of age, and both recovered well without any neurological deficit with non-operative management.

In EDH, the injured artery is usually the middle meningeal artery in temporo-parietal trauma and anterior ethmoidal artery in frontal trauma. The source can also be bleeding from the superior sagittal/lateral sinus and Diploic vein [15]. This correlates to the location of EDH, which is most commonly in the temporal or temporo-parietal area [2,8,14]. A temporal EDH has a higher risk of haematoma growth and should lower the threshold for surgery [10,13]. However, 85% of PFEDHs are of venous origin and develop as a result of injury to the transverse or sigmoid sinuses secondary to occipital fracture [4,16]. The posterior fossa has limited space, and patients can deteriorate with early obstructive hydrocephalus, visible on the CT in 30% of cases [4,9]. Management of hydrocephalus was key in the management of PFEDH [9]. A PFEDH that is 10 ml may produce the same degree of MLS and compression and can be as dangerous as an EDH of 30 ml in the more spacious supratentorial compartment [7,8]. The current guidelines may not be applicable to the management of PFEDH [11].

Regarding the resolution of EDH, there seemed to be evidence of a relationship between the presence of an underlying skull fracture and outcome in EDH. Fracture, most often linear, produces detachment of dura directly beneath the site of the blow, and injures blood vessels [14]. Some authors argue that the presence of skull fracture is an indicator for intracranial complication [17], but others have argued against this, claiming that there is no relationship with final outcomes [6,18], even for patients who were treated conservatively [2,11]. Tuncer et al. [3] calculated the resorption rate in patients with skull fractures who were treated conservatively and showed that EDHs associated with an underlying fracture resolve quickly. This was postulated to be due to epicranial transfer through the skull fracture. Our first and second patient both had skull fractures. There may be an element of the above evidence in the resolution of these two EDHs.

The two most important indications for surgery are EDHV and GCS at presentation, and these are emphasised as the key factors in the current guidelines for surgical treatment. Bozbuğa et al. [19] suggested that CT findings were more predictable than clinical findings, but Dubey et al. [8] and Roka et al. [4] argued the opposite. A CT scan performed less than 6 h after trauma had a higher risk of haematoma enlargement, especially in the temporal fossa [10]. The frequency of EDH enlargement ranges from 5.5% to 65% [13,20], and may represent continued haemorrhage or re-haemorrhage from an arterial or venous origin. Sullivan et al. [18] reported that the mean time to enlargement was 8 h after injury and 5.3 h after CT diagnosis, with a mean enlargement of 7 mm. Clinical deterioration generally corresponded to the degree of enlargement and occurred more frequently if it enlarged by 1 cm or greater. Therefore, serial CT scans in non-operative patients should be obtained within 6–8 h after the initial injury [5]. We developed an algorithm for the management of intracranial EDHs including supratentorial and PFEDHs based on the above variables (Table 3). This summarises the overall management strategies for both supratentorial and PFEDHs.

#### 4. Conclusion

We conclude that EDH, both supratentorial and in the posterior fossa, can be managed non-operatively. Several factors must be considered while managing this condition and it must be managed in a neurosurgical unit. These factors include the location of the EDH (supratentorial or in the posterior fossa), GCS at presentation, CT scan findings including the EDHV, presence or absence of a 5 mm MLS and the clinical course of the patient after diagnosis. Large volume EDHs (>30 cm<sup>3</sup>) can be managed non-operatively provided that the GCS at presentation and follow-up remains the same with symptomatic improvement. Prompt treatment of large volume EDHs may still result in poor outcomes.

#### Conflict of interests

The authors declare no conflicts of interest.

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