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Original Article

Factors Influencing Surgical Outcome of Patients with Traumatic Acute Subdural Hematoma

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Abstract

Background: *Traumatic acute subdural hematoma (ASDH) is a catastrophic devastating component of brain injury in neurosurgical arena. Due to its significant mortality rate, potential for functional disability and disastrous consequence of complications, it is considered as a challenge for neurosurgeons worldwide. Consequently, precise recognition of predictive outcome factors is crucial for appropriate neurosurgical management and prognostication for patients with traumatic ASDH.*

Aims: *The study aimed to determine the demographic, clinical, radiological and therapeutic factors associated with the surgical outcomes in patients with traumatic acute subdural hematoma (ASDH) who managed surgically in the Neurosurgery Department at a tertiary level hospital in Bangladesh.*

Materials and Methods: *This prospective observational study included 40 radiologically diagnosed cases of traumatic ASDH age more than 18 years who were admitted and operated in the Department of Neurosurgery of Chittagong Medical College Hospital from May 2022 to April 2023. Data regarding demographic, clinical, radiographic, surgical procedure and findings were recorded. Three months mortality rate with clinical outcome was assessed by Glasgow Outcome Scale (GOS) score and analyzed. The outcome was divided into favorable outcomes (GOS score >3) and unfavorable outcomes (GOS score d"3).*

Results: *The median age of the patients was 45 years (range: 19-82 years), and there was a male predominance (82.5%) with a male to female ratio of 4.7:1. Road traffic accident (RTA) was the most common cause of trauma (65%), followed by fall from height (15%), and physical assault (12.5%). Craniotomy was done in 16 (40%) patients and other 24 (60%) patients had decompressive craniectomy. Overall, 21 (52.5%) patients had good outcome and other 19 (47.5%) had poor outcome, and three months mortality rate was 42.5%. Regression analysis revealed that, increasing age [Odds ratio (OR): 1.12, 95% Confidence interval CI: 1.02-1.22. p=0.014], preoperative GCS of d"8 (OR: 13.98, 95% CI:1.22-160.00, p=0.034), and presence of Anisocoria with non-reacting pupil (OR; 17.99, 95% CI: 1.32-244.08, p=0.030) were independently associated with poor outcome.*

Conclusions: *This study identified higher age, preoperative low GCS score and pupillary abnormality as the independent predictors for 3-months poor outcome in patients who underwent surgical treatment for traumatic ASDH.*

Keywords: *Traumatic Acute Subdural Hematoma, Surgical treatment, Risk factors, GOS.*

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Introduction:

Traumatic Acute subdural hematoma (ASDH) is a significant clinical entity occurs immediately in the context of severe head injury, usually with skull fracture and laceration of the underlying dura and brain which forms between the inner leaf of the dura and the arachnoid overlying the brain in the subdural space. The source of bleeding is due to rupture of the numerous bridging veins that drain blood from the cortical surface to the Dural sinuses. Symptoms of ASDH may be due to compression of underlying brain parenchymal injury and possibly cerebral edema.

ASDH is reported to affect 11% of all patients with head injuries and up to 30% of patients with severe TBI. Acute Subdural Hematoma (ASDH) disproportionally affects young people with a mean age of 30 to 50 years old [1]. 73% of traumatic ASDHs occur as a result of falls and assaults in which short duration angular acceleration forces dominate the injury biomechanics. In contrast, only 11% of ASDHs occur in motor vehicle accidents, in which linear acceleration/deceleration dominate and the angular acceleration is less prominent [2]. This space-occupying hematoma can significantly impede blood flow to the brain, and elevate intracranial pressure (ICP) potentially leading to brain herniation, diminished functional outcome, and even death [3]. Hence, acute subdural hematoma (ASDH) manifests as a life-threatening neurosurgical emergency, and is associated with a very high mortality of approximately 50% to 90% [1-3].

The widely accepted indications for surgery are hematoma thickness greater than 10 mm or midline shift (MLS) greater than 5 mm regardless of the patient's GCS score. Furthermore, all patients with hematoma size that does not fulfill the above-mentioned criteria but have had neurological deterioration and/or have pupillary abnormalities and/or have intracranial pressure (ICP) >20 mm Hg and present with GCS score < 9 should undergo surgery [1]. The goal of surgery is to minimize secondary ischemic brain injury and relieve brain herniation. There is no conclusive evidence about the surgical technique. A variety of surgical techniques such as large craniotomies, decompressive craniectomies, hinged craniotomies, or combinations of these techniques were recommended for the management of ASDH to maximize the amount of space available for edematous brain tissue expansion as a salvage procedure for uncontrollable high intracranial pressure (ICP). The mortality rate for ASDH is documented as elevated, and a significant number of those who survive do not fully recover their previous level of functioning, particularly in cases requiring surgical intervention for severe ASDH. The rates of favorable outcomes following ASDH vary between 14% and 40% [4].

Numerous studies have been conducted to identify preoperative factors that could elucidate the prognosis of patients who undergo surgery for ASDH, [5,6,7,8] where research has discovered a variety of important variables, including advanced age, the context of polytrauma and the mechanism of injuries, status on admission, the timing of surgery, number of comorbidities, level of consciousness evaluated by the GCS score, initial computed tomography (CT) scan findings such as hematoma thickness, midline shift (MLS), brain edema and other factors.

Considering, the background of this research, the present baseline study is thus aimed at documenting the determinants that influence surgical outcomes in patients with traumatic ASDH in a tertiary-level hospital in Bangladesh.

Methods:

This prospective observational study was conducted in the Department of Neurosurgery, Chittagong Medical College Hospital, Chattogram, Bangladesh from May 2022 to April 2023. Consecutive sampling considering the inclusion and exclusion criteria was considered for the patient admitted in Department of Neurosurgery, CMCH within time frame. Inclusion criteria was Patient of age more than 18years in all sex who had surgical intervention for the management of acute subdural hematoma (ASDH) following trauma were included in the study. Penetrating head injury, concomitant spinal injury, chest, abdomen or other organ injury, conservatively managed traumatic ASDH and surgically unfit or denying formal consent 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 mean ± standard deviation (SD) for normally distributed data or median and 25%–75% interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as percentages (%) or proportions. The study population were divided into two groups depending upon three months' outcomes (functional recovery/good outcome versus nonfunctional recovery/poor outcome). Between these groups, continuous and categorical variables were analyzed. Student's *t*-test was used to analyze normally distributed continuous variables, while Mann–Whitney U-test was used for non-normally distributed continuous variables. Categorical variables were compared using the Chi-square test or Fisher's exact test. Logistic regression analysis was used to determine the independent predictors of poor outcome by incorporating the variables having significant association with outcome in univariate analysis. For each baseline variable, adjusted odds ratios (ORs) were calculated as measures of relative risk. Results were reported as odds ratios (OR) together with a 95% confidence interval (CI). $P < 0.05$ were considered statistically significant.

Study CONSORT chart:

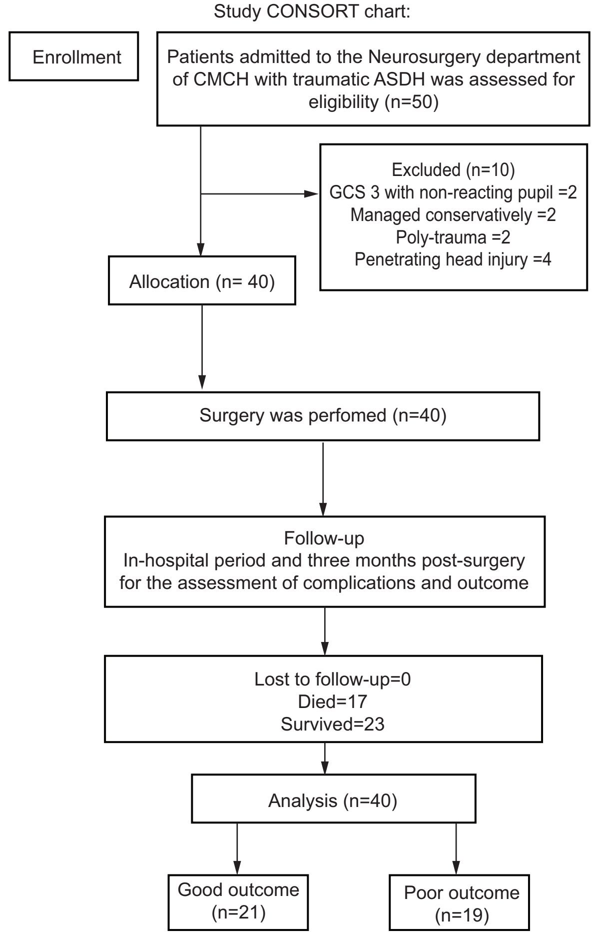

Figure 1: *CONSORT diagram.*

Results:

A total of 50 patients were screened and 40 of them were found to full fill the eligibility criteria for the study. The final analysis included these 40 patients, of which 21 (52.5%) patients had good outcome and other 19 (47.5%) had poor outcome (expired within three months or recovery with severe disability, GOS score was 3). Different demographic, clinical, and radiological findings were compared between patients with good and poor outcome in the following tables and charts.

The median age of the patients was 45 years (range: 19-82 years) and there was a male preponderance (82.5%) with a male-to-female ratio of 4.7:1 (Table 1). The median age of the patients with poor outcome was higher than the patients with good outcome (52 vs. 42 years). Proportion of female patients were higher in poor outcome group than the good outcome group. However, none of the differences reached statistical significance (p>0.05).

Table 2 shows that, 37.5% patients were smoker, 14 (35%), and 12 (30%) patients, respectively, had any comorbidity and hypertension. RTA was the most common cause of trauma (65%), followed by fall from height (15%), and physical assault (12.5%). Table 2 shows that, smoking, comorbid conditions, and mechanisms of injury failed to show any significant association with outcome.

Table 3 shows that, the mean preoperative GCS scores were significantly lower in patients with poor outcome than the patients with good outcome. Preoperative Anisocoria with Non-reacting pupil and Anisocoria with reacting/ sluggish reacting pupil were also significantly associated with poor outcome (P<0.05).

Table 5 shows that, craniotomy was done in 16 (40%) patients and other 24 (60%) patients had decompressive craniectomy. Earliest time of injury to surgery interval was 6.5 hours in the study and median time was similar between patients with good and poor outcome. Postoperative ICU admission was associated with poor outcome, as 78.9% of the patients with poor outcome need ICU admission compared to 33.3% of the patients with good outcome. Surgical approach, preoperative brain swelling was not associated with poor outcome.

Table-I

Distribution according to Demographic characteristics and surgical outcome of the patients (n=40)

Characteristics	Total (n=40)	3-months outcome		P value
		Good (n=21)	Poor (n=19)	
Age, years				
Median (IQR)	45.0 (25.0-58.8)	42.0 (26.5-50.0)	52.0 (25.0-60.0)	0.161*
Sex				
Female	7 (17.5)	2 (9.5)	5 (26.3)	0.226†
Male	33 (82.5)	19 (90.5)	14 (73.7)	

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

Table-II

Personal habit, comorbidities & mechanism of injuries of the patients (n=40)

Characteristics	Total (n=40)	3-months outcome		P value
		Good (n=21)	Poor (n=19)	
Smokers	15 (37.5)	9 (42.9)	6 (31.6)	0.462*
Hypertension	12 (30.0)	5 (23.8)	7 (36.8)	0.369*
Diabetes mellitus	7 (17.5)	5 (23.8)	2 (10.5)	0.412†
Ischemic heart disease	1 (2.5)	1 (4.8)	0 (0)	1.0†
Mechanism of injury				
Fall from different level	6 (15.0)	2 (9.5)	4 (21.1)	0.758*
Road traffic accident	26 (65.0)	14 (66.7)	12 (63.2)	
Physical assault	5 (12.5)	3 (14.3)	2 (10.5)	
Others	3 (7.5)	2 (9.5)	1 (5.3)	

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

Table-III

Baseline clinical characteristics of the patients (n=40)

Characteristics	Total (n=40)	3-months outcome		P value
		Good (n=21)	Poor (n=19)	
Preoperative GCS	8.2±2.2	9.2±2.2	7.1±1.7	0.001**
Anisocoria with Non-reacting pupil	7 (17.5)	0 (0)	7 (36.8)	0.003‡
Anisocoria with reacting/ sluggish reacting pupil	16 (40.0)	3 (14.3)	13 (68.4)	<0.001‡
Focal neurological deficit	12 (30.0)	8 (38.1)	4 (21.1)	0.340‡

Data were expressed as frequency (%) or Median (IQR), or Mean ± SD; *Mann-Whitney U test; ‡Chi-square test. **Independent sample t test.

A total of 15 (37.5%) patients had postoperative complication, and the most common complication was aspiration pneumonia (12, 30%), followed by recollection of SDH (1, 2.5%), and ventricular hemorrhage (1, 2.5%). Figure 4.1 shows that, significantly higher proportion of patients with poor outcome had postoperative complications than the patients with good outcome (57.9% vs. 19%, p=0.011 by Chi-square test).

Out of 40 patients with traumatic ASDH, 27 (67.5%) survived at least 30 days post-surgery. Other 13 cases expired, giving the 30 days mortality rate of 32.5%. Out of 40 patients, 23 (57.5%) survived at least 90 days post-surgery. Other 17 cases expired, giving the

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Table-IV

Preoperative imaging characteristics of the patients (n=40)

Imaging characteristics	Total(n=40)	3-months outcome		P value
		Good (n=21)	Poor (n=19)	
Hematoma volume, ml	38 (28-61)	34 (24-56)	45 (30-74)	0.376*
Hematoma thickness, mm	10 (10-15)	10 (10-15)	10 (7-15)	0.452*
Midline shift, mm	10 (7-15)	10 (10-10)	15 (5-15)	0.768*
Extradural hematoma	6 (15.0)	5 (23.8)	1 (5.3)	0.186†
Cranial fracture	10 (25.0)	7 (33.3)	3 (15.8)	0.281†
Intraparenchymal hematoma	5 (12.5)	4 (19.0)	1 (5.3)	0.345†
Contusion	22 (55.0)	12 (57.1)	10 (52.6)	0.775‡
Subarachnoid hemorrhage	16 (40.0)	7 (33.3)	9 (47.4)	0.366‡

Data were expressed as frequency (%) or Median (IQR), or Mean ± SD; *Mann-Whitney U test; ‡Chi-square test; †Fisher's exact test. **Independent sample t test.

Table 4 shows that, none of the imaging characteristics have any significant association with outcome in the present study.

Table-V

Treatment related characteristics of the patients (n=40)

Variables	Total (n=40)	3-months outcome		P value
		Good (n=21)	Poor (n=19)	
Injury to surgery, hours	18 (12-28)	18 (9.3-27.5)	18.5 (12-30.5)	0.611
Surgical approach				
	Craniotomy	16 (40.0)	10 (47.6)	6 (31.6)
0.321‡				
	DC	24 (60.0)	11 (52.4)	13 (68.4)
Per operative brain swelling	25 (62.5)	12 (57.1)	13 (68.4)	0.462†
Postoperative ICU stay	22 (55.0)	7 (33.3)	15 (78.9)	0.004‡

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

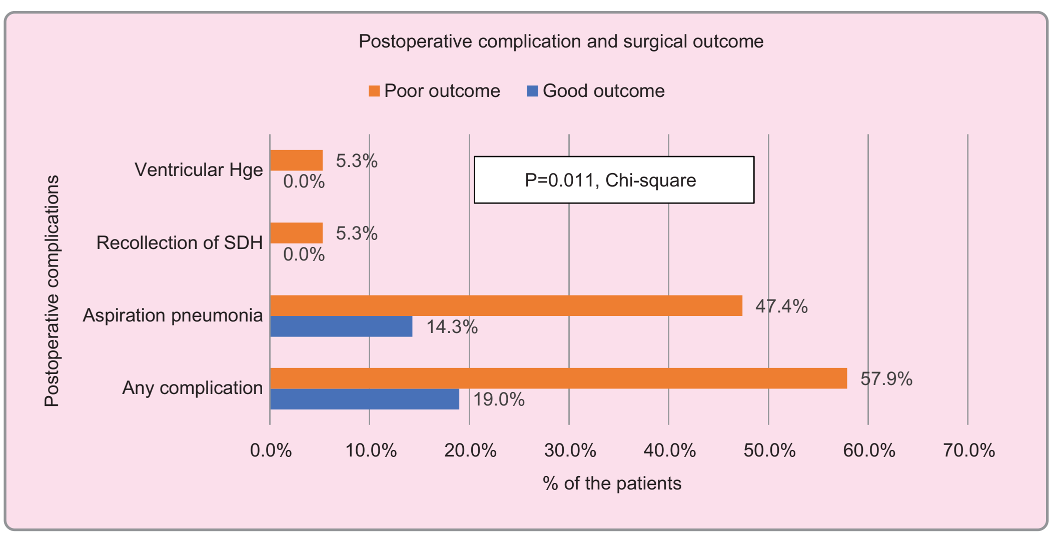

Figure 2: *Postoperative complications and surgical outcome*

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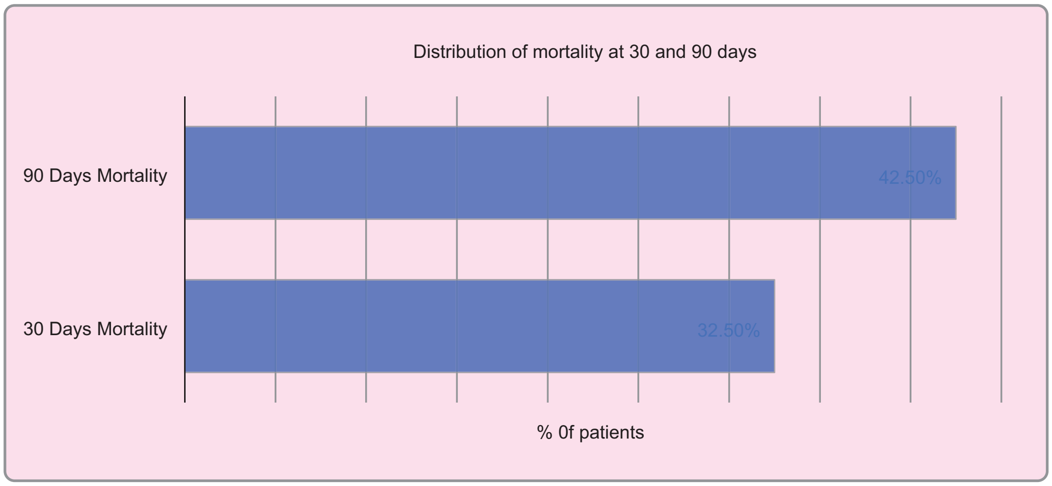

Figure 3: *Distribution of the patients based on their 30 days and 90 days mortality*

90 days mortality rate of 42.5% (Figure 3). Among the 17 deceased patients, 13 (32.5%) and 4 (10%) patients expired in-hospital and after discharge, respectively.

At the final follow-up (3-months), out of 40 patients, 17 (42.5%) patients had a GOS score of 1(Death), 2 (5%) patients had a GOS score of 3 (indicating severe disability). One (2.5%) patient had recovery with moderate disability and 20 (87%) patients had good recovery at the final follow-up.

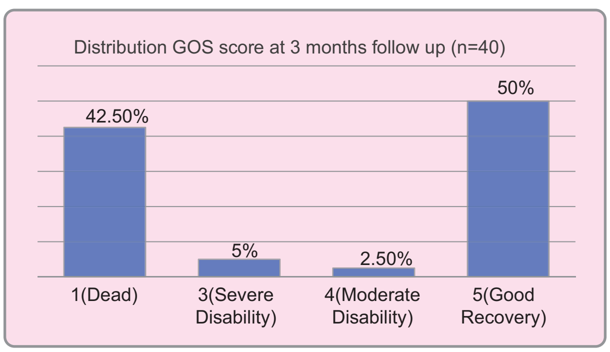

Figure 4: *Distribution GOS score at 3 months follow up (n=40)*

Multivariate binary logistic regression analysis revealed that, increasing age, preoperative GCS of d”8, and presence of unilateral or bilateral non-reacting pupils was independently associated with three months poor outcome. With one year increase in age, the risk of poor outcome following surgery in patients with ASDH was increased by 1.12 times (OR: 1.12, 95% CI: 1.02-1.22. p=0.014). Patients with preoperative GCS d”8 were 13.98 times more likely to have poor outcome (OR: 13.98, 95% CI:1.22-160.00, p=0.034), than the patients with preoperative GCS >8. Presence of Anisocoria with non-reacting pupil increased the chance of poor outcome by 17.99 times (OR; 17.99, 95% CI: 1.32-244.08), p=0.030).

Table-VI

Logistic regression analysis to determine the independent predictor for poor outcome

Variables	B	P value	OR	95% CI for OR	
				Lower	Upper
Age, years	0.115	0.014	1.122	1.024	1.229
Preoperative GCS d”8	2.638	0.034	13.983	1.222	160.000
Anisocoria with reacting/ sluggish reacting pupil	3.399	0.186	29.933	0.193	4635.230
Anisocoria with Non-reacting pupil	2.890	0.030	17.991	1.326	244.086

OR: Odds ratio; CI: Confidence interval

Discussion:

Bangladesh has unique distinction of having a huge number of head injuries in the world [9,10,11]. In the current study, the median age of the patients was 45 years (range: 19-82 years) which agreed with a recent study conducted in two tertiary level hospital in Dhaka Bangladesh [11]. In their study, mean age was 40.39±17.43 years and the most common age group which was vulnerable to TBI was between 18 and 27 years which accounts to about 28.6% followed by 28 to 37 years of age group which accounted for 21.0% and between 38 to 47 years age group which accounted for13.8%. Regarding gender distribution, there was a male preponderance (82.5%) with a male-to-female ratio of 4.7:1 in the current study.

In the present study, RTA was the most common cause of trauma (65%), followed by fall from height (15%), and physical assault (12.5%). The mortality rate was 42.5% in the present study. Mortality rate in traumatic ASDH surgery remains dramatically high despite modern medical care, as it usually ranges between 40-70% through the past decades [12-15] .In the current study, the good functional neurological outcome was detected in 52.5%, which is comparable to Hutchinson et al.'s study [16]. Although the mortality in the current study was reported in 42.5% of the patients which is higher than the mortality in the Hutchison et al.'s study (26.9%), the overall unfavorable outcome which included both mortality and severe disability is generally comparable. The higher proportion of mortality rate in the current study could be attributed to the known higher risk of mortality due to the presence of ASDH in all of the present study cases which was not present mostly in Hutchinson's cases [16]. In a single center retrospective cohort study [3,16] about 82 patients who underwent surgical evacuation of a traumatic ASDH, at 6 months, 76% of patients achieved unfavorable outcome (GOS 1 to 3), which was much higher than the present study. This discrepancy could be attributable to the differences in the baseline characteristics of the patients in two studies.

Chen et al. [17] recently found that time from injury to surgery was a significant factor for functional outcomes in the univariate and multivariate regression models. In our study, multivariate binary logistic regression analysis revealed that, increasing age, preoperative GCS of d"8, and presence of unilateral or bilateral non-reacting pupils was independently associated with three months poor outcome.

Craniotomy and decompressive craniectomy are two common surgical approaches used, however, there is currently no universal consensus regarding the most appropriate management strategy given the lack of level I randomized evidence. In the meta-analysis of Phan et al. [18] poor outcome and mortality were lower in patient with severe TBI and ASDH who were treated by craniotomy and evacuation of the hematoma than those who underwent DC as the poor outcome was (50.1% vs. 60.1%) and the mortality rate was (13.9% vs. 40.5%), respectively. In the present study, craniotomy was done in 16 (40%) patients and other 24 (60%) patients had decompressive craniectomy. Proportion of patients with poor outcome was 37.5% and 54.1%, respectively, in craniotomy and DC group. Though the proportion of poor outcome was higher with DC, the difference was not significant statistically (p=0.321), which agreed with a recent study of ElGaidi et al. [19], who found that both craniotomy and DC were viable surgical options with no difference in the outcomes and complications following the evacuation of traumatic ASDH.

In the present study, median age of the patients with poor outcome was higher than the patients with good outcome (52 vs. 42 years), but the difference failed to reach statistical significance probably due to small sample size in univariate analysis. However, in multivariate analysis, age revealed as an independent predictive factor in the present study for poor outcome. With one year increase in age, the risk of poor outcome following surgery in patients with ASDH was increased by 1.12 times (OR: 1.12, 95% CI: 1.02-1.22. p=0.014). Similarly, Gunjkar et al. [20] observed that patients younger than 40 years had mortality rate of 16.66% and 22.22% in patients in the age group 40 to 64 years. The increased mortality in the elderly patients may be partly explained by the intrinsic properties of the aging brain, pre-existing comorbidities and complications.

In the current study, mean admission and preoperative GCS scores were significantly lower in patients with poor outcome than the patients with good outcome. The most detailed analysis of the effect of GCS score on outcome after STBI was done in the IMPACT (International mission for prognosis and analysis of clinical trials in TBI) study [14]. It was shown that the GCS score on hospital admission was strongly related to the GOS score at 6 months after trauma. In the present study patients with preoperative GCS d"8 were

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13.98 times more likely to have poor outcome (OR: 13.98, 95% CI:1.22-160.00, p=0.034), than the patients with preoperative GCS >8. Nevertheless, Demetriades et al. [21] reported an overall mortality of 60% among critically low GCS on admission; on the other hand, there were case reports describing the presence of good functional recovery after decompressive craniectomy for critically severe initial neurological status (GCS 3-4) [22].

Different preoperative radiological variables were found to be significantly related to functional recovery, like midline shift, thickness of hematoma, secondary brain injuries such as intracranial hypertension, brain herniation, brain swelling; associated cranial lesions such as intraparenchymal hematoma, and cranial fracture [22-24]. Present study had included all of these radiological variables but none of them revealed a significant association with three months outcome even in the univariate analysis. It was likely, as the sample size of the present study was not adequate enough to do a rigorous analysis for detecting predictive factors.

In the present study, postoperative ICU admission was associated with poor outcome, as 78.9% of the patients with poor outcome need ICU admission compared to 33.3% of the patients with good outcome, which agreed with the study of Lenell et al. [25] where mechanical ventilation proved to be independent negative prognostic factors.

Despite the presence of several studies in the literature discussing the factors influencing surgical outcome of ASDH following TBI, the current study to the best of our knowledge, involved patients from a tertiary level setting in Bangladesh. In addition, the current study has discussed almost all the important clinical and radiological factors that might affect the functional outcome among TBI patients in particular which were not frequently addressed in other previous studies. This finding may allow for more informed decision making in approaching a particular case.

Conclusion:

This study identified higher age, preoperative low GCS score and pupillary abnormalities as the independent predictors for 3 months poor outcome in patients who underwent surgical treatment for traumatic acute subdural hematoma (ASDH).

Limitation:

In our study, sample size was small and 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 three months only.

Recommendation:

Based on the study findings, it could be recommended that neurosurgeons should consider age, preoperative GCS, and pupillary abnormality in triage protocols in resource-limited settings for patients with traumatic ASDH. Nevertheless, considering the limitations, the results of this study need to be validated in a large cohort with extended follow-up schedule. Future research should be long-term follow-up cohort studies to evaluate the proportion of this cohort that return to productive work.

Conflict of interest: None to disclose.

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