EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-8 | Issue-6 | Nov-Dec-2026 | DOI: https://doi.org/10.36349/easjrit.2026.v08i06.001

Original Research Article

Ocurrence of Intracranial Bleed in Patients Having Cranial Fractures Using CT as Diagnosing Modality

Dr. Ajinkya Deepak Mirajkar[1]*, Dr. Sachin R Bagale[2], Dr. Shephali S Pawar[3]

[1]Junior Resident, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH)India
[2]Professor, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH)India
[3]Professor and Head of Department, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH)India

Article History
Received: 07.09.2026
Accepted: 04.11.2026
Published: 09.11.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background:*** Cranial fractures are frequently accompanied by intracranial injuries, which require prompt identification for appropriate management. Non-contrast computed tomography (NCCT) provides rapid assessment of both fracture patterns and associated haemorrhage. ***Aim:*** To determine the occurrence and CT characteristics of intracranial haemorrhage in patients with cranial fractures and assess their association with fracture patterns and clinical outcomes. ***Methods****:* This hospital-based prospective observational study included 100 patients with CT-confirmed cranial fractures. Demographic and clinical details, including Glasgow Coma Scale (GCS), were recorded. NCCT images were evaluated for fracture type and location, haemorrhage type, anatomical distribution, volume and midline shift. Surgical intervention and in-hospital mortality were documented. Statistical analysis was performed using appropriate tests, with p less than 0.05 considered significant. ***Results:*** The mean age was 32.74 ± 14.12 years, and 81% were male. Road traffic accidents accounted for 59% of injuries. Intracranial haemorrhage was detected in 62% of patients. Epidural haematoma was the most common type (53.2%), followed by subdural haematoma (41.9%), cerebral contusion (32.3%), subarachnoid haemorrhage (25.8%) and intraventricular haemorrhage (8.1%). Multiple haemorrhage types coexisted in 50% of affected patients. Haemorrhage volume differed significantly across types (H = 51.55, p less than 0.001). Intracranial haemorrhage was significantly associated with fracture type (p = 0.026). Depressed fractures were associated with cerebral contusions (p = 0.001), while basilar fractures were associated with intraventricular haemorrhage (p = 0.01). Surgical intervention was more frequent in patients with haemorrhage (45.2%; p less than 0.001). Mortality was higher in patients with haemorrhage than without (19.4% vs 2.6%; p = 0.016) and was associated with severe GCS (p less than 0.001). ***Conclusion:*** Intracranial haemorrhage occurred in nearly two-thirds of patients with cranial fractures. NCCT characterisation of haemorrhage and fracture patterns, alongside clinical assessment, is important for management and outcome evaluation.

Keywords: Cranial fractures.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of mortality, morbidity and long-term disability worldwide. It contributes substantially to the global burden of injury, particularly in low- and middle-income countries, where road traffic injuries, falls and other forms of trauma remain important causes of head injury. The Global Burden of Disease Study 2019 estimated 27.16 million new cases of TBI worldwide, highlighting its continuing public health significance.[1] The burden is particularly relevant in resource-constrained healthcare settings, where timely diagnosis, appropriate triage and access to neurosurgical care are essential for improving patient outcomes.[2]

Cranial fractures are important radiological indicators of traumatic force transmitted to the skull. They may be classified as linear, depressed, basilar or

***Corresponding Author:** Dr. Ajinkya Deepak Mirajkar
Junior Resident, Department of Radiodiagnosis, B. J. Government Medical College & Sassoon General Hospital, Pune, (MH)India

comminuted, depending on their morphology and anatomical location. However, the presence of a skull fracture does not invariably indicate an associated intracranial haemorrhage, and intracranial injury may also occur in the absence of a demonstrable fracture. The relationship between fracture morphology, anatomical location and intracranial injury is therefore clinically important. Skull base fractures, in particular, have been associated with different patterns of traumatic intracranial haemorrhage, including epidural haemorrhage and cerebral contusions.[3]

Traumatic intracranial haemorrhage may involve several anatomical compartments, including the epidural, subdural, subarachnoid, intraparenchymal and intraventricular spaces. Epidural haematomas are frequently associated with an overlying skull fracture and may occur following injury to meningeal vessels. Subdural haematomas commonly result from injury to bridging veins, while cerebral contusions may develop following direct impact or acceleration–deceleration mechanisms. These lesions may produce mass effect, cerebral oedema, midline shift and, in severe cases, raised intracranial pressure and cerebral herniation.[4]

Non-contrast computed tomography (NCCT) is the preferred initial imaging modality for the assessment of acute traumatic brain injury. It enables rapid evaluation of intracranial haemorrhage, skull fractures, cerebral contusions, mass effect and midline shift. The use of appropriate brain and bone window settings, together with thin-section imaging and multiplanar reconstructions when indicated, facilitates the identification and anatomical characterisation of traumatic cranial injuries. [4,5]

In addition to detecting haemorrhage, CT enables estimation of haematoma volume, which may assist in assessing the extent of injury and planning clinical management. The ABC/2 method provides a practical approach to estimating intracranial haematoma volume using the maximum axial dimensions and the extent of the lesion across CT slices.[6] CT findings, including haemorrhage type, volume and mass effect, may also contribute to clinical assessment and evaluation of outcomes in patients with traumatic brain injury. [7-9]

Although CT-based assessment of traumatic brain injury has been extensively described, the occurrence and distribution of intracranial haemorrhage specifically among patients with CT-confirmed cranial fractures remain important areas for focused clinical evaluation. The relationship between fracture type, fracture site and individual haemorrhage patterns may provide useful information for radiological assessment and clinical decision-making.[10]

Therefore, the present study was undertaken to determine the occurrence of intracranial haemorrhage in patients with cranial fractures using NCCT and to characterise the type, anatomical distribution and volume of haemorrhage. The study also evaluated the association of fracture characteristics and Glasgow Coma Scale (GCS) categories with intracranial haemorrhage, along with CT findings, surgical intervention and in-hospital mortality. [11,12]

MATERIALS AND METHODOLOGY

The present hospital-based prospective observational study was conducted in the Department of Radiology of a tertiary care hospital over a period of 18 months. A total of 100 patients presenting with acute head trauma and having cranial fractures confirmed on initial computed tomography (CT) examination were included. Patients with a history of head trauma without cranial fractures and those with previous neurosurgical intervention were excluded. Written informed consent was obtained from patients or their legal guardians before enrolment.

Demographic and clinical details, including age, sex, mechanism of injury, presenting features and Glasgow Coma Scale (GCS) score, were recorded using a structured case record form. All patients underwent non-contrast CT (NCCT) of the head using a multidetector CT scanner. Images were evaluated using brain, bone and subdural window settings, with multiplanar reconstructions where required. Cranial fractures were classified according to type and anatomical location. Intracranial haemorrhages were assessed for type, anatomical distribution, laterality and associated findings. Haemorrhage volume was estimated using the ABC/2 method and categorised as small, medium or large. Midline shift was measured in millimetres. Surgical interventions and in-hospital outcomes were recorded. Data were analysed using descriptive statistics, chi-square test, Fisher's exact test and Kruskal–Wallis H test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULT

Table 1: Baseline demographic, clinical and fracture characteristics

Characteristics	Category	n (%)
Age (years)	**Mean ± SD**	**32.74 ± 14.12**
Sex	Male	81 (81.0)
	Female	19 (19.0)
Mechanism of injury	RTA	59 (59.0)
	Fall	22 (22.0)

	Assault	13 (13.0)
	Other	6 (6.0)
GCS	Mild	38 (38.0)
	Moderate	35 (35.0)
	Severe	27 (27.0)
Fracture type	Linear	64 (64.0)
	Depressed	18 (18.0)
	Basilar	11 (11.0)
	Comminuted	7 (7.0)
Fracture site	Temporal	26 (26.0)
	Frontal	22 (22.0)
	Parietal	21 (21.0)
	Occipital	20 (20.0)
	Anterior fossa	7 (7.0)
	Middle fossa	4 (4.0)

Table 2: Prevalence, pattern and volume of intracranial haemorrhage on CT

CT findings	**n (%) / Mean ± SD**
Intracranial haemorrhage (N=100)	
Present	62 (62.0)
Absent	38 (38.0)
Type of haemorrhage (n=62)	
EDH	33 (53.2)
SDH	26 (41.9)
SAH	16 (25.8)
Contusion	20 (32.3)
IVH	5 (8.1)
Mean haemorrhage volume (mL)	
EDH	22.72 ± 14.54
SDH	12.54 ± 8.69
SAH	3.20 ± 1.50
Contusion	11.47 ± 5.75
IVH	2.96 ± 0.98
Comparison of haemorrhage volumes	**H = 51.55; p < 0.001**

Table 3: Association of fracture characteristics with intracranial haemorrhage

Fracture characteristic	**Category**	**Haemorrhage present n/N (%)**	**p-value**
Fracture type	Linear	33/64 (51.6)	
	Depressed	16/18 (88.9)	
	Basilar	8/11 (72.7)	
	Comminuted	5/7 (71.4)	0.026
GCS category	Mild	21/38 (55.3)	
	Moderate	23/35 (65.7)	
	Severe	18/27 (66.7)	0.553

Table 4: Midline shift, surgical intervention and clinical outcomes

Parameter	**Category**	**n (%) / Mean ± SD**
Midline shift (n=62)	None	7 (11.3)
	Mild	45 (72.6)
	Moderate	8 (12.9)
	Severe	2 (3.2)
	Mean shift (mm)	3.22 ± 2.81
Surgical intervention (N=100)	Bleed present	28/62 (45.2

A total of 100 patients with CT-confirmed cranial fractures were included in the study. The mean age was 32.74 ± 14.12 years, with a median age of 30 years. A male predominance was observed, with males accounting for 81% of the study population. Road traffic accidents were the leading mechanism of injury (59%), followed by falls (22%) and assaults (13%). Linear fractures were the most frequently observed fracture type

(64%), while temporal fractures were the most common anatomical location (26%). Based on GCS scores, 38% of patients presented with mild, 35% with moderate and 27% with severe head injury.

Intracranial haemorrhage was detected in 62 (62%) patients, whereas 38 (38%) patients had cranial fractures without associated haemorrhage. Among patients with bleeding, epidural haematoma was the most common finding (53.2%), followed by subdural haematoma (41.9%), cerebral contusion (32.3%), subarachnoid haemorrhage (25.8%) and intraventricular haemorrhage (8.1%). Multiple types of haemorrhage were observed in 50% of patients with bleeding. Regarding haemorrhage volume, epidural haematoma demonstrated the highest mean volume (22.72 ± 14.54 mL), followed by subdural haematoma (12.54 ± 8.69 mL). The difference in volume across haemorrhage types was statistically significant (H = 51.55, p less than 0.001), indicating variation in the volume distribution according to the type of haemorrhage.

A statistically significant association was observed between fracture type and the occurrence of intracranial haemorrhage (p = 0.026). Depressed fractures showed the highest proportion of associated haemorrhage (88.9%), compared with 51.6% among patients with linear fractures. Further analysis revealed a significant association between depressed fractures and cerebral contusions (p = 0.001), while basilar fractures were significantly associated with intraventricular haemorrhage (p = 0.01). Fracture location was also significantly associated with selected haemorrhage types, particularly temporal fractures with epidural haematoma (p = 0.046), frontal fractures with cerebral contusions (p = 0.005) and anterior cranial fossa fractures with intraventricular haemorrhage (p less than 0.001). However, GCS category was not significantly associated with the presence of intracranial haemorrhage (p = 0.553).

Among the 62 patients with intracranial haemorrhage, mild midline shift was the most frequently observed finding (72.6%), while moderate and severe shifts were observed in 12.9% and 3.2%, respectively. Surgical intervention was required in 28 (45.2%) patients with intracranial haemorrhage, whereas none of the patients without haemorrhage underwent surgery. This association was statistically significant (p less than 0.001). Overall, 13 deaths (13%) were recorded. Mortality was significantly higher among patients with intracranial haemorrhage compared with those without haemorrhage (19.4% versus 2.6%; p = 0.016). Furthermore, mortality was significantly associated with GCS severity (p less than 0.001), with the highest mortality observed among patients presenting with severe head injury (44.4%).

DISCUSSION

The present study evaluated the occurrence and CT characteristics of intracranial haemorrhage in 100 patients with cranial fractures. Intracranial haemorrhage was detected in 62% of patients, indicating a substantial burden of associated intracranial injury in this population. The predominance of young adult males and road traffic accidents was consistent with the recognised epidemiological pattern of traumatic brain injury. The Global Burden of Disease analysis by Guan *et al.,* also highlighted the considerable global burden of traumatic brain injury, particularly in low- and middle-income countries.[1]

Epidural haematoma was the most frequently observed haemorrhage (53.2%), followed by subdural haematoma (41.9%) and cerebral contusion (32.3%). Multiple haemorrhage types were present in half of the patients with bleeding, emphasising the importance of systematic evaluation of all intracranial compartments. Although other CT-based studies have reported varying distributions of haemorrhage types, differences in study populations and inclusion criteria may explain these variations. [4,5] The role of non-contrast CT in rapidly identifying acute haemorrhage, associated fractures and mass effect has been well established in previous imaging studies. [4,5]

A significant association was observed between fracture type and the occurrence of intracranial haemorrhage, with depressed fractures showing the highest proportion of bleeding (88.9%). Depressed fractures were significantly associated with cerebral contusions, while basilar fractures demonstrated a significant association with intraventricular haemorrhage. These findings support the relationship between fracture morphology and the underlying pattern of intracranial injury. Faried *et al.,* also reported an association between skull base fractures and intracranial haemorrhage, supporting the importance of fracture assessment during CT evaluation.[3]

Fracture location demonstrated further associations with specific haemorrhage types. Temporal fractures were significantly associated with epidural haematoma, whereas frontal fractures showed a significant association with cerebral contusions. These observations are anatomically plausible, considering the vulnerability of meningeal vessels and the cerebral cortex to traumatic injury in these regions. [4,5] The significant variation in haemorrhage volume across different types, with EDH demonstrating the highest mean volume, further highlights the importance of documenting haemorrhage size during CT assessment. The ABC/2 method provides a practical approach for estimating haemorrhage volume in clinical settings.[8]

Although the proportion of intracranial haemorrhage increased with greater injury severity, its association with GCS category was not statistically

significant. However, mortality was significantly higher among patients with severe GCS scores and among those with intracranial haemorrhage. Surgical intervention was also significantly more frequent in patients with haemorrhage. Similar importance of CT findings in outcome assessment has been demonstrated by Goswami et al., who reported the prognostic utility of CT-based Marshall and Rotterdam scoring systems in patients with traumatic brain injury.[7] These findings reinforce the complementary role of clinical assessment and CT imaging in the evaluation of patients with cranial fractures.

CONCLUSION

Intracranial haemorrhage was observed in 62% of patients with cranial fractures, with epidural haematoma being the most common type. Depressed fractures were significantly associated with intracranial haemorrhage, while specific fracture locations demonstrated associations with individual haemorrhage patterns. Haemorrhage volume varied significantly according to its type. The presence of intracranial haemorrhage was significantly associated with surgical intervention and in-hospital mortality, while severe GCS was significantly associated with mortality. The study highlights the importance of systematic non-contrast CT evaluation for identifying and characterising intracranial injuries in patients with cranial fractures.

REFERENCES

1. Guan B, Anderson DB, Chen L, Feng S, Zhou H. Global, regional and national burden of traumatic brain injury and spinal cord injury, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. BMJ Open. 2023;13(10):e075049. doi:10.1136/bmjopen-2023-075049.
2. Allen BC, Cummer E, Sarma AK. Traumatic brain injury in select low- and middle-income countries: a narrative review of the literature. J Neurotrauma. 2023;40(7–8):602–619. doi:10.1089/neu.2022.0068.
3. Vidyasagar G. Epidemiology of traumatic brain injuries in India. Eur J Cardiovasc Med. 2024; 14:1083–1085. doi:10.5083/ejcm.
4. Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. Neurol Res. 2002;24(1):24–28. doi:10.1179/016164102101199503.
5. Tsiouris AJ, Lui YW. Neuroimaging update on traumatic brain injury. In: Hodler J, Kubik-Huch RA, Roos JE, editors. Diseases of the Brain, Head and Neck, Spine 2024–2027: Diagnostic Imaging. Cham: Springer; 2024.
6. Khairat A, Margetis K, Waseem M. Epidural hematoma. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026.
7. Siahaan AMP, Susanto M, Luis D, Chairul M, Saragih SGR, Harahap AR. Delayed progressive intracranial bleeding in pediatric acute epidural hemorrhage treated expectantly. Int J Surg Case Rep. 2023; 105:108005. doi: 10.1016/j.ijscr.2023.108005.
8. Kopacz AA, Miears H, Collins RA, Nagy L. Novel predictive markers on computed tomography for predicting early epidural hematoma growth in pediatric patients. J Neurosci Rural Pract. 2021;12(4):689–693. doi:10.1055/s-0041-1735327.
9. Parizel PM, Philips CD. Traumatic neuroemergency: imaging patients with traumatic brain injury—an introduction. In: Diseases of the Brain, Head and Neck, Spine 2020–2023: Diagnostic Imaging. Cham: Springer; 2020.
10. Nugraha EW, Tumboimbela MJ, Ngantung DJ, Wariki WMV, Tumewah R, Warouw F. Indicators of abnormal CT scan findings in clinically mild traumatic brain injury patients. Neurol Asia. 2024;29(1):207–213. doi:10.54029/2024wwh.
11. Goswami B, Nanda V, Kataria S, Kataria D. Prediction of in-hospital mortality in patients with traumatic brain injury using the Rotterdam and Marshall CT scores: a retrospective study from Western India. Cureus. 2023;15(7):e41548. doi:10.7759/cureus.41548.
12. Kothari RU, Brott T, Broderick JP, Barsan WG, Sauerbeck LR, Zuccarello M, *et al.,*The ABCs of measuring intracerebral hemorrhage volumes. Stroke. 1996;27(8):1304–1305. doi: 10.1161/01.STR.27.8.1304.

Cite This Article: Mirajkar, A. D., Bagale, S. R., & Pawar, S. S. (2026). Ocurrence of Intracranial Bleed in Patients Having Cranial Fractures Using CT as Diagnosing Modality. *EAS J Radiol Imaging Technol, 8*(6), 153-157.
https://doi.org/10.36349/easjrit.2026.v08i06.001