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Original Article

Clinical and Radiological Criteria for Surgery in Posttraumatic Extradural Hematoma: An Update from Central India

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Abstract

Background The surgical management guidelines for any intracranial hemorrhage were objectively defined by the Brain Trauma Foundation (BTF) in 2006 for patients who should be treated surgically or conservatively. Since then, not much work has been done toward the identification of patients who are at high risk and may have progression of the hematoma who may ultimately require surgery. This study aimed to apply the said criteria to all patients coming to the hospital with extradural hematoma (EDH) and analyze the outcome of the patient whether treated conservatively or surgically on the basis of the Glasgow Outcome Scale (GOS) and to observe the factors and variables that are associated with EDH that will help in furthering the demographic design of the entity in central India.

Materials and Methods A prospective and retrospective, ambivalent cohort study was performed at a hospital in central India involving all cases of computed tomography (CT) diagnosed EDH that were reported to the center from October 2016 to March 2018. A total of 78 patients were included in the study. Patients were selected and managed conservatively or surgically as per the criteria and were followed up until the outcome. In retrospective analysis, we evaluated the current criteria for surgery in all patients of posttraumatic EDH in the past 5 years and whose records were available. Condition on discharge or the outcome along with GOS was taken as the endpoint for retrospective analysis.

Results Temporoparietal and frontal regions were the most common sites of EDH and also presented higher mortality rates as compared with other sites. The majority of patients had EDH of length of greater than 5 cm and the mortality rate for the same group also increased with lesser survival chances with length of greater than 10 cm. Patients who presented with an EDH of greater than 1-cm width were higher in

Keywords
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- head trauma
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numbers, with survival rates decreasing with an increase in width, especially with an EDH greater than 2 cm.

Conclusion We conclude that the criteria laid out by the BTF, namely, CT findings of an EDH volume greater than 30 mL, width greater than 15 mm, and mildline shift of greater than 5 mm, hold good in cases of EDH. This study reviewed the previous criteria in the Indian setting and found them to hold good so far.

Introduction

Traumatic brain injury (TBI) is, with time, taking a higher toll on life globally. An estimated 57 million people worldwide have been hospitalized with one or more TBIs.[1] The diagnosis of extradural hematoma (EDH) is made in approximately 2% of all cases of head injury. Around 5 to 15% of cases of fatal head injuries include EDH.[2] Head injury has multiple grievous complications; among all, EDH is the most amenable to intervention. However, the persistently high incidence of mortality remains a matter of concern. In lowering the mortality rate in patients of EDH, most neurosurgeons agree that better neurosurgical organization, early diagnosis, and timely intervention play a significant role. The treatable nature of EDH has led some authors to suggest that "toward zero mortality" is an achievable target concerning this condition.[3] Incidences of epidural hematoma are maximally seen in the second decade of life, with a mean age of patients harboring EDH between 20 and 30 years.

The surgical management guidelines were objectively defined by the Brain Trauma Foundation (BTF) for patients who can be managed surgically or conservatively.[4] The criteria laid out for conservative management comprises noncomatose patients with EDH less than 30 cm^3 in volume, less than 15 mm in thickness, and causing less than 5-mm midline shift (MLS) with a Glasgow Coma Scale (GCS) score of more than 8 and no focal neurological deficit. Patients harboring a hematoma of $\geq$30 cm^3 should be operated on irrespective of the GCS score.[5] These criteria were laid down in 2006, and since then not much work has been done toward the identification of patients who are at high risk of hematoma progression who may ultimately require surgery.

This study aimed to apply the said criteria to all patients coming to the hospital with EDH and analyze the outcome of the patients treated conservatively or surgically on the basis of the Glasgow Outcome Scale (GOS) score. We also carefully observed the factors and variables that are associated with EDH that will help in furthering the demographic design of the entity in central India.

Aims and Objectives

Aim

The aim of the study was to analyze the clinical and radiological criteria for surgery and the outcome of the operative/nonoperative management of patients with posttraumatic EDH as per the current criteria given by the BTF in our setup.

Objectives

The objectives of the study were the following:

- Study the currently defined radiological criteria and clinical criteria as per the BTF.
- Application of the above on the patients presenting with posttraumatic EDH and study the effect of management on the patient on the basis of the GOS score and the final outcome.

Materials and Methods

This was a prospective and retrospective ambivalent cohort study performed at People's College of Medical Sciences and Research Center, Bhanpur, Bhopal, involving all cases of computed tomography (CT) diagnosed EDH that were reported to the center from October 2016 to March 2018. A total of 78 patients were included in the study.

The inclusion criteria were the following:

- All patients presenting with posttraumatic EDH with any level of GCS from 3 to 15.
- Patients who have presented with posttraumatic EDH in the previous 5 years (similar number of cases records).

The exclusion criteria were the following:

- Patients presenting with traumatic subdural hematoma without EDH.
- Patients presenting with traumatic intraparenchymal hemorrhage without EDH.
- Patients presenting with TBI other than EDH.

The duration of the study was 5 years for the retrospective portion and 1.5 years for the perspective portion.

Methods

- Permission from the institutional ethical committee was taken.
- Informed consent was taken from the patients/relatives in their language.
- All patients presenting to the emergency department (ED) with TBI and CT scan suggestive of EDH were evaluated on the basis of the following:
  - CT scan report at presentation.
  - GCS at presentation.
  - Other clinical signs, for example:

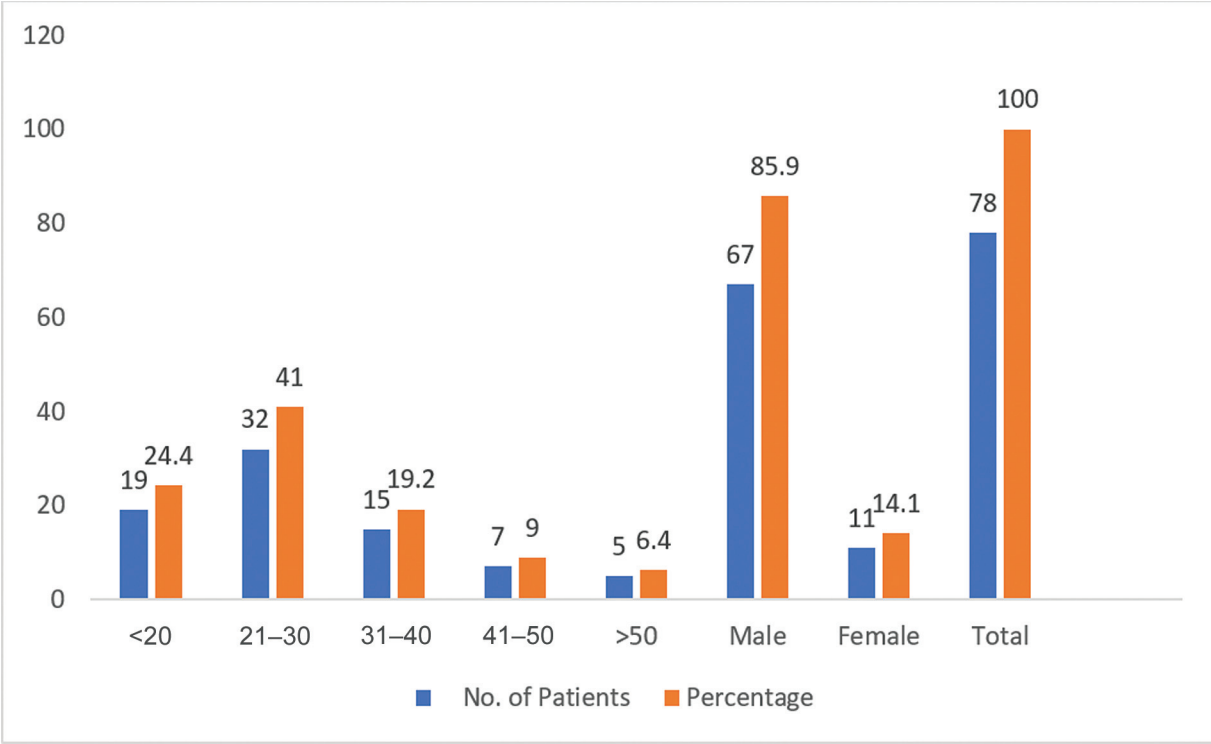

Fig. 1 Distribution of patients according to age group and gender.

- Pupillary reflex.
- Focal neurological deficits.

- On the basis of the current criteria for surgery given by BTF which include
  - Radiological (on CT):
    - Hematoma volume greater than 30 mL.
    - Size greater than 15 cm.
    - MLS greater than 5 mm.
  - Clinical criteria:
    - GCS score less than 8.
    - Presence of lateralizing signs.

Patients were selected and managed conservatively or surgically as per the criteria and were followed up until the outcome.

Retrospective Analysis

In this study, we evaluated the current criteria for surgery in all patients of posttraumatic EDH in the past 5 years and whose records were available. Condition on discharge or the outcome along with the GOS score was taken as the endpoint for retrospective analysis.

Source of Data

Case records of patients who presented during study period and a similar number of case records of patients who presented in the previous 5 years were the sources of the data.

Statistical Analysis

All data analyses were performed using appropriate statistical software (Epi Info, version 6). Frequency distribution and cross-tabulation were used to prepare the tables. Quantitative variables were expressed as the mean and standard deviation. Categorical data were expressed as percentage. Microsoft Office was used to prepare the graphs. Student's *t*-test was used to compare the means. The chi-squared test was used to compare the categorical data. A *p*-value of less than 0.05 was considered significant.

Results

This was a prospective and retrospective study involving 78 patients of TBI presenting with posttraumatic EDH with any level of GCS from 3 to 15 with the objective to study the currently defined radiological criteria and clinical criteria as per the BTF and the effect of management on the patients on the basis of the GOS score and the final outcome.

In the present study, the majority of the patients with EDH belonged to the age group of 20 to 30 years, with only 6.4% patients being older than 50 years (►**Fig. 1**). In terms of gender , the majority of the patients were males at 85.9%, with only 14.1% being females (►**Fig. 1**).

Road traffic accident (RTA) was the most significant mode of injury (61.5%), with two-wheeler accidents being the major cause, followed by fall (19.2%) and assault (15.4%). The mode of injury could not be identified in 3.8% patients.

Out of 78 patients, 25 (32.1%) had a GCS score between 3 and 7, 29 (37.2%) patients had a score of 8 to 12, and 24 (30.8%) patients had a GCS score of 13 to 15 (►**Table 1**).

Table 1 Distribution of patient Glasgow Coma Scale score and volume of EDH versus outcome

	GCS score			Volume of EDH			
	3–7	8–12	13–15	<30 mL	30–60 mL	60–90 mL	>90 mL
Discharged	10	27	23	35	13	10	2
Expired	14	1	0	0	6	6	3
LAMA	1	1	1	3	0	0	0
p-value	0.0001			0.001			

Abbreviations: EDH, extradural hematoma; LAMA, leave against medical advice.

Patients with a GCS score of ≥8 had the most favorable outcomes and the patients with a GCS of ≤7 had the highest comparative mortality.

Volumetric analysis showed that patients with EDH volumes less than 30 cm^3 had significant survival rates, whereas the survival rates decreased with EDH volumes greater than 30 cm^3, with the prognosis being most dire for EDH volumes greater than 60 cm^3 (►**Table 1**).

Temporoparietal and frontal regions were the most common sites of EDH and also presented higher mortality rates as compared with other sites (►**Table 2**).

In our study, most patients were with EDH volumes less than 30 cm^3 and were managed conservatively, whereas EDH patients with volumes greater than 30 cm^3 underwent surgery (►**Fig. 2**).

It was found that the majority of patients had EDH of length of greater than 5 cm and the mortality rate for the same group also increased with lesser survival chances with lengths greater than 10 cm. Similarly, patients who presented with an EDH width greater than 1 cm were higher in numbers, with survival rates decreasing with an increase in width, especially with greater than 2 cm. Patients who presented with an EDH height greater than 3 cm were common, with higher survival rates between 3 and 6 cm, but the same decreased with EDH heights greater than 6 cm. The MLS could be distributed in two significant groups. The first group comprised patient with MLS of less than 10 mm who had higher survival chances and the second comprised patients with MLS greater than 10 mm, with a decreasing survival rate with an increase in MLS (►**Fig. 3**).

In our study, 44 cases fully recovered, 17 cases had mild disability, 1 was in a persistent vegetative state, 1 case experienced severe disability, and 15 patients died (►**Table 3**).

Discussion

This was a prospective and retrospective study involving 78 patients of TBI presenting with posttraumatic EDH with any level of GCS from 3 to 15 with the objective to study the currently defined radiological criteria and clinical criteria as per the BTF and the effect of management on the patient on the basis of the GOS score and the final outcome.

In the present study, the majority of the patients with EDH belonged to the age group of 20 to 30 years, with only 6.4% patients being older than 50 years. Similar results were found in the study conducted by Babu et al[3]; however, the median age of the patients in Chen et al's study was 35.4 years.[6] Similarly, Offner et al found that the mean age of the patients was 27 ± 1.6 years.[7] Hence, the differences in the median age groups can be attributed to regional differences.

In terms of gender, the majority of the patients were males (85.9%), with only 14.1% being females. RTA was the significant mode of injury (61.5%, with two-wheeler accidents being the major cause), followed by falls (19.2%) and assaults (15.4%). The mode of injury could not be identified in

Table 2 Distribution of patients according to site of EDH versus outcome

Site of EDH	Discharged	Expired	LAMA	Total
Frontal	16	3	1	20
Parietal	6	2	0	8
Frontoparietal	5	1	0	6
Temporal	12	2	1	15
Temporoparietal	15	5	0	20
Bilateral	6	0	0	6
Fronto-temporoparietal	0	1	0	1
Frontotemporal	0	1	1	2
Total	60	15	3	78

Abbreviations: EDH, extradural hematoma; LAMA, leave against medical advice.
Note: *p*-value = 0.07.

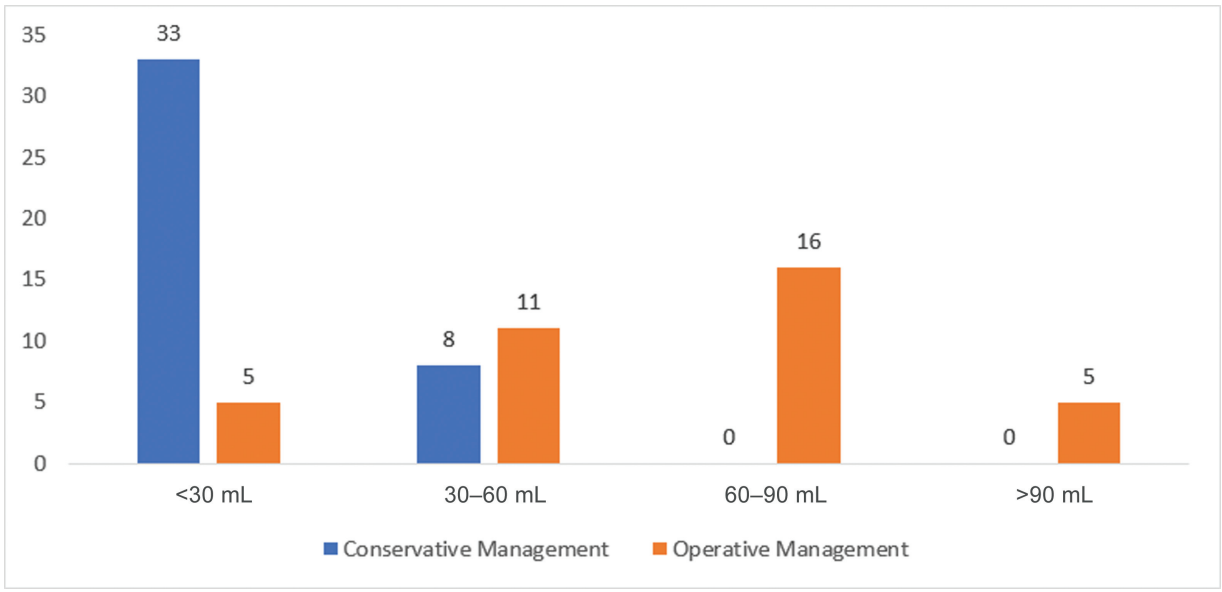

Fig. 2 Distribution of patients as per management and volume of extradural hematoma .

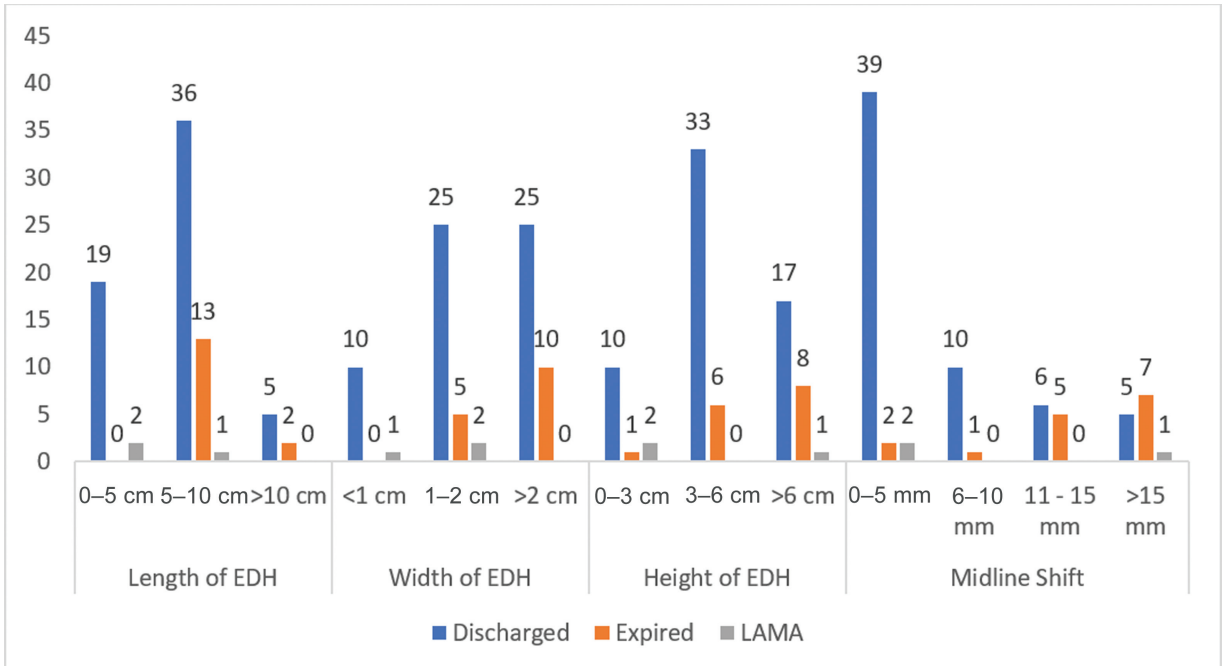

Fig. 3 Distribution of patients according to length, width, height, and midline shift of extradural hematoma (EDH) versus outcome. LAMA, leave against medical advice.

Table 3 Distribution of patients according to outcome versus recovery

Recovery	Discharged	Expired	LAMA	Total
Full recovery	42	0	2	44
Mild disability	17	0	0	17
PVS	1	0	0	1
SD	0	0	1	1
Death	0	15	0	15
Total	60	15	3	78

Abbreviations: LAMA, leave against medical advice; PVS, persistent vegetative state; SD, severe disability.
Note: *p*-value-= 0.0001.

3.8% patients. RTA seems to be the major cause of EDH in the majority of the studies.[8]

The GCS was used to assess the severity of head injury and predict the prognosis in head injury. Patients who presented with a GCS score below 8 had a high mortality rate, while those with a GCS above 13 had better outcomes. The site of EDH was most commonly the temporoparietal (33.45%) and frontal regions (23.28%), with maximum mortality observed in the temporoparietal region followed by the frontal regions. This differed from a study by Tataranu et al[9] where the temporal region was involved in the majority of patients (23.2%), followed by the frontal region in 17.85% cases.

The GCS is a potent indicator of patient outcomes in cases of EDH. The Revised Trauma Score, which includes GCS, systolic blood pressure, and respiratory rate, has been shown to have a strong correlation with the probability of survival. In the study, patients with a GCS score greater than 8 without focal deficit and an EDH volume less than 30 cm^3, EDH thickness less than 15 mm, and MLS of less than 5 mm could be managed nonoperatively with serial CT scanning and close neurological observation in a neurosurgical center (source: BTF guidelines for management of EDH[10]).

Surgical drainage was recommended for patients with an EDH volume of greater than 30 mL, while those with a volume less than 30 mL could be managed conservatively. The criteria for surgical intervention were based on CT scan findings, including the volume of hematoma, width, and MLS. The study found that the criteria laid out by the BTF held good in cases of EDH. The results we obtained were similar to a study conducted at the Imperial Healthcare Hospital, United Kingdom, by Soon et al[11] and Mohammad Basamh et al.[12] In contrast, a study conducted in 2018 in Oman[13] found that 62 EDH patients were treated conservatively irrespective of the volume and the mortality was found to be nil.

The length, width, and height of EDH are important indicators in determining the need for surgical intervention. In our study, the EDH length was found to be 5 to 10 cm in the majority of patients, and EDH with a length greater than 10 cm was present in the least number of patients.

As per the study, the width of EDH is an important indicator in determining the need for surgical intervention. A width greater than 15 mm is one of the criteria for surgical intervention according to the BTF guidelines. The study found that patients with an EDH width greater than 15 mm had a higher mortality rate compared with those with a width of less than 15 mm.

Patients who presented with an EDH height greater than 3 cm were common, with higher survival rates observed in those with an EDH height between 3 and 6 cm, but the same decreased when the EDH height was greater than 6 cm.

In this study, MLS of EDH is an important indicator in determining the need for surgical intervention. A mild MLS of greater than 5 mm is one of the criteria for surgical intervention according to the BTF guidelines. The study found that patients with an MLS greater than 5 mm had a higher mortality rate compared with those with an MLS less than 5 mm.

These findings are consistent with the study by Zwayed et al,[13] while in study by Gupta et al[14] 72% patients had favorable outcomes despite MLS of 6 to 10 mm. According to a study by Maugeri et al,[2] the case with an MLS of 1.2 cm was successfully managed conservatively, suggesting that multiple factors, rather than a single factor, play a role of in the mortality of EDH.

Conclusion

In light of the current study, we conclude that the criteria laid out by BTF, namely, CT findings of an EDH volume greater than 30 mL, width greater than 15 mm, and mildline shift of greater than 5 mm, hold good in cases of EDH. The limitation of our study was the time taken by the patients to reach the hospital, which plays a role in the overall outcomes. We conclude that low-risk patients can be managed conservatively and high-risk patients need surgical treatment. Patients who are on the borderline require close observation and accurate judgment based on the clinical condition and radiological criteria. Other limitations of the study include its retrospective nature, the single-center setting, and the lack of consideration of other factors that may affect patient outcomes.

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Conflict of Interest
None declared.

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