Section: Neurosurgery

JAMP

Original Research Article

A STUDY TO DETERMINE A CRITICAL VOLUME FOR EARLY SURGERY IN PATIENTS WITH BIFRONTAL BRAIN CONTUSIONS AND TO EVALUATE PROGNOSTIC FACTORS

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Received : *25/05/2024*
Received in revised form : *22/07/2024*
Accepted : *06/08/2024*

Keywords:
Bifrontal contusions, early surgery, frontal contusions.

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DOI: 10.47009/jamp.2024.6.4.84

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 418-423

Abstract

Background: 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. It may be more difficult to treat a patient with severe frontal cerebral contusions than it is to care for a patient with other significant intracranial haemorrhages. This study aimed to evaluate various prognostic factors and their impact on the outcome of patients with bifrontal brain contusions to define the critical volume of bifrontal brain contusions and advise early surgery. **Materials and Methods:** This prospective study was performed with 100 patients admitted to a tertiary care hospital in Mahabubabad. **Result:** In this work, we have examined the different results from brain computed tomography (CT) scans that impact the final result. These include Frontal horn compression on both sides, the third ventricle's distortion, the genu's posterior migration, and the basal cisterns' destruction. they delayed cerebral haemorrhage development (ICH). These variables are all linked to the worst outcomes. In patients who experienced a delayed increase in contusion volume the median volume at admission was between 22 and 32 mL, with a mean of 27 mL, we advise preventive surgery to shield them from experiencing a sharp decline in their Glasgow Coma Scale (GCS) as a result of delayed ICH. **Conclusion:** The critical volume of bilateral frontal contusion that warrants prophylactic surgical intervention irrespective of the admission GCS is 27mL. An improved result was independently predicted by younger age and a higher entrance GCS. Patients who have a contusion larger than 50 mL will almost invariably have a poor prognosis. Poor outcomes in bifrontal brain contusions are predicted by CT by bilateral frontal horn effacement, anteroposterior shift of the corpus callosum's genu, distortion of the third ventricle, and obliteration of the basal cisterns.

INTRODUCTION

Cerebral contusions are areas of the brain that enlarge due to trauma. These regions of cellular damage also impact the microvasculature.[1] When blood and necrotic brain tissue combine in the contused area, it is referred to as a "haemorrhagic contusion".[2] An intracerebral hematoma may occasionally result from bleeding from a tiny broken vessel.[3] Treating a patient with severe frontal cerebral contusions can be more challenging than treating a patient with other substantial intracranial haemorrhages (ICH). Approximately 15% of individuals who suffer from traumatic brain injury (TBI) experience intracranial haemorrhage or contusion.[4] Bifrontal contusions are among the most common and frequent among them. After being admitted, patients with bifrontal brain contusions may have periods of lucidity. Early computed tomography (CT) scans performed in the early stages could only show modest frontal contusions and no ambient cistern obliteration. As a result, these patients are occasionally not given priority in casualty. Research has shown that certain individuals who have had bifrontal contusions may go on to develop larger intracranial hematomas and/or oedema in the months or years after their injury. This might result in a fast worsening of their condition or possibly result in death due to cerebral herniation.[5,6]

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

Aim and objective

The critical volume of bifrontal brain contusions was defined, several prognostic indicators and their effects on the prognosis of patients with post-traumatic bifrontal brain contusions were evaluated and analysed, and early surgical care was recommended before clinical deterioration.

MATERIALS AND METHODS

One hundred patients who had been admitted to a Mahabubabad tertiary care hospital participated in the current prospective research. The study included all individuals with head injuries in all age groups who showed evidence of bifrontal brain contusions on computed tomography (CT) scans. Individuals with nontraumatic parenchymal haemorrhages, unilateral frontal brain contusions, related other system injuries, poor hemodynamic condition, and bleeding diathesis were not accepted.

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.

i. Volume of contusion:

The volume of contusion (cc) is calculated by using Di Chiro's formula= (Anteroposterior dimension X Mediolateral dimension X Superoinferior dimension)/2

Where anteroposterior, mediolateral and 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 (Figure-1), status of the third ventricle, an anteroposterior shift of the genu of the corpus callosum, development of delayed ich in follow-up scans, status of the basal cisterns, fractures, if any, and associated other intracranial hematomas, if any

All patients had at least two CT scans, including an initial brain CT scan and the indications for repeat CT brain are as follows: Routine follow-up CT brain for all patients after 24 hours of the first scan, clinical deterioration (fall in GCS or fresh neurological deficits, postoperative follow-up, follow-up before discharge.

The timing of the second scan is therefore erratic. Depending on the extent of the contusion, the patients are treated either conservatively or surgically. Antibiotics, anticonvulsants, antiedema medications (20 per cent mannitol), sufficient analgesics, proton pump inhibitors, nootropics, limb and chest physical therapy, and routine neurological exams are all part of the conservative treatment plan. We have tried to identify the essential volume of contusion that requires surgery before clinical deterioration since bifrontal contusions tend to enlarge in the early post-injury days and patients with excellent GCS might worsen quickly.

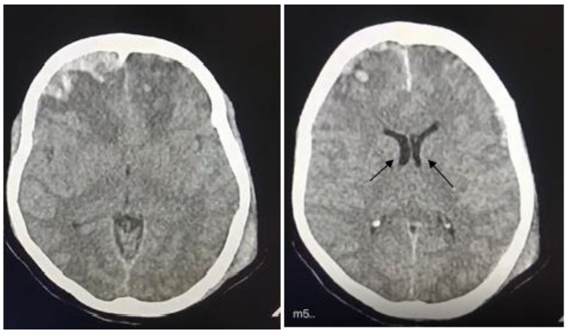

Figure 1: Unilateral frontal horn splaying bilateral frontal horn splaying (arrow) and anteroposterior shift of genu of corpus callosum

RESULTS

Our study yielded the following observations: the majority of the patients were in the 15–45 age range. The mean age of the patients is 36.9 years, with the youngest being 9 years old and the oldest being 76. 62% of the patients that were examined were men, and 38% were women. In our investigation, road traffic accidents were found to be the primary cause for worry, accounting for almost 70% of the incidents. These were followed by falls, train traffic accidents, and assaults, all of which included high-velocity injuries that resulted in bifrontal contusions. Injury mechanisms are classified as coup or contrecoup. In this research group, contrecoup injuries accounted for around 65% of the patients [Table 1]. Out of the 100 patients who were examined, 41 (41%) of them had surgery. Out of the 41 patients, only 22 underwent primary surgical intervention, determined by the CT scan criteria and clinical state. Twelve patients who were treated conservatively at first either experienced a decline in their clinical condition throughout the follow-up period, or a delayed rise in the volume of contusion and/or oedema was observed on a follow-up scan. The course of treatment for these individuals has shifted from conservative measures to surgical surgery.

The indications for surgical intervention are a volume of contusion of more than 30mL, splaying of the frontal horn of the lateral ventricle, and basal cistern effacement. The distribution of the study population in these variables is tabulated in [Table 1].

Variable and Outcome Measurement:

Approximately 65% of the individuals in this research group had contrecoup injuries [Table 1]. 41 (41%) of the 100 patients who underwent examination had surgery. Based on the CT scan criteria and clinical status, only 22 of the 41 patients received main surgical surgery. Twelve patients who were initially treated conservatively either showed a delayed increase in the volume of contusion and/or edema on a follow-up scan, or their clinical status declined throughout the follow-up period. For many patients, surgical intervention has replaced more conservative treatment methods.

Three groups of patients have been established based on their GCS scores upon admission: GCS<8, GCS 9–12, and GCS 13–15. Patients were again separated into three groups based on the volume of contusion: group 1 had a contusion volume of less than 25 mL, group 2 had a contusion volume of 26 to 50 mL, and group 3 had a volume of more than 51 mL. The patients have been separated into three age groups: under 18, between 19 and 45, and above 46 years old. Patient outcomes were documented in the third month following admission using the Glasgow Outcome Scale (GOS). Three categories of results were identified: bad (death or vegetative state), favourable (moderate impairment and excellent recovery), and unfavourable (severe disability). The distribution of the study population in these variables is tabulated in [Table 1].

Statistical Analysis

Both statistical analyses were conducted using SPSS (IBM Corp., Armonk, NY, US). It represents the mean ± SD of the continuous variables. Categorical considerations and counts are expressed as percentages. The distribution of CT features related to age and sex has been measured using the Chi-square scale.

Results

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

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. However, the majority of our patients sustained a head injury due to road traffic accidents. When it comes to the outcome, patients who had a fall or who sustained train traffic accidents had the worst outcomes with a higher rate of mortality.

In our study, we observed that the mechanism of injury versus outcome analysis find 65% of patients with a contrecoup type of injury had a poor prognosis. Contrecoup contusions are slightly more in volume compared to coup contusions, contributing to a bad prognosis [Table 1].

The patients with severe head injury with admission GCS less than 8 had a very bad outcome. 80% 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 50mL volume of contusion.

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].

Patients with a volume of contusion versus outcome of more than 51cc (60%) and patients with a contusion volume of 26 to 50cc (50%) had poor outcomes with GOS scores of 1 and 2, respectively. Patients with admission GCS less than 8 had an average volume of contusion of more than 50cc and they had a very poor prognosis (Table 3). So, admission GCS and volume of a contusion are good predictors of outcome.

The anteroposterior shift of the genu of the corpus callosum is another important parameter to assess the mass effect. About 51.73% of the patients with the anteroposterior shift of genu of corpus callosum had a poor prognosis. The average volume of contusion measured in patients showing an anteroposterior shift of genu of the corpus callosum was 41mL. Patients who were noticed to have deformed third ventricles had a poor prognosis (58.62%). In basal cistern versus outcome analysis of the patients who had fully effaced suprasellar, peri mesencephalic cisterns, 70% of the patients had a very poor prognosis. Patients with occipital bone fracture had increased mortality when compared with frontal bone fracture, as these patients had contrecoup brain contusions. 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). In this study, around 41 individuals experienced an increase in the oedema or clot size, when compared to the scan taken at the time of admission. The development of a delayed increase in the size of the contusion was associated with unfavourable and poor outcomes [Table 3].

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	1 (1%)
	11–20 years	12 (12%)
	21–30 years	28 (28%)
	31–40 years	21 (21%)
	41–50 years	17 (17%)
	51–60 years	15 (15%)
	>61 years	6 (6%)
Sex	Male	62 (62%)
	Female	38 (38%)
Mode of injury	RTA	70 (70%)
	Fall	20 (20%)
	TTA	6 (6 %)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

	Assault	4 (4%)
Mechanism of injury	Coup type	35 (35%)
	Contrecoup type	65 (65%)
GCS	<8	10 (10%)
	9–12	32 (32%)
	13–15	58 (58%)
Volume contusion	10–20mL	54 (54%)
	20–30mL	22 (22%)
	30–50mL	14 (14%)
	>50mL	10 (10%)
Treatment	Conservatively managed	59 (59%)
	Operated	41 (41%)
Outcome	Favorable (GOS 4, 5)	65 (65%)
	Unfavorable (GOS 3)	11 (11%)
	Poor (GOS 1,2)	24 (24%)

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

Table 2: Comparison of the clinical profile with outcome

Variables	No. of patients	Favourable	Unfavorable	Poor
Age				
<18	12	10 (83.33%)	-	2 (16.67%)
19–45	66	39 (59%)	11(816.66%)	16 (24.24%)
>46	22	10 (45.45%)	2 (9.10%)	10 (45.45%)
GCS at admission				
GCS <8	10	1(10%)	1(10%)	8(80%)
GCS 9–12	32	16 (50%)	6(18.75%)	10(31.25%)
GCS 13–15	58	48 (82.76%)	5(8.62%)	5 (8.62%)
Pupillary reflex				
Normally reacting	67	55 (82.10%)	4 (6%)	8 (11.90%)
Sluggish reaction	23	3 (13.04%)	7(30.43%)	13 (56.53%)
No reaction to light	10			10 (100%)

Table 3: Comparison of the radiologic findings with outcome

Variables	No. of patients	Favourable	Unfavorable	Poor
AP shift of genu/volume/mean GCS				
AP shift present/ 41mL/ 10.7	29	5 (17.24%)	9 (31.03%)	15 (51.73%)
AP shift absent/ 18.3mL/ 13.6	71	43 (60.56%)	10 (14.08%)	18 (25.36%)
Volume				
<25mL	72	61 (84.72%)	5 (6.94%)	6 (8.34%)
26–50 mL	28	6 (21.43%)	8 (28.57%)	14 (50%)
>51 mL	10	3 (30%)	1 (10%)	6 (60%)
Frontal horn status/volume				
Normal/ 16.6mL	59	49 (83.06%)	3 (5.08%)	7 (11.86%)
Unilateral splay/ 33.7mL	30	14 (46.67%)	6 (20%)	10 (33.33%)
Bilateral splaying/45mL	11	2 (18.18%)	3 (27.27%)	6 (54.56%)
Third ventricle				
Normally seen	71	59 (83.10%)	5 (7.04%)	7 (9.86%)
Abnormal	29	5 (17.24%)	7 (24.14%)	17 (58.62%)
Basal cistern				
Normal	68	52 (76.47%)	5 (7.36%)	11 (16.17%)
Partial effaced	22	4 (18.18%)	6 (27.27%)	12 (54.54%)
Fully effaced	10	1 (10%)	2 (20%)	7 (70%)
Fracture				
Occipital	49	25 (51.02%)	8 (16.32%)	16 (32.66%)
Frontal	21	12 (57.14%)	3 (14.28%)	6 (28.58%)
Status of contusion				
Same size contusion	78	61 (78.20%)	6 (7.70%)	11 (14.10%)
Delayed ICH	22	9 (40.90%)	5 (22.73%)	8 (36.37%)

AP, anteroposterior; GCS, Glasgow coma scale; ICH, intracranial haemorrhage.

Table 4: Development of delayed ICH versus initial volume and its impact on prognosis

21–30mL	Treatment		No. of patients	Initial volume	Delayed ICH	Favourable	Unfavorable	Poor
	Conservative		6	22.29mL	-	6	-	-
	Operated	Primarily	2	28mL	-	-	2	-
		Delayed	11	27.8mL	40	4	6	1

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

A subgroup of individuals with head injuries known as bifrontal contusions is at risk of rapid deterioration as a result of central herniation, oedema, or advancing hematoma.[7] Since the extent of the damage and any indications of elevated intracranial tension are not clinically apparent in the early stages, the bifrontal region of the brain is regarded as quiet.[8] Early identification of individuals who are at risk of deterioration can be facilitated by clinical monitoring of the neurologic state, routine follow-up scans, and intracranial pressure monitoring. Early surgical planning may be aided by the Xenon CT scan, which will demonstrate a decrease in blood flow in the frontal lobes as a result of oedema development.[8] Unilateral traumatic frontal contusions resulted in an acceptable outcome, but severe bifrontal contusions had a significant risk of worsening.[9] Numerous investigations conducted worldwide have verified this. In contrast to unilateral frontal traumatic ICH, bilateral frontal ICH typically affects older people, is more often caused by falls, and has been connected by Hung et al. to a higher risk of delayed ICH or brain stem compression.[10] Our study's results were comparable to this. According to recent research, patients who undergo decompression without contusion evacuation would have the worst results.[11] 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 increased ICH in these groups 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.

Numerous studies in the literature demonstrate that a CT scan taken 12 hours after the initial CT scan can accurately predict the result; most patients would deteriorate during the first 24 hours; parenchymal injuries are likely to enlarge; and frontal and temporal contusions are known to worsen during the first 24 hours.[12,13] A low threshold for reimaging to detect silent enlargement of hematomas is insisted upon in a recent review study.[14] These findings emphasise the value of routine CT brain follow-up in patients who are clinically stable to detect hematoma development before clinical deterioration. Magnetic resonance imaging brain will pick up central herniation evidenced by oedema of the midbrain and downward shift of bilateral red nucleus, which warrants early decompressive surgery.[15]

In addition to the prognostic factors we studied, Steyerberg et al,[16] suggested traumatic subarachnoid haemorrhage is a significant predictor of poor outcomes in bifrontal contusion patients. The research by Suresh et al,[17] 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,[18] in their 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,[19] concluded that contrecoup contusions, whether present with or without coup contusions, are linked to poor outcomes across all GCS and age groups. Our study also had similar findings. As per the Brain Trauma Foundation guidelines,[20] and the status of the basal cistern and admission GCS, the patients were subjected to operative intervention if the volume of contusion was more than 30mL. In our study, we observed that many of the patients, even with a contusional volume of less than 30mL 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/oedema, resulting in GCS deterioration and these patient's management had been changed from conservative arm to operative intervention.

Comparatively speaking, there is a lower percentage of individuals in this subgroup who worsened and were discovered to have acquired delayed ICH. Our goal in this study was to determine the patient subgroups that will benefit from early surgical intervention as well as the crucial volume of contusion. Teasdale and Galbraith,[21] claim that if patients who are likely to worsen could be identified as soon as the lesions are found, they may have early surgery without running the risk of worsening, and the rest could avoid unnecessary surgery. We have calculated the mean admission volume of contusion for patients with delayed ICH who had experienced a fast decline in consciousness to determine the critical volume of contusion.

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

Eleven patients who had an entrance volume of contusion between 21 and 30 mL and a preoperative mean volume of 27.8 to 40 mL had progressed to delayed ICH. During the follow-up period, surgery was necessary for all of these individuals. Of them, six suffered from severe handicaps and just four had a good outcome. Patients who, as [Table 4] makes clear, had a median threshold volume of 27 mL would have benefited from surgery, and their rates of morbidity and death would have dropped.

Therefore, we suggest that the critical volume of a bifrontal brain contusion that should be surgically repaired before it causes clinical deterioration is 27 mL. Sarma et al. conducted a retrospective analysis,[11] to determine the optimal surgical treatment for bifrontal contusions. In patients who declined, the mean volume of bifrontal contusion was

28 mL. Other research did not look at the critical volume of bifrontal contusions to recommend surgery as soon as possible. current research supports the use of supraorbital keyhole craniotomy/ supraorbital endoscopy in some cases of traumatic frontal intracerebral hematoma, given the current spike in minimally invasive surgery.[22,23]

In a spectrum of head injuries, bifrontal contusions vary from other types of head injuries in that the oedema progresses anteroposteriorly rather than cranially caudally as in other disorders, leading to a quicker rate of deterioration. Since no previous studies have fully examined the CT results or critical volume of bifrontal contusions in detail in the literature, this study will aid in the early identification of the subgroup of patients with bifrontal contusions that are at risk for quick deterioration. This patient group can be spared if early surgery is used.

CONCLUSION

To conclude, regardless of the admission GCS, a bilateral frontal contusion with a critical volume of 27 mL requires preventive surgical surgery. An improved result was independently predicted by younger age and a higher entrance GCS. Patients who have a contusion larger than 50 mL will almost invariably have a poor prognosis. Poor outcomes in bifrontal brain contusions are predicted by CT by bilateral frontal horn effacement, anteroposterior shift of the corpus callosum's genu, distortion of the third ventricle, and obliteration of the basal cisterns.

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