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Institutional Experience of Post-Traumatic Posterior Fossa Extra Dural Hematoma: A Prospective Longitudinal Study

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ABSTRACT

AIM: To analyze clinical and imaging characteristics of post-traumatic posterior fossa extradural hematoma (PFEDH).

MATERIAL and METHODS: Between 2018 and 2022, 51 patients were admitted to our tertiary care trauma center with a diagnosis of PFEDH. The management decision was tailored by an individual consultant based on clinicoradiological findings. We did a prospective analysis of patient characteristics, radiology, clinical presentation, management, and outcome at discharge and one-month follow-up.

RESULTS: Of the 51 patients diagnosed with a PFEDH, 45 (88.2%) were male, and six (11.8%) were female with a mean age of 31.2 years (range 2-77 years). Twenty-six patients needed surgical evacuation of the EDH, while the rest 25 patients were managed conservatively. There was one crossover patient from the conservative to the surgical arm. Road traffic accidents (RTA) were the most common cause of injury (n=35; 68.6%), followed by falls from height (n=16; 31.4%). Most patients presented with vomiting and loss of consciousness (LOC). At presentation, 30 patients (58.5%) had a GCS 15. Seven patients (13.7%) presented with a GCS of 9-14, and 14 patients (27.5%) with GCS ≤ 8. The mean EDH volume in conservatively and surgically managed patients was 14.1 and 25.1cc, respectively. Five patients (9.8%) had significant midline shift with obliteration of basal cisterns, 15 patients (29.4%) had effacement of the fourth ventricle, and 11 patients (21.5%) had the presence of hydrocephalus. All patients with features suggestive of tight posterior fossa (hydrocephalus, obliterated basal cisterns, and fourth ventricle compression) needed surgical intervention. Of the 25 conservatively managed patients, 24 (96%) had favorable GOS scores at discharge, while one (4%) had an unfavorable score. 16/26 (61.5%) surgically treated patients had a good outcome at discharge (GOS=4-5), while ten patients (38.4%) had adverse outcomes (GOS <4). Initial EDH volume was inversely correlated with presenting GCS and GOS with a mean volume of 21.5 ± 8.5 cc in patients presenting with a GCS ≤8. Patients with a GCS of 15 at presentation had a mean EDH volume of 16.1 ± 8.2 cc. Patients with smaller EDH had much higher GOS scores than patients with higher volume EDH (GOS 1 = 22.0 ± 9.83 cc vs. GOS 5 = 18.9 ± 12.2 cc). Outcomes mainly depended on factors like GCS at arrival and associated supratentorial, thoracic/abdominal polytrauma.

CONCLUSION: In patients with a clot volume of <15 cm^3 and GCS of 15 at presentation with no mass effect and absence of tight posterior fossa, a conservative trial under strict clinicoradiological monitoring in a neuro-critical multidisciplinary setting can be offered with good results. In cases of altered GCS, findings of a TPF, or clinicoradiological deterioration, immediate surgery is warranted.

KEYWORDS: Craniotomy, Decompressive craniectomy, Glasgow coma score, Guidelines, Neurosurgery, Traumatic brain injury

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INTRODUCTION

An extradural hematoma (EDH) is a common traumatic lesion seen in head injury occurring in 1-3% of all traumatic brain injury (TBI) patients and up to 15% of all patients presenting in an unconscious state (1). Posterior Fossa EDH (PFEDH) represents a rare clinical entity with an incidence ranging from 1.2-12.9% of all EDH (4). In 1938, McKenzie was the first to document PFEDH in a child who fell off a chair and died. Coleman and Thompson (10) performed the first successful operation for PFEDH in 1941. The clinical symptoms range from mild headache, vomiting, altered sensorium, and rapid deterioration to fatal outcomes. Timely diagnosis and management ensure good results as patients quickly deteriorate without localizing signs (12).

A non-contrast CT of the brain is highly sensitive for diagnosing PFEDH, as relying on clinical examination alone may delay the diagnosis (11). Contrary to the supratentorial EDH, there are no strict volumetric criteria for PFEDH. Hence the treatment is mainly tailored to individual patients, with much variability in the literature. Treatment is a surgical evacuation of hematoma in tight posterior fossa (TPF) cases. At the same time, a conservative approach is appropriate if the above radiological criteria are not satisfied and the patient is alert and conscious (13).

This study compares surgery results versus conservatively managed patients in our institute to frame an institutional recommendation for patients presenting with PFEDH with a comparative literature analysis.

MATERIAL and METHODS

Between January 2018 and December 2022, 51 patients presented to the trauma center with head injuries and a diagnosis of PFEDH (Ethics Committee , PGIMER , Chandigarh; Date: 10/12/2021; No: INT/IEC/2021/SPL - 1743). After resuscitation and clinical stabilization, all suspected patients underwent a non-contrast CT scan head. We used McDonald's criteria to evaluate hematoma volume based on the formula (a x b x c x 0.5) on the CT slice thickness with maximum length and breadth of hematoma. The maximum thickness of EDH, effacement of the fourth ventricle and perimesencephalic cisterns, hydrocephalus, tonsillar or upward transtentorial herniation, associated supratentorial, calvarial injuries, and polytrauma were also recorded. Patients with supratentorial hydrocephalus, basal cistern obliteration, the fourth ventricle effacement, and midline shift were considered to have a 'tight posterior fossa (TPF). Based on the above clinical-radiological findings, patients of PFEDH either underwent surgery or were managed conservatively by a multidisciplinary team of neurosurgeons, intensivists, trauma surgeons, and nurses in a critical care setting (Figure 1). The surgery commonly done in our center is a midline/paramedian suboccipital craniotomy/craniectomy with hematoma evacuation. Hydrocephalus may require the placement of a ventriculoperitoneal shunt (2,3,8). We did not do intracranial pressure monitoring for any of these patients. Outcomes were evaluated based on the Glasgow Outcome Scale (GOS) at discharge and one-month follow-up. For this study, GOS 4-5 was considered good outcomes, while GOS ≤ 3 was considered poor.

RESULTS

Out of 51 patients (45 male; 6 females), 26 (50.9%) underwent surgical evacuation, while 25 were managed conservatively. One patient needed surgical evacuation after initial observation for 72 hours because of delayed neurological deterioration (crossover rate 3.8%). The mean age of patients was 31.2 (range 2 – 77) years. The mean age of patients that underwent surgery vs. conservative arm was 31.7 (range 2-62) and 30.6 (range 9-77) years, respectively.

The most common mode of injury was road traffic accidents (RTA) (n= 35;68.6%). Fall from height was responsible for injury in 16 patients (31.4%). The clinical presentation of patients included loss of consciousness (LOC) in 39 patients (76.4%), vomiting in 35 patients (68.6%), ENT bleeding in 16 patients (31.3%), and seizure in one patient (1.9%). Two patients (3.9%) had anisocoria, probably due to upward transtentorial cerebellar herniation and compression of the oculomotor nerve.

The GCS at admission was 15 in 30 patients (58.8%), with 7(26.9%) and 23 (92%) in both surgery and conservative arms, respectively (Figure 2A). One patient (3.8%) had a GCS of 13

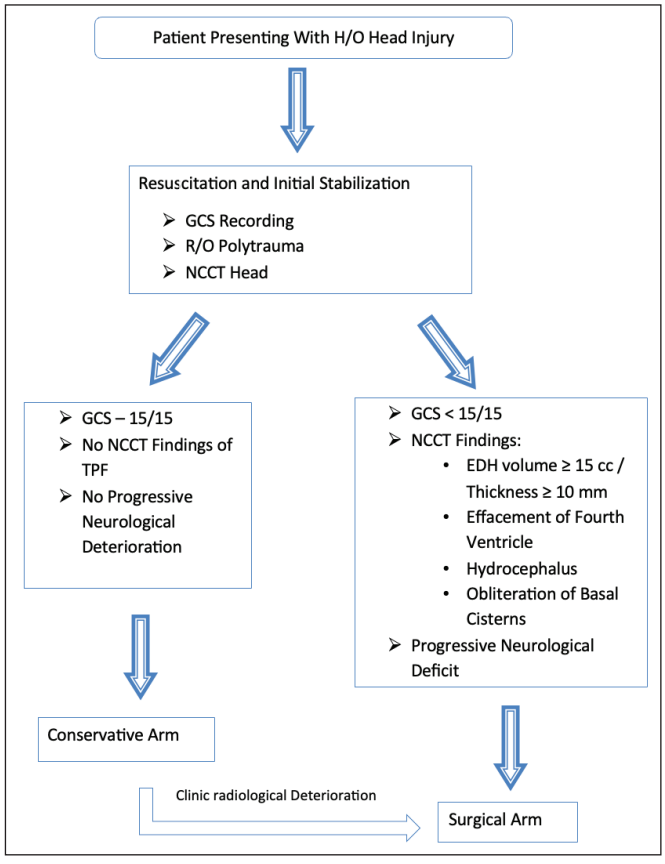

Figure 1: Management algorithm for posterior fossa extradural hematoma.

Table I: Comparative Evaluation of 51 Patients Treated with Surgery or Conservative Management

Criteria	Surgery (%)	Conservative (%)
Number	26	25
Mean age (years)	31.7	30.6
Median age (years)	32.5	27
Range	2 - 62	9 - 77
Male: Female Ratio	7.6 : 1	7.5 : 1
Mode of injury; n		
RTA	15 (57.6)	20
Falls	11 (42.3)	5
GCS at admission; n		
15	7 (26.9)	23 (92.0)
13 – 14	1 (3.8)	0
9 - 12	5 (19.2)	1 (4.0)
3 - 8	13 (50.0)	1 (4.0)
Clinical Features ; n		
Loss of Consciousness	24 (92.3)	15 (60.0)
Vomiting	22 (84.6)	13 (52.0)
ENT Bleed	9 (34.6)	7 (28.0)
Seizure	0	1 (4.0)
Anisocoria	2 (7.6)	0
Radiological Features; n		
Mean Volume of PFEDH (cc)	25.1	14.1
Mean Thickness (mm)	17.6	8.7
Laterality,		
Left	12 (46.1)	11 (44.0)
Right	7 (26.9)	13 (52.0)
Bilateral	7 (26.9)	1 (4.0)
TPF		
• Midline Shift	5 (19.2)	0
• Hydrocephalus	11 (42.3)	0
• Effacement of fourth ventricle	15 (57.6)	0
Supratentorial EDH	2 (7.6)	0
Frontal Contusion	2 (7.6)	1 (4.0)
Temporal Contusion	3 (11.5)	1 (4.0)
Supratentorial SDH	2 (7.6)	0
ICH	18 (69.2)	15 (60.0)
Occipital bone Fracture	19 (73.0)	14 (56.0)
GOS at Discharge		
5	14 (53.8)	24 (96.0)
4	2 (7.6)	0
3	3 (11.5)	1 (4.0)
2	2 (7.6)	0
1	5 (19.2)	0
Good Outcome	16 (61.5)	24 (96.0)
Poor Outcome	10 (38.4)	1 (4.0)
GOS at 1 month		
5	16 (61.5)	24 (96.0)
4	0	0
3	3 (11.5)	1 (4.0)
2	2 (7.6)	0
1	5 (19.2)	0
Good Outcome	16 (61.5)	24 (96.0)
Poor Outcome	10 (38.4)	1 (4.0)
Mean Hospital Stay (days)	6.5	3.5

EDH: *Extradural hematoma,* ***ENT:*** *Ear nose throat,* ***GCS:*** *Glasgow coma scale,* ***GOS:*** *Glasgow outcome score,* ***ICH:*** *Intracerebellar hematoma,* ***PFEDH:*** *Posterior fossa extradural hematoma,* ***RTA:*** *Road traffic accidents,* ***SDH:*** *Subdural hematoma.*

and underwent surgery. Six patients (11.7%) had a GCS of 9-12, with five in the surgical arm. Fourteen patients (27.4%) had severe head injuries with GCS≤8, of which 13 needed surgical evacuation (Table I).

On radiology, 23 patients had left-sided (45%) EDH, while 20 in the right side (39.2%). Eight (15.6%) patients had bilateral hematomas. The occipital fracture was a common finding observed in 33 (64.7%) patients. Mean hematoma volume was 25.1 and 14.1 cm3 in respective surgical and conservative arms (Figure 2B). The mean thickness of the clot was 17.6 and 8.7 mm, respectively (Figure 2C). The surgical arm included all patients with TPF (five patients (9.8%) with obliteration of perimesencephalic cisterns, 15 patients (29.4%) with effacement of the fourth ventricle, and 11 patients (21.5%) with hydrocephalus.).

Six patients (11.7%) had a supratentorial extension of EDH, with four belonging to the surgical arm. Associated supratentorial contusions were seen in five patients (9.8%), with four in the surgical arm. Four patients (7.8%) had a supratentorial subdural hematoma (SDH); three needed surgical evacuation. Two patients (3.9%) had a traumatic intracerebral hematoma (ICH), both of whom underwent surgery. The mean hospital stay was 6.5 days for surgically treated patients versus 3.5 days for patients managed conservatively.

Outcome assessments were based on the Glasgow Outcome Scale (GOS) at discharge and one-month follow-up. At discharge, 38 patients (74.5%) had excellent outcomes with a GOS of 5, with 14 (53.8%) belonging to the surgical arm and 24 (96%) to the conservative arm (Figure 2D). Two patients (3.9%) had moderate disabilities (GOS=4) and needed surgical evacuation. Four patients (7.8%) had GOS=3, two patients (3.9%) were in a persistent vegetative state (GOS=2), and five patients died (GOS =1). At one month follow-up, 40/51 patients (78.4%) had good outcomes with a GOS of ≥4, of which 16/40 (40.0%) belonged to the surgical arm while 24/40 (60.0%) belonged to the conservative arm. Eleven patients (21.5%) had poor outcomes, of which ten were managed surgically (Table I).

The study also revealed that most patients that presented with a poor GCS underwent surgery, with half (n=13; 50%) of the operated patients having a GCS ≤8. Most conservatively managed patients (n=23; 92%) had an excellent GCS score of 15. Patients with an EDH volume of ≥15 cc needed surgical evacuation (Mean=25.15 cc) compared to conservatively managed patients with a mean EDH volume of 14.16 cc. Clot thickness was also an important deciding factor with patients ≥10 mm thickness undergoing surgery (mean thickness = 17.62 mm), while patients with thickness ≤10 mm

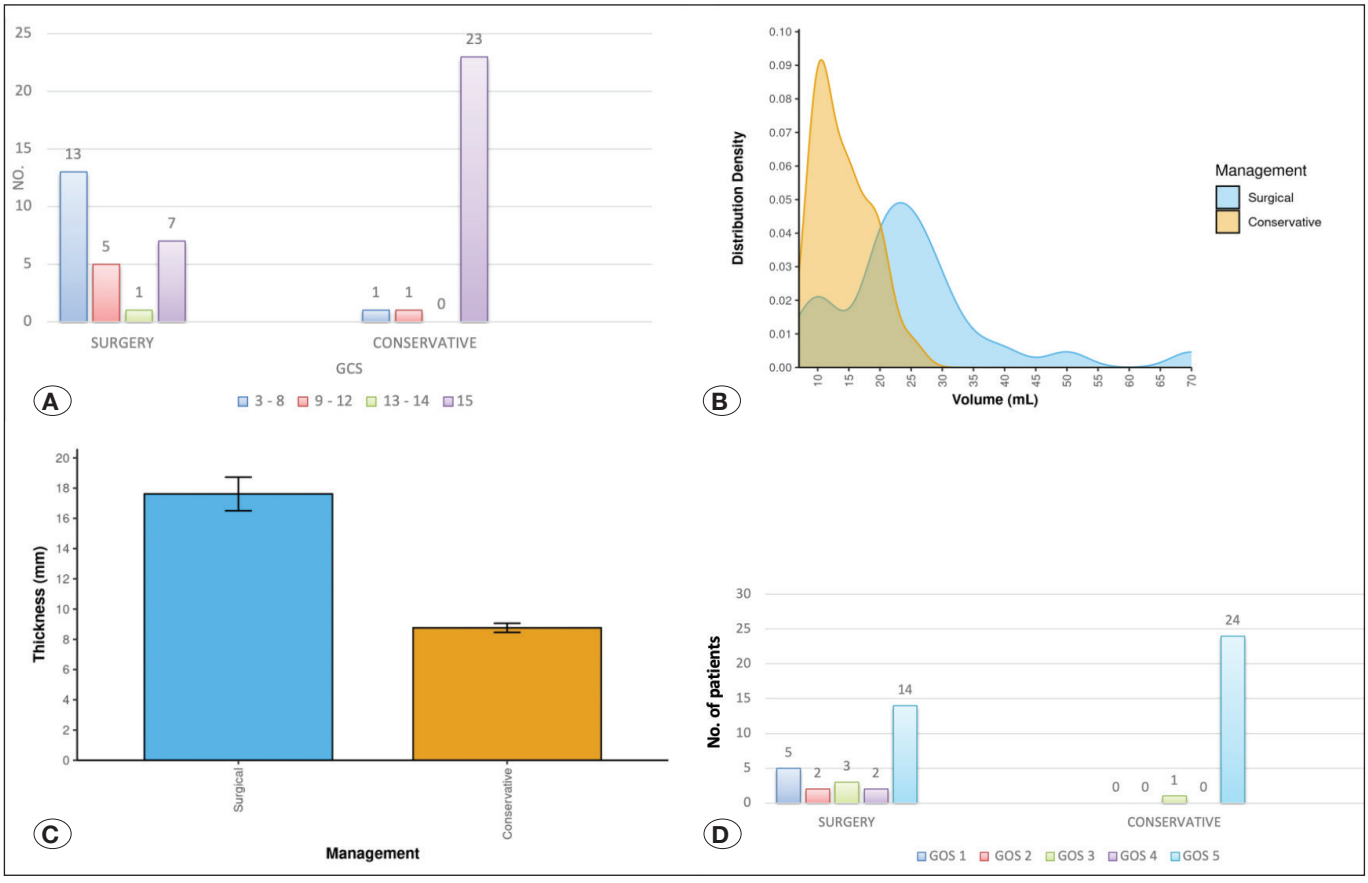

Figure 2: Correlative evaluation of. **A)** Patient management according to the GCS at presentation. **B)** Volume of extradural hematoma and management strategy. **C)** Thickness of blood clot between surgical and conservative arms. **D)** Patients' outcome in the surgical and conservative arms.

were managed conservatively (mean = 8.76 mm). Initial EDH volume was also inversely correlated with presenting GCS and overall GOS, with the mean volume being 21.5 ± 8.5 cc in patients presenting with a GCS ≤8. Patients with a GCS of 15 at presentation had a mean volume of 16.1 ± 8.2 cc. Patients with smaller hematomas also had much higher GOS scores than patients with higher-volume clots (GOS 1 = 22.0 ± 9.83 cc vs. GOS 5 = 18.9 ± 12.2 cc) (Tables II and III).

DISCUSSION

The overall incidence of PFEDH is around 0.1 – 0.3% of all TBI patients (12). The hematoma usually develops due to the stripping of the dura from the calvaria and the rupture of epidural vessels. The epidural bleed in the posterior fossa is typically venous in origin in close to 85% of cases (7). It occurs due to injury to the transverse or sigmoid venous sinus and blood seeping between the dura and calvarium. It accumulates over a prolonged period, which leads to initial atypical symptoms, delayed onset, and occasional rapid progression. Patients usually give a history of occipital trauma along with headache and vomiting, which over 3 – 8 hours, rapidly progresses to altered sensorium and coma due to compression of the brainstem and cerebellum (6). The GCS at admission is universally an essential criterion for short-term and long-term outcomes in patients of PFEDH (14). The treating team should have a lesser threshold for radiological investigations and surgical intervention that translates to a better outcome. Patients presenting late to our trauma center, primarily referrals from remote and rural areas, had a significantly lower GCS at presentation, had features of herniation or evolving infarcts on radiology, and subsequently had poor outcomes. Associated polytrauma and multisystem involvement further complicate management and leads to a dismal outcome.

The mechanism of injury leading to posterior fossa hematomas depends on the patient's age, with falls being more common in the pediatric age group and RTA being the most common cause in the adult population. In our study, most patients (n=35; 68.6%) had TBI due to an RTA. Hematomas may be classified as acute (<24hrs), subacute (2-4 days), or chronic (7 - 21 days) (9). Subacute and chronic hematomas are rare in the posterior fossa, and all our patients had acute hematomas. Most of our patients were males (n=45; 88.2%), corresponding to the country's motor vehicle driving pattern.

Non-contrast CT head is the investigation of choice and clinches the diagnosis before clinical symptoms appear. Hence it should be ordered routinely in all such cases. Most patients present with a fracture of the occipital bone, as also seen in our study (n=33; 64.7%) (1-4). The occipital fracture may be linear or comminuted with underlying sinus injury. Linear fractures with underlying sinus injury can usually be managed with mechanical pressure and hemostats like gel foam and tack-up sutures. In contrast, more complex comminuted or diastatic fractures involving transverse–sigmoid sinuses might require vascular repair, cause more blood loss, and are associated with a significantly worse prognosis.

We considered EDH volume > 15 cc; thickness > 10 mm; effacement of the fourth ventricle; midline shift > 5 mm; obliteration of perimesencephalic cisterns, or hydrocephalus as indications of surgery. A tight posterior fossa is an alarming radiological feature for urgent surgical evacuation. A low threshold for surgery in patients qualifying the above indications gives excellent results.

Patients not qualifying the above criteria may be given a conservative trial in an ICU setting with hourly GCS monitoring and CT head examinations per the clinical condition. A few patients may also require delayed surgery. Age-related atrophy might allow the accumulation of large-volume hematoma

Table II: Association Between Hematoma Volume, Glasgow Coma Score at Discharge and 1 Month in Patients Managed in Surgical Arm

Mean Hematoma Volume (cc)	GCS at presentation	Management	GOS at Discharge (no of patients; %age)	GOS at 1 month (no of patients; %age)
16.1 ± 8.2	15	Surgery	5 (14; 53.8%)	5 (16; 61.5%)
17.2 ± 2.1	13 – 14	Surgery	4 (2; 7.6%)	4 (0)
24.3 ± 8.3	9 – 12	Surgery	3 (3; 11.5%)	3 (3; 11.5%)
21.5 ± 8.5	3 – 8	Surgery	1-2 (7; 26.9%)	1-2 (7; 26.9%)

Table III: The Evaluation of the VAS Scores in Early Recurrent Lumbar Disc Herniation Patients and Late Recurrent Lumbar Disc Herniation Patients Who Underwent Single Lumbar Transforaminal Epidural Steroid Injections

Early recurrent lumbar disc herniation TFESI patients (392 patients)		Late recurrent lumbar disc herniation TFESI patients (346 patients)		p-value
Before TFESI	After TFESI	Before TFESI	After TFESI	
85.44 ± 6.85	20.16 ± 3.77	72.82 ± 5.12	30.87 ± 4.17	**0.001***

Paired sample t test, *p<0.05, statistically significant.

without being symptomatic. Hence even large volume EDH is often managed conservatively in the elderly population. When used in well-selected patients, the conservative approach also yields excellent results and satisfactory outcomes (5).

In our study, most patients with good GCS at admission had excellent outcomes (GOS 5 in n=38; 74.5%). 14/38 patients (36.8%) belonged to the surgical arm, and 24 (64.2%) to the conservative arm. It is to be noted that most patients in this study that underwent surgery had a much worse GCS at admission. In contrast, patients with a good GCS at admission and small hematomas without associated supratentorial injuries were mainly managed conservatively. At a follow-up of one month, 40/51 patients in our study had "good outcomes" (78.4%), of which 16 (40%) belonged to the surgical arm while 24 (60%) belonged to the conservative arm. Eleven patients had poor outcomes, with a presenting GCS of ≤8. It is to be noted that multisystem injuries are a confounding factor in many of these cases. A higher volume of EDH at initial CT is associated with poor GCS at presentation. Patients presenting with GCS ≤ 8 had much larger EDH volume (21.5 ± 8.5 ccs) compared to patients who presented with a good GCS (16.1 ± 8.2 cc). The EDH volumes at presentation were also directly proportional to the overall outcomes, as patients with larger hematomas inevitably fared worse than those with smaller volumes.

The criteria for surgery in supratentorial hematomas are clearly defined, but no consensus has yet been formulated for indications of surgery in infratentorial hematomas. As per our above study, we would like to suggest that the criteria for surgical evacuation of an infratentorial hematoma should be hematoma volume > 15cc; thickness > 10 mm; tight posterior fossa with effacement of the fourth ventricle, obliteration of perimesencephalic cisterns or tonsillar herniation and back pressure changes such as hydrocephalus.

Limitations

The management in our patient cohort was based on clinicoradiological criteria and the decision of treating neurocritical teams, which may be affected by individual bias. Per the prevailing practice in our center for posterior fossa hematomas, we did not do intracranial pressure (ICP) monitoring in our patients. This study was limited to PFEDH, with no acute or chronic subdural hematomas or intraparenchymal bleed evaluation. The outcome in the surgical arm is inferior to observation because of selection bias in patients with poor neuroradiological conditions. The follow-up was also limited to a maximum one-month period, and a longer-term follow-up is required to evaluate the delayed side effects.

CONCLUSION

PFEDH is a rare entity. CT head is the investigation of choice and should be done immediately. EDH volume > 15 cc; thickness > 10mm; effacement of the fourth ventricle; midline shift > 5 mm; obliteration of perimesencephalic cisterns or hydrocephalus demand surgical evacuation. A low threshold should be kept for surgical intervention to ensure excellent results. PFEDHs are usually associated with occipital bone fractures and venous sinus injury that complicate management. The GCS at admission is the most critical factor determining outcome and prognosis. Conservative management is also viable in carefully selected patients with good results.

AUTHORSHIP CONTRIBUTION

Study conception and design: SM, MT
Data collection: PG
Analysis and interpretation of results: BS, AR
Draft manuscript preparation: BS
Critical revision of the article: MT
Other (study supervision, fundings, materials, etc...): MT
All authors (PG, BS, AR, SM, MT) reviewed the results and approved the final version of the manuscript.

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