https://doi.org/10.3329/bjns.v13i2.74131

Original Article

Prognostic Factors of Outcome in Patients Undergoing Surgical Intervention following Traumatic Intracerebral Haemorrhage

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Conflict of interest: There is no Conflict of interest relevant to this paper to disclose.

Funding Agency: Was not funded by any institute or any group.

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Editorial formatting - Dr. S. M. Noman Khaled Chowdhury

Received: October 20, 2023
Accepted: November 15, 2023

Abstract:

Background: *Intracerebral hemorrhage is a common complication after traumatic brain injury. While it is accepted practice to remove extra-axial (extradural and subdural) haematoma following traumatic brain injury, but surgical practice in the treatment of traumatic intracerebral hemorrhage (TICH) differs widely, and prognostic factors associated with outcome following surgery have not yet been well established.*

Aims: *The study aimed to determine the prognostic factors of outcome in patients undergoing surgical intervention following traumatic intracerebral hemorrhage in a tertiary care hospital in southeastern part of Bangladesh.*

Materials and Methods: *This prospective interventional study included 45 patients requiring craniotomies for decompression and evacuation of an intracranial hemorrhage following traumatic intracerebral hemorrhage in the Neurosurgery Department of Chittagong Medical College Hospital between December 2021 to June 2023. Demographic features, perioperative clinical and radiological characteristics of these patients were examined in relation to favorable/good outcome, defined as Glasgow Outcome Scale (GOS) score >3 at 3months follow-up, and unfavorable/poor outcome, defined as 3months mortality or GOS score d”3 at 3months after surgery.*

Results: *The median age was 45 (range 8-75) years, 82.2% were male, and road traffic accident was the commonest cause (73.3%). Initial loss of consciousness was found in 75.7% of patients and the median GCS on admission was 9 (Interquartile range 8-10). Craniotomy and evacuation was done in 23(51.1%) of the cases, followed by craniectomy and evacuation in 22 (48.9%)patients. In-hospital and 3 months mortality rate was 28.9%. At three months post surgery, all of the survived patients(32) had good outcomes; 29 (92.3%) had GOS scores of 5, while the remaining 3 had GOS scores of 4. In bivariate analysis, age, history of comorbidity and loss of*

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consciousness, GCS on admission, hematoma volume, and injury to surgery interval was found to have significant association with poor outcome (p<0.05). Age (OR: 1.211, 95% CI: 1.012-1.241, p=0.009) and GCS score on admission (OR: 0.301, 95% CI: 0.086-0.827, p=0.004) were independent predictors of 3-months poor outcome or mortality in multivariate logistic regression analysis.

Conclusions: *This study presented that older age(60 years) and lower GCS(7-10) on admission were the independent predictors of poor outcome after 3 months of surgery. Multicenter studies are needed to provide accurate data on traumatic intracerebral hemorrhage in Bangladesh.*

Keywords: *Traumatic Intracerebral haemorrhage; Prognostic factors; Surgical intervention.*

Bang. J Neurosurgery 2024; 13(2): 104-111

Introduction:

Traumatic brain injury is the leading cause of mortality and morbidity worldwide. Among this population, intracerebral haemorrhage is a common finding. Traumatic intracerebral haemorrhage (TICH) occurs in 20–30% of patients with a traumatic brain injury (TBI) [1]. Traumatic intracerebral haemorrhage (TICH) is also stated as traumatic intraparenchymal haemorrhage and (haemorrhagic) contusion. ICP can become elevated due to cerebral swelling and delayed haematoma formation in the pericontusional area [2]. Mortality secondary to TICH is related to the location and size of the lesions. Surgical interventions are aimed at preventing secondary damage, brainstem compression, and herniation of the brain.

Trumatic intracerebral haemorrhage is sometimes a life-threatening emergency. The accumulation of blood in intracerebral space causes raised intracranial pressure with subsequent damage to the brain, which may lead to a persistent vegetative state or even death. The removal of the intracerebral haematomas provides a decrease in elevated intracranial pressure and removes the local mass effect. The indications for evacuation of hematoma are established, and their favorable outcome has been accepted. However, among patients requiring surgical intervention, prognostic factors associated with improved outcomes have not yet been well established [3].

Gregson et al. conducted the first ever trial of surgery for TICH, which indicates that early surgery may be a valuable tool in the treatment of TICH, especially if the Glasgow Coma Score (GCS) is between 9 and 12. The trial has demonstrated a large reduction in mortality associated with early surgery for parenchymal TICH and there were no vegetative survivors. This trial has given a very strong signal that early surgery is superior to initial conservative treatment for patients with TICH [4].

However, surgical practice in the treatment of TICH differs widely. Several issues inform the debate: (a) the contused brain does not recover but appears as encephalomalacic brain tissue . This argues that removing TICH does not increase tissue loss; (b) extravasated blood is believed to be neurotoxic, leading to secondary injury that may be avoided by surgical removal; (c) larger TICHs may be associated with an ischemic penumbra of brain tissue that could be salvaged; and (d) some TICHs expand to the point where they cause a mass effect resulting in secondary brain injury. Early surgical TICH removal is necessary to prevent secondary brain injury from these mechanisms [5].

As TICH continue to contribute significantly to poor outcome in patients with TBI, every effort should be made to minimize the impact on morbidity and mortality. Among patients who are under consideration for operative intervention following TBI, however, identifying which patients are likely to benefit most from operative or otherwise intensive measures is crucial to patient selection and the related prognosis.

This study was designed to determine the prognostic factors of outcome in patients undergoing surgical intervention following TICH which may be helpful for neurosurgeons.

Methods:

This prospective interventional study was conducted in the Department of Neurosurgery, Chittagong Medical College Hospital, Chattogram, Bangladesh from December 2021 to May 2023. Consecutive sampling considering the inclusion and exclusion criteria was considered for the patient admitted in Department of Neurosurgery, CMCH. Inclusion criteria was Patient of all age and sex who had evidence of a TICH on CT with indications for surgical intervention.A significant surface hematoma (EDH or SDH) requiring surgery or if the hemorrhage/contusion is located in the cerebellum(posterior fossa) with severe pre-existing mental disability or poly trauma, penetrating head injury, traumatic intracerebral haemorrhage associated with SAH and refusal to participate in the study were excluded from the study.

A pre-tested structured case record form including questionnaire and checklist was used to collect data. The outcome of the patients was assessed at discharge and after 3 months in terms of GOS. After completion of data collection, they were fed into SPSS version 23 for processing analysis. Continuous data were expressed as median and 25%–75% interquartile range as they were non-normally distributed. Categorical data were presented as percentages (%). The study population was divided into 3-months poor and good outcomes by GOS. Between these groups, continuous and categorical variables were analyzed. Mann–Whitney's U-test was used for continuous variables. Categorical variables were compared using the Chi-square test or Fisher's exact test. Variables with $P < 0.05$ on univariate analysis for good outcome 3-months after TICH surgery were included in multivariate logistic regression analysis to determine the independent predictors of 3-months poor outcome. Results were reported as OR together with a 95% CI. $P < 0.05$ was considered statistically significant.

Study CONSORT chart:

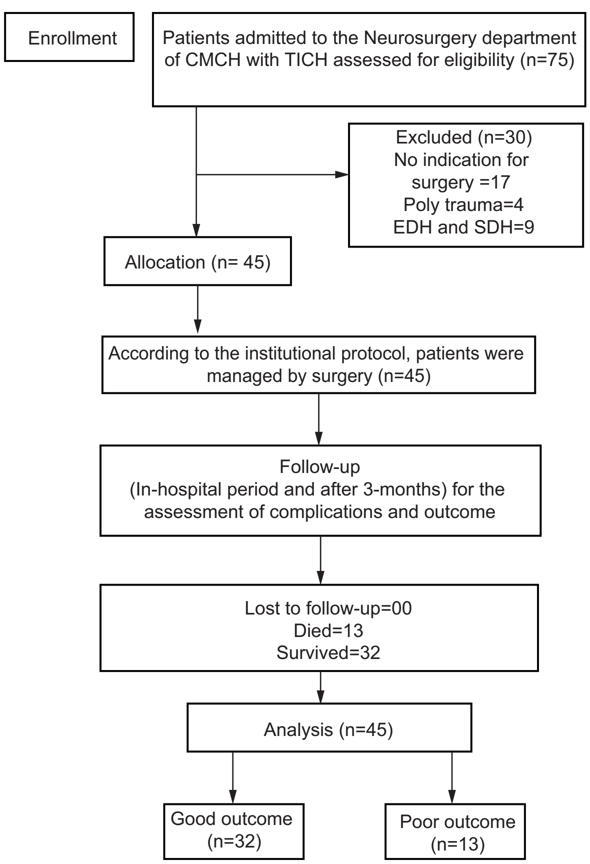

Figure 1: *Patient CONSORT diagram.*

Results:

A total of 75 patients were screened and 45 of them were found to fulfill the eligibility criteria for the study. All 45 patients were included in the final analysis. Results and observations of the present study were described in the following tables and charts.

Table-I

Demographic characteristics of the patients (n=45)

Characteristics	Frequency (%)
Age, years	
Median (IQR)	45.0 (26.0-55.0)
Range	8.0-75.0
Sex	
Female	8 (17.8)
Male	37 (82.2)

Data were expressed as frequency (%) if not mentioned otherwise. IQR: Interquartile range.

The median age of the patients was 45 years and age ranged between 8-75 years. There was a male preponderance (82.2%) with a male-to-female ratio of 4.62:1 (Table 1).

Table 2 shows that median age of the patients with poor outcomes (60 years) was higher than the patients with good outcomes (38.5 years) and the difference was highly significant statistically ($p < 0.001$). Sex had no significant association with 3-month outcome ($p = 0.553$).

Table 3 shows that RTA was the most common cause of trauma (73.3%), followed by fall from height (11.1%), and physical assault (6.5%). Mechanisms of injury failed to show any significant association with outcome.

Table 4 shows that, history of comorbidity, loss of consciousness and GCS on admission, have significant association with 3-months outcome ($p < 0.05$). Higher proportion of the patients with poor outcome had history of comorbidity and loss of consciousness, and median admission GCS was lower in patients with poor outcome than the patients with good outcome (8 versus 10, $p = 0.017$).

Table 5 shows that the patients with 3-months poor outcome had significantly higher hematoma volume compared to the patients with good outcome (58.5ml versus 38.8 ml, $p = 0.029$).

Table 6 shows that, median injury to surgery interval was longer in patients with poor outcome (22 versus

Table-II

Association between demographic characteristics and outcome of the patients (n=45)

Characteristics	3-month outcome		P value
	Good (n=32)	Poor (n=13)	
Age			
Median (IQR)	38.5 (20.5-45.8)	60.0 (50.8-68.8)	<0.001‡
Sex			
Female	5 (15.6)	3 (23.1)	0.553*
Male	27 (84.4)	10 (76.9)	

Data were expressed as frequency (%) if not mentioned otherwise. *Fisher's exact test; ‡Mann-Whitney U test. IQR: Interquartile range.

Table-III

Mode of injury of the patients (n=45)

Mechanism of injury	Total (n=45)	3-months outcome		P value†
		Good (n=32)	Poor (n=13)	
Road traffic accident	33 (73.3)	21 (63.9)	11 (36.4)	0.134†
Fall from height	05 (11.1)	5(100.0)	0 (0)	1.0 *
Physical assault	3(6.5)	3 (100.0)	0 (0.0)	1.0 *
Others	4(8.9)	3 (75.0)	01(25.0)	0.201 *

Data were expressed as frequency (%); *Chi-square test; †Fisher's exact test

Table-IV

Association between baseline clinical characteristics and outcome of the patients (n=45)

Characteristics	3-month outcome		P value
	Good (n=32)	Poor (n=13)	
Comorbidity	1 (3.1)	6 (46.2)	0.001*
Loss of consciousness	19 (59.4)	13 (100.0)	0.005*
GCS on admission	10 (9-11)	8 (7-10)	0.017†
Injury to admission interval(hours)	3.0 (3.0-4.0)	4.0 (3.0-5.8)	0.342†

Data were expressed as frequency (%) or median (IQR). *Fisher's exact test; †Mann-Whitney U test; ‡Chi-square test.

Table-V

Association between baseline radiological findings and outcome of the patients (n=45)

Imaging characteristics	Total(n=45)	3-months outcome		P value
		Good (n=32)	Poor (n=13)	
Side of hematoma				
Right	18 (40.0)	13(72.2)	5 (27.77)	0.272*
Left	22 (48.9)	17(77.27)	5(22.72)	
Bilateral	5(11.1)	2(40.0)	3 (60.0)	
Hematoma volume, ml		38.8(30.5-50)	58.5(40.0-70.0)	.029†

Data were expressed as frequency (%) or median (IQR). *Fisher's exact test; †Mann-Whitney U test.

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Table-VI

Association of injury to surgery interval, surgical procedures, duration of surgery, and postoperative complications with outcomes

Characteristics	3-month outcome		P value
	Good (n=32)	Poor (n=13)	
Injury to surgery interval, hours	15.0 (12.0-20.0)	22.0 (19.3-27.0)	0.008†
Surgical procedures			
Craniotomy and evacuation	18 (56.3)	5 (38.5)	0.279‡
Craniectomy and evacuation	14 (43.8)	8 (61.5)	
Duration of surgery, hours	2.5 (2.0-3.0)	3.0 (2.1-3.0)	0.274†
Postoperative complications	2 (6.3)	9 (69.2)	0.001*

Data were expressed as frequency (%) or median (IQR). *Fisher's exact test; †Mann-Whitney U test; ‡Chi-square test.

15 hours, p=0.008). Poor outcome was more frequent in the patients had craniectomy, than craniotomy, but the difference was not significant statistically (p=0.279). Significantly, higher proportion of the patients who had poor outcome had complication in their postoperative period, than the patients with good outcome (69.2% versus 6.3%. p=0.001).

Out of 45 patients, 13 patients expired giving the 3-months mortality rate of 28.9%. 32 patients survived at least 3-months post-surgery, giving the 3-months survivality rate of 71.1% (Figure 2).

Out of 45 patients, 32 were alive and discharged from

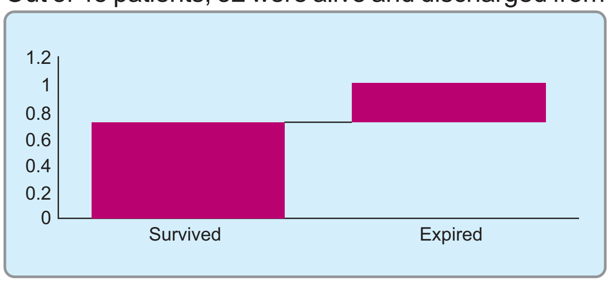

Figure 2: *Distribution of the patients based on their 3-months survivability (n=45)*

the hospital after surgery. At the final follow-up(3-months), out of 45 patients, all 32 were available for GOS assessment. All of them had a good outcome, 29 (92.3%) had GOS score of 5 and rest of the 3 patients had GOS score of 4 (Figure 3).

At 3-months follow-up, all the survived patients had good outcome (32/45, 71.1%). So, in this study, patients those were expired during the 3 months follow-up, were categorize as having poor outcome (13/45, 28.9%) (Figure 4).

A multivariate binary logistic regression analysis was performed using the variables which had a significant association with outcome in univariate analysis, with the 3-months poor outcome as the dependent variable (Table 7). Age and GCS score on admission were independent predictors of 3-months poor outcome or mortality. With 1 year of increasing age, the chance of having poor outcome increased by 11.7% (OR: 1.211, 95% CI: 1.012-1.244, p=0.009). Regarding GCS, one unit decrease would increase the chance of having poor outcome by 4 times (OR: 0.301, 95% CI: 0.086-0.827, p=0.004).

Discussion:

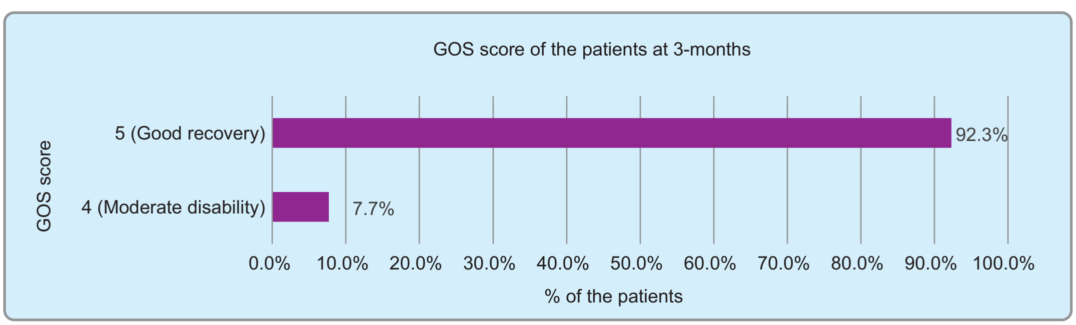

Figure 3: *Distribution of the patients based on their 3-months GOS score (n=32)*

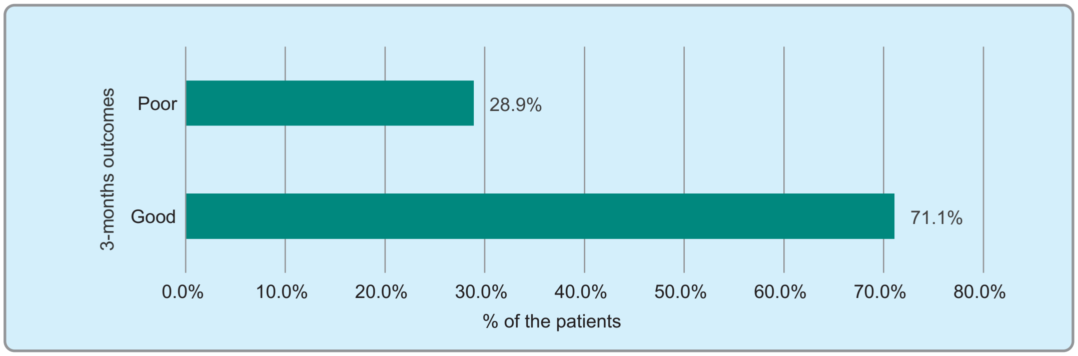

Figure 4: *Distribution of the patients based on their 3-months outcomes*

Table 7: *Logistic regression analysis with a 3-months poor outcome as the dependent variable*

Variables	OR	95% CI for OR		P value
		Lower	Upper	
Age, years	1.211	1.012	1.241	0.009
ComorbidityAbsent vs. present	2.912	0.445	76.321	0.364
Loss of consciousnessAbsent vs. present	1.0324	0.154	6.014	0.841
GCS on presentation (per point)	0.301	0.086	0.827	0.004
Hematoma volume, ml	1.031	0.983	1.122	0.179
Injury to surgery interval, hrs.	1.001	0.983	1.038	0.552

OR: Odds ratio; CI: Confidence interval

A total of 45 patients with TICH were enrolled in the Department of Neurosurgery, CMCH. 3-month mortality and functional ability data were available for all the 45patients. Certain factors, such as age and admission GCS, which have been previously reported [6,7] as strong predictors of outcome, were found to be significantly associated with favorable 3-months outcome in the present studied patients. However, probably due to the small sample size, the study could not report additional independent factors for predicting outcome.

In the present study, out of 45 patients, 3-months outcome was favorable in majority (71.1%) of the patients. In a previous study comparing traumatic and spontaneous ICH, two thirds of all TICH patients had favorable outcomes, as determined using the GOS, compared to one third of patients having SICH; this difference is accountable by virtue of younger age of TICH patients [8].

In-hospital mortality rate and three months mortality rate was 28.9%, in the current study. In the study of Motha et al. [9] the in-hospital mortality rate of the patients with traumatic intracranial hemorrhage was 17.4%. TICH is a source of significant mortality as stated in previous large studies [10,11].

In the present study age ranged between 8 to 75 years and the median age was 45, a finding consistent with previous studies, where young adults are the most affected age groups [3]. The mean age was 40 ± 20 years, and the most represented age group was 27 to 35 years in the study of Motha et al. [9]. Age was an independent prognostic factors for poor outcome in the present study. The median age was significantly higher in patients with poor outcome than the patients with good 3-months outcome (38.5 vs. 60 years). Older age was an independent risk factor for in-hospital mortality in the study of Motha et al. [9], and age groups e” 63 was independently associated to in-hospital death following TICH. There was a male preponderance (83.8%) with a male-to-female ratio of 4.62:1 in the present study. Male predominance has been reported by many studies [3,9]. This gender difference in this study due to the increased risk of injury in male in addition to the growing environment, and sociological attributes [12]. However, sex had no significant association with 3-month outcome in the present study, which was consistent with the findings of Mulyawan etal [13]. Gender, mechanism of injury,

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and pupillary response did not affect the outcome significantly in the study of Mulyawan et al. [13], which was confirmed in the present study.

GCS has previously been reported as a predictor of neurologic decline, intervention, and mortality [14,15,16]. In the present study, GCS on admission was found to be predictive of 3-months outcome. A one-point decrease would increase the chance of having poor outcome by 4 times (OR: 0.301, 95% CI: 0.086-0.827, p=0.004). Severe coma (admission GCS d” 8) was the independent predictor of mortality, multiplying by 4 the risk of death among the patients of Motha et al. [9]. Fujii et al. [15] found that, greater GCS score on admission was an independent predictor of favorable outcome.

Previous studies [17] reported association of some preoperative radiological features like initial TICH volume, cisternal compression, decompressive craniectomy, age, falls, multiple lesions, and hypoxia with TICH progression and outcome. The present study showed that the patients with 3-month poor outcome had significantly higher hematoma volume compared to the patients with good outcome.

The treatment options for TICH can be surgical or medical depending on the patient's condition. In the present study, all the patients were managed surgically based on the predefined criteria. The most used surgical technique in the present study was craniotomy and evacuation of ICH (51.1%), followed by craniectomy and evacuation (48.9%). Craniotomy is commonly used for TICH because is less prone to surgical wound complications compared to craniectomy [9,18,19]. In the present study out of 45 operated case, postoperative complications were observed in 11 (24.4%) cases. Common in-hospital complications found in the studied patients were related to prolong immobility such as ventilator-associated pneumonia, aspiration pneumonia, and pressure ulcers. These are frequent complications reported in bedridden patients [11].

A measure that has been broadly studied is the time it takes for patients to be taken to the operating room, classically known as injury-to-incision time [11,15,20] found that subjects who underwent an early decompression with a mean injury-to-incision time of 4.5 hours had significantly favorable outcome than patients who underwent a delayed decompression. Another work found that longer injury-to-incision time is really associated with better outcome [20]. In the present study, median injury to surgery interval was longer in patients with poor outcome than their counterpart (22.0 vs. 15.0 hours).

Moreover, other variables significantly correlate with outcome. These include location of the lesion, ICH volume, GCS at time of follow-up CT, lowest recorded GCS, severity of surrounding edema, timing of surgery, occurrence of preoperative neurological deterioration, and presence of acute hemispheric swelling or concomitant subdural hematoma [20,21]. Among these factors, only the age and GCS on admission were found to have an independent association with 3-months outcome in the present study.

However, during consideration of the present study results, one should keep in mind that, sample size was not large enough to do a robust analysis for detecting the predictive utility of the individual factors. By considering the results from this study and improving data collection, more accurate models and even risk scores could be designed to achieve the desired goal in the future.

Conclusion:

In conclusion, this study presented that older age(60 years) and lower GCS(7-10) on admission were the independent predictors of poor outcome after 3 months of surgery.

Limitation:

In our study, patients were selected from a single tertiary level center and outcome assessment is restricted to GOS. Other important parameters, including cognitive disability, etc., have not been assessed. The follow up period was six months only. Further study covering these limitation may add value to the management of traumatic intracerebral hematoma management strategy.

Conflict of interest: None to disclose.

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