ORIGINAL RESEARCH

Functional outcomes of patients following emergency neurosurgical interventions for traumatic brain injury performed by general surgeons at rural hospital in Ethiopia

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Abstract

Background
Traumatic brain injury (TBI) is an important public health problem in Ethiopia and worldwide. TBI can lead to lifelong issues that not only affect the lives of individuals and their families but also have a significant impact on society and the economy, especially where there is poor pre-hospital care, proper intensive care unit and rehabilitation centres. The aim of the study is to assess the functional outcome of patients after neurosurgical intervention following traumatic brain injury performed by general surgeons.

Methods
This was a single hospital based prospective study on the functional outcomes of patients following neurosurgery at Soddo Christian Hospital (SCH), representing a rural hospital in Ethiopia from January 2015 to January 2017. Outcome was described by using the Extended Glasgow Outcome Score (GOSE). Descriptive statistics and non-parametric methods were used for data analysis.

Results
Ninety patients underwent neurosurgical intervention. The ages ranged from 2 to 76 years, with a male predominance of 84.4%. Head injury was severe in 23%, moderate in 17% and mild in 60% of patients. Thirty-seven patients had chronic subdural hematomas (CSDH), 28 had epidural hematomas (EDH), 18 had depressed skull fractures (DSF), 4 had EDH and DSF, and acute subdural hematoma (ASDH) was seen in 3 patients. Functional outcomes based on GOSE were as follows: 61 (67.8%) had upper good recovery, 15 (16.7%) lower good recovery, 6 (2.2%) upper moderate disability, and 1(1.1%) lower moderate disability score. Overall mortality was 12.2% (n-11).

Conclusions
Neurosurgical interventions for intracranial haemorrhage and depressed skull fractures can be done safely by general surgeons with good functional outcomes, and acceptable morbidity and mortality rates.

Keywords: traumatic brain injury, Extended Glasgow Outcome Scale, functional outcomes

Introduction

Head injury is recognized as a major public health problem which is a frequent cause of death and disability. It puts a considerable demand on health services and it is the most common cause of death in the trauma victims. [1, 2, 3,]. In developing countries, the burden is more pronounced and the lack of pre hospital care with low number of physicians has made the outcomes worse than that of developed countries. [1, 2, 3]

Currently there is a better understanding of the mechanism of both the primary and secondary neurologic injury that can have an impact on patients. [7] Significant reduction in mortality and morbidity associated with head injury has been achieved with aggressive management protocols that focuses on maintaining the hemodynamic state of the patient, prompt evacuation of mass effects and proper control of intracranial pressure (ICP) with early neurosurgical interventions. [7].

Table 1. Glasgow Outcome Scale - Extended

1	Dead	
2	Vegetative State (VS)	Condition of unawareness with only reflex responses but with periods of spontaneous eye opening.
3	Low Severe Disability (SD-)	Patient who is dependent for daily support for mental or physical disability, usually a combination of both. If the patient can be left for more than 8h at home it is upper level of SD, if not then it is low level of SD.
4	Upper Severe Disability (SD+)	
5	Low Moderate Disability (MD-)	Patients have some disability such as aphasia, hemiparesis or epilepsy and/ or deficit of memory or personality but are able to look after themselves. They are independent at home but dependent outside. If they are able to return to work even with special arrangement it is upper level of MD, if not then it is low level of MD.
6	Upper Moderate Disability (MD+)	
7	Lower Good Recovery (GR-)	Resumption of normal life with the capacity to work even if pre- injury status has not been achieved. Some patients have minor neurological or psychological deficits. If these deficits are not disabling then it is upper level of GR, if disabling then it is lower level of GR.
8	Upper Good Recovery (GR+)	

Most studies show high mortality rate (76%-90%) and morbidity rate for acute subdural hematoma (ASDH) compared to other type of traumatic brain injuries that need`s surgical intervention [5, 12, 18, 22, 27]. The prognosis is affected with many factors mostly of the severity of the brain injury and type of the pathology with the intervened time frame [4, 5, 10, 12, 18, 22, 27]. Epidural hematoma has promising outcomes if the surgical intervention is in timely manner [5, 18, 26]. Patients with chronic subdural hematomas (CSDH) managed surgically should regain their premorbid neurological function (72%-90%) in majority of cases [8, 18].

In Ethiopia, the number of the hospitals that have the capacity to manage head injuries and the number of neurosurgeons in the country does not correlate with the burden of disease that the country is facing. [2). Soddo Christian Hospital (SCH) is a rural General Hospital in southern Ethiopia with a surgical training program run by the Pan African Academy of Christian Surgeons (PAACS). The teaching faculty consists of general surgeons, hence all head injured patients are managed by general surgeons. SCH only manages emergent cases and refers elective cases to other facilities staffed by neurosurgeons.

The study attempts to find out the outcomes of neurosurgical procedures done for traumatic brain injury (TBI) by general surgeons from a single institution.

Methods

This is a single-hospital based prospective study conducted at Soddo Christian Hospital. The hospital has all the necessary equipments for emergency neurosurgical operations and has adequately trained staffs. All patients who underwent an emergency neurosurgical procedure from January 2015 to January 2017 were recruited for the study. However, patients with incomplete document, patients with significant associated injury other than head injury and pateints who were lost to follow up were excluded. The Pan African Academy of Christian Surgeons (PAACS) electronic logbook was used for data recording: Operations, socio-demographic status. GOSE at follow up, pupillary reaction, lateralizing sign, GCS, complications, outcome condition on discharge and mechanism of TBI are recorded on separate recording sheet. The study was given official permission to be conducted

All patients involved in the study had at least one CT scan as the imaging modality.Head injury severity was assessed at presentation using the standard Glasgow Coma Scale (GCS), Mild being GCS 13-15, moderate 9-12 and severe was less than 9. Functional outcomes were assessed with Glasgow outcome scale (GOSE). Glasgow outcome scale rates patient status into one of five categories: Dead, vegetative state, severe disability, moderate disability or good recovery.The GOSE provides more detailed categorization in to eight

Table 2. Overall mortality association with preoperative diagnoses

Outcome	Preoperative diagnosis					Total
	CSDH	DSF	EDH	EDH + DSF	ASDH	
Dead	2 (2.2%)	1 (1.1%)	7 (7.8%)	0%	1 (1.1%)	11 (12.2%)
Alive	35 (38.9%)	17 (18.9%)	21 (23.3%)	4 (4.4%)	2 (2.2%)	79 (87.8%)
Total	37 (41.1%)	18 (20%)	28 (31.1%)	4 (4.4%)	3 (3.3%)	90 (100%)

Table 3. Pupillary status association with preoperative diagnoses

Pupil stats	Preoperative diagnosis					Total
	CSDH	DSF	EDH	EDH + DSF	ASDH	
Equal and reactive	3 (3.3%)	0%	11 (12.2%)	0%	0%	14 (15.6%)
Pupillary change	34 (37.8%)	18 (20%)	17 (18.9%)	4 (4.4%)	3 (3.3%)	76 (84.4%)
Total	37 (41.1%)	18 (20%)	28 (31.1%)	4 (4.4%)	3 (3.3%)	90 (100%)

Table 4. Overall mortality vs pupillary change and GCS

	GCS < 8	GCS > 8	Total
Pupilary change	10	4	14
Dead	8	0	8
Alive	2	4	6
Total	10	4	14

categories by subdividing the categories of severe disability, moderate disability and good recovery into a lower and upper category [28]. During follow up, patients were contacted in person at the surgical outpatient clinic or followed with telephone interview. For those who could not respond, a responsible adult was interviewed.

A descriptive statistical analysis was made using SPSS software version 21 and non-parametric method was used for data analysis. Association among independent variables were tested using Chi - Square statistic. The data are presented as frequency and percentages, medians or means ± SD. A value of $p < 0.05$ was considered statistically significant. Odds ratio was done for groups, which have significant association.

Results

The total number of head injury patients admitted over the two year period of time were 515 at Soddo Christian hospital (SDH). Majority of them were managed non-operatively (419 patients). The overall deaths in non-operative cases were 45. Ninety-six patents underwent neurosurgical procedures during the two year period at Soddo Christian hospital. Six patients were excluded from the study since either they were lost to follow up and could not be contacted after discharge or had significant associated injury other than head injury. Hence, ninety patients who underwent neurosurgical intervention were included in the study.

Seventy six (84.4%) patients were male and 14 (15.6%) were female. Male to Female ratio was 5.4:1. The age distribution ranged from 2 to 76 years with mean age of presentation of 36.9 ± 18.5 years (Fig. 1). Mean ages significantly differed based on pathology ($P<0.001$); Mean age for CSDH was 48.4 (±16.5) years, mean age for DSF 24.8 (±15) years, mean age for AEDH 30.5 (±14.5) years. Mechanism was strongly associated with pathology ($P<0.001$). The majority of the patients 94.4% were from Southern Nations, Nationalities and Peoples (SNNP) region of Ethiopia where the SCH is located.

About a quarter (24.4%) of the injuries was caused by road traffic injuries (RTI), 29% from assaults or domestic incident; falls caused 19% and 24.4% had an unknown cause of injury – majority being those with chorinc subdural hematomas. Head injury was severe in 23%, moderate in 17% and mild in 60% of patients. For CSDH the majoriy (43.2%) were caused by unknown mechanism and 29.7% were due to falls. For DSF, assault was the leading mechanism accounting for 66.7% of presentations requiring elevation (Table 1).

Non-contrast CT scan was done for all patients and it was found that 37 (41.1%) chronic subdural hematomas (CSDH), 28 (31.1%) had acute epidural hematomas (AEDH), 18 (20%) had depressed skull fractures (DSF), 4 (4.4%) with both AEDH and DSF, and acute subdural hematoma (ASDH) was seen in three patients. Based on preoperative neurological findings, localizing signs were present in 37 (41%) and pupillary changes were seen on 14 (15.6%) patients on presentation. Abnormal pupillary reaction was seen in 14 (15.6%) patients and normal in 76 (84.4%) patients. Pupillary changes differed significantly by pathology and were seen most frequently in AEDH (39.3%; $p = 0.001$) (Table 2 and 3). Four of

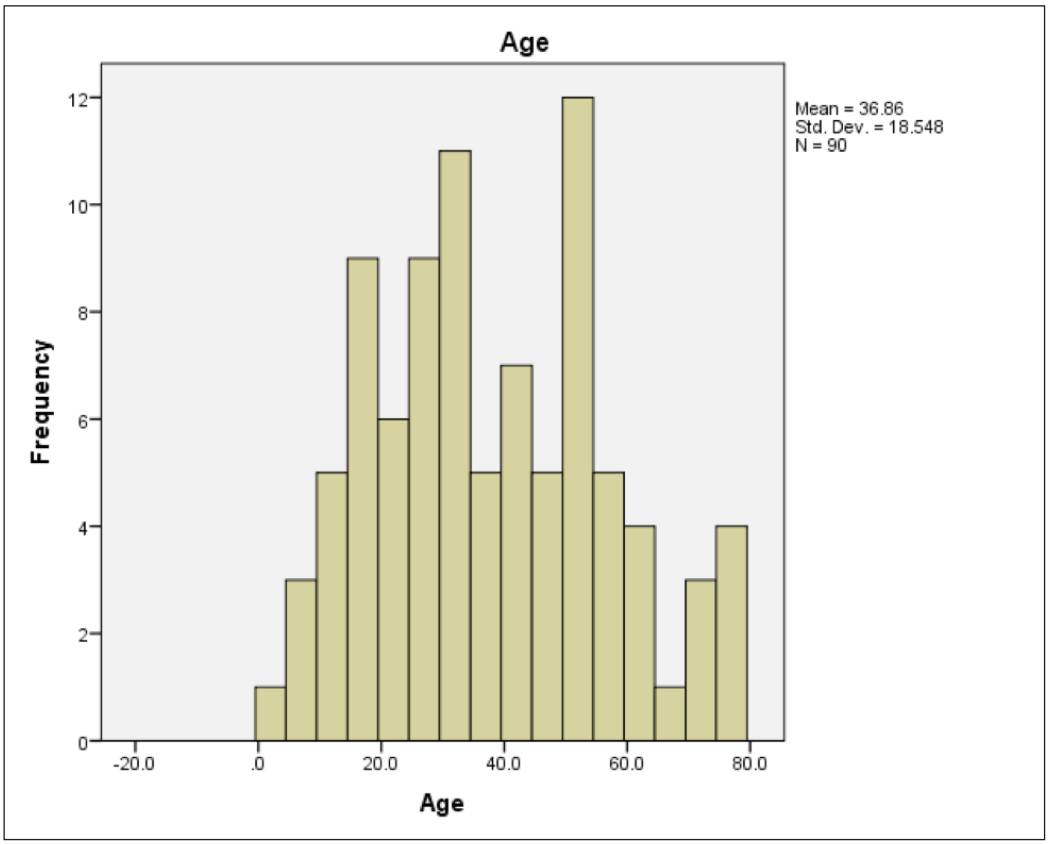

Figure 1. Age Distribution Of Patients With Traumatic Brain Injury Between January 2015 To January 2017, Soddo Christian Hospital, Ethiopia

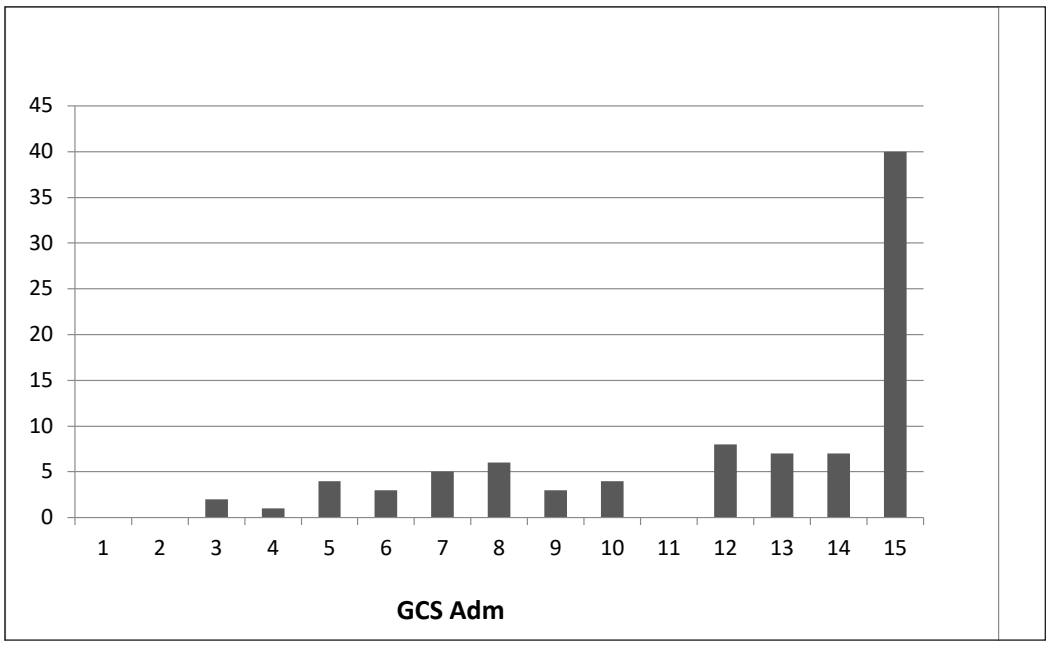

Figure 2. GCS Distribution Of Patients With Traumatic Brain Injury Between January 2015 To January 2017, Soddo Christian Hospital, Ethiopia

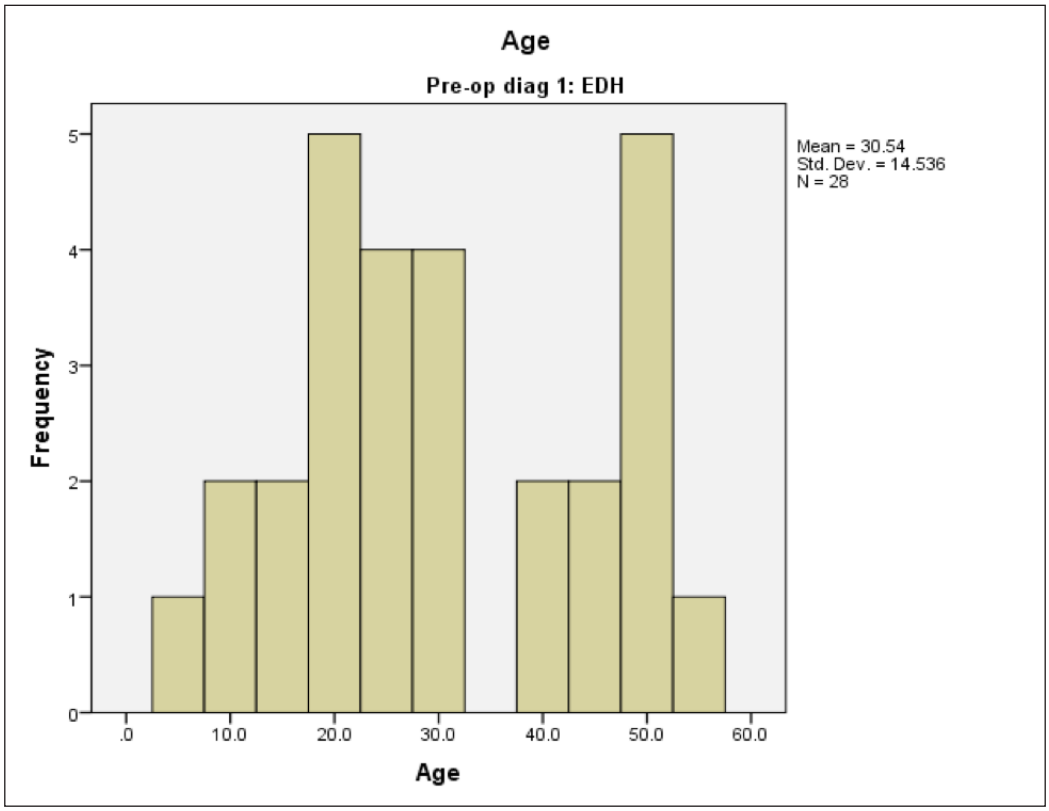

Figure 3. Age distribution of patients with EDH of traumaticbrain injury from January 2015 To January 2017, Soddo Christian Hospital, Ethiopia

them had unilateral pupillary change.

The overall mortality was 12.2 % (n=11) of which 8 died in the hospital and 3 after discharge. Seventy nine (87.8%) were alive at follow up. Mortality rates differed significantly by pathology (p=0.02) and was proportionally highest for ASDH (33.3%, n=1) followed by AEDH (28.6%, n=8). CSDH had mortality of 2.7 % (n=1) and DSF 5.6 % (n=1) (Table 1). Median admission GCS for patients who died was 5 (3-8). During discharge, most patients had a GCS of 15 [n=75 (83.3%)].

Two patients died of aspiration pneumonia, one patient died of surgical site infection and developing meningitis after one month of discharge who had a GCS of 15 at discharge (admission GCS was 13), and one patient died after self-discharge with family request against medical advice. Others died from their head injury. Pupillary change was strongly associated with mortality (OR=27.8 [4.8-161.1],[n-8]; (P<0.001). All patients with pupillary change who died had GCS of £ 8 (n= 8) and those who survived had GCS ³ 9 (n=6) (Table 2 and 3).

No deaths occurred for patients displaying lateralizing signs on admission (n=37). The median admission GCS for patients who died was 5 (3-8) which was significantly lower compared to patients who survived 14 (11-15) (P<0.001). The median age for patients who survived was 33 (21-50) however this was not statistically significant compared to median age for patients who died 41 (23-51) (p=0.771). When mortalities are compared based on the pre-operative GCS, patients with severe head injury had a mortality rate of 47.6% (10/21) and one death from mild head injury (1/54). No death was seen from moderate head injury patients.

At follow up, functional outcomes based on GOSE were as follows: 61 (67.8%) had upper good recovery (CSDH 75.7%[28/37], EDH 60.7%[17/28], DSF 66.7%[12/18]), 15 (16.7%) lower good recovery, 6 (2.2%) upper moderate disability, and 1 (1.1%) lower moderate disability score (Fig 5).

Discussion

Head injury is becoming the most common cause of death and disability. [3, 27] According WHO report TBI will surpass many diseases as a major cause for mortality and disability by year 2020 [24]. This particularly predominates in developing countries and is likely due to absence of pre hospital care and the ability of hospitals to care for these patients. [1, 2, 27] Soddo Christian Hospital is one of the few general hospitals located in the southern part of Ethiopia staffed primarily by general surgeons and orthopedic surgeons. The high flow of patients from SNNP region of Ethiopia to the hospital is likely due to the location of the hospital and the absence of hospitals around the area which are capable of handling neurosurgical cases. [9]

The age distributions for TBI in AEDH and DSF was

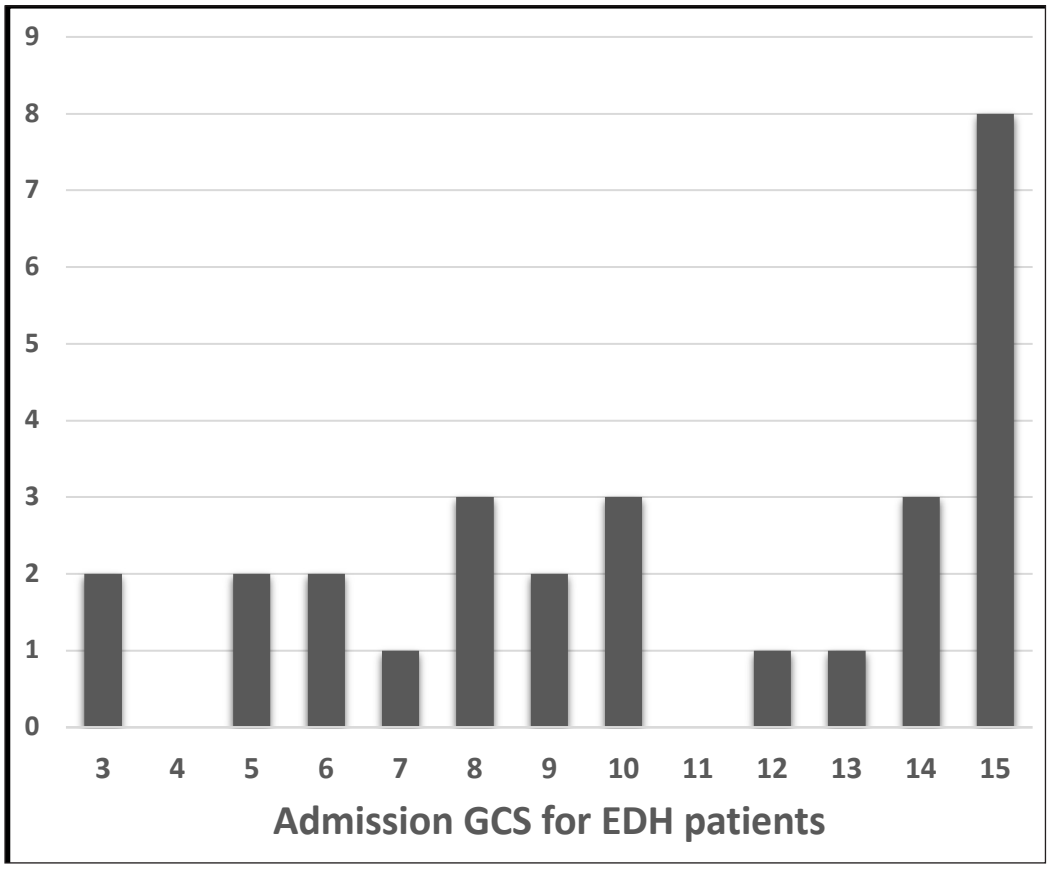

Figure 4. GCS Distribution for patients with EDH on traumatic brain injury between January 2015 and January 2017, Soddo Christian Hospital, Ethiopia

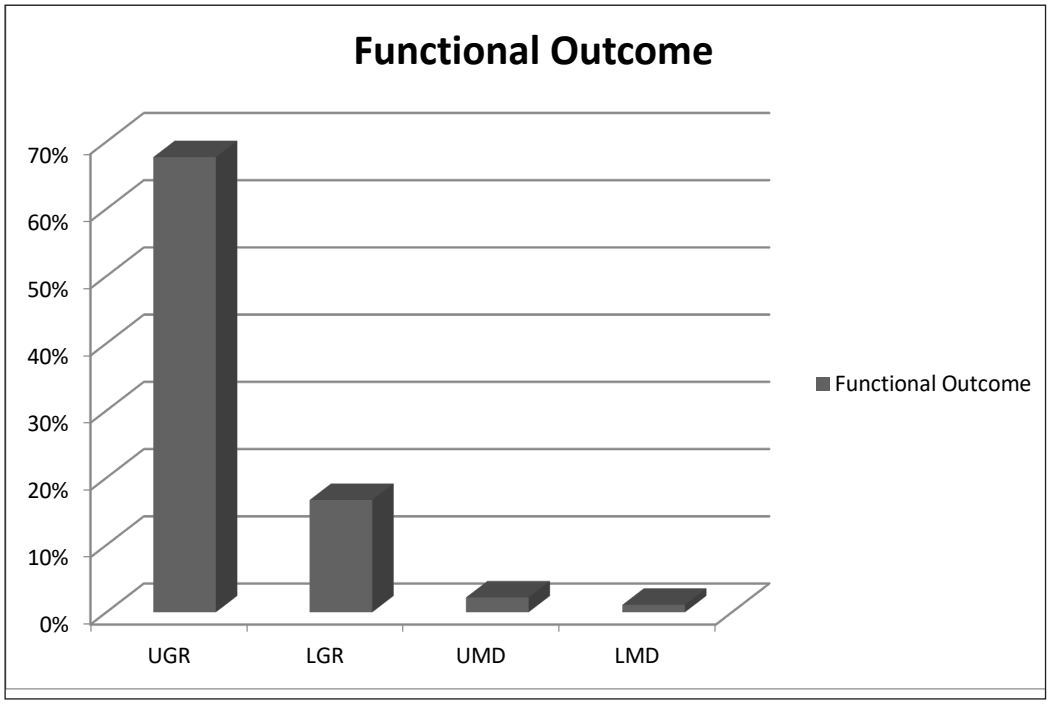

Figure 5. Functional outcomes of neurosurgical interventions of patients with traumatic brain injury between January 2015 To January 2017, Soddo Christian Hospital, Ethiopia

30.5 (±14.5 years) and 24.8 (±15 respectively. This supports the concept that head injuries are more common in young adults [5, 7], possible secondary to high risk behaviors which could lead to injury. In addition, the majority of the motor vehicle(MVH) are owned by young adults in Ethiopia. A hospital study from Darwin, Australia found that 74% of patients were male and the median age was 38-years-old. [7, 18] Tikur Anbessa Specialized Teaching Hospital (TASTH) from Ethiopia found 95% male predominance and mean age of 32.3± 12.05 [5] which are similar to our study (76% and 37-years-old, respectively. [5, 7]. Mean ages significantly different based on pathology ($p < 0.001$); mean age for CSDH was 48.4 (±16.5) years. Similar finding was reported in the Darwin hospital study, where the mean age was 47 years and only 27% of the patients were above 65 years.

Mechanism was strongly associated with pathology ($p < 0.001$). For CSDH the majority (43.2%) was caused by unknown mechanism and 29.7% were due to falls; whilst for DSF, assault was the leading mechanism accounting for 66.7% of patients requiring elevation.

The most common case handled in the Darwin hospital study was ASDH in 32% followed by CSDH with 24%, AEDH in 11% and DSF in 9%. [18] TASTH AEDH in 86.8% and ASDH in 12.1. [5] Our study differed in that CSDH was 41.1% followed by AEDH (31.1%) and DSF (18%). ASDH was seen in 3 patients only. The low number of ASDH treated in our hospital might be from the inability of patients to get to the hospital in a timely manner and from the absence of pre hospital care in the area. ASDH can be lethal if not treated promptly. [10, 18, 22]

The incidence of assault or domestic incident is high in the Darwin hospital study and also on TASTH which is similar to our study. MVA is the most common cause of head injury in most of study [4, 7] but in majority of the developing countries assault and domestic incidents are prevalent. Most patients with pupillary change have died in current study (Table 4). Report by Biluts H *et al* and Heiden *et al* revealed that those patients with pupillary change either died or had poor functional outcome. [5, 25]

Overall mortality rate in the study was 12.2% and severe head injury had a mortality of 47.6% (10/21). TASTH showed 18.7% overall mortality and 50% death for those with severe head injuries. [5]. According to Darwin study 72% ended with good recovery from CSDH. [18] Laidlaw [8] suggested good recovery to be in between 75 and 90%. Our study showed 75.5% upper good recovery from CSDH. AEDH had 28.6% mortality recorded in this study which is different from Rivas et al .14 [26] report which was 12% and TASTH which was 16.5% which might be due to a very delayed presentation. TASTH showed 36.4% mortality from ASDH which is somewhat close with our study 33.3%. [5]

At follow up, functional outcomes based on GOSE were as follows: 61 (67.8%) had upper good recovery, 15 (16.7%), lower good recovery, 6 (2.2%) upper moderate disability, and 1 (1.1%) lower moderate disability score (Fig 5).

Limitations

Inadequate number of pateints and short follow up period, loss of patient`s document, difficulty of tracing some patients after discharge due to absence of network to cantact them with phone and lack of transportation to come back on the visit days were some of the limitations of the study.

Conclusions and recommendations

Young male populations are mainly affected by TBI and mechanism of injury was found significantly associated with the pathology. Low pre-operative GCS is associated high mortality rate as compared with patients with higher GCS. The study showed ASDH has the worst outcome followed by AEDH.

Majority of the patients had good recovery with the ability of returning to their previous activities. This showed emergency neurosurgical operation can be safely done by general surgeons in the absence of neurosurgeons provide adequate equipments are available. Training general surgeons to handle emergency neurosurgical cases significantly reduces mortality and morbidity associated with the condition.

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