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A Study to Evaluate Prognostic Factors and Define a Critical Volume for Early Surgery in Patients with Bifrontal Brain Contusions

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Abstract

Aim The aim of this study was to evaluate various prognostic factors and their impact on the outcome of patients with bifrontal brain contusions and to define the critical volume of bifrontal brain contusions and to advice early surgery

Materials and Methods This is a prospective study performed with 250 patients admitted in a tertiary care hospital in Chennai.

Observations and Results In this study, we have studied the various findings in computed tomography (CT) scan brain that haves influence over the outcome. These are: Bilateral squashing of frontal horn, Posterior shift of genu, The deformation of third ventricle, The complete obliteration of basal cisterns, 5. Development of delayed intracranial hemorrhage (ICH). All these factors are associated with worst outcome and in patients those developed delayed increase in contusion volume, the median volume of contusion at the admission time ranged from 22 to 32 mL and the mean being 27 mL, we recommend prophylactic surgery in this subset of patients to prevent them from developing rapid deterioration in Glasgow coma scale (GCS) due to delayed ICH.

Conclusion Critical volume of bilateral frontal contusion that warrants prophylactic surgical intervention irrespective of the admission GCS is 27 mL. Younger age and good admission GCS are independent predictors for better outcome. Patients with volume of contusion more than 50 mL are always associated with unfavorable outcome. Bilateral frontal horn squashing, anteroposterior shift of genu of corpus callosum, deformation of third ventricle, and obliteration of basal cisterns are CT predictors for poor outcome in bifrontal brain contusions.

Keywords
- bifrontal contusions
- early surgery
- frontal contusions

Introduction

Trauma-induced regions of brain swelling are known as cerebral contusions. The microvasculature is also affected in these areas of cellular injury. The so-called "haemorrhagic contusion" occurs when the contused region becomes an amalgam of blood and necrotic brain tissue. Sometimes an intracerebral hematoma develops as a consequence of bleeding from a small ruptured vessel.[1]

It may be more difficult to treat a patient with severe frontal cerebral contusions than it is to care for a patient

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with other significant intracranial hemorrhages (ICH). Bifrontal contusions are a subset of patients, who have a high propensity to deteriorate faster. This is due to the shift being anterior–posterior rather than lateral. The deterioration is thus most likely to occur in the first 3 days after the injury.[2] There is no existing information on either the frequency of deterioration or the patients who are more at risk for it.

This analysis aims to identify the critical volume of bifrontal brain contusions and to advise early surgery before clinical deterioration occurs.

Aim

The aim of this study was to assess and analyze different prognostic factors and their impact on the outcome of patients with post-traumatic bifrontal brain contusions, define the critical volume of bifrontal brain contusions, and to advise early surgical management before clinical deterioration.

Materials and Methods

The present prospective study was performed with 250 patients admitted to a tertiary care hospital in Chennai. All head injury patients with computed tomography (CT) scan evidence of bifrontal brain contusions in all age groups were included in the study. Patients with poor hemodynamic status, bleeding diathesis, associated other system injuries, unilateral frontal brain contusions, and nontraumatic parenchymal hemorrhages were excluded.

To prognosticate the outcome, the following information was obtained:

- Clinical details:
  Age, sex, mode of injury, mechanism of injury(coup/contrecoup), admission Glasgow coma scale (GCS), GCS during treatment, pupillary reactions
- Imaging details:
  i. Volume of contusion:

Volume of contusion(cc) is calculated by using

$$\text{Di Chiro's formula} = \frac{a \times b \times c}{2}$$

Where *a* is anteroposterior dimension in cm

b is mediolateral dimension in cm

c is superoinferior dimension in cm

ii. Status of the frontal horn of lateral ventricles, whether they are splayed or normally seen if the frontal horns are splayed, details like unilaterally splayed or bilaterally splayed were also noted (►**Fig. 1**).

iii. Status of the third ventricle (►**Fig. 2**)

iv. An anteroposterior shift of the genu of the corpus callosum (►**Fig. 1**)

v. Development of delayed ICH in follow-up scans (►**Figs. 3**, **4**)

vi. Status of the basal cisterns (►**Fig. 2**)

vii. Fractures, if any

viii. Associated other intracranial hematomas, if any

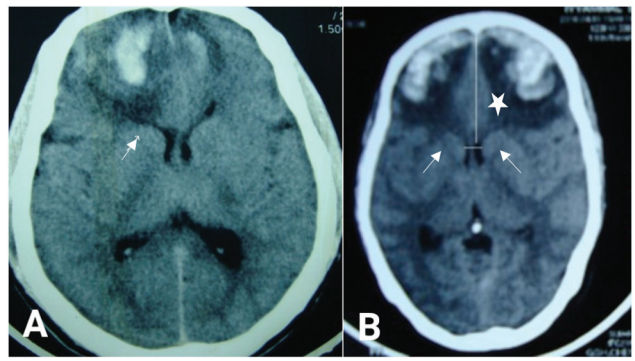

Fig. 1 Unilateral frontal horn splaying (arrows; **A**); bilateral frontal horn splaying (arrow) and anteroposterior shift of genu of corpus callosum (star; **B**).

All patients had at least two CT scans, including an initial brain CT scan and the indications for repeat CT brain are as follows:

1. Routine follow-up CT brain for all patients after 24 hours of first scan.
2. Clinical deterioration (fall in GCS or fresh neurological deficits).
3. Postoperative follow-up (►**Fig. 5**).
4. Follow-up before discharge.

As a result, the second scan's timing is unpredictable. The patients are managed either conservatively or surgically (►**Fig. 5**) based on the volume of contusion. The conservative treatment includes antibiotics, anticonvulsants, antiedema measures (20% mannitol), adequate analgesia, proton pump inhibitors, nootropics, limb, and chest physiotherapy with periodic neurological examinations. Since bifrontal contusions tend to increase in size in the early postinjury days, and patients with good GCS can deteriorate rapidly, we have attempted to define the critical volume of contusion that needs surgery before clinical deterioration.

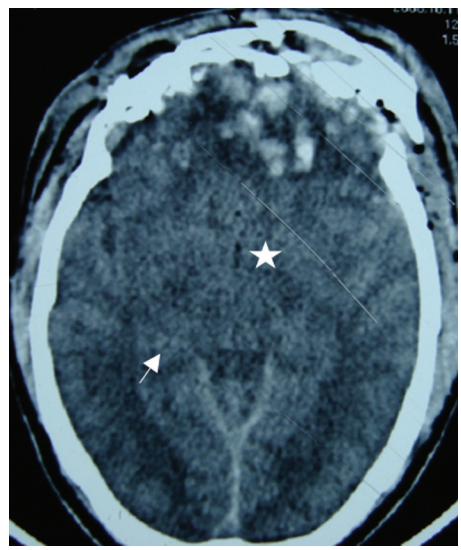

Fig. 2 : Obliteration of quadrigeminal cistern (arrow) and deformed third ventricle (star).

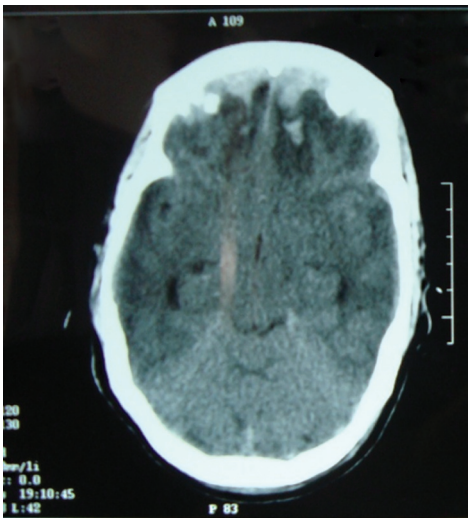

Fig. 3 Computed tomography scan on admission showing bifrontal thin subdural hematoma with small contusions and edema.

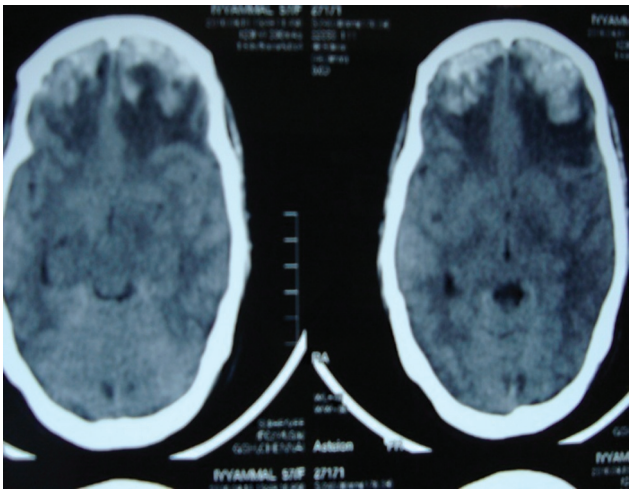

Fig 4 Same patient's computed tomography scan after deterioration at 15 hours showing progression of bifrontal contusions and edema.

Observation

The following observations were made in our research, most of the patients were between the ages of 16 and 45. The youngest patient was 8 years old, while the oldest was 78, and the mean age of the patient is 38.2 years (►**Table 1**). Of all the patients studied, 79% were male and 21% were female (►**Table 1**). Road traffic accidents were observed as the major cause of concern, constituting about 70%, followed by falls, train traffic accidents, and assaults in our study, implicating high-velocity injuries resulting in bifrontal contusions (►**Table1**). The mechanism of injury is assessed as coup or contrecoup injury. About 65% of the patients in this study group had a contrecoup type of injury (►**Table 1**).

Of the 250 patients studied, a total of 110 patients were subjected to surgical intervention. Among these 110 patients, only 58 patients were subjected to primary surgical intervention based on the clinical status and CT scan criteria. Fifty-two patients who were initially managed with the conservative line of management had either deteriorated clinically in the follow-up period or a follow-up scan showed a delayed increase in the volume of contusion and/ or edema. For these patients, the mode of treatment had been changed from conservative arm to surgical intervention. The indications for surgical intervention are volume of contusion more than 30 mL, splaying of the frontal horn of the lateral ventricle, and basal cistern effacement. The remaining 140 patients were managed conservatively.

Variable and Outcome Measurement:

The following clinical and radiological variables, namely initial GCS, age, pupillary abnormalities, the volume of

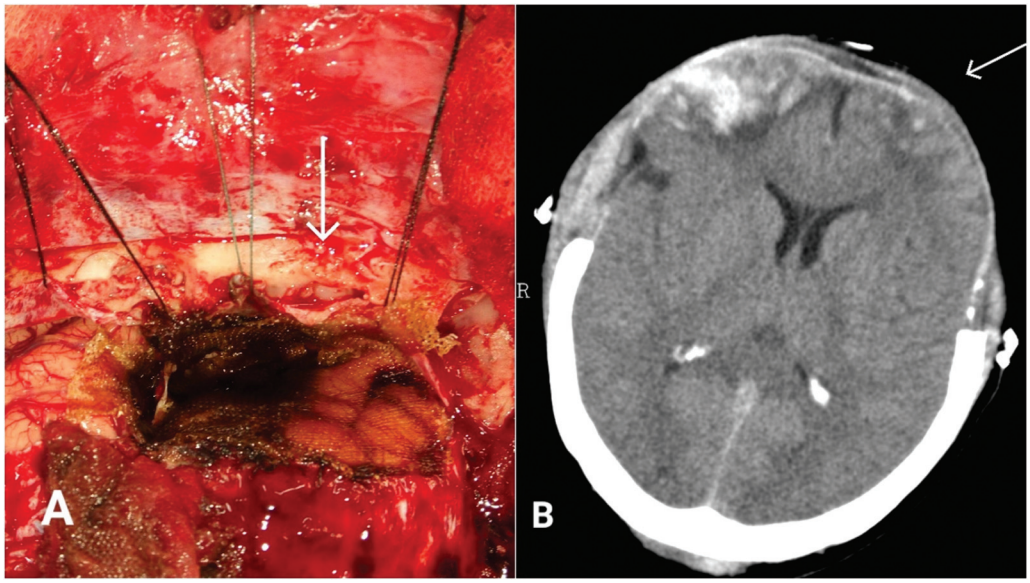

Fig. 5 Bifrontal craniotomy and rt frontal contusion removal (arrow; **A**): bifrontal decompressive craniotomy (arrow; **B**).

Table 1 The distribution of demographic parameters, volume of contusion, treatment types, and outcome in the study population

Parameters	Distribution	Percentage of population
Age	<10 years	3 (1.2%)
	11–20 years	22 (8.8%)
	21–30 years	37 (14.8%)
	31–40 years	97 (38.8%)
	41–50 years	34 (13.6%)
	51–60 years	36 (14.4%)
	>61 years	21 (8.4%)
Sex	Male	197 (79%)
	Female	53 (21%)
Mode of injury	RTA	175 (70%)
	Fall	50 (20%)
	TTA	16 (6%)
	Assault	9 (4%)
Mechanism of injury	Coup type	87 (34.8%)
	Contrecoup type	163 (65.2%)
GCS	<8	25 (10%)
	9–12	78 (31.2%)
	13–15	147 (58.8%)
Volume contusion	10–20 mL	136 (54.4%)
	20–30 mL	54 (21.6%)
	30–50 mL	34 (13.6%)
	>50 mL	26 (10.4%)
Treatment	Conservatively managed	147 (58.8%)
	Operated	103 (41.2%)
Outcome	Favorable (GOS 4, 5)	163 (65%)
	Unfavorable (GOS 3)	23 (11%)
	Poor (GOS 1,2)	60 (24%)

Abbreviations: GCS, Glasgow coma scale; GOS, Glasgow outcome scale; RTA, road traffic accident; TTA, time-to-accident.

contusion, delayed ICH, the status of the frontal horns, the status of the third ventricle, and anteroposterior shift of the genu of the corpus callosum, basal cisterns obliteration are analyzed in detail for their impact in prognosis.

Different patient groups were formed depending on GCS, age, the extent of the contusion, and the final outcome. Patients have been divided into three categories according to admission GCS scores (GCS 13–15), (GCS 9–12), and (GCS < 8). According to the volume of contusion, again patients were divided into three groups, group 1 having less than 25 ml of the volume of contusion, group 2 with a contusion volume of 26 to 50 mL, and group 3 with more than 51 mL. According to age, patients have been divided into three groups, age less than 15 years, 16 to 45 years, and more than 46 years. Utilizing the Glasgow outcome scale (GOS) patient outcomes in the third month after admission were documented. Three kinds of outcomes were defined: unfavorable (severe disability) and favorable (moderate disability and good recovery) and poor outcome (death or vegetative state). The distribution of the study population in these variables is tabulated in ►**Table 1**.

Results

Outcome analysis was done by analyzing various factors studied and their impact on the final outcome as listed in ►**Table 2**.

Age versus Outcome

The age of the patient has an important bearing on the outcome of the patient. Patients aged more than 46 years had worse outcomes when compared with younger patients (►**Table 2**).

Mode of Injury versus Outcome

However, majority of our patients sustained a head injury due to road traffic accidents. When it comes to the final outcome, patients who had a fall or who sustained train

Table 2 Comparison of the clinical profile with outcome

Variables	No. of patients	Favorable	Unfavorable	Poor
Age				
<15	18	16 (88.8%)	0	2 (11%)
16–45	165	116 (69.6%)	18 (10.8%)	31 (18.7%)
>46	67	29 (43.2%)	8 (12%)	29 (43.2%)
GCS at admission				
GCS <8	25	1 (4%)	1 (4%)	23 (92%)
GCS 9–12	78	39 (50%)	13 (16.6%)	24 (30.7%)
GCS 13–15	147	121 (82.3%)	13 (8.8%)	13 (8.8%)
Pupillary reflex				
Normally reacting	185	159 (85.9%)	9 (4.8%)	12 (6.4%)
Sluggish reaction	53	4 (7.5%)	13 (24.5%)	36 (67.9%)
No reaction to light	12	0	0	12 (100%)

Abbreviation: GCS, Glasgow coma scale.

traffic accidents had the worst outcomes with a higher rate of mortality.

Mechanism of Injury versus Outcome Analysis

In our study, we observed that 29.4% of patients with contrecoup type of injury had a poor prognosis. Contrecoup contusions are slightly more in volume compared to coup contusions, contributing to bad prognosis.

Admission GCS versus Outcome

The patients with severe head injury with admission GCS less than 8 had a very bad outcome. Ninety-two percent of the patients with bilateral frontal brain contusions with the admission GCS less than 8 (►**Table 2**) had GOS of 1 and 2 with more than 50 mL volume of contusion.

Pupillary Reaction versus Outcome

The response of pupils to light is again a significant prognostic factor and it also gives a clue regarding the severity of the injury. Reassessment of pupillary response at regular intervals will help in prognosticating the patient. In our study, patients with nonreactive pupils and sluggishly reacting pupils had a grave prognosis (►**Table 2**).

The Volume of Contusion versus Outcome

Patients with contusion volume of more than 51 mL (88%) and patients with contusion volume of 26 to 50ml (54%) had poor outcomes with the GOS score of 1 and 2, respectively. Patients with admission GCS less than 8 had an average volume of contusion of more than 50 mL and they had a very poor prognosis (►**Table 3**). So, admission GCS and volume of a contusion are good predictors of outcome.

Frontal Horn Status versus Outcome

The mass effect of bifrontal contusions is most evident over the frontal horns of the lateral ventricle. Eighty-one percent of the patients with bilateral splaying of the frontal horn of lateral ventricles had a poor outcome. And patients with normal frontal horns of the lateral ventricle had a better outcome. Patients with bilateral splaying of the frontal horn of the lateral ventricle had an average volume of contusion of about 45 mL, and 81% of the patients had GOS of 1 and 2 (►**Table 3**); so the volume of contusion of more than 45 mL with associated bilateral frontal horn splaying is unfavorable prognostic factors(►**Table 4**).

The Anteroposterior Shift of Genu of Corpus Callosum versus Outcome

The anteroposterior shift of genu of the corpus callosum is another important parameter to assess the mass effect. About 60% of the patients with the anteroposterior shift of genu of corpus callosum had a poor prognosis (►**Table 3**). The average volume of contusion measured in patients showing anteroposterior shift of genu of the corpus callosum was 41 mL.

Third Ventricle Status versus Outcome

Patients who were noticed to have deformed third ventricle had a poor prognosis (64%) (►**Table 3**) and the average volume of contusion measured in patients with deformed third ventricle was 43.4 mL.

Basal Cistern versus Outcome Analysis

Among the patients who had fully effaced suprasellar, perimesencephalic cisterns, 87% of the patients had a very poor prognosis (►**Table 3**), with the average volume of contusion being 47 mL.

Fracture versus Outcome

Patients with occipital bone fracture had increased mortality when compared with the frontal bone fracture (►**Table 3**), as these patients had contrecoup brain contusions.

Table 3 Comparison of the radiologic findings with outcome

Variables	No. of patients	Favorable	Unfavorable	Poor
Volume				
<25cc	156	143 (91.6%)	6 (3.8%)	7 (4%)
26–50cc	57	16 (28%)	20 (35%)	31 (53.4%)
>51cc	27	2 (7.4%)	1 (3.7%)	24 (88.8%)
AP shift of genu/volume/mean GCS				
AP shift present/ 41mL/ 10.7	84	18 (21.4%)	15 (17.85%)	51 (60%)
AP shift absent/ 18.3mL/ 13.6	166	143 (86.1%)	12 (7%.2%)	11 (6.6%)
Frontal horn status/volume				
Normal/ 16.6mL	144	137 (95%)	3 (20.8%)	4 (2.7%)
Unilateral splay/ 33.7mL	64	24 (37.5%)	18 (28%)	22 (34.3%)
Bilateral splaying/45mL	42	2 (4.7%)	6 (14.2%)	34 (80.9%)
Third ventricle				
Normally seen	185	150 (81%)	15 (8.1%)	20 (10.8)
Abnormal	65	11 (16.9%)	12 (18.4%)	42 (64.6%)
Basal cistern				
Normal	195	158 (81%)	16 (8.2%)	21 (10.7%)
Partial effaced	24	2 (8.3%)	8 (33.3%)	14 (58.3%)
Fully effaced	31	1 (3.2%)	3 (9.3%)	27 (87%)
Fracture				
Occipital	85	49 (57.6%)	12 (14.1%)	23 (27%)
Frontal	44	29 (65.9%)	6 (13.6%)	9 (20.4%)
Status of contusion				
Same size contusion	197	143 (72.5%)	11 (5.58%)	43 (21.82%)
Delayed ICH	53	21 (39.6%)	16 (30.1%)	16 (30.1%)

Abbreviations: AP, anteroposterior; GCS, Glasgow coma scale; ICH, intracranial hemorrhage.

Table 4 Volume of contusion and frontal horn status—most reliable predictors for outcome

Volume	Outcome						Total		*p*-Value
	Favorable		Unfavorable		Poor				
	n	%	*n*	%	*n*	%	*n*	%	
≤ 20 mL	130	95.6	2	1.5	4	2.9	136	100.0	0.001 (HS)
21–30 mL	25	46.3	17	31.5	12	22.2	54	100.0	
31–50 mL	6	17.6	8	23.5	20	58.8	34	100.0	
> 50 mL	2	7.7	0	0.0	24	92.3	26	100.0	
Total	163	65.2	27	10.8	60	24.0	250	100.0	
Frontal horn status									
Normal	135	95.1	3	2.1	4	2.8	142	100.0	0.001 (HS)
U/L splaying	24	37.5	18	28.1	22	34.4	64	100.0	
B/L splaying	2	4.8	6	14.3	34	81.0	42	100.0	
Total	161	64.9	27	10.9	60	24.2	248	100.0	

Delayed Intracerebral Hematoma

The definition of a delayed ICH is either an ICH at a site where the original CT revealed no hemorrhagic lesion or an expansion of a known ICH (A 25% or greater rise in one or more lesion dimensions from the initial CT scan).[3] In this study, around 53 individuals experienced an increase in the edema or clot size (►**Figs. 4**, **5**) when compared to the scan taken at the time of admission. Children and elderly patients had a high propensity to develop delayed intracerebral hematoma when compared to young adults. Among these 53 patients, 45 patients had been operated on. Most of the patients experienced an increase in clot size between 24 and 48 hours after the injury, 21% in 24 hours and 63% in 48hours post-injury. On the second day after the trauma, clot size increased in 63% of the patients. Development of delayed increase in the size of the contusion was associated with unfavorable and poor outcome (►**Table 3**).

Statistical Analysis:

The outcomes were statistically evaluated using:

a) Chi-squared test-x^2
b) Student's *t*-test
c) Simple linear regression analysis.

Discussion

Bifrontal contusions are a subset of head injury patients, who are prone to sudden deterioration due to progressing hematoma or edema or central herniation and risk of death.[4] Bifrontal region is considered silent area of the brain, as the quantum of injury and signs of raised intracranial tension are not clinically evident in the early stage.[5] Clinical monitoring of neurologic status, periodic follow-up scans, and intracranial pressure monitoring will help in early identification of patients, who are at risk of deterioration. Xenon CT scan will show reduction in blood flow in frontal lobes due to progression of edema, which may aid in planning early surgery.[6] While severe bifrontal contusions had a considerable risk of deterioration, unilateral traumatic frontal contusions had a satisfactory result.[7] This has been confirmed by various studies all over the world. When compared to unilateral frontal traumatic ICH, bilateral frontal ICH often affects older individuals, is frequently driven by falls, and has been linked to an increased risk of delayed ICH or brain stem compression by Hung et al.[8] The findings of our study were similar to this. Fifty-three patients developed a delayed increase in hematoma size when compared to the previous CT scan, Out of this 45 patient's treatment plan had been changed from conservative line of management to surgical intervention and 63% of the patients who had delayed ICH found to occur in the second post-injury day, delayed ICH is associated with unfavorable outcome. A recent study concluded that the outcome will be worst for patients who undergo decompression without contusion evacuation.[9]

In addition, in our study, we observed that patients aged above 60 years had poor prognosis. The reason may be due to an associated comorbid condition and the higher incidence of development of delayed increase ICH in these group of patients. Therefore, age is considered to be an independent risk factor in assessing the prognosis. Our study aims at identifying the subset of bifrontal contusion patients, who are likely to deteriorate, to advise early surgery to save precious lives.

Various studies in literature show that a CT scan obtained 12 hours after the original CT scan may reliably predict the outcome, majority of the patients would worsen during the first 24h, parenchymal injuries are likely to increase in size and in particular, and frontal contusions and temporal contusions are notorious to increase in the first 24 hours.[8,10,11] A recent review article insists on having a low threshold for reimaging to pick up silent expansion of hematomas.[12] These studies reinstate the importance of routine follow-up CT brain in clinically stable patients to identify hematoma progression before clinical deterioration. Magnetic resonance imaging brain will pick up central herniation evidenced by edema of midbrain and downward shift of bilateral red nucleus, which warrants early decompressive surgery.[13]

In addition to the prognostic factors we studied, Steyerberg et al[14] suggested traumatic subarachnoid hemorrhage is a significant predictor of poor outcomes in bifrontal contusion patients. The research by Suresh et al[3] found that pediatric patients under the age of 2 years had a poor prognosis. The youngest patient we studied was 8 years old. Jayakumar et al[15] in his research, which only included contrecoup injury cases, patients under 40 years old had a death rate of 41%, whereas patients over 40 years old had a mortality rate of 67%. In this research, the mortality rate for bilateral contusions was 79%. Bhateja et al[16] concluded that contrecoup contusions, whether present with or without coup contusions, are linked to poor outcome across all GCS and age groups. Our study also had similar findings.

As per the brain trauma foundation guidelines[17] and the status of the basal cistern and admission GCS, the patients were subjected to operative intervention if the volume of contusion is more than 30 mL. In our study, we observed that many of the patients, even with a contusional volume of less than 30 mL and who had good GCS at admission and managed initially with a conservative line of management, developed rapid deterioration in consciousness. On evaluating those patients with follow-up CT scan brain, it showed an increase in clot size/ edema, resulting in GCS deterioration and these patient's management had been changed from conservative arm to operative intervention. However, the percentage of better outcome in this subset of patients, who deteriorated and were found to have developed delayed ICH, is comparatively less. In this study, we have tried to identify those subsets of patients and to define a critical volume of contusion who will benefit from early surgical intervention. According to Teasdale and Gallbraith,[18] if those who are likely to deteriorate could be recognized quickly after the lesions have been diagnosed, they could have early surgery without the risk of deterioration, and the others would be saved from needless surgery. To identify the critical volume of

Table 5 Development of delayed ICH versus initial volume and its impact on prognosis

21–30 mL	Treatment		No. of patients	Initial volume	Delayed ICH	Favorable	Unfavorable	Poor
	Conservative		14	22.28ml		14	0	0
	Operated	Primarily	3	28ml		0	3	0
		Delayed	37	27.6ml	40.3	11	17	2

Abbreviation: ICH, intracranial hemorrhage.

contusion, we have taken the mean admission volume of contusion of patients who had developed rapid deterioration in consciousness with delayed ICH.

In patients, those developed delayed increases in contusion volume, the median volume of contusion at the admission time ranged from 22 to 32 mL and the mean was 27 mL; we recommended prophylactic surgery in this subset of patients to prevent them from developing rapid deterioration in GCS due to delayed ICH.

In patients with admission volume of contusion of 21 to 30 mL, 37 patients had developed delayed ICH, with progression from the preoperative mean volume of contusion being 27.6 to 40 mL. All of these patients required surgery during the follow-up period. Among those, only 11 patients had a favorable outcome and 17 patients had severe disability. Patients having a median threshold volume of 27 mL as evident from this (►**Table 5**), would have benefitted from surgery, and the morbidity and mortality rates would have decreased. Hence, we propose that, in bifrontal brain contusions, the critical volume of contusion that warrants surgery before clinical deterioration is 27 mL. There was one retrospective study by Sarma et[9] al from National Institute of Mental health and Neuro Sciences, Bengaluru (NIMHANS), which analyzed the best surgical option for bifrontal contusions. The mean volume of bifrontal contusion observed in patients who deteriorated was 28 mL. No other studies examined the critical volume of bifrontal contusions to advise early surgery. As there is a surge in minimally invasive surgery in recent days, newer studies advocate the use of supraorbital key hole craniotomy/ supraorbital endoscopy in selected cases of traumatic frontal intracerebral hematoma.[19,20]

In this study, we concentrated on various findings in CT scan brain, which could influence the outcome

1. The status of the frontal horns was noted in all patients; 81% of the patients with bilateral effacement of the frontal horn had a very grave prognosis and the average volume of contusion needed to splay both the frontal horns from this study is 45 ml (►**Tables 3**, **4**) and its significance has been proven statistically.
2. Location of the genu of the corpus callosum in relation to the belly of the caudate nucleus. We had 84 patients with a posterior shift of genu associated with 60% of poor outcomes that is statistically significant.
3. The deformation of the third ventricle has also shown significant implications in the outcome as the patients with a deformed third ventricle had only an 11% favorable outcome.
4. The complete obliteration of basal cisterns is associated with an unfavorable outcome in this group. The average volume of contusion needed to completely obliterate the basal cistern is 47 mL.
5. Delayed intracerebral hematoma: Of the patients who developed delayed ICH, 63% of the patients developed it on the second post-injury day, and 42% of the patients aged more than 61 years developed delayed ICH with 55 % unfavorable outcomes. The development of delayed ICH is associated with unfavorable outcomes.

Bifrontal contusion is a spectrum of head injury, which is different from other injuries, as the progression of edema is anteroposterior rather than cranial caudal as in other conditions, resulting in faster deterioration. This study will help in early identification of the subset of bifrontal contusion patients, at risk for sudden deterioration, as no other studies in the literature thoroughly analyzed the CT findings or critical volume of bifrontal contusions in detail. By adopting early surgery, this subset of patients can be saved.

Conclusion

To conclude, the critical volume of bilateral frontal contusion that warrants prophylactic surgical intervention irrespective of the admission GCS is 27 mL. Younger age and good admission GCS were independent predictors for a better outcome. Patients with a volume of contusion more than 50 mL are always associated with unfavorable outcome. Bilateral frontal horn effacement, anteroposterior shift of genu of the corpus callosum, deformation of the third ventricle, and obliteration of basal cisterns are CT predictors for poor outcomes in bifrontal brain contusions.

Conflict of Interest
None declared.

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