

Original Article

Predictors of Surgical Outcome Following Cerebral Contusion in Severe Head Injuries

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ABSTRACT

Objective: There are controversies regarding the management of Cerebral Contusion. The study sought to identify parameters influencing the surgical outcome of individuals suffering from a brain contusion.

Methods: A quasi-experimental study was conducted at the Department of Neurosurgery, Mayo Hospital Lahore, and 37 patients were included. The information on the mode/mechanism of injury, time of presentation, clinical presentation, and contusion type/location was collected. GCS (at 1st, 2nd and 6th weeks) and GOS were used for the neurological assessment of pre-operative and post-operative status.

Results: The average age of presentation was 42.57 years. There were 21.6% female and 78.4% male patients. 64.9% presented with road traffic accidents. 4% of patients presented to the hospital within 12 hours of injury, 16.2% between 12 to 24 hours, and 5.4% between 24 to 48 hours. 29% had seizures and upgoing plantar. 18% had hemiparesis or hemiplegia. Light reflex was absent in 40.5% of patients. The GCS kept improving postoperatively. GCS at admission was averaging 8 which improved to 10, 12, and 13 after surgery. The presenting mean GCS at 1st-week, 2nd-week, 6th-week, and mean GOS at 30th PAD. Counter coup injury improved to 15/15 right in 1st week. Mean GOS was 5 at 30th PAD. The most improvement was seen in the frontoparietal, temporoparietal, and fronto-temporo-parietal locations. The mean GOS at 30th PAD was 4.

Conclusion: The outcome following cerebral contusion depends upon the initial presenting GCS and GOS. Therefore, the better the presenting GCS and GOS better is the prognosis of the patient.

Keywords: Cerebral Contusion (CC), Bruise, Decompression, Brain Injury, Traumatic Brain Injury (TBI), Loss of Consciousness, Counter Coup Injury.

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INTRODUCTION

Cerebral contusion (CC) is a form of localized traumatic brain injury that causes a bruise in the neural parenchyma. Cerebral contusions account for 8% of all traumatic brain injuries and 13% to 35% of severe head injuries. It progresses swiftly within 12 to 48 hours of damage. There are disagreements over how CC should be managed. There is considerable debate over surgical therapy of cerebral contusion (CC), namely the indication, timing, and favorable variables. The study sought to identify parameters influencing the surgical outcome of individuals suffering from a brain contusion. Traumatic brain injury (TBI) is the main reason for morbidity and mortality in youths (15-35 years of age). More than 1.7 million individuals in the US suffer from TBI each year.¹ Cerebral contusion (CC) is the type of focal TBI, where there is a bruise in the neural parenchyma because of injury. They are common and found in 8% of all TBIs and 13 – 35% of severe head injuries.³⁻⁴ Cerebral contusion is generally connected with non-hemorrhagic mass impact. It advances quickly within 12 to 48 hours post-injury. In cerebral contusion breakdown of brain tissue and cytoplasmic structures produces high osmolality inside the contused brain. The high osmotic potential brings about water accumulating in contused tissue, which is hypothesized for the rapid progression of edema.⁶⁻⁷

TBI is a leading cause of illness and mortality in the United States, particularly among the young. Primary TBI harm is avoidable, whereas subsequent TBI injury is curable. As a result, significant research efforts have been directed toward explaining the biology of secondary damage and identifying various prognosticators to enhance the ultimate prognosis by limiting secondary harm. GCS is a regularly used metric for determining the severity of an injury. It is a prognostic sign of cognitive recovery and functional prognosis, as well as a predictor of subsequent parenchymal alteration. Patients with

CC can be managed both conservatively and surgically depending on GCS, size, and volume of contusion associated. Surgical intervention should be considered an early line for treatment as there is a high rate of rapid progression of CC which causes significant morbidity and mortality.¹¹ Commonly used interventions to prevent an increase in intracranial pressure are contused brain tissue excision, decompressive craniectomy (DC), or both. The main indications for surgical treatment are a) rapid and progressive deterioration of neurological status or sign of mass effect on CT b) contusional focus of > 50 cc) GCS: 6-8 with frontal or temporal CC volume > 20 cc with midline shift >5mm and /or compressed basal cisterns on CT.⁸⁻¹⁴ Due to the high mortality and morbidity associated with CC, this study was conducted to ascertain the factors responsible for the good outcome following surgical management for a cerebral contusion. Contrecoup brain damage is a typical finding in closed-head traumas. Given that the in vivo brain is less dense than the cerebrospinal fluid (CSF), one explanation for this observation is that, upon skull impact, the denser CSF moves toward the site of skull impact, displacing the brain in the opposite direction, causing the initial impact of the brain parenchyma to be at the contrecoup location.¹⁴⁻¹⁵ The study aimed to uncover factors that influence the surgical outcome of people who had had a brain contusion (CC).

MATERIALS AND METHODS

Study Design & Setting

A Quasi-Experimental study was conducted at Mayo Hospital, Neurosurgery department, Lahore for one year from 1st January 2021 to 31st December 2021. A total of 37 patients were enrolled as per the defined criteria.

Inclusion Criteria

GCS 3 – 8 with contusion volume greater or equal to 30cc with midline shift > 5mm and/or

compressed basal cisterns on CT.

Exclusion Criteria

Extremes ages such as < 13 years and > 80 years were excluded.

Data Collection & Analysis

The data was collected after taking IRB from the university's ethical committee and with patients' informed consent. The information on age, gender, mode/mechanism of injury, time of presentation, clinical presentation, pre/post-operative GCS (Glasgow Coma Scale), GOS (Glasgow Outcome Scale), and contusion type/location was collected. The SPSS 25 was used to

analyze and process the data. Mean \pm SD and median (range) were used in continuous variables. frequencies (percentages) were used in categorical variables. The Chi-Square test was applied to see the significant/insignificant difference between mean GCS (at 1st, 2nd and 6th weeks) with the mode of injury, type of contusion, mechanism of injury, and location of contusion.

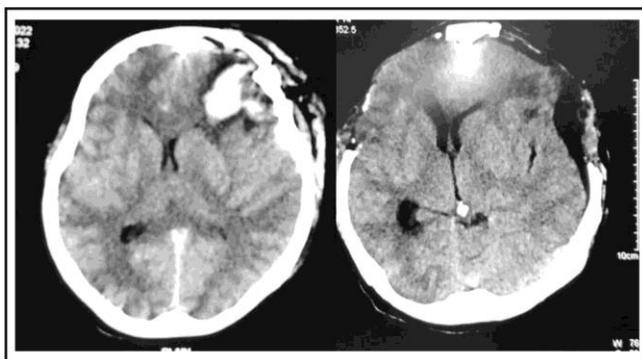


Figure 1(A): Pre-Operative (Left Frontal Contusion); **(B):** Post-operative (Bilateral Frontal Hemicraniectomy).

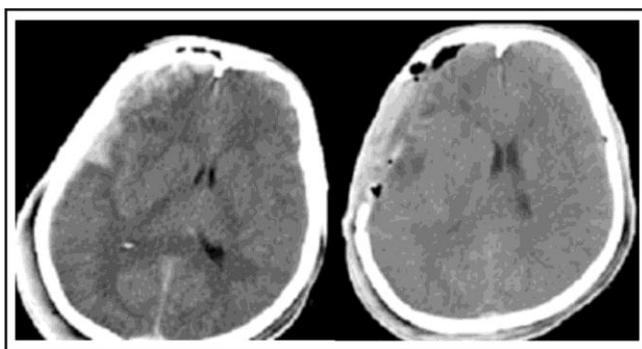


Figure 2(A): Pre-Operative (Right Frontotemporal Contusion); **(B):** Post-operative Right Fronto-Temporal Decompressive Hemicraniectomy.

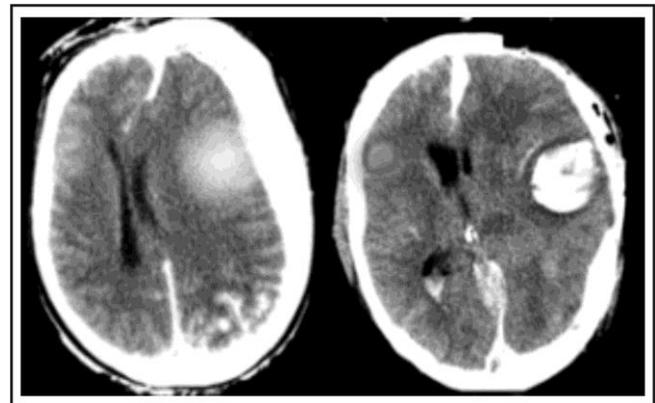


Figure 3(A): Pre-Operative Left Frontoparietal Contusion; **(B):** Post-operative Left Frontoparietal Decompressive Hemicraniectomy.

CT Findings

Figure 1 (A) shows a pre-operative CT scan of the brain showing the contusion and Figure 1(B) shows the post-operative CT scan of the same patient's brain with the removal of bone and clot. Figures 2 (A) & 3 (A) show hematoma and contusion and Figures 2 (B) & 3 (B) show post-operative CT scans of the same patient after the hematoma and bone were removed.

RESULTS

Age Distribution

A total of 37 patients were taken in this study, among them, the minimum age was 17m whereas the oldest patient was 75 years old. The average age of presentation was 42.57 years.

Gender Distribution

Gender distribution shows 8 (21.6%) female while 29 (78.4%) male patients.

Mode of Injury in CC

Regarding the mode of injury in a total of 37 patients, 24 (64.9%) presented with Road traffic accidents, 27% presented with falls, and 8.1% with physical assault (Table 1).

Table 1: Mode of Injury.

Mode of Injury	Number of Patients	Percentage
RTA (Road Traffic Accident)	24	64.9
Physical Assault	3	8.1
Fall	10	27.0
Total	37	100.0

Clinical Presentation

Out of 37 patients, 78.4% of patients presented to the hospital within 12 hours of injury, 16.2% between 12 to 24 hours, and 5.4% between 24 to 48 hours (Table 2). Table 3 shows the clinical symptoms of patients presenting to the hospital after head trauma. All patients had a loss of consciousness, vomiting, and deterioration in their consciousness levels. 29% had seizures and upgoing plantar. 18% had hemiparesis or hemiplegia. Light reflex was absent in 40.5% of patients. All 37 patients had a history of loss of consciousness. Seizures were present in 11 (29.7%) patients while 26 (70.3%) had no history of fits. There is a history of at least one episode of vomiting in 37 patients. All the patients had a history of deterioration of consciousness level.

22 (59.5%) patients had reactive right pupils and the remaining 15 (40.5%) had non-reactive or could not be assessed. The left pupil was reactive in 28 (75.1%) and 9 (24.3%) left pupil was dilated or could not be assessed. Hemiplegia or hemiparesis was present in 7 (18.9%) of the

patients among which 3 (8.1%) were on the right while 4 (10.8%) were on left. Planters reflex among the patients admitted had down going bilateral in 20 (54.1%) either one or both planters up going in 11 (29.7%) and 6 (16.2%) could not be tested or unresponsive.

Table 2: Time of Presentation.

Time of Presentation	Number of Patients	Percentage
Less than 12 hours	29	78.4
12 to 24 hours	6	16.2
24 – 48 hours	2	5.4
Total	37	100.0

Table 3: Clinical Presentation of Patients.

Symptoms	No. of Patients	Percentage
Loss of Consciousness	37	100%
Vomiting	37	100%
Deteriorating Conscious level	37	100%
Seizure	11	29%
Upgoing Planters	11	29%
Hemiparesis/ Hemiplegia	7	18%
Light Reflex	15	40.5

Comparison of Mode of Injury with Post Op/Pre Op GCS and GOS

Regardless of the mode of injury (RTA, physical assault, or falls), the GCS kept improving (from 10/15 in the beginning to 14/15 at 6 weeks postoperatively) The GOS was 4 at the 30th post-admission day in all categories of injury (Table 4). GCS at admission was averaging 8 which improved to 10, 12, and 13 after surgery. The mean GOS at 30th PAD was 4 (Table 5). An insignificant association (p-value: 0.99) was found between the mode of injury with mean GCS at 1st, 2nd and 6th weeks.

Table 4: Mode of Injury Compared with Postoperative GCS and 30th-Day GOS.

Mode of Injury	Mean GCS			Chi-Square χ^2 : 0.21 P value: 0.99 (insignificant result)	Mean GOS 30 th PAD
	1st Week	2nd Week	6th Week		
RTA	10	12	14		4
Physical Assault	12	13	13		4
Fall	10	11	12		4

Comparison of Contusion Type with Post Op GCS and GOS

Table 6 shows the types of contusion and the presenting mean GCS at 1st-week, 2nd-week, 6th-week, and mean GOS at 30th PAD. An insignificant association (p-value: 0.995) was found between the type of mean GCS at 1st, 2nd and 6th weeks.

Comparison of Mechanism of Injury with Post Op GCS and GOS

On CT scan evaluation, 23 (62.2%) patients had lobar contusion > 1 cm, while bilateral lobar contusion > 1 cm was present in 4 (10.8%) patients, and the unilateral hemispheric mass effect was found in 6 (16.2%) patients and the bilateral hemispheric mass effect was discovered

in 4 (10.8%) patients. The type of contusion coup was predominated in, 23 (62.2%) patients, followed by counter coup 10 (27%), fractures 3 (8.1%), and coup + counter coup injury in 1 (2.7%). Location of contusion was highest in frontal and parietal regions 9 (24.3%) each followed by temporal 3 (8.1%), occipital 1 (2.7%), and others included more than one region 15 (40.6%).

Table 7 shows the mechanism of injury compared with the mean post-operative GCS at the 1st week, 2nd week, and 6th week which ranged

Table 5: Pre-operative GCS Compared with Postoperative GCS and 30th Day GOS.

Mean Pre-Op GCS	GCS			Mean GOS 30 th PAD
	1st Week	2nd Week	6th Week	
8	10	12	13	4

Table 6: Type of Contusion Compared with Postoperative GCS and 30th Day GOS.

Type of Contusion	Mean GCS			Chi-Square χ^2 : 0.206 P value: 0.995	Mean GOS 30 th PAD
	1st Week	2nd Week	6th Week		
Lobar >1 cm	11	12	13		4
BL lobar >1 cm	13	15	15		5
Hemisphere with Unilateral mass effect	9	12	13		4
Hemisphere with Bilateral mass effect	3		Expired after 1 week		
Total	9	13	14		4

Table 7: Mechanism of Injury compared with Postoperative GCS and 30th Day GOS.

Mechanism of Injury	Mean GCS			Chi-Square χ^2 : 1.16 P value: 0.97 (insignificant result)	Mean GOS 30 th PAD
	1st Week	2nd Week	6th Week		
Coup	11	12	13		4
Counter coup	15	15	15		5
Fracture	9	10	11		4
Coup and counter-coup injury	9	15	15		5
Total	11	13	14		5

Table 8: Location of Contusion Compared with Post-Operative GCS and 30th Day GOS.

Location of Contusion	Mean GCS			Chi-Square	Mean GOS 30 th PAD
	1st Week	2nd Week	6th Week		
Frontal	12	12	12	χ^2 : 2.89 P value: 0.999 (insignificant result)	4
Temporal	8	10	12		4
Parietal	10	10	13		4
Occipital	10	13	13		3
Fronto-temporal	9	13	14		5
Fronto-parietal	14	15	15		5
Temporo-parietal	8	15	15		5
Fronto-temporo-parietal	9	15	15		5
Total	10	12	14		4

between 9/15 and 14/15. Counter coup injury improved to 15/15 right in 1st week. Mean GOS was 5 at 30th PAD. An insignificant association (p-value: 0.995) was found between the mechanism of injury (p-value: 0.97) with mean GCS at 1st, 2nd and 6th weeks.

Comparison of Location of Contusion with Post Op GCS and GOS

Table 8 shows the improvement in GCS in patients with contusions at various locations in the brain, measured at the 1st, 2nd, and 6th weeks. These ranged between 8/15 and 15/15. The most improvement was seen in the frontoparietal, temporoparietal, and fronto-temporo-parietal locations. The mean GOS at 30th PAD was 4. An insignificant association (p-value: 0.999) was found between the location of injury with mean GCS at 1st, 2nd and 6th weeks.

Survival & Death

The time interval between incident and operation was recorded, and 24 hours was reported in 31 (83.8%) patients, and 24 – 48 hours was reported in 6 (16.2%) patients. Out of the total patients, 25 (67.6%) patients survived 30 days while 12 (32.4%) patients didn't survive for 30 days. Most deaths occurred on the first postoperative day followed by the 3rd, 6th, and 13th postoperative days.

DISCUSSION

Dynamic loading refers to traumatic insults that occur over brief periods. Dynamic loading encompasses both direct or impact loading as well as impulsive loading, which happens without physical touch.¹⁶ Contrecoup contusions (CCs) are a common finding in closed-head traumas and may be an independent cause of long-term neurodisability. Their formation methods are currently being debated. The purpose of this study was to determine the link between the direction of the blow to the head and the location of brain contusion following a head injury. The site of scalp damage was detected in 98 instances, which were employed in the study. The rear of the head was the site of 66% of scalp injuries. The majority of contusions (77%) were contracoup in nature, impacting the frontal and temporal lobes. Sixty percent of the injuries were caused by a fall from a standing posture impacting the back of the head on a paved surface, most usually during an attack.¹⁷ Intracranial hypertension and low perfusion pressure secondary to serious brain injury will bring about cerebral ischemia, cerebral damage, and death.¹⁸ We determined the factors that influence the surgical result of those who have had a brain contusion. In our study, Preoperative GCS is directly related to the outcome i.e., the better the GCS on presentation better the outcome. Our study showed that the Neurological

progression of cerebral contusion is directly related to the presenting GCS and GOS. The more the GCS and GOS at the presentation better are the chance for the patient post-operatively. The amount of midline shift and the outcome was inversely related in the first week of operation but after that, there was no significant relationship. There was a significant improvement when done within one week and then later on.

With an age of more than 30 years, a low Glasgow coma score and a shift of midline for more than 5 mm are the predictors of mortality after surgery for cerebral contusions. The outcome following CC depends upon increased patient age, lower Glasgow coma scale at first evaluation, clinical deterioration in the first hour after trauma, and or increase of midline shift on CT scans. The factors important for the outcome following decompressive craniectomy were a Glasgow coma score of 8 and above, age less than 50, and early intervention.¹⁹⁻²⁰ Similar findings were observed in our patients. We observed a relationship between the initial presentation and the outcome following the operation. Better the GCS on the presentation, the better the outcome. In our study, we have noticed that the younger the age of the patient better the GOS after surgery whereas the duration of presentation after trauma also affects the postoperative outcome.

We observed that the GCS was an average of 8 before admission but improved to 10, 12, and 13 following surgery. The presented mean GCS during the first, second, and sixth weeks, as well as the mean GOS at the 30th PAD. The counter-coup injury improved to 15/15 in the first week. At the 30th PAD, the mean GOS was 5. The frontoparietal, temporoparietal, and fronto-temporoparietal sites showed the largest improvement. The average GOS at the 30th PAD was 4. Focal cerebral contusions can be dynamic and expansive, resulting in a delayed onset of symptoms. The sole and most common cause of mortality in head-injured individuals is an

increase in intracranial pressure (ICP) caused by uncontrolled swelling. According to research, brain swelling induced by traumatic brain injury (TBI) is caused by brain edema rather than cerebral blood volume (CBV). Following a severe TBI, CBV decreases in direct proportion to CBF decrease. Cerebrovascular injury, which leads to declines in regional CBF, may play a significant role in secondary cell damage after TBI. Within 6 hours of damage, histological investigation demonstrated the production of microthrombosis in the contused region, spreading from the center to the periphery areas. In the mammalian brain, glutamate is the most broadly distributed excitatory neurotransmitter. When glutamate levels are high, it can over-activate certain ion channels, particularly the N-methyl-D-aspartate channel. A movement of potassium into the extracellular space causes fast swelling of astrocytes, which absorb large amounts of potassium to maintain ionic equilibrium. This mechanism may result in fast cytotoxic edema, which is most likely a primary contributor to the development of posttraumatic elevated ICP. The presence of a localized contusion and primary or secondary ischemia episodes were the clinical characteristics that were most substantially associated with elevated glutamate dialysate levels. Raised ICP was much more prevalent in patients with high glutamate levels, and the prognosis was poorer.²¹ Using Xenon Computed Tomography, several authors discovered decreased absolute values of cerebral blood flow (CBF) in both the contusion core and the pericontusional parenchyma of head-injured individuals (CT). Perfusion CT is now a novel and proven method for investigating CBF in patients. The current study sought to determine the relationship between contusion volume expansion and pericontusional CBF as evaluated by perfusion CT.²²

Yamaura et al,²³ reported a series of 154 patients and found that 17% and 33% mortality and 100% and 73% functional recovery rates and

prognosis depends upon patients under and over 30 years of age and pupillary difference. Qi et al,²⁴ found overall prognosis following CC was (41.5%) with moderate disability, 22 (15.5%) with severe disability, 23 (16.2%) in vegetative status, and 15 patients (10.6%) expired. Rubine et al,²⁵ looked at 173 consecutive adult patients who were admitted with a diagnosis of cerebral contusion or tSAH and at least one clinic follow-up visit with CT. 60.1% of patients were asymptomatic, 39.3% had moderate, nonspecific neurological symptoms, and 1.0% had serious neurological symptoms. 2.9% of the asymptomatic patients had novel CT abnormalities, and 1.0% had their treatment plans changed as a result of these discoveries.

CONCLUSION

It is concluded that the higher the initial presenting GCS and GOS higher the post-operative GCS and GOS. When surgical intervention for a cerebral contusion is done earlier better the post-operative GOS noticed. There is a significant correlation between cerebral contusion location with 2nd-week post-operative GCS and GOS. An episode of seizure and neurological deficit is associated with poor post-operative GOS whereas young age is a better indicator for post-operative GCS on 1st and 2nd week and GOS. Delays in surgery may have repercussions on the outcome of the patients regardless of traumatic insult, hence a quick intervention should be in order.

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Additional Information

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Human Subjects: Consent was obtained by all patients/participants in this study.

Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTION

Sr. #	Author's Full Name	Intellectual Contribution to Paper in Terms of.
1.	Shahzaib Tasdique	Study design and methodology.
2.	Diggaj Shrestha	Paper writing.
3.	Zainab Sarwar	Data Collection and Calculation.
4.	Samra Majeed	Analysis of Data and interpretation of results.
5.	Obaid ur Reman, Waqas Mehdi	Literature review and referencing.
6.	Waqas Mehdi, Azam Niaz	Analysis of data and quality insurer.