Original Article

Epidemiology and Functional Outcome of Head Injury in Rural Kenya

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Abstract

Background: Head injury is a major cause of disability, morbidity, and mortality and is responsible for a significant proportion of all traumatic deaths. The aim of this study was to document the epidemiology and factors influencing functional recovery in patients treated for head injury in a rural institution in Kenya. **Methods**: A retrospective analysis of 209 patients admitted to the surgical unit at Consolata Hospital and diagnosed with head injury between January 2009 and December 2012. Outcome was assessed according to the Glasgow Outcome Scale (GOS) score at the time of discharge from hospital. **Results**: There were 180 men (86.1%) and 29 women (13.9%). The median age was 30 years. Road traffic accidents (56.7%), assault (23.9%), and falls (15.4%) were the leading causes of head injury. The distribution of head injury severity was mild in 72.5%, moderate in 9%, and severe in 18.5%. Good functional recovery was achieved by 139(66.5%) of the patients in our series, whereas moderate and severe disability accounted for 18.2% and 5.3% while mortality accounted for 10%. Increasing age ($p=0.006$), a lower GCS score at admission, pupillary abnormalities, a history of loss of consciousness and admission into our Intensive Care Unit were all associated with poorer outcomes ($p<0.000$). **Conclusion**: Outcome depended on age, initial GCS score, pupillary abnormalities, history of loss of consciousness and admission into our Intensive Care Unit. These findings can be used to improve the management criteria in rural hospitals but we recommend establishment of a standardized surveillance system for head injuries to aid in development of new, more effective, targeted prevention strategies.

Key Words: Head injury, Outcome, Epidemiology, Incidence

Introduction

Head injury is a major cause of disability, morbidity, and mortality and is responsible for a significant proportion of all traumatic deaths (1). It accounts for nearly 50% of all injury deaths and remains the leading cause of both injury death and disability among children and young adults (2). As such, head injury is a public health problem that has a great impact on society, costing it the loss of human potential and a lot of capital in treatment and rehabilitation of head injury patients. In the past few years, rapid economic development and urbanization in rural areas like Nyeri has resulted in increases in motor vehicles, motor bikes, tall buildings and accompanying change of lifestyle. These changes may have increased the risk of traffic accidents and high-level falls associated with head injury that we are encountering more frequently in these areas. However, to the authors' knowledge, there is no data to support this epidemiologic transition of head injury in the rural areas nor has there been any other study that addressed the epidemiology and outcome of head injury in a rural Kenyan hospital.

The aim of this study was to review patients who were treated for head injury in a single rural institution in Kenya in order to study the epidemiology and elucidate factors influencing functional recovery. The institution, Consolata Hospital, is a mission hospital that handles a lot of the head injury burden in Nyeri County.

Methodology

After approval from the Consolata Hospital administration, a retrospective analysis was conducted, including 209 consecutive patients who were admitted to the surgical unit at Consolata Hospital and diagnosed with head injury between January 2009 and December 2012. The records were analyzed for demographic characteristics. In addition, clinical variables were recorded such as gender, age, GCS on admission, pupil abnormalities, blood pressure, mechanism of injury, accompanying injuries, convulsions, loss of consciousness and type of mass lesion if present. Surgical variables were also recorded, such as type of surgery and time elapsed from accident to surgery. Outcome was assessed according to the Glasgow Outcome Scale (GOS) score at the time of discharge from hospital.

The data was collected in questionnaires, coded and analyzed using Statistical Package for Social Sciences (SPSS), version 18.0. Various variables were described using computed frequencies and means; discrete variables were compared using the chi square test and continuous variables compared using Student's T test. According to the GCS score determined upon admission, all patients were divided into three groups; those with GCS scores of 3–8, 9–13, and 13–15 for statistical analysis. Logistic and univariate linear regression models were run to determine which variables are independently associated with functional recovery and mortality.

Our retrospective design had a limitation since we had to rely on others for accurate record-keeping. We had 178 complete data sets. The 31 incomplete data sets were mostly missing the reporting of the GCS score at admission. Another limitation associated with retrospective studies because of the retrospective aspect is selection bias, but we mitigated this by retrieving all the stored records instead of sampling.

Glasgow outcome scale scores

1: Death

2: Persistent vegetative state:

Patient exhibits no obvious cortical function

3: Severe disability (conscious but disabled):

Patient depends upon others for daily support due to mental or physical disability or both

4: Moderate disability (disabled but independent):

Patient is independent as far as daily life is concerned. The disabilities found include varying degrees of dysphasia, hemiparesis, or ataxia, as well as intellectual and memory deficits and personality changes

5: Good functional recovery:

Resumption of normal activities even though there may be minor neurological or psychological deficits

Results

During the study period, 209 patients diagnosed with head injury at Consolata Hospital met the inclusion criteria. Of these, there was a clear male predominance, with 180 (86.1%) male and 29 (13.9%) female patients. The mean age was 32.61 years (±18.310), with a range from 1 year to 93 years. Majority of the patients (42.1%) were aged between 26 and 45 years, whereas 12% and 6.7% were younger than age 13 years and older than age 61 years, respectively (Figure 1). The most common cause of injury was road traffic accidents (56.7%), with assault and falls accounting for 23.9% and 15.4% respectively (Figure 2).

Insert Figure 1-2 here

According to CT scan findings, the most common injury was skull fractures (23%) (Table1). Ten percent of the head injury patients had subdural hematomas, 7.7% extradural hematomas, 7.2% intra-cerebral hemorrhage and 9.1% contusions. Skull fractures were more common in patients with extradural hematomas (43.8%), intracerebral hemorrhage (40%), subarachnoid hemorrhage (50%) and contusions (31.6%). Forty one percent of patients also had other accompanying injuries such as chest injury (6.2%), abdominal injury (2.9%), limb injury (28.7%), pelvic injury (1.4%) and a combination of chest and limb injury (2.4%).

Insert Table 1 here

With regards to presentation, most of the patients (61.7%) arrived directly from the site of injury, whereas 38.3% were referrals from other health facilities. A number of the patients (48.3%) reported a period of loss of consciousness while 6.2% experienced convulsions. 9.1% of the patients were under the influence of alcohol when the head injury occurred. Only 10.2% of the patients presented with pupillary abnormalities: anisocoria (6.6%) and bilaterally abnormal papillary responses (3.6%). On admission, 33 (18.5%) of the patients had severe head injury while 16 (9%) and 129 (72.5%) had moderate and mild head injury respectively (Figure 3). The incidence of head injury in our center has been on the rise. Only 5.3% of the head injury cases occurred in 2009, 26.3% in 2010, 18.2% in 2011 and the majority of the cases occurring in 2012 (50.2%) (Figure 4). The peak incidence of head injuries was during the holiday season in the month of December (13.4%) while July had the lowest incidence (3.8%).

Insert Figure 3 and 4 here

Good functional recovery was achieved by 139 (66.5%) of the patients in our series whereas moderate and severe disability accounted for 18.2% and 5.3%, respectively (Figure 5). Females were more likely to have functional recovery (72.4%) than males (65.6%) but this was not statistically significant (P=0.627). None of female patients had severe disability as compared to 6.1% of male patients. Females had a higher mortality (17.2%) as compared to males (8.9%). The proportion of patients who achieved functional recovery seemed to decrease with increasing age. Patients aged between 26 and 45 years (71.6%, P=0.034) were more likely to have good recovery as compared to patients older than age 60 years, among whom only 28.6% had good recovery. Severe and moderate disability was more prevalent in those older than age 65 at 7.1% and 35.7% respectively, as compared to the other age sets. In addition, mortality was also higher in those older than age 65 at 28.6% as compared to the other age sets.

Insert Figure 5 here

Patients who fell were less likely to have functional recovery (64.5%) than those who were assaulted (71%) or involved in a motor vehicle accident (64.9%) but this was not statistically significant (P=0.983). Severe disability was more prevalent in those who fell (9.7%) as compared to motor vehicle accidents (4.4%) and assault (4.2%). Mortality was higher in motor vehicle accidents at 13.2% as compared to assault (4.2%) and falls (6.5%). With regards to the type of head injury, patients with skull fractures had the highest proportion of functional recovery (58.3%), whereas patients with contusions, extradural hematomas, subdural hematomas and intracerebral hemorrhage had functional recovery rates of 31.6%, 31.3%, 28.6% and 26.7% respectively. Subarachnoid hemorrhage had the lowest functional recovery rate of 0% and the highest mortality (50%) and residual disability (50%) but there were only 2 cases recorded in the study. Contusions had a percentage mortality of 21.1%, closely followed by intracerebral hemorrhage (20%) and extradural hematomas (18.8%), whereas subdural hematomas and skull fractures had a percentage mortality of 9.5% and 6.3% respectively. Figure 6 is a graph comparing the relationships the different types of lesions had to patient outcomes measured by the Glasgow outcome scale.

Insert Figure 6 here

Glasgow Coma Scale (GCS) score on admission was recorded for 178 patients, among whom 129(72.5%), 16 (9%), and 33 (18.5%) patients had mild, moderate, and severe head injury respectively. When outcome was cross-tabulated against admission GCS, it was observed that the proportion of patients with good functional recovery increased gradually from 12.1% in patients with GCS score 3-8, to 37.5% and 82.2% for patients with GCS scores 9–12 and 13-15, respectively (P<0.000) (Figure 4). Furthermore, percentage mortality significantly increased with decreasing GCS score. Patients with mild head injury (GCS score 13-15) had a percentage mortality of 0.8% as compared to 12.5% and 48.5% in those who had moderate (GCS score 9-12) and severe head injury (GCS score 3-8) respectively.

Pupillary reaction was recorded for 197 patients. With regard to these patients, 74% of those with bilateral reactive pupils achieved a functional recovery compared with only 15.4% and 0% of patients who had anisocoric but reactive pupils and bilateral abnormal pupillary responses respectively (P=0.000). Details regarding loss of consciousness following trauma was available for 209 patients, with 101 (48.3%) having a positive history. Patients who did not have traumatic loss of consciousness were more likely to have good functional outcome (82.4) whereas those who had such a history were more likely to have severe disability (9.9%) (P=0.000).

Twenty three (11%) of the patients in our series had surgical intervention. Patients who had surgical intervention were less likely to achieve functional outcome (17.4%) as compared to 72.6% in those managed conservatively. In addition, severe disability was also more common among surgically (21.7%) than conservatively managed patients (3.2%) (P=0.002). Furthermore, the time elapsed from initial trauma to surgery significantly influenced outcome. Of the 17 patients who had surgical intervention within 24 hours, good recovery and moderate disability accounted for 17.6% and 47.1% respectively, as compared to 25% and 75% of those who had surgical intervention more than 24 hours after trauma.

The mean duration of hospital stay was 7.78 (±9.603) days. Patients who stayed for a shorter duration had a better outcome. Those who stayed for 1 day or less and those who stayed for 2 to 10 days had a good functional recovery of 79.4% and 74.2% respectively. In contrast, those who stayed for 11 to 20 days and greater than 20 days had a functional recovery of 48.6% and 18.8% respectively. 23% of the patients in our series were admitted to our Intensive Care Unit (ICU). These patients had a poorer outcome with only 20.8% achieving good functional recovery, as compared to 80.1% functional recovery achieved by patients not admitted in ICU (P<0.000).

Insert Table 2 here

Discussion

The mean age of the patients in our study was 32.61 years (±18.310), and the incidence of head injury peaked in the young and active group (15 to 45 years old), which accounted 66.5% for all of the patients, and was more common in males. The risk taking behavior of males and the young and active age group may be the cause of this gender and age difference. Wu et al while studying an Chinese population reported a mean age of 36 years (± 17), an incidence of head injury that also peaked in the young and active group (15 to 54 years old), 71.5% for all of the patients, and was more common in males, which is similar to the results of our series (3). Since most head injuries occur in the young population during their productive working year, the economic costs are high (4).

In our study, motor vehicle accidents (56.7%), assault (23.9%) and falls (15.4%) are the leading causes of head injury. As compared with a study done by Kiboi et al in 2011, in Nairobi (urban Kenya), the percentage of head injury caused by assault (48%) was more than twice that recorded in our series (5). The percentage caused by motor vehicle accidents (28%) was half that recorded in our series. These findings were in accordance to statistics published by the National Road Safety Council, which showed that most injury-producing crashes occur on roads in rural areas (60%), mostly intercity highways, whilst only 40% take place in urban areas (6). Falls accounted for 24% of the head injuries in Nairobi. The higher rate of head injury caused by assault in urban Kenya may be attributed to the higher crime rate and insecurity in the city. Motor vehicle accidents, assault and fall related injury have the same distribution pattern with ages, which indicated a peak at 26 to 45 years age group. This pattern was not similar to other head injury studies in developed countries, whereby the second most common cause of head injury was fall-related injury which mainly affected the elderly population. Falls in our study only accounted for about 15.4% of all cases, ranked the third cause of head injury. In addition, fall-related injury mainly occurred in young patients, not in elderly and children as other studies showed (7-9). In contrast, motor vehicle accidents were the most common cause of head injury in elderly and children. Earlier studies conducted by Hukkelhoven et al in 2003, showed that elderly persons aged 65 years and above with severe head injury had a higher mortality as compared with younger age groups (10).

Motor vehicle accidents were the leading causes of head injury, which was much higher than USA and European countries. This may be due to underlying interrelated factors such as: rapid growth in motorisation and human population; increased traffic volume and movement; deficiencies and problems in road user behaviour; and poor public transport system with special reference to buses and *'matatus'*; the declining economic conditions in Kenya; deficiencies in road network development and maintenance; and deficiencies in road safety planning, management and interventions (11). Patterns of incidence by gender as well as the male to female ratio are in agreement with previous findings with males showing a higher incidence than females (12). The main incidence and mortality peaks were in 26 to 45 age groups, which is slightly later in life than seen in European reports. A study done by Javouhey et al in France showed an incidence peak in ages 18 to 24 years in males and 15 to 17 years in females (12). The high frequency of motor vehicle crashes as the main etiology of head injury may be explained by lack of use of personal protective equipment at time of injury especially for motor cyclists. Seat belts and airbags for motor vehicle occupants and helmets for both motorcyclists and bicyclists have been demonstrated to substantially reduce the risk of head injury (13-17). New traffic laws have recently been enacted in Kenya, which mandate helmet usage for motorcycle drivers and seat belt usage for drivers and passengers of motor vehicles, so we expect a decrease in incidence of head injury due to motor vehicle accidents once these laws are fully enforced.

According to our study, 72.5% of head injuries were mild, 9% were moderate, and 18.5% were severe. In comparison with most other studies, in which mild, moderate, and severe cases counted for approximately 80%, 10%, and 10%, respectively, the increased percentage of severe head injury most likely results from different admission procedures, leading to a bias regarding the proportion of mild cases (8,19-21).

About 66.5% of the patients hospitalized with a head injury had a good functional recovery, 18.2% had moderate disabilities, 5.3% had severe disabilities and 10% died. Luerssen et al stated that age is a good indicator of mortality in cases of traumatic brain injury (4). There is an increased chance of survival in the younger age group, they tolerate periods of coma better than the older age group, and have fewer life-threatening complications. Those in the extreme age groups have a higher mortality. Our current study showed a highly significant relation between age and prognosis ($p = 0.034$). The age group that recorded the highest percentage mortality was that of those older than 61 years, they had a percentage mortality of 28.6%. This was followed by those between ages 46 and 60 years with a percentage mortality of 12.9%. Several studies, including those done by Fearnside et al and Luerssen et al, have shown that there is a good correlation between the GCS score and the neurologic outcome (4,18). These findings were similar to those of our study which confirmed that a GCS score had a significant relationship with the outcome.

This report has multiple limitations and weakness. First, the collected data come from hospitalized patients only because the surveillance system of head injury has not been established in Kenya. Therefore, it is not likely to study the epidemiology of head injury based on population. Second, this study is a single center study in a rural area with a huge proportion of head injury patients being referred from neighboring centers. Although the center of study is well equipped with facilities and specialists, the other centers in the same rural area which refer patients to the center of study have poor or no facilities, which may result in a bias when assessing the outcome of patients with head injury. Third, because GCS and GOS are early, global measures, more detailed follow-up studies are needed to identify the specific long-term outcomes of head injury. In addition, this being a retrospective study, we relied on records but there were a few data variables which did not have complete data sets as illustrated by our results.

The characteristics of head injury in rural central Kenya are associated with the rapid increase of motor vehicle accident-caused head injuries which consist of a higher proportion of more severe head injuries. The lack of an adequate system of surveillance to quantitatively characterize and accurately assess the scope of head injury is unfortunate, but we hope a regional head injury registration system is established in the near future. In USA, these systems have been shown to decrease mortality according to a study carried out by Nathens et al (22). Head injury is largely preventable, so public awareness and prevention programs targeting the high-risk groups should be made a priority. Such programs may be incorporated into the school educational curriculum to modify risk-taking behavior among the young. Another priority should be full enforcement of the legislation which mandate seat belt usage for motor vehicle users and helmets for motorcyclists and cyclists.

Conclusion

In conclusion, males and young adults were affected more often by head injury. Motor vehicle accidents, assault and falls are the leading causes of head injury in Consolata Hospital, Nyeri. According to our study, 72.5% of head injuries were mild, 9% were moderate, and 18.5% were severe. 66.5% of the patients had a good functional recovery, 18.2% had moderate disabilities, 5.3% had severe disabilities and 10% died. Predictors for poor outcomes included older age, a lower preoperative GCS score, pupillary abnormalities, history of loss of consciousness and admission into our Intensive Care Unit. We recommend establishment of a standardized surveillance system for head injuries and development of a national head injury database to guide creation and implementation of prevention strategies locally. We hope our findings will help in improving the management of head injury in the rural settings.

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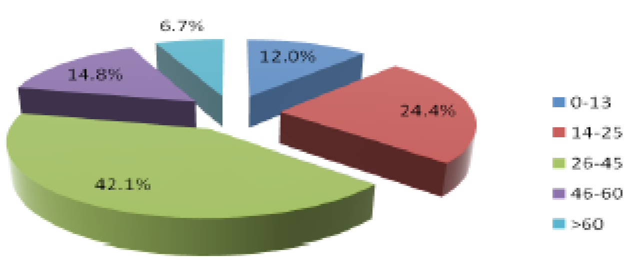

Figure 1. The distribution by age of patients with head injury.

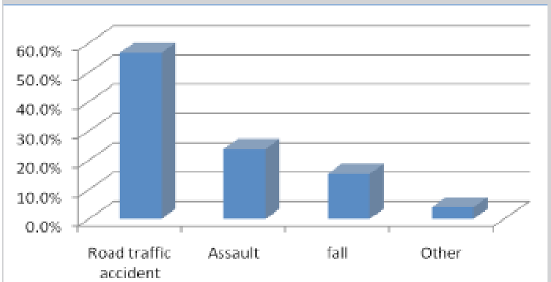

Figure 2. Frequencies of the respective mechanisms of injury.

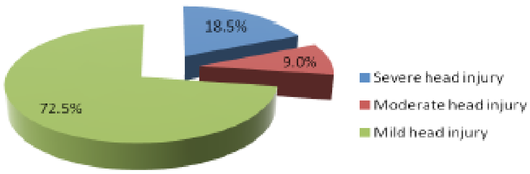

Figure 3. A pie chart showing the severity of injury

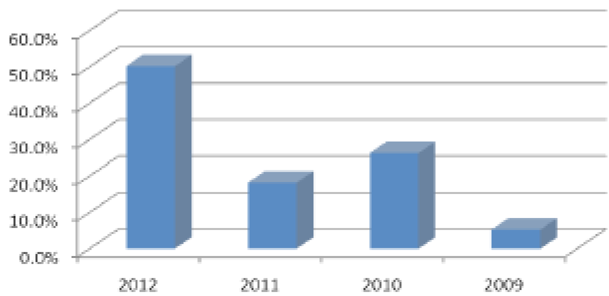

Figure 4. Incidence of head injury

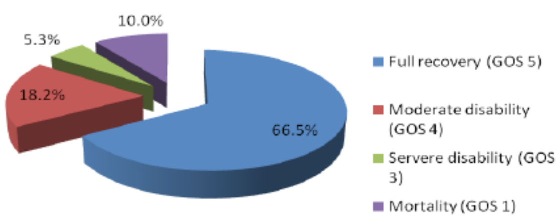

Figure 5. Outcome of patients with head injury.

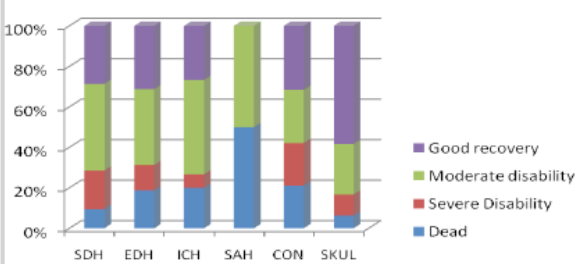

Figure 6. An illustration comparing the relationships the different types of lesions had to the patient glasgow outcome scale scores. SKUL, Skull fracture. CON, Contusion

Table 1. Frequency of the various posttraumatic injuries in patients in our series

Type of Injury	Frequency	Percentage
Skull fractures	48	23.0%
Subdural hematoma	21	10.0%
Contusion	19	9.1%
Extradural hematoma	16	7.7%
Intracerebral hemorrhage	15	7.2%
Traumatic subarachnoid hemorrhage	2	1.0%

Table 2. Clinical variables and their influence on patient outcome

Clinical Variables	No. of Patients	Mortality	Severe disability	Moderate disability	Good Recovery	P
Totals	209	21	11	38	139	
Sex						0.627
Male	180	16	11	35	118	
Female	29	5	0	3	21	
Age (years)						0.034
0–13	25	1	1	1	22	
14–25	51	6	4	7	34	
26–45	88	6	3	16	63	
46–60	31	4	2	9	16	
≥61	14	4	1	5	4	
Mechanism of injury						0.983
Motor vehicle collision	114	15	5	20	74	

Assault	48	2	2	10	34	
Fall	31	2	3	6	20	
Other	8	2	1	1	4	
Glasgow Coma Scale score						0.000
≤8	33	16	6	7	4	
9–12	16	2	3	5	6	
≥13	129	1	2	20	106	
Pupillary abnormalities						0.000
Reactive to light	177.0	11.0	9.0	26.0	131.0	
Anisocoric	13.0	4.0	1.0	6.0	2.0	
Bilateral abnormal responses	7.0	5.0	1.0	1.0	0.0	
Referral from another health facility						0.000
Yes	80	15	6	20	39	
No	129	6	5	18	100	
History of loss of consciousness						0.000
Yes	101.0	21.0	10.0	20.0	50.0	
No	108.0	0.0	1.0	18.0	89.0	
History of convulsions						0.638
Yes	13	1	2	3	7	
No	196	20	9	35	132	
Duration of hospital stay (Days)						0.060
≤1	34	7	0	0	27	
2-10	124	9	2	21	92	
11-20	35	4	3	11	17	

≥21	16	1	6	6	3	
ICU stay						0.000
Yes	48	15	8	15	10	
No	161	6	3	23	129	
Surgery done						0.002
Yes	23	3	5	11	4	
No	186	18	6	27	135	
Time from trauma to surgery						0.899
<24 hours	17	3	3	8	3	
1–4 days	4	0	0	3	1	
>4 days	2	0	2	0	0	
Type of surgery						0.000
Craniotomy and evacuation	7	1	3	3	0	
Burr hole evacuation	10	2	1	5	2	
Craniotomy and elevation of a depressed skull fracture	6	0	1	3	2	