Research article

Optimal timing of surgical intervention in acute subdural hematoma

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ABSTRACT

Introduction and Aim: The most common intracranial injury was subdural hematoma (SDH). In this study, as a primary objective, we evaluated the association between the timing of surgical evacuation in patients with SDH and the functional outcome. The secondary objective is to identify prognostic factors associated with poor outcomes in patients with SDH.

Methods: This is a retrospective study of medical records from the injury registry of patients with traumatic brain injury (TBI). The patients were divided into three groups according to their assessment by the Glasgow coma scale scores: mild TBI (13 to 15), moderate TBI (9 to 12), and severe TBI (3 to 8).

Results: The average age of the studied population was 49.8 ± 19.7 years, there were 77.2% of male patients in the study population. In terms of severity, 63.4% of patients had severe head injuries, while 17.9% had mild head injuries. The average severity of the damage was 25.5 ± 5.7 and the low score on the Glasgow coma scale was 4.7 ± 0.4.

Conclusion: Signs of a compressed brainstem are strong prognostic factors in predicting the functional outcome in patients with acute SDH who underwent surgery.

Keywords: Subdural hematoma; traumatic brain injury; Glasgow coma scale; Glasgow outcome scale; intensive care unit.

INTRODUCTION

The death rate as a result of road accidents in the period from 2011 to 2021 in Kyrgyzstan was 21.61–23.16% in 100,000 people. Several researches reported that 15.8–29% of patients with trauma in the emergency department had head injuries, and the most common intracranial injury was subdural hematoma (SDH; 1-3).

Acute SDH correlates with mortality in traumatic brain injury (TBI; 4-6). Indications for surgery in patients with SDH are the thickness of the hematoma >10 mm or displacement of the median structures of the brain >5 mm with computed tomography. All patients with a score on the Glasgow coma scale (GCS) <9 with acute, SDH <10 mm thickness and displacement of the median structures of the brain <5 mm should undergo surgery if the score of the GCS decreases by 2 or more points and/or the pupils become asymmetric or fixed (7-9).

However, the timing after the patients got admitted into the intensive care unit (ICU) for surgery is still controversial. It was found that surgical evacuation of SDH within 4 hours (h) after the patient's injury was related with a positive outcome, which showed that patients who fell into a coma due to SDH should be operated on within 2h after neurological deterioration. It was found that the timing of surgical intervention in patients with SDH is not related to either mortality or outcome, and a shorter time before surgery is not a prognostic factor related to the mortality or functional outcome. Additionally, patients with SDH who underwent surgery within 4h after admission to the ICU had a higher mortality rate than patients who underwent surgery later than 4h after admission (10-12).

In this study, as a primary objective, we evaluated the association between the timing of surgical evacuation in patients with SDH and the functional outcome. The secondary objective is to identify prognostic factors associated with poor outcomes in patients with SDH.

MATERIALS AND METHODS

This is a retrospective study of medical records from the injury registry of patients with TBI who were admitted to the level-I trauma center of the Osh Hospital, Kyrgyzstan. The study included patients with SDH who subsequently underwent surgery, while patients with failure of initial conservative treatment, penetrating trauma mechanism, and/or unstable vitals were excluded.

Characteristics such as demographic data, the mechanism of injury, the results of physical and neurological examination, the results of neuroimaging, the thickness of SDH, concomitant intracranial lesions, treatment, and type of surgery were included. The patients were divided into three groups according to their assessment by the GCS scores: mild TBI (13 to 15), moderate TBI (9 to 12), and severe TBI (3 to 8).

During discharge from the hospital, the patients were divided into five groups based on the Glasgow Outcome Scale (GOS): (1) death, (2) post-coma unresponsiveness, (3) severe disability, (4) moderate disability, and (5) good recovery. Finally, scores were dichotomized into favorable (GOS 4 and 5) and unfavorable categories (GOS 1 to 3). The main sociodemographic and clinical characteristics of the study population are presented in Table 1.

Table 1: Sociodemographic and clinical characteristics in patients with SDH

Characteristics	**n (%)**
Sex	
Male	112 (77.2%)
Female	33 (22.8%)
Age (years)	
Up to 60 years old	95 (65.5)
Above 60 years old	50 (34.5%)
Mechanism of injury	
Car accident	90 (62.1%)
Fall	33 (22.7%)
Attack	10 (6.9%)
Motorcycle	12 (8.3%)
Concomitant diseases	
Heart diseases	18 (12.4%)
Previous brain injury	3 (2.4%)
COPD	2 (1.4%)
Kidney diseases	1 (0.7%)
Liver diseases	1 (0.7%)
Undergoing medications	
Antiplatelet agents	7 (4.8%)
Anticoagulants	3 (2.1)
Vitals before admission	
Hypotension	6 (4.1%)
Bradycardia	3 (2.1%)
Fever	1 (0.7%)
Tachypnea	6 (4.1%)
O2 <90 mm Hg	7 (4.8%)
PaO2 <60 mm Hg	6 (4.1%)

The time coefficients used in this study were calculated using various start and end points collected from the injury registry. The time from the accident scene to arrival to the ICU and the time from arrival to the ICU to brain computed tomography was documented by the ambulance team.

Clinical characteristics are evaluated using mean ± standard deviation and n (%). The mean values between the two groups were compared using an independent t-test, and the analysis of the relationship between different factors and functional outcomes was carried out using binary logistic regression. Clinical characteristics were analyzed in univariate analysis, and patient's characteristics for multivariate analysis were any variables with a univariate analysis value of P <0.1. Statistical analysis was performed using Excel.XLSTAT v2020.1 (Microsoft, Addinsoft, Paris, France).

RESULTS

The study included 145 patients with SDH and more than 2/3rd of patients had road traffic injuries. The post-traumatic seizure was observed in 2.1% of patients. The most common concomitant injury was a fracture of the maxillofacial region in 13.8% of patients, as shown in Table 2.

Table 2: Distribution by GCS scores, pupil reactions, and concomitant injury

Characteristics	n (%)
GCS scores	
15-13	26 (17.9%)
12-9	27 (18.6%)
8-3	92 (63.4%)
Pupil reactions	
Both eyes react	74 (51.0%)
Mydriasis on both eyes	41 (28.3%)
Mydriasis in one eye	29 (20.0%)
Impossible to evaluate	1 (0.7%)
Hemiparesis	7 (4.8%)
Seizures	3 (2.1%)
Concomitant injury	
Maxillofacial	20 (13.8%)
Musculoskeletal	14 (9.7%)
Pneumothorax	11 (7.6%)
Bruised lung	5 (3.4%)
Cervical spine	4 (2.8%)
Rib fracture	4 (2.8%)
Liver damage	1 (0.7%)
Other damages	5 (3.4%)

Glasgow Outcome Scale; GOS

The average age of the studied population was 49.8 ± 19.7 years, there were 77.2% of male patients in the study population. In terms of severity, 63.4% of patients had severe head injuries, while 17.9% had mild head injuries. The average severity of the damage was 25.5 ± 5.7 and the low score on the GCS was 4.7 ± 0.4. All patients underwent surgery, and decompressive craniectomy with hematoma removal was performed in 71.7% of patients, as shown in Table 3.

Table 3: Characteristics of intracranial injuries

Characteristics	n (%)
The thickness of SDH (mm)	
<10	36 (24.8%)
>10	109 (87.6%)
The average thickness of SDH (mm)	13.2 (6.0%)
Location of SDH	
Frontal lobe	45 (31.0%)
Parietal lobe	25 (17.2%)
Temporal lobe	15 (10.3%)
Occipital lobe	4 (2.8%)
Subdural hematoma side	
Left hemisphere	63 (43.4%)
Right hemisphere	61 (42.1%)
Displacement of median structures (mm)	
<5	18 (12.4%)
>5	127 (87.6%)
Basal cisterns	
Without changes	50 (34.5%)
Obliteration	95 (65.5%)
Combined intracranial injury	
Subarachnoid hemorrhage	127 (87.6%)
Brain injury	76 (52.4%)
Skull fracture	70 (49.0%)
Fracture of the base of the skull	48 (33.1%)
Intraventricular hemorrhage	5 (3.4%)

Subdural hematoma; SDH

The average thickness of the SDH was 13.2 ± 6.0 m, and 31% of the SDH was located in the frontal lobe. More than 2/3rd of patients had basal cistern obliteration, and displacement of median brain structures of more than 5 mm was found in 87.6% of patients.

The average length of hospital stay of patients with SDH was 31.5 ± 53 days. Upon discharge from the hospital, 34.5% died, and the discharge outcomes were good (31.0%), with moderate disability (20.0%), severe disability (10.3%), and vegetative state (4.1%). The average follow-up time was 182.3 ± 42 days, and the final reported outcomes were good recovery (47.4%), moderate disability (30.5%), severe disability (15.8%), persistent vegetative state (6.3%), and no cases of death.

The results of the multivariate analysis carried out in accordance with the reverse selection procedure are presented in Table 4.

Table 4: Distribution by type of treatment and outcomes

Characteristics	n (%)
Type of operation	
Craniotomy with hematoma removal	41 (28.3%)
Decompressive craniectomy	104 (71.7%)
Bed days	31.5 (53.0%)
The outcome of the GOS at discharge	
Good outcome	15 (10.3%)
Moderate disability	21 (14.5%)
Severe disability	40 (27.6%)
Vegetative state	19 (14.5%)
Death	50 (34.5%)
The outcome of the GOS in the distant period	
Good outcome	45 (47.4%)
Moderate disability	29 (30.5%)
Severe disability	15 (15.8)
Vegetative state	6 (6.3%)

Glasgow coma scale; GCS

From univariate analysis, patients characteristics for multidimensional analysis were any variables with a one-dimensional value of P <0.1. However, the type of operation was removed because this factor was associated with the severity of the injury, as evidenced by a low GCS score and/or basal cistern obliteration.

The variables were independently (P <0.05) related to negative results, a single fixed pupil (OR 2.5, 95% CI 1.03–0.2) and basal cistern obliteration (OR 3.2, 95% CI 1.3–7.8), while the duration before arrival at the ICU was insignificant. The regression analysis was performed again using the direct selection procedure and got similar outcomes. Since the correction of the collinearity of the data was not required, the coefficient of variance inflation for each covariate was <10 (Table 5).

Table 5: Logistic regression for an unfavorable outcome

Characteristics	Univariate analysis	
	OR (95% CI)	p
The thickness of SDH (mm)		
<10	Ref	
>10	1.22 (0.5–2.8)	0.63
Pupil reaction		
Both eyes react	Ref	
Mydriasis	3.39 (1.4–7.9)	0.05
Basal cisterns		
No changes	Ref	
Obliteration	4.5 (2.0–10.0)	<0.01
GCS scores		
Mild brain injury	Ref	
Moderate brain injury	0.90 (0.2–2.7)	0.85
Severe brain injury	2.33 (0.8–6.0)	0.08
Type of surgery		
Craniotomy	Ref	
Decompressive craniectomy	3.60 (1.7–7.3)	<0.01
Time interval before the operation (hours)		
>4	Ref	
<4	3.43 (1.03–11.4)	0.04

In this study, the optimal timing of surgical intervention in patients with SDH was considered. The main controversy related to this study was about patients with SDH having a better outcome during surgery within 2 h after neurological deterioration, while the time of surgery within 4 h was related to positive results. However, much research showed that surgical evacuation within 4 h was not related to either an improvement in the functional outcome or survival, but related to a higher incidence of adverse outcomes.

DISCUSSION

This research showed several contrary results of the interrelationships of different temporal factors. The early one was significantly associated with a poor outcome, and faster surgery was associated with negative results in a univariate analysis. However, after the introduction of multivariate analysis to manage confounders, finally, a single fixed pupil and basal cistern obliteration was potentially related to negative results (13).

Patients with signs of brainstem compression, including fixed pupils and/or basal cistern obliteration, should receive surgical evacuation of SDH earlier. As a rule, the neural pathway of the pupillary light reflex is located in its own brain stem. The light reflex is controlled by the fibers of the optic tract in the perirectal region, prerectal neurons synapse in the Edinger-Westphal nucleus. Finally, the ciliary nerve serves to constrict the pupils. Dilation of the pupils without reaction to light is caused by compression of the oculomotor nerve and ischemia of the brainstem. Much research showed bilateral fixed and dilated pupils are related to an unfavorable outcome, showing a single fixed pupil is associated with a negative result from brain stem injury (14).

The key limitation of this research is retrospective, which showed bias and an inability to manage confounding factors. Then, planned to overcome this with the help of multivariate analysis. However, the strength of our study lies in the fact as it is the first study to describe the inverse correlation between the time interval before surgery and the functional outcome, according to the alteration of several clinical characteristics (15).

CONCLUSION

Thus, the optimal time for surgical evacuation of acute SDH is difficult to assess, since the signs of compression of the brainstem are crucial compared to temporal factors. Signs of a compressed brainstem are strong prognostic factors in relating the functional outcome in patients with acute SDH who underwent surgery.

CONFLICTS OF INTEREST

None.

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