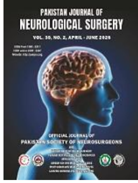

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

Frequency and Determinants of Surgical Intervention in Traumatic Epidural Hematoma Cases: A Retrospective Study

Seema Sharafat, Tamazar Noor, Mashal Khan, Zahid Khan

Department of Neurosurgery, MTI Lady Reading Hospital, Peshawar – Pakistan

ABSTRACT

Objective: To determine the frequency of surgical intervention among patients with traumatic extradural hematoma (EDH) and identify clinical and radiological factors associated with the decision to operate.

Materials and Methods: A retrospective review of 141 patients diagnosed with traumatic EDH was conducted at a tertiary care neurosurgical center. Demographic, clinical, and radiological variables, including age, sex, Glasgow Coma Scale (GCS) at presentation, EDH volume, maximal thickness, midline shift (MLS), skull fracture, and the frequency of surgical intervention, were recorded. The chi-square test was used to assess associations, and independent predictors of surgery were identified using binary logistic regression. A p-value <0.05 was considered statistically significant.

Results: 42 patients (29.8%) underwent surgical evacuation. On univariate analysis, EDH volume ≥30 mL (p = 0.002), EDH thickness ≥15 mm (p = 0.008), and MLS ≥5 mm (p = 0.003) were associated with surgical intervention. Multivariable logistic regression demonstrated that EDH volume ≥30 mL (OR 162.47; p = 0.002), EDH thickness ≥15 mm (OR 175.61; p = 0.008), and lower GCS at presentation (OR 49.46; p = 0.012) were independent predictors of surgery, while MLS and skull fracture were not significant after adjustment.

Conclusion: Surgical evacuation of extradural hematoma (EDH) is required in nearly one-third of patients. Hematoma volume and thickness, together with neurological status at presentation, were the strongest predictors of operative management, which shows the importance of objective radiological parameters in surgical decision-making.

Keywords: Extradural hematoma; epidural hematoma; surgical intervention; hematoma volume; Glasgow Coma Scale.

Corresponding Author: Zahid Khan
Department of Neurosurgery, MTI Lady Reading Hospital, Peshawar
Email: *neurosurgeonzahid@yahoo.com*

Date of Submission: 02-02-2026
Date of Revision: 10-05-2026
Date of Acceptance: 11-06-2026
Date of Online Publishing: 16-6-2026
Date of Print: 30-6-2026

DOI: 10.36552/pjns.v30i2.1247

INTRODUCTION

Trauma is the leading cause of mortality in the population younger than 45 years, and head injury is the main cause of death among those

trauma patients.[1] In traumatic brain injury patients, approximately 2.5% to 5% individuals have EDH (extradural hematoma)[2] which is the accumulation of blood in the potential space between the skull and the Dura mater. Mortality rate associated with epidural hematoma has been reported to be about 5 – 50%.[3]

The mode of injury in traumatic extradural hematoma can be falls, MVA (motor vehicle accidents), physical assault, blunt trauma, and sports injuries.[3] Middle meningeal artery or vein is the source of bleeding in 73% of all EDH cases, which are almost always associated with an underlying fracture of the temporal bone.[2] Other causes of bleeding in EDH are diploic veins and dural venous sinuses.[4]

The clinical presentation of an extradural hematoma is deterioration of conscious level, lucid interval, headache, vomiting, bradycardia, hemiparesis, and anisocoria. Extradural hematoma in the posterior fossa presents with signs of respiratory distress, Cheyne-Stokes breathing, neck rigidity, and brain stem compression effects.[3,5]

In appropriately selected patients, timely surgical intervention generally has favourable outcomes in the absence of associated injuries. However, not all patients require surgery. Neurological status, hematoma size, midline shift, age, and radiological findings affect treatment decisions. Despite existing guidelines, significant variation persists in clinical practice.[1]

This study aims to determine the frequency of surgical intervention in patients with traumatic EDH and to identify clinical and radiological factors of surgical decision-making. Understanding these determinants may help improve decision-making and support more standardized, evidence-based management strategies.

MATERIALS AND METHODS

Study Design and Setting

A retrospective descriptive study was carried out at the Department of Neurosurgery, Lady Reading Hospital, Peshawar. Hospital records of all patients with traumatic EDH who presented to the neurotrauma unit between 1 March 2025 and 31 August 2025 were reviewed.

Sample and Sampling

A total population sampling approach was used. One hundred forty-one (n = 141) consecutive patients with a CT-confirmed diagnosis of traumatic EDH and complete records were included.

Inclusion Criteria: Patients were included if they had a traumatic extradural (epidural) hematoma diagnosed on computed tomography, regardless of age, and presented to the neurotrauma unit between 1 March 2025 and 31 August 2025. Only patients with complete medical and imaging records, including documented arrival Glasgow Coma Scale scores, CT findings, and clearly recorded management decisions, whether surgical or conservative, were eligible.

Exclusion Criteria: Patients were excluded if the extradural hematoma was non-traumatic in origin (such as postoperative or spontaneous cases), if clinical or imaging records were incomplete, if they were referred after having already undergone surgery at another hospital, or if they were dead on arrival without imaging or a documented treatment decision.

Ethical Approval

Ethical clearance was obtained from the Institutional Review Board (IRB) of Lady Reading Hospital, Peshawar (Ref. no. 511/LRH/MTI), before data collection.

Data Collection

After IRB approval, hospital records, CT reports, operative notes, and discharge summaries were reviewed. A structured proforma was used to extract data on:

- Demographics: age, sex.
- Mechanism of injury.
- Clinical: Glasgow Coma Scale (GCS) at presentation, focal neurological signs, vital parameters.
- Radiological: hematoma location, maximum thickness (mm), estimated volume, midline shift (mm), skull fracture, and presence of other intracranial injuries.
- Management: surgical evacuation or conservative treatment, time from presentation to surgery (if applicable).
- Short-term outcome at discharge (survived, died, neurological status).

Radiological Measurements

Hematoma thickness was recorded as the greatest single-slice thickness (in mm). Volume was estimated using the ABC/2 method (A = largest length, B = largest width perpendicular to A, C = number of slices with hematoma × slice thickness), rounded to the nearest milliliter. Midline shift was measured at the septum pellucidum level in millimeters. Location was categorized (temporal, frontal, parietal, occipital, posterior fossa).

Definition of Surgical Criteria

Treatment decisions followed institutional practice and the treating neurosurgeon's judgment. For analysis, commonly reported thresholds were noted when present in the record (e.g., hematoma thickness >15 mm, midline shift >5 mm, declining neurological status, or focal deficit). The final decision to operate was recorded as a binary outcome (yes/no).

Data Processing and Statistical Analysis

Data were entered and analysed using SPSS version 25. Categorical variables are presented as frequencies and percentages. Continuous variables are reported as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution. The frequency of surgical intervention was expressed as a percentage of the total cohort.

Associations between categorical variables and the binary outcome "surgery (yes/no)" were assessed using the Pearson chi-square test, and Fisher's exact test was used when any expected cell count was <5. Continuous variables were tested using the independent samples t-test when normally distributed or the Mann–Whitney U test when distributions were non-normal. Variables with $p < 0.10$ on bivariate testing were entered into a multivariable binary logistic regression model (enter method) to identify independent predictors of surgical evacuation. Odds ratios (ORs) with 95% confidence intervals (CI) are reported; p-values for regression coefficients are from the chi-square test.

RESULTS

Basic Clinical Information

A total of 141 patients with traumatic epidural hematoma (EDH) were included. The cohort was predominantly male (105, 74.5%), with 36 females (25.5%). The median age was 17 years (mean 20.4 ± 15.7; range 1–65 years), indicating a predominance of pediatric and young adult patients. Road traffic accidents were the most common mechanism of injury (48.9%), followed by falls from height (30.5%). Other mechanisms were relatively infrequent. Most EDHs were located in the temporoparietal region (46.1%), followed by frontal (31.9%) and

occipital/posterior fossa (22.0%) locations (Table 1).

Radiological Characteristics

Most patients presented with mild head injury (GCS 14–15). Radiologically, 81.6% had a midline shift (MLS) <5 mm. Hematoma volume was <30 mL in 70.2% of cases and ≥30 mL in 29.8%. Maximum EDH thickness was <15 mm in 60.3% and ≥15 mm in 37.6%. Skull fractures were present in 54.6%, and associated intracranial injuries in 40.4%.

Table 1. *Demographic, clinical, and radiological characteristics (n = 141).*

Variable	n (%)
Sex	
Male	105 (74.5)
Female	36 (25.5)
Mechanism of injury	
Road traffic accident	69 (48.9)
Fall from height	43 (30.5)
Others	29 (20.6)
GCS category	
Mild (14–15)	89 (63|.1)
Moderate (9–13)	41 (29.1)
Severe (3–8)	11 (7.8)
Radiological parameters	
EDH volume ≥30 mL	42 (29.8)
EDH thickness ≥15 mm	53 (37.6)
Midline shift ≥5 mm	26 (18.4)
Skull fracture present	77 (54.6)

Surgical Management and Associated Factors

Overall, 42 patients (29.8%) underwent surgical evacuation, while 99 (70.2%) were managed conservatively. Surgical intervention increased with worsening clinical and radiological severity. Surgery was performed in 23.6% of mild, 31.7% of moderate, and 72.7% of severe GCS categories.

Among patients with EDH volume <30 mL, only 5.1% underwent surgery, compared with 88.1% of those with volume ≥30 mL. Similarly, surgery was required in 67.9% of patients with thickness ≥15 mm, compared with 7.1% of those with thickness <15 mm. An MLS ≥5 mm was associated with surgery in 80.8% of cases.

Univariate analysis showed significant associations between surgical intervention and hematoma volume, thickness, midline shift, and GCS category (all p-values <0.01). Mode of injury, skull fracture, and sex were not significantly associated (Table 2 and Figure 1).

Table 2: *Factors associated with surgical intervention.*

Variable	Surgery n/N (%)	p-value
EDH volume ≥30 mL	37/42 (88.1)	<0.001
EDH thickness ≥15 mm	36/53 (67.9)	<0.001
Midline shift ≥5 mm	21/26 (80.8)	<0.001
Severe GCS (3–8)	8/11 (72.7)	0.003
Skull fracture	26/77 (33.8)	0.257
Mode of injury	—	0.451

Multivariable Analysis

On multivariable logistic regression, EDH volume ≥30 mL, EDH thickness ≥15 mm, and lower GCS category remained independent predictors of surgical intervention. Midline shift and skull fracture lost significance after adjustment. The final model demonstrated excellent fit and discrimination (Nagelkerke R^2 = 0.902; Hosmer–Lemeshow p = 0.988) with 95% overall classification accuracy.

Table 3: *Independent predictors of surgical intervention (multivariable logistic regression).*

Variable	OR (95% CI)	p-value
EDH volume ≥30 mL	162.47	0.002
EDH thickness ≥15 mm	175.61	0.008
Worse GCS category	49.46	0.012
Midline shift ≥5 mm	5.18	0.230
Skull fracture	6.70	0.119
Sex	0.61	0.718

A focused univariable analysis confirmed hematoma volume as the dominant determinant of surgery (OR 139.12, p < 0.001; Nagelkerke R^2 = 0.729), further supported by ANOVA (F = 308.871, p < 0.001).

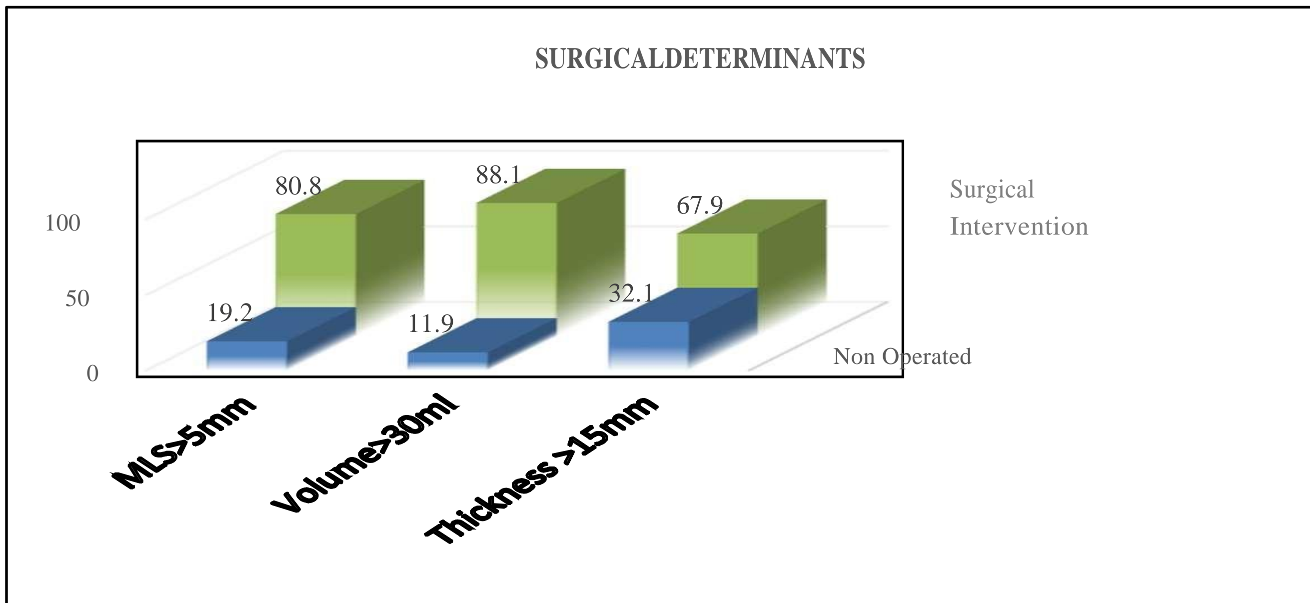

Figure 1: *Significant Surgical Determinants of Surgical Intervention.*

Key Findings

Nearly **one-third** of patients with traumatic EDH required surgical evacuation. Radiological severity, particularly hematoma volume ≥30 mL and thickness ≥15 mm, as well as lower GCS at presentation, were the strongest determinants of surgery. Although midline shift and skull fracture were associated with surgery on univariate analysis, they did not retain independent significance after adjustment. The final model showed excellent predictive performance.

DISCUSSION

This study gives a focused analysis of surgical predictors in traumatic extradural hematoma in the local population. Among 141 cases, 42 (29.8%) required hematoma evacuation. On multivariable analysis, hematoma volume ≥30 mL (OR 162.5), thickness ≥15 mm (OR 175.6), and lower GCS at presentation (OR 49.5) were the strongest predictors of surgical management. These results highlight that radiological severity has a greater effect on the decision to operate than the mechanism of injury, sex, or the presence of a skull fracture. The findings therefore support the use of clear radiological and clinical thresholds to guide treatment and improve patient outcomes.

Our findings are in accordance with the guidelines of the American College of Surgeons and the Brain Trauma Foundation. Both the guidelines recommend surgical intervention for EDH volume ≥30 ml, thickness ≥15 mm, or midline shift ≥5 mm, regardless of GCS.[6,7,8,9,10,11]

Midline shift and skull fracture were also associated with surgical decision-making on univariate analysis, but the associations disappeared after adjustment. Multivariable analysis in our study showed an instrumental effect of hematoma volume and thickness, characterized by larger effect sizes and high model accuracy, leading to surgery, which reinforces the primary importance of radiological findings. Mechanism of injury and sex were not associated with surgical disposition, aligning with multicenter cohort data showing that radiologic features and neurological status, rather than demographic or injury mechanism, drive management decisions.[6,7,8]

The overall surgical rate, along with the strong predictive value of volume and thickness, supports current practice standards and highlights the importance of early, guideline-adherent intervention for high-risk EDH. Close monitoring and repeat imaging remain essential for conservatively managed cases, especially when borderline radiologic findings or concurrent subarachnoid hemorrhage are present. In pediatric populations, thresholds for intervention may be lower, and delayed surgery is associated with larger hematoma size, greater mass effect, and more severe clinical symptoms.

Notably, infants and children with smaller hematoma volumes and thickness, a normal neurological examination, and no mass effect can be safely managed conservatively, with excellent long-term outcomes.[7,8,13,14,15,16,17]

Recent multicenter studies and meta-analyses confirm that timely surgical intervention in EDH is associated with a favorable prognosis, particularly in isolated cases with access to neurosurgical care. The only difference is the presence of concomitant intracranial lesions, coagulopathy, or rapid hematoma expansion, which often make individualized management strategies necessary and closer observation. The risk of delayed surgical intervention is low overall, but is significantly higher in adults and in those cases with larger initial hematoma sizes, mass effects, or coagulopathies.[6,7,8,14,15,17]

The results of our study reinforce the necessity for standardized protocols and further research into optimal and better management strategies for EDH, especially in patients with concurrent intracranial injuries or borderline radiologic findings. Future studies should focus more on refining risk stratification, evaluating long-term neurological outcomes, and updating guidelines to improve long-term patient care and resource allocation.

CONCLUSION

This study demonstrates that radiological severity and clinical status at presentation are the primary determinants of surgical intervention in traumatic extradural hematoma. Hematoma volume ≥30 mL, maximum thickness ≥15 mm, and a lower Glasgow Coma Scale (GCS) score are the strongest independent predictors of operative management. Among these, hematoma volume showed the highest predictive value, particularly in borderline cases, underscoring its importance in surgical decision-making.

LIMITATIONS

This study has certain limitations. It was a single-center, retrospective analysis, which may limit the generalizability of the findings. Treatment decisions were influenced by institutional practice and surgeon judgment, which may introduce a selection bias.

RECOMMENDATIONS

Prompt surgical intervention should be considered for patients who meet established clinical and radiological criteria. Based on our findings, hematoma volume should be given particular importance, especially when managing borderline cases. Future multicenter, prospective studies are recommended to validate these predictors and to help develop standardized, evidence-based management protocols for traumatic extradural hematoma.

ACKNOWLEDGEMENTS

The authors acknowledge the contributions of the Department of Neurosurgery, Lady Reading Hospital, Peshawar, and thank the Institutional Review Board (IRB) for their support and approval of this study.

REFERENCES

1. Maugeri R, Anderson DG, Graziano F, Meccio F, Visocchi M, Iacopino DG. Conservative vs. surgical management of post-traumatic epidural hematoma: a case and review of literature. Am J Case Rep. 2015;16:811–7. Doi: 10.12659/AJCR.895231
2. Haq N ul, Hammad Mehtab, Shah A, Mushtaq M, Sattar A. Compare the outcome of surgical versus conservative treatment of traumatic extradural hematoma in the supratentorial region. Pak J Med Health Sci. 2021;15(12):3835–8. Doi: 10.53350/pjmhs2115123835
3. Khan MA, Anwar M, Akmal M, Ashraf N, Mahmood K. Conservative management of extradural hematoma in minor head injury. Pak J Neurol Surg. 2018;17(2):156–60.
4. Basamh M, Robert A, Lamoureux J, Saluja RS, Marcoux J. Epidural hematoma treated conservatively: when to expect the worst. Can J Neurol Sci. 2015;43(1):74–81. Doi: 10.1017/cjn.2015.232
5. Sharafat S, Azam F, Khan Z. Posterior fossa epidural hematoma: a 6-year management experience. Pak J Med Sci. 2022;39(1). Doi: 10.12669/pjms.39.1.6408
6. Pisică D, Volovici V, Yue JK, et al. Clinical and imaging characteristics, care pathways, and outcomes of traumatic epidural hematomas: a collaborative European NeuroTrauma effectiveness research in traumatic brain injury study. Neurosurgery. 2024;95(5):986–999. Doi: 10.1227/NEU.0000000000002982
7. Radmard M, Miller L, Tafazolimoghadam A, et al. Risk factors for epidural hematoma expansion and the need for surgery. AJNR Am J Neuroradiol. 2025:ajnr.A8832. Doi: 10.3174/ajnr.A8832
8. Gok H, Celik SE, Yangi K, et al. Management of epidural hematomas in pediatric and adult population: a hospital-based retrospective study. World Neurosurg. 2023;177:e686–e692. Doi: 10.1016/j.wneu.2023.06.123
9. Bullock MR, Chesnut R, Ghajar J, et al. Surgical management of acute epidural hematomas. Neurosurgery. 2006;58(3 Suppl):S7–15; Discussion Si–iv.
10. Manley GT, Albert GW, Brophy GM, et al. Best practices in the management of traumatic brain injury. Am Coll Surg. 2024.
11. Soon WC, Marcus H, Wilson M. Traumatic acute extradural haematoma - indications for surgery revisited. Br J Neurosurg. 2016;30(2):233–4. Doi: 10.3109/02688697.2015.1119237
12. Yang C, Huang X, Feng J, et al. Prospective randomized evaluation of decompressive ipsilateral craniectomy for traumatic acute epidural hematoma (PREDICT-AEDH): study protocol for a randomized controlled trial. Trials. 2021;22(1):421. Doi: 10.1186/s13063-021-05359-6
13. Baş NS, Karacan M, Doruk E, Karagoz Guzey F. Management of traumatic epidural hematoma in infants younger than one year: 50 cases - single center experience. Pediatr Neurosurg. 2021;56(3):213–20. Doi: 10.1159/000514810
14. Abe N, Gardiner M, Dory C, et al. Predictive factors for delayed surgical intervention in children with epidural hematomas. Pediatr Emerg Care. 2023;39(6):402–407. Doi: 10.1097/PEC.0000000000002825
15. Rahimi A, Corley JA, Ammar A, et al. The unmet global burden of cranial epidural hematomas: a systematic review and meta-analysis. Clin Neurol Neurosurg. 2022;219:107313. Doi: 10.1016/j.clineuro.2022.107313
16. Xiao B, Ma MY, Duan ZX, et al. Could a traumatic epidural hematoma on early computed tomography tell us about its future development? A multicenter retrospective study in China. J Neurotrauma. 2015;32(7):487–94. Doi: 10.1089/neu.2013.3297
17. Shih, FY., Chang, HH., Wang, HC. *et al.* Risk factors for delayed neuro-surgical intervention in patients with acute mild traumatic brain injury and intracranial hemorrhage. *World J Emerg Surg* **11**, 13 (2016). https://doi.org/10.1186/s13017-016-0069-2

Additional Information

Disclosures: The authors report no conflict of interest.
Ethical Review Board Approval: Approval was obtained from the IRB committee of Lady Reading Hospital. (Reference no 511/LRH/MTI).
Human Subjects: Consent was obtained from all patients/participants in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
Data Availability Statement: For data sharing, interested researchers can contact the corresponding authors.
Funding: None.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Seema Sharafat	1. Study design, methodology, Analysis of data, and interpretation of results.
2.	Tamazar Noor	2. Paper writing.
3.	Mashal Khan	3. Data collection, calculations, and referencing.
4.	Zahid Khan	4. Literature review, editing, and quality assurance.