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Analysis of Factors Affecting Outcome of Acute Extradural Hematoma—Our Observation in Dhaka Medical College and Hospital

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Abstract

Background Extradural hematoma (EDH) is a leading cause of death in young population. Timely intervention gives dramatic recovery but often fatal if not treated in time. The surgical outcome of EDH depends on many variables that strongly affect the prognosis of the disease, which are preoperative Glasgow coma scale (GCS), overlying skull fracture, time interval between injury and surgery, other associated intracranial injuries (like cerebral contusion, subdural hematoma, or intracerebral hematoma), pupillary abnormalities(anisocoria), and hematoma volume. But no correlation was found between surgical outcome of EDH and age, sex, etiology, and site of hematoma.

Objective We want to identify the factors affecting the surgical outcome of EDH that will help us in preoperative prioritization of the cases for intervention, adequate resuscitation, and counselling the attendant regarding the outcome. Our ultimate goal was to reduce the mortality and morbidity from this disease.

Methods This study was conducted on the patients admitted through neuroemergency and diagnosed as EDH by computed tomography scan of head, in the department of Neurosurgery of Dhaka medical college and hospital from January 1, 2017 to December 31, 2019. This is three-year prospective interventional study where all the patients underwent surgical evacuation of EDH on emergency basis and outcome was measured by Glasgow outcome scale (GOS) after 48 hours of admission and at discharge.

Results Outcome was divided into good (GOS 4,5) and poor (GOS 1–3) groups. Pre-operative GCS, overlying skull fracture, time interval between injury and surgery, associated intracranial injuries, anisocoria and hematoma volume were the factors affecting the surgical outcome significantly.

Conclusion Good surgical outcome is associated with EDH volume less than 40cc, pre-operative GCS more than 8, absence of anisocoria, overlying skull fracture, no associated intracranial injury and surgery within 12 hours of injury. But age, sex and site of EDH has no definite correlation with outcome.

Keywords
- EDH
- GCS
- GOS
- hematoma

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Introduction

Accumulation of blood in the potential space between dura matter and skull is called extradural hematoma (EDH).[1] Fractures on the skull bone having rupture of middle meningeal artery or its branches are present in approximately 85% of cases and the rest occur by ruptured venous sinuses and fractured diploic bone.[1,2] EDHs have three classical presentations. First, a brief period of post-traumatic loss of consciousness; second, a lucid interval for several hours; and lastly obtundation, contralateral hemiparesis, and ipsilateral mydriasis.[3,4]

EDHs are a very common clinical condition among traumatic brain injury counting around 2.7 to 4%.[5] It is the leading cause of death in the age group of 16 to 40 years.[6] With the availability of computed tomography (CT) scan of head almost everywhere in Bangladesh and economic solvency of the people, EDH can be diagnosed immediately after trauma. Temporal region is most prone for developing EDH in head injury, followed by frontal, parietal regions, and posterior fossa[7] as people of our country are very reluctant to use helmet while riding motor bike. Most of the patients present with headache, vomiting, altered sensorium, and lucid interval.[8,9]

Despite advancement in neurosurgical management and increasing health care costs within the United States and other countries including Bangladesh, EDH remains a major cause of significant morbidity and mortality.[1] EDH is a neurosurgical emergency and timely surgical intervention for significant EDH is the gold standard.[10] Craniotomy and evacuation of the hematoma are the treatment of choice.[3] The Brain Trauma Foundation has recommended that any EDH more than 30 mL should be surgically evacuated regardless of the patient's Glasgow coma scale (GCS) score.[11,12] The GCS score on admission is one of the most important predictors of eventual prognosis, with the outcome being better when the initial GCS score is high.[12] The level of consciousness before surgery had been correlated with mortality rate by Wells et al[12,13] as follows: (1) no mortality for patients who are awake/conscious at the time of presentation in the hospital, (2) mortality of 9% for obtunded patients, and (3) mortality of 20% for comatose patients.

The surgical outcome of EDH depends upon many variables, in which the following six have special importance: (1) Preoperative GCS, (2) time between injury and surgery,[14] (3) overlying skull fracture, (4) associated intracranial injuries (like contusion, subdural or intracerebral hematoma), (5) pupillary abnormality (anisocoria), and 6) Hematoma volume.[8] Outcome was measured during second postoperative day and at discharge from hospital by using GOS.[15] In GOS good outcome was defined as GOS of 4 to 5 and poor as GOS of 1 to 3.[15,16] The patients having GCS of 13 to 15 at admission have a good outcome in 85% of cases, while those with GCS of 9 to 12 and 3 to 8 have 67 and 39%, respectively.[8] Mortality rate of 23.5% in patients having surgery later than 6 hours of injury can be reduced to 18.5%, if surgery is performed within 6 hours of injury.[17] Associated intracranial injuries are found in 32.46% of cases of EDH and are important to prognosticate the outcome, as 15 out of 45 patients (33.3%) who expired with EDH had associated brain injuries.[7,9,18] These injuries may be subdural hematoma, contusion, and intracerebral hemorrhage. About 15 to 22% of patients have anisocoria prior to surgical evacuation of EDH.[7,9] Time between injury and surgery and the hematoma volume are important factors affecting the surgical outcome.[19,20]

The rationale of this study is to determine the effects of said factors on the surgical outcome that will help in preoperative counseling and selecting the operative candidates earlier to reduce mortality and morbidity among the young population.

Materials and Methods

Patients with traumatic EDH diagnosed on plain CT scan of brain admitted through emergency at department of neurosurgery, Dhaka Medical College and Hospital, fulfilling the inclusion criteria for surgical evacuation were included in this study. After initial resuscitation in emergency, conservative management was decided for the patients who had all of the following: (1) volume less than 25 cm^2, thickness less than 10 mm, 3 midline shift less than 5 mm, (4) GCS more than 8 and (5) no focal neurological deficit.[21] Those who were selected for emergency operation were taken to operating room after blood arrangement and consent was documented. Surgical evacuation was performed within first 24 hours in all patients. Under general anesthesia or regional block, after all aseptic measures, craniotomy and evacuation of hematoma were performed. Hemostasis was secured and hitch sutures were applied prior to wound closure. Postoperatively some of the patients were shifted to neurosurgical intensive care unit (ICU) or high-dependency care unit as per need. Surgical outcome was measured by the GOS after 48 hours of surgery and at discharge from hospital.

Our sample size was very large. Detail of sample size is shown in ►**Table 1** that is documented unit wise and was published as "Year Book" of the Department of Neurosurgery in Dhaka Medical College and Hospital in the year of 2017, 2018, and 2019.

Results

Out of 1,978 patients, 1,543 (78%) patients were male and female were 435 (22%) with M:F= 3.5:1. Majority of the patients were around 30 years of age with a mean age of 30.2 years (►**Figs. 1** and **2**).

One thousand one hundred and twenty-eight (57%) patients presented with a GCS of 9 to 13. The GCS was in 14 to 15 and 3 to 8 ranges in 594 (30%) and 257 (13%), respectively. The 1,681 (85%) patients with EDH had bilateral equal pupils (3–4 mm) on inspection and remainder 297 (15%) had anisocoria (pupil $>$ 4mm) when examined preoperatively. Majority of patients (930; 47%) showed extra dural hematoma volume on CT scan brain in the range between 41 and 60 mL. Hematoma volume of 20 to

Table 1 Distribution of study population by admitting neurosurgical units (NSUs; $n = 1,978$)

Year	NSU I	NSU II	NSU III	NSU IV	NSU V	NSU VI	Total
2017	143	119	145	142	90	–	639
2018	155	104	124	139	130	20	672
2019	138	103	118	120	98	90	667
Total	**436**	**326**	**387**	**401**	**318**	**110**	**1,978**

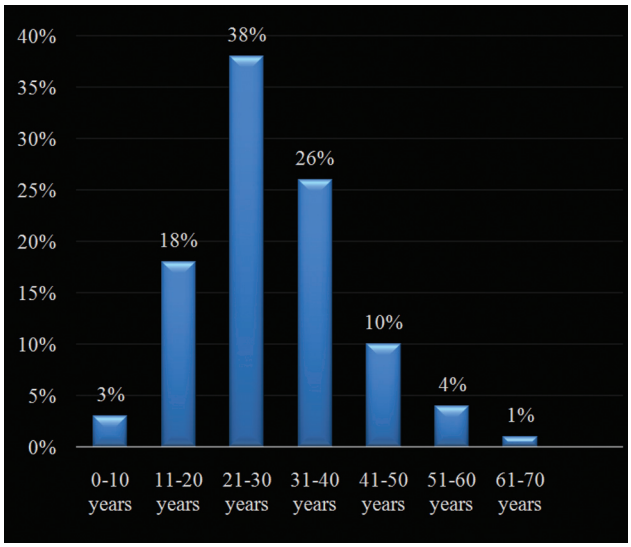

Fig. 1 Distribution of study population by age.

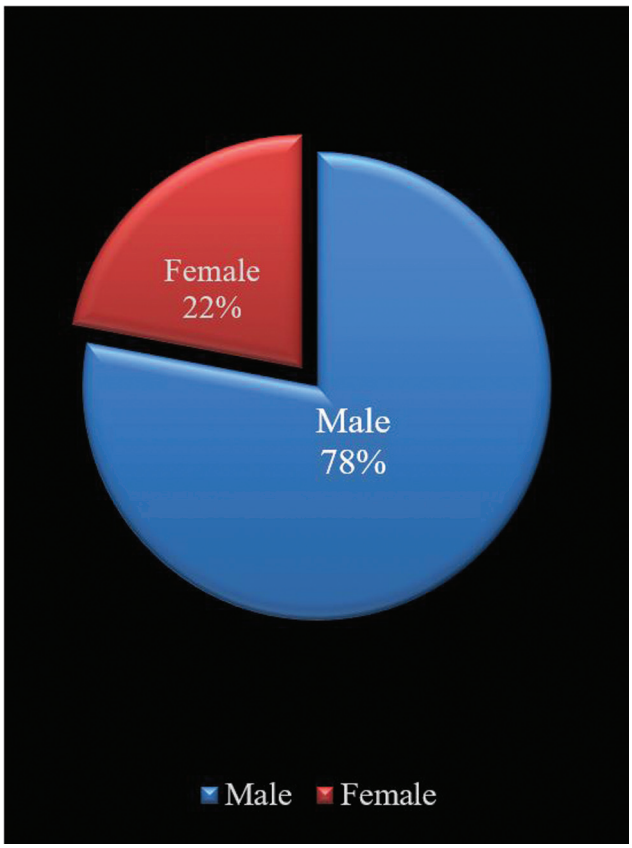

Fig. 2 Distribution of study population by gender.

40 mL was found in 792 patients (40%). A large number of patients, 1,681 (85%), had overlying skull fracture.

After surgery, 1,642 (83%) patients with EDH had good surgical outcome, of which 1,068 (54%) had GOS 5 and 574 (29%) had GOS 4. The remaining 336 (17%) faced poor surgical outcome with GOS 3 in 237 (12%) and GOS 2 in 40 (02%) of patients. Fifty-nine (03%) patients expired after surgery (GOS 1) out of 1,978 patients (►**Table 2**). Age, sex, cause, and site of EDH had no correlation with outcome. Almost 85% of patients were operated within 24 hours of trauma and the remainder were operated after 24 hours (►**Figs. 3** and **4**).

►**Table 3** shows analysis of factors affecting the outcome of surgery of the study population. Preoperative GCS of the patient showed significant effect on final outcome. Thirty percent patients had GCS of 14 to 15, 563 (95%) patients had good surgical outcome, while those (57%) with GCS of 9 to 13,1038 (92%) had good outcome. Thirteen percent patients were with poor GCS of 3 to 8, while 180 (70%) cases had poor surgical outcome. Anisocoria is associated with poor surgical outcome in 249 (84%) of the patients. Seventy-six (64%) patients with hematoma volume more than 60 mL had good outcome, but those with 21 to 40 mL and 41 to 60 mL had good surgical outcome in 759 (96%) and 856 (92%) cases following surgical evacuation. When EDH was associated with other intracranial injuries in 25% (495) cases on CT scan, 296 (60%) had poor surgical outcome, while those having no such injuries (only 119 out of 1,484; 8%) showed poor outcome. The patients having skull fractures had good outcome in 1,378 (82%) cases, while patients with no fracture (297; 15%) showed good outcome in only 125 (42%) cases. Good surgical outcome was reported in 100% cases with surgical evacuation within 12 hours of injury (475; 24%), while outcome was good in 1,116 (94%) and 202 (64%) cases when operated in 12 to 24 hours and more than 24 hours, respectively. So, delayed surgery beyond 24 hours caused poor outcome (GOS 1–3) in 114 (36%) of case (►**Figs. 5** and **6**).

Discussion

In our study, majority of patients were in the most acute period of life with mean age of 30.2 years that is comparable with the age mentioned in studies of Ozkan et al and Cheung et al, who found the mean age of patients with EDH as 26.9 and 37.7 years, respectively, in their series.[8,17] Babu et al in his experience of 300 EDH cases noticed the third decade as the most frequent age group that was later reproduced in 2008 by Chowdhury in his study of 610 patients.[8,22] In our

Table 2 Outcomes of the study population ($n = 1,978$):

S.no.	Outcomes	GOS	Number (%)	Total, *n* (%)
1.	Good outcome	5	1,068 (54%)	1,642 (83%)
2.		4	574 (29%)	
3.	Poor outcome	3	237 (12%)	336 (17%)
4.		2	40 (02%)	
5.	Expired	1	59 (03%)	
Total				**1,978 (100%)**

Abbreviation: GOS, Glasgow outcome scale.

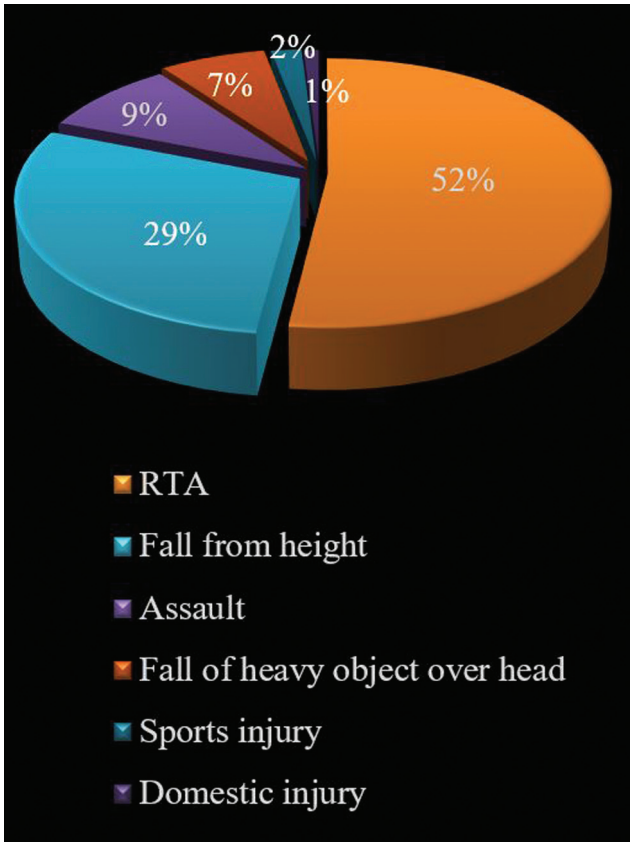

Fig. 3 Distribution of study population by mode of injury. RTA, road traffic accident.

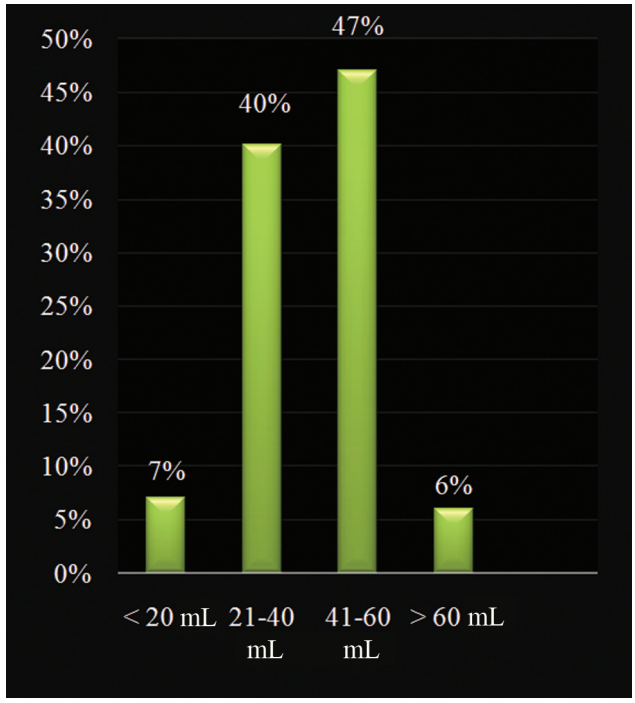

Fig. 4 Distribution of study population by volume of extradural hematoma.

series of 1,978 patients, 1,543 (78%) were males and 435 (22%) were females with a male to female ratio 3.5:1. Much higher male predominance of 13:1 was reported in a Pakistani study on 38 patients at Pakistan Institute of Medical Sciences, Islamabad by Mushtaq and Khaleeq.[23]

Patients with traumatic EDH frequently present with altered state of consciousness[9] that is measured by GCS. In our study, 593 (30%), 1,128 (57%), and 257 (13%) patients presented with a GCS of 14 to 15, 9 to 13, and 3 to 8, respectively,[20,22–24] which is majority (57%) of patients presented with GCS of 9 to 13. This is in contrary to the results of Cohen et al and Cheung et al in which the GCS of the majority of patients was in 13 to 15 range, that is, 67 and 70%, respectively.[8,24] The reason of more patients with decreased GCS in our series is due to the inclusion of the very cases who underwent neurosurgical evacuation of hematoma as compared with the studies mentioned in which patients who needed conservative management only were also included.

In literature, approximately 15 to 22% of patients have anisocoria prior to surgical evacuation of EDH.[7,9] Our result of 297 (15%) patients with anisocoria is comparable with these studies. One of the most important prognostic factors in EDH is its volume.[23] Chowdhury et al and Ayub et al also explained the importance of volume in surgicaloutcome.[9,19] In our series, there were four groups with respect to EDH volume: less than or equal to 20ml, 21 to 40ml, 41 to 60ml, and more than 60ml. Majority of the patients (930; 47%) presented with volume between 41 and 60 mL, followed by 791 (40%) cases with 21 to 40 mL volume. Only 138 (7%) and 119 (6%) of patients had volume of less than or equal to 20 and more than or equal to 60 mL, respectively.

Cheung et al in his study in Hong Kong showed that 5 patients out of 89 (5.6%) have associated intracranial injuries in traumatic EDH cases.[8] In the relatively larger series of 300

Table 3 Factors affecting the outcome ($n = 1,978$)

Sl. no.	Factors affecting outcome			Outcomes	
		GCS	*n* (%)	Good (GOS 4–5) *n* (%)	Poor (GOS 1–3) *n* (%)
1.	Preoperative GCS	14–15	593 (30%)	563 (95%)	30 (05%)
		9–13	1,128 (57%)	1,038 (92%)	90 (08%)
		3–8	257 (13%)	77 (30%)	180 (70%)
2.	Anisocoria	Present	297 (15%)	48 (16%)	249 (84%)
		Absent	1,681 (85%)	1,597 (95%)	84 (05%)
3.	Hematoma volume	> 60 mL	119 (06%)	76 (64%)	43 (36%)
		41–60 mL	930 (47%)	856 (92%)	74 (08%)
		21–40 mL	791 (40%)	759 (96%)	32 (04%)
		< 20 mL	138 (07%)	124 (90%)	14 (10%)
4.	Overlying skull fracture	Present	1,681 (85%)	1,378 (82%)	303 (18%)
		Absent	297 (15%)	125 (42%)	172 (58%)
5.	Associated intracranial injuries	Present	494 (25%)	198 (40%)	296 (60%)
		Absent	1484 (75%)	1,365 (92%)	119 (08%)
6.	Time of surgery	≤ 12 hours	475 (24%)	475 (100%)	00 (00%)
		12–24 hours	1,187 (60%)	1,116 (94%)	71 (06%)
		≥ 24 hours	316 (16%)	202 (64%)	114 (36%)

Abbreviations: GOS, Glasgow outcome scale; GCS, Glasgow coma scale.

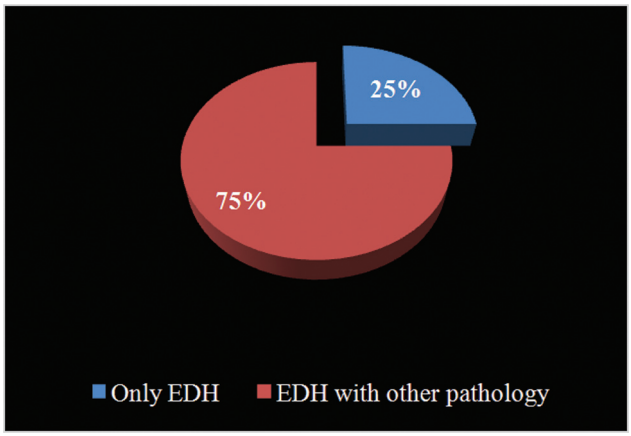

Fig. 5 Distribution of study population by types of lesions. EDH, extradural hematoma.

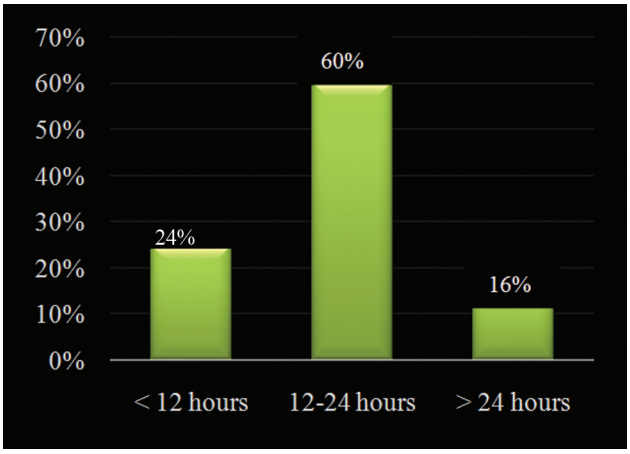

Fig. 6 Distribution of study population by timing of surgery.

patients, Babu et al got a higher (14.3%) cases with associated injuries along with EDH.[7] Later in 2008, Chowdhury et al published still a higher percentage of 32.4% (in 610 patients) for associated injuries.[9] While comparing our result of 494 (25%) associated traumatic injuries was somewhat in between these two larger series. Our result is very comparable with the study at Saudi Arabia, in which 73% had EDH alone and 27%had additional intradural injury.[9] In our study, skull fracture was found in 1,681 (85%) of cases on CT scan of head and preoperative findings that somehow reduce intracranial pressure and give better outcome in comparison to those who did not a fracture. There are multiple studies in the literature explaining the possible factors on which the surgical outcome of EDH depends in which the following five have special importance: Associated intracranial injuries, anisocoria, time between injury and surgery, hematoma volume, and preoperative GCS.[7–9,19,25] In our series, the surgical outcome of EDH was measured by GOS.[15] After surgery, 1,642 (83%) of patients with EDH had good surgical outcome (GOS 4 and 5). The remaining (336; 17%)patients were in poor surgical outcome group (GOS 1–3). Mushtaq et al got comparable postsurgical outcome in which, 86.8% cases were in good scale and the remaining 13.2% were in poor scale.[23] Similarly, Cheung et al experienced postsurgical good and poor outcome in 76.6 and 23.3%, respectively.[5] The mortality rate of 3% in our study was

comparable to the 2.63% of Mushtaq's series.[23] Cheung et al reported a higher mortality of 13.3%.[8]

In our study, GCS of 14 to 15 and 9 to –13 had good surgical outcome in majority of cases (i.e., 100 and 95%, respectively); while the GCS of 3 to 8 had poor outcome in majority (70%) of patients. This result was supported by the Hong Kong series, in which GCS of 13 to 15 and 9 to 12 had good final outcome in 90.5 & 100% cases, respectively, and GCS 3 to 8 had poor outcome in 71.4% cases.[8] The Pakistani study published better outcome of 100% for GCS of either 13 to 15 or 9 to 12, with only 55.5% poor outcome for GCS 3 to 8.[23] We also found that anisocoria is associated with poor surgical outcome in 249 (84%) patients and patients with bilateral equal pupil (1,681; 85%) had good GOS in 1,597 (95%) cases.

Hematoma volume is calculated on CT scan brain by measuring the three dimensions (i.e., transverse, anteroposterior, and craniocaudal) in mm and using the formula: $0.5 \times$ transverse diameter × anteroposterior diameter × craniocaudal diameter. Many studies included this variable while determining the factors affecting outcome in EDH patients.[23] In our series, volume of more than or equal to 60 mL had poor outcome in 36% of cases with 64% good outcome, while volume of 21 to 40 mL and 41 to 60 mL had good surgical outcome in majority of cases (i.e., 96 and 92%, respectively). This observation is partly supported by Mushtaq et al, with 90% good outcome when hematoma volume is less than 50 mL. On the contrary, Mushtaq et al reported good outcome in still 83.3% of cases even when the volume was more than 50 mL.[23]

In this study, EDH coexisted with other intracranial injuries on CT scan head in 494 (25%) cases. Of which, 296 (60%) patients had poor surgical outcome, while in patients with no associated intracranial injuries 1484 (75%) with EDH only 119 (08%) showed poor outcome.[26] Good surgical outcome was reported in 100% cases with surgical evacuation within 12 hours of injury (475; 24%), while outcome was good in 1,116 (94%) and 202 (64%) cases when operated in 12 to 24 and more than 24 hours, respectively. So, delayed surgery beyond 24 hours caused poor outcome (GOS 1–3) in 114 (36%) of case.

Ozkan et al in his retrospective analysis published that mortality rate of 23.5% in patients having surgery later than 6 hours of injury can be reduced to 18.5%, if surgery is performed within 6 hours of injury.[17] In our study, all the patients (1978) who were operated within 12 hours of injury achieved good outcome (i.e., GOS 4 and 5); while the patients in whom the surgery was done between 12 and 24 hours achieved GOS of 4 to 5 (94% cases) and those who were operated beyond 24 hours ended up with GOS 4 to 5 (64% cases). Fifty-nine (3%) patients expired in our series, all of whom had time between injury and surgery of more than 12 hours specially more than 24 hours. So, if we can evacuate all EDH within 12 hours of injury, if we can provide ICU support to all patients and if evacuation can be done under general anesthesia, eventually mortality can be reduced close to nil.

Conclusion

Preoperative GCS, anisocoria, time interval between injury and surgery, hematoma volume, overlying skull fracture, and associated intracranial injuries affect the surgical outcome significantly.

Good surgical outcome is associated with patients with solitary extra dural hematoma of:

- Preoperative GCS ≥ 8
- Absence of anisocoria
- Absence of overlying skull fracture
- Absence of associated intracranial injury
- Undergoing surgical evacuation within 12 hours of injury
- Volume of EDH less than 60 mL

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Conflict of Interest

None declared.

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