

CORRELATIONS OF COMPUTERIZED TOMOGRAPHIC SEVERITY WITH CLINICAL SEVERITY AND OUTCOME OF HEAD INJURY PATIENTS AT TIKUR ANBESSA SPECIALIZED REFERRAL AND TEACHING HOSPITAL, AA, ETHIOPIA

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Table of contents

| | |
|---|-----|
| ABSTRACT..... | i |
| ACKNOWLEDGEMENT | ii |
| Acronyms | iii |
| 1.0 INTRODUCTION..... | 1 |
| 1.1 BACKGROUND..... | 1 |
| 1.2. Statement of the Problem | 2 |
| 1.3. Significance of the study | 4 |
| 2.0 Literature review..... | 5 |
| 3.0 Objectives..... | 8 |
| 3.1 General objectives: | 8 |
| 3.2 Specific objectives:..... | 8 |
| 4.0 Materials and Methods:..... | 9 |
| 4.1 Study Area:..... | 9 |
| 4.2 Study design:..... | 9 |
| 4.3 Study duration: | 9 |
| 4.4 Study Population:..... | 9 |
| 4.5 sample size:..... | 9 |
| 4.6 Inclusion and exclusion criteria..... | 9 |
| 4.6.1 Inclusion criteria..... | 9 |
| 4.6.2 Exclusion criteria:..... | 10 |
| 4.7 Data collection tools and techniques..... | 10 |
| 4.8 Ethical considerations | 10 |
| 5.0 Results..... | 11 |
| 6.0 Discussions | 22 |
| 7.0 Conclusions | 25 |
| 8.0 Limitations of the study | 25 |
| 9.0 Recommendations | 25 |
| 10. References | 26 |
| 11. ANNEX..... | 27 |
| Questionnaire | 28 |

List of Tables and Figures

| | |
|--|----|
| Table1: Mechanisms of injury in different age categories..... | 12 |
| Table2: The outcome of subarachnoid hemorrhage patients | 16 |
| Table3: Clinical severity score (GCS) of diffuse axonal injury patients..... | 17 |
| Table 4. Clinical severity scores (GCS)..... | 18 |
| Table 5: Correlation of outcome and known clinical severity scores (GCS) | 19 |
| Table 6: Correlation of Rotterdam CT severity score and clinical severity score (GCS)..... | 20 |
| Table 7: Correlation of Rotterdam CT severity score and known outcomes of injury | 21 |
| Table 8: Mechanism of injury and Rotterdam CT severity score | 21 |
| Table 9. Summary of CT findings and correlation with CT and clinical severity scores..... | 27 |
| Figure 1 age distribution..... | 11 |
| Figure2 sex distribution..... | 13 |
| Figure3 Frequencies of mechanism of injury..... | 14 |

ABSTRACT

BACKGROUND: Polytrauma due to road traffic accidents (RTA) is the leading cause of head injury in all age groups especially in young adults. More than half of the cases of head trauma are caused by RTA, leading to 70% of all deaths due to brain injury.

OBJECTIVE: To correlate the computed tomographic (CT) severity of head injury patients with their clinical severity score (GCS) and outcomes.

MATERIALS AND METHODS: An institutional based prospective cross sectional study was conducted among 131 head injury patients over a period of 6 months (from March to August 2017). The patients' levels of consciousness (GCS) were determined and non-contrast head CT scans were performed from vertex to base of the head. The causes for head injury were recorded. The outcomes of patients were also documented from direct telephone communications and chart retrieval and document reviews using patients' medical record numbers.

RESULTS: The age range of patients was 6 months to 80 years. The mean age of patients was 30.9 with male to female ratio being 5:1. The most common causes for head injury were RTA (46.6%), fighting (32.1%) and falling down injury (19.1%). The most common CT findings were skull fractures (51.9%), soft tissue swelling (34.4%), brain contusions (32.8%), brain herniation (29.8%), brain edema (29.0%), SDH (22.9%), SAH (18.3%), EDH (16.0%) and IVH (6.9%). There were a total of 6 (6.6%) deaths which were resulted from fall down (3 cases), RTA (2 cases) and fighting (1 case). Most patients had Rotterdam CT severity score of 2 and GCS of 13 and above. Loss of consciousness and vomiting were the commonest clinical features in head injury patients brought to emergency department.

CONCLUSION: The Rotterdam CT scores of most of the patients in this study was 2. Significant correlation (P-value <0.001) was found between the Rotterdam CT severity scores and clinical severity scores (GCS). The CT severity scores showed inverse correlation with clinical severity scores (GCS) of patients and found to be strong predictor of outcome. The CT severity score was also found to have positive correlation with mechanism of injury (P-value=0.044). It was also shown that significant association was found between the outcome of study subjects and Rotterdam CT severity scores (P-value =0.02). The most severe clinical and CT severity scores were found in road traffic accident cases.

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Acronyms

A.A-Addis Ababa

CT-Computed Tomography

DAI-Diffuse axonal injury

EDH-epidural hematoma

ED-Emergency Department

GCS-Glasgow Comma Scale

IVH-Intraventricular hemorrhage

JUTH-Jimma University Teaching Hospital

MOI-Mechanism of injury

MR-Magnetic resonance

MPR-Multiplanar Reconstructions

MVA-Motor vehicle accident

RTA-Road Traffic Accident

SAH-subarachnoid hemorrhage

SDH-subdural hematoma

TASH- Tikur Anbessa Specialized Referral and Teaching Hospital

TBI-Traumatic brain injury

WHO- World health organization

1.0 INTRODUCTION

1.1 BACKGROUND

Trauma especially head trauma is an expanding major public health problem and the leading cause of death in young and productive part of the world's population. Head injury is trauma related injury to the scalp, skull or brain [1]. Globally head injury is a substantial cause of mortality and morbidity across all age groups, with a disproportionately greater burden borne by low- and middle-income countries such as Ethiopia. Head injuries rank high among morbidities due to trauma. Computerized tomography (CT) is an important modality in the investigation of these cases as it can precisely define the nature and location of the culprit lesion(s). Motor vehicle accidents (MVAs) are the leading cause of head injury followed by falls, assaults, firearm wounds and others. High risk groups for TBI include adolescents, young adults and the elderly, with males being affected 2-3 times more often than females. The studies also showed that the main causes and risk factors for head injury in Africa are road traffic accident (RTA), falls and violence (10).

CT is ideally suited to evaluate patients immediately after trauma. It is widely available, and rapid that permits close monitoring of unstable patients. It is very sensitive in detecting acute hematomas and depressed fractures that require emergency surgery. The fast examination time, wide availability, lack of contraindications and high accuracy for detecting hemorrhages have made CT the diagnostic study of choice for initial evaluation of head injury [4]. The initial assessment of a patient with TBI includes the clinical assessment, commonly used is the GCS, data regarding the accident and imaging commonly CT. It is essential to determine the cause of the trauma, the impact intensity, presence of neurological symptoms, convulsion, and particularly document any reports on loss of consciousness, time elapsed between the accident and the examination, vomits and seizures.⁷

According to the GCS, traumatic brain injuries are classified as mild, moderate or severe. The GCS was initially described by Teasdale & Jennet in 1974, and is currently the most widely used parameter for assessment of consciousness level, as amongst its advantages, it comprises a set of very simple and easy to- perform physical examinations.⁸ According to the great

observational studies, of all attendance to clinical settings because of head trauma, 93% of adults and 96% of children suffer mild head injury, 6% of adults and 5% of children suffer moderate head injury and only 1% of adults and 0.5% of children suffer severe head injury based on the GCS stratification rule.[7-10]

CT findings in TBI vary according to the trauma severity. The relationship among types and severity of brain lesions demonstrated on CT and prognosis are described by several authors in the literature^{9,10} all of them reporting approximately the same variation: the more severe the TBI is, more numerous and severe are the findings on CT. Severe head injury is associated with high mortality and morbidity [8]. Lower GCS and special CT scan findings including SAH, midline shift of more than 5mm, and mass lesions are poor prognostic indicators after closed head injury.

Not all patients with head injury should have CT scan examination. Patients with moderate and severe head injury with GCS 9-12 and below 9 respectively should have a CT scan examination. Patients with mild head injury should have CT scan based on criteria set by additional clinical findings in addition to GCS of 13-14. This includes clinical signs of skull fracture, amnesia, vomiting, posttraumatic seizure, Age ≥ 60 y, neurologic deficit and use of anticoagulant therapy by the patient (Shoar and Saadat; Mohammad *et al*, 2005).

In Ethiopia the availability of CT is rapidly increasing. It is available in more than 20 government and private health facilities in the capital city, AA and recently CT is installed in most teaching and regional hospitals in the country. Previous studies in TASH had shown patterns of CT findings of head injury patients diagnosed at department of radiology. Yet, no study conducted in TASH, as well as in the country which showed the correlation of CT findings, mechanism of injury and clinical severity score.

Therefore, the aim of this study was to document the CT severity score in head injury patients who were diagnosed and treated at TASH. And, to correlate their clinical severity score (GCS) and MOI for laying the foundation for further similar studies in the country. It also allows and guides evidence based evaluation and management of head injury patients.

1.2. Statement of the Problem

Head injury is a morbid condition resulting from structural changes in the scalp, skull and/or contents of the skull, produced by mechanical forces [1]. It accounts for a large number of

hospitalizations and considerable mortality throughout the world. It has been estimated that, each year, over 1.2 million people sustain a head injury in the United States. Of these, approximately 50,000 die, 230,000 are hospitalized and survive and 80,000 to 90,000 develop a long-term disability [2]. In UK, craniocerebral trauma alone is responsible for 150,000 hospital admissions per year [3]. TBI accounts for up to 10% of the health care budget and an estimated annual cost to society of \$30 billion (4). In Europe, the annual incidence rate of hospitalized and fatal TBI is about 235 per 100,000 people per years (9).

In developing countries accident rates in general and traumatic brain injury in particular are increasing as traffic increases besides other factors like industrialization, falls and ballistic trauma. Head injuries account for one quarter to one third of all accidental deaths, and for two thirds of trauma deaths in hospitals [1]. The annual incidence of traumatic brain injury in different African countries ranges from 150-500/100,000 per year depending on the individual country. It is estimated that 1-2% of high income populations live with a TBI disability and the incidence is high in some countries in Africa. In South Africa, the mortality rate of TBI was reported to be 81/100,000 per year; with greater than 10% of all case fatality rate. High risk groups for TBI include adolescents, young adults and the elderly, with males being affected 2-3 times more often than females.(9). Despite advances in medical and surgical treatments, the mortality rate of TBI remains high, i.e., 29-36% in cases of severe TBI (Bahoul et al., 2004). Such a high mortality and disability rates have led to intensive efforts to identify prognostic predictors in TBI. In studies, mortality and Glasgow Outcome Scale (GOS) scores have been most frequently used as measures of prognostic outcomes. GOS is designed to evaluate the recovery into five levels, i.e., death, vegetative, severe disability, moderate/mild disability, and recovery. In regard to the incidence of traumatic injury; people with lower levels of education are at greater risk (Hannay, Howieson, Loring, Fischer, &Lezak, 2004).

According to World Health Organization (WHO), low and middle income countries (LMICs) share more than 90 % of injury cases. Of which Africa regions contribute for about 21 %, mainly the sub Saharan countries [3]. Reports from South Africa and Zimbabwe revealed that injury accounted for the largest proportion of all deaths and morbidities [7]. Findings from East Africa countries such as Kenya, Sudan and Tanzania demonstrate that there is a significant growing burden of traumatic injuries [2, 8].

In Ethiopia, a prospective study which was conducted at JUTH on 52 head injury patients indicated that the main risk factors are interpersonal fight 20 (38.5%) followed by RTA 19 (36.5%) and of all injuries 8 (15.4%) were due to falling accidents. According to this study, the most affected age groups are < 15 years 17 (33%), 15- 24 years 17 (33%), 25- 34 years 9 (17%), 35- 44 years 4 (9%) and greater than 45 years accounts 5 (10%).

Another cross sectional study which was conducted in University of Gondar teaching Hospital (UOG) in Ethiopia showed that most (74%) patients were male and majority were in age range of 20 to 40 years with a mean age of 31yrs. The most common CT findings in this study were skull fracture (52%) and intracerebral hemorrhage and contusions (51%) followed by subdural hemorrhage (33%) soft tissue swelling 32% and epidural hemorrhage 10%. The third study conducted in Ethiopia, in the capital city, AA, at TASH regarding the cause of hospital admissions showed gastrointestinal and neuro-surgical cases constituted 75.8% of all emergency admissions. Among patients with trauma, isolated head injury was major (59.2%) cause of death. Neurosurgical emergencies had the highest mortality rate (36.8%) (10) .

1.3. Significance of the study

There is no standardized protocol for the management of head injury patients at national level including TASH; therefore this study adds knowledge for better understanding of primary and secondary patterns of head injury on CT and their correlations with the clinical severity scores of patients. In addition, the study allows proper prediction of the prognosis of head injury patients based on the combined clinical severity score and corresponding CT severity scores and cause(s) of trauma.

2.0 Literature review

Head injury remains an important cause of death and disability in young adults, with over 50% of patients experiencing unfavorable outcomes.

Subdural hematoma occurred in approximately 5% to 22% of patients with severe head injury as reported by Seeling *et al* and was the most lethal of all head injuries as it was commonly associated with concomitant parenchymal brain injuries [12]. Studies have found that less than 10% of patients that are considered to have minor head injuries have positive findings on CT and less than 1% require neurosurgical intervention.

According to the cross sectional study conducted in India over a period of 2 years on 382 head injury patients who had cranial CT, cerebral edema was detected in 63.4% of the cases, followed by skull fracture (62%), hemorrhagic contusion (46.3%), and epidural hematoma (30.4%). Acute subdural hematoma was present in 19.4% and subarachnoid hemorrhage was seen in 28.8% patients, midline shift in 24.3% patients, pneumocranium in 12% and intra-ventricular hemorrhage in 10.7% of the patients. Among various CT findings, intraventricular hemorrhage was associated with the highest mortality (77.8%) and epidural hematoma was about one-fourth (24%). The presence of diffuse axonal injury was associated with poor prognosis. The mortality rate associated with pneumocranium was 10.9%.

A prospective study done on 400 head injury patients in Lagos state university teaching hospital in Nigeria from June 2010 to October 2011, RTA (69%) was the most common mechanism of injury followed by fall (16.8%), assault (9.5%), gunshot (1.5%) and others (3.3%). Of the abnormal CT findings of these patients (65.5%), cerebral contusions (35%) were the most common followed by fractures (linear 22.8%, depressed 9.3%, basilar 4%), hemisinus (19.3%), pneumocephalus (7.5%) and foreign bodies (1.5%). Thirty-four point five percent of the patients were having normal CT findings. The CT abnormalities were more seen in subjects who were unconscious (80.81%), while patients presented with headaches (39.39%) have the least CT findings. Of 204 subjects who had GCS records, a clear association was found between incidence of positive CT findings and GCS ($P=0.000$), showing an increase in the rate of positive CT findings as the GCS score decreases. GCS score of 11 to 13 were associated with negative CT findings in all cases. All subjects with normal CT findings (100%) survived. Mortality was highest in subjects with intraventricular hemorrhage (100%), pneumocephalus (100%) and depressed skull fracture (100%). There was an increase in mortality as GCS

decreases. Strong association between positive CT findings and mechanism of injury for gunshot (100%) and RTA (73.6) while less positive CT findings if MOI is from assault (50%) and falls (47.8%).

Another prospective study conducted over a 12-month period at University of Benin Teaching Hospital, Nigeria on 100 head injury patients showed that RTA was the most common mechanism of injury (79%), other causes being falls from height (11%), assaults (6%) and gunshot injuries (4%). The interval between occurrence of traumatic event and CT examination ranged from a few days to 20 weeks, with about one third of the scans done within one week of the traumatic event. Twenty six percent (26%) of patients in this study had normal CT findings while 74% had abnormal scans. Thirty patients (40%) of the abnormal patients had single lesion. The patterns of abnormalities were intracerebral hemorrhage; 35 cases (47%), fractures; 23 cases (31%), subdural hemorrhage; 16 cases (21%), cerebral edema 11 cases (15%), ventricular compression with mass effect, 9 cases (12%). Other abnormal findings included foreign bodies (intracerebral) in four cases, scalp swelling in one case, sinus fractures with collection in nine cases. Full clinical recovery occurred in 28 patients (39%), death in 23 patients (31%), posttraumatic seizures with headaches in 9 (12%), ischemic cerebrovascular accident in 3 (4%), nerve palsies – 3rd, 5th, 6th cranial nerves in 3 (4%), progressive visual impairment 2 (3%), chronic mastoiditis in 2 (3%), others 4 (5%), of those with abnormal findings. The study also showed that there is a correlation between abnormal CT findings, presence of neurological features and low Glasgow Consciousness Scores ($P=0.018$).

A five month /January to May-2009/ study conducted on 102 head injury patients in reference trauma center at a hospital in the city of Sorocaba, SP, Brazil, showed that the main causes for TBI were: car accidents (52.9%) and fall from height (20.6%). Among the studied patients, 79.42% (81/102) had alterations reported at CT, with 71.6% of them presenting subgaleal hematoma, 34.3% with craniofacial fractures, 18.6% with subarachnoid hemorrhage, 10.8% with area of brain contusion with hemorrhagic suffusion, 7.8% with specific basilar skull fractures, 5.9% with diffuse cerebral edema, and 5.9% with extraparenchymal blood collection. Three or more findings were observed in 18.6% of the patients. All the patients with no finding at CT (20.58%) presented mild TBI at the moment of the diagnosis. The study also showed the association of different types of TBI with the tomographic findings. Eighty four patients (82.4%) with mild TBI, 2 patients (2%) presented moderate TBI and severe TBI was observed in 16

patients(15.6%).There was a significant increase in the incidence of all CT findings in severe TBI.One half of the patients with diffuse cerebral edema presented severe TBI.

Prospective observational study carried out on head injury cases in pediatric age group (below 14years) over a period of 2years (Nov2012 to Dec 2014) in medical college hospital of central India showed all (100%) of the patients with GCS< 9, 16 out of20 (80%) patients with GCS 9-12 and 1 out of 26 (3.8%) with GCS 13-15 have positive CT findings.

Another study conducted on 80 head injury patients at College of Medical Sciences and teaching hospital, Bharatpur, India over a period of one year showed that the most common causes of head injury were RTA (65%), fall injuries (20%) and physical assaults (15%). Loss of consciousness 46(57.5%) and vomiting 35(43.8%) were the commonest clinical features and alcohol consumption in 15(18.8%). Out of eighty cases, 55(68.8%) had mild, 12(15%)moderate and 13(16.2%) severe head injury.RTA was the prime etiological factor in all types of severity of head injury. Twenty five patients (31.2%) had normal CT findings and 55(68.8%) had abnormal CT findings (all patients with moderate and severe and 54.5% with mild TBI).Skull fractures were the most common noted in 39 cases (48.8%), followed by EDH 31 cases (38.8%).All the patients who expired had severe head injury (GCS 3-8). RTA was the commonest mode of injury in the patients who expired.

A cross sectional study conducted in Chitwan Medical College and teaching Hospital, Bharatur, Nepal over a period of 4 months (March to June, 2012) on 50 patients showed RTA(60%), as commonest cause of injury followed by falls(20%), physical assault (12%) and pedestrian injuries (8%). The study also showed lower GCS was found in patients multiple lesions on CT (mean GCS 10.50 ± 1.990) than single (mean GCS 13.33 ± 1.330) and in single+ multiple lesions + midline shift (mean GCS 6.22 ± 1.202) than single and multiple lesions on CT. The study showed 54 % mild head injury cases, 28 % moderate cases and 18% severe cases.

A retrospective study done on 200 hospitalized head trauma patients (76 were children <12yrs) in Tehran, Iran between 2006 and 2008 showed that the most common causes of head injury was an accident followed by falling, hitting objects to the head. Of 200 study subjects, 161 (80.5%) had GCS 13–15 that among those, 45% had GCS 15. Also,21 (10.5%) had GCS ranged 9–12 and 18 (9%) had GCS<8.Among those with positive CT findings on brain abnormality (109patients=54.5%), 77.1% patients had a mild brain injury, 11.0% had a moderate brain injury, and 11.9% had a severe brain injury.

3.0 Objectives

3.1 General objectives:

- To assess the correlation of CT severity, clinical severity score and outcome of head injury patients who presented to the department of radiology of TASH, from March 2017 to August 2017.

3.2 Specific objectives:

- To assess the CT severity of TBI patients
- To identify the correlation of CT severity of head injury patients with mechanism of injury.
- To assess the correlation of CT severity of head injury patients with clinical severity scores.
- To assess the clinical outcome of head injury patients as correlated to initial CT scan findings.

4.0 Materials and Methods:

4.1 Study Area: Tikur Anbessa Specialized Referral and Teaching Hospital, Department of Radiology, Addis Ababa, Ethiopia. Tikur Anbessa Specialized Referral and Teaching Hospital is found in the college of health sciences campus of Addis Ababa University which is one of the biggest universities in the country, Ethiopia. The hospital is a tertiary level referral and teaching hospital giving service to the city and rural population. It is one of the centers of excellence in Ethiopia in undergraduate, post graduate and sub specialty programs in medical and health sciences. The radiology department is one of the many departments in the institution which gives radiologic medical service and academic activities. The department is equipped with high-tech radiologic machine including 64 and 128 slice CT and 1.5T MR scanners.

4.2 Study design:

As part of the ongoing thematic research on traumatic head injury, prospective institutional based cross sectional study of all head injury patients diagnosed with non-contrast cranial CT scan at the department of Radiology, TASH.

4.3 Study duration:

The study was conducted from March 2017 to August 2017 in all patients who underwent Cranial CT scan.

4.4 Study Population:

All the patients who sustained head injury and evaluated at ER and referred to the radiology department of TASH for head CT scan.

4.5 sample size: was determined using time bound convenient method.

4.6 Inclusion and exclusion criteria

4.6.1 Inclusion criteria

All patients who sustained head injury and presented to emergency room and have CT scan at department of radiology of TASH during the study period.

4.6.2 Exclusion criteria:

All head injury patients who died before the initial non-contrast CT scans those patients without adequate documented clinical information and if the CT image is not available for review.

4.7 Data collection tools and techniques

A structured questionnaire was prepared which was containing the socio-demographic, relevant clinical data and CT scan imaging findings of patients. The non-contrast cranial CT scan of each head injury patient was reviewed by the principal investigator and/or the consultant neuroradiologist. The images were held with CDs and some cases were also seen directly from PACS. The charts of patients were retrieved and analyzed using their medical record numbers, direct telephone communications with the patients and/or relatives in order to document their clinical outcomes at discharge from ER or inpatients (surgical ward, ICU) and fill other incomplete data. The collected data was entered using SPSS version 23 statistical packages and analyzed. The correlations of different variables were analyzed using the software only for those patients whose outcomes were known.

4.8 Ethical considerations

Data collection was being started after getting permission from the ethical review committee of the department of radiology of Addis Ababa University. Data collection was done by the principal investigator and information about the patients was confidential. On the data retrieval form, anonymity was assured by omitting all parts including names and personal documents.

5.0 Results

There were 131 head injury patients. The mean, range and median age were similar to the findings in the first part of this study. The number of male patients was 109 and female were 22 with male: female ratio of 5:1. The educational levels of participants range from illiterate (16.8%) to tertiary school level (9.9%) and about 42.7% of patients have primary school level of education.

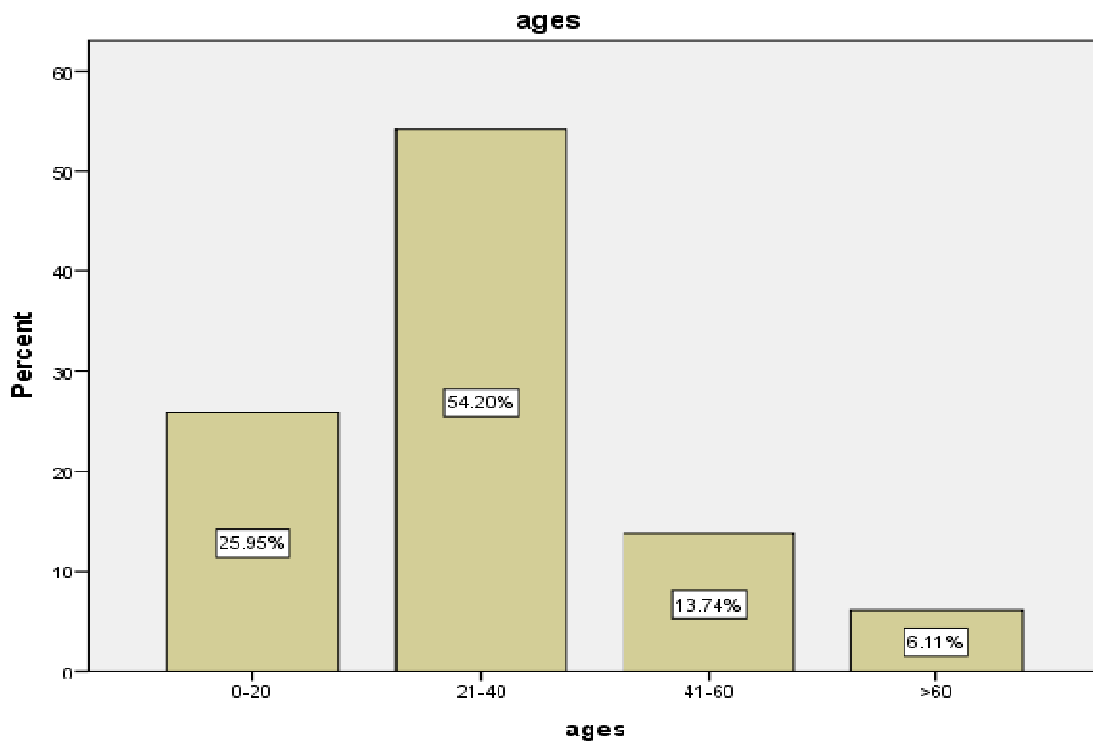


Figure1.Age distribution

Most patients who sustained head injury were in the age range of 21 to 40 years followed by below 20 years. Out of 26.0% of patients whose age was under 20years, 11(32.4%) cases were 12 years and below.

Table1: Mechanisms of injury in different age categories

| MOI | Ages | | | | Total |
|-------------------|------|-------|-------|-----|-------|
| | 0-20 | 21-40 | 41-60 | >60 | |
| RTA | 20 | 30 | 8 | 3 | 61 |
| fall down | 8 | 12 | 2 | 3 | 25 |
| Fighting | 6 | 26 | 8 | 2 | 42 |
| Workplace injury | 0 | 2 | 0 | 0 | 2 |
| electrical injury | 0 | 1 | 0 | 0 | 1 |
| Total | 34 | 71 | 18 | 8 | 131 |

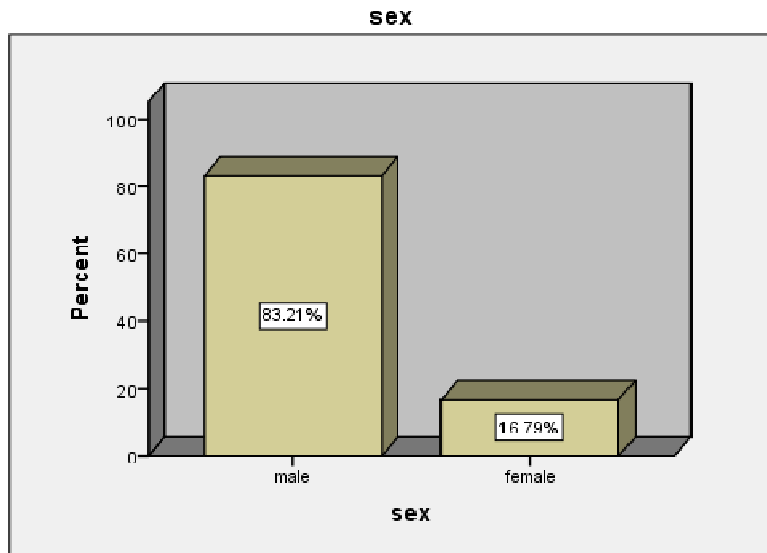


Figure2.Sex distribution

Among those patients whose age was above 18 years and their habit was known (109cases), 9.3 %(8) of patients were having a habit of excessive drinking and 2.3 %(2) habit of smoking and drinking. Only 1.2% (1) of patients had a habit of drug use/abuse. There was no habit below 18 years.

For all age groups the most common mechanism of injury was RTA (46.6%) followed by fighting (32.1%) followed by fall down accidents (19.1%) followed by work place injury (1.5%) and the least was electrical injury (0.8%).Among 46.6% of RTA patients 64% were passengers and 36% were pedestrians.Loss of consciousness(80.2%)and vomiting(28.2%) were the most common presentations of patients.

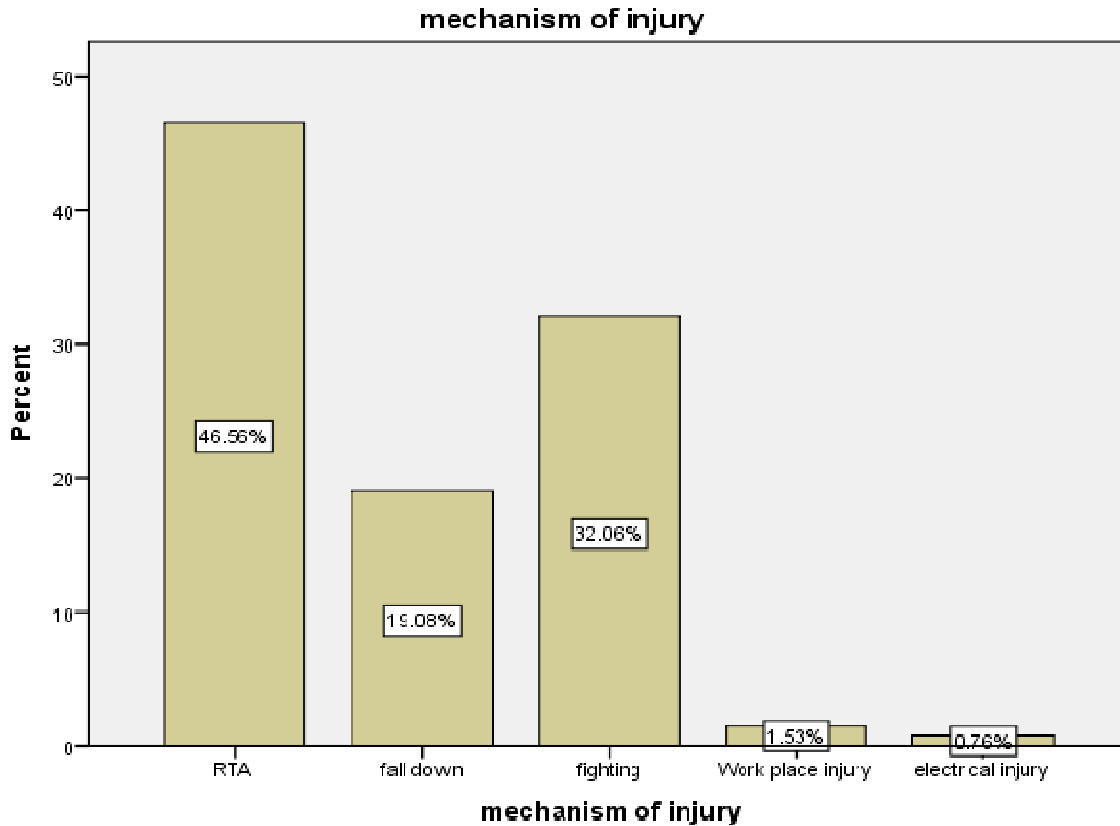


Figure3.Frequencies of mechanism of injuries

Abnormal CT finding was found in 97(74%) of 131 patients. Most patients(78=80.4%) with abnormal CT finding had loss of consciousness. RTA was the most common mechanism of head injury in patients with abnormal CT finding followed by fighting injury. Severe clinical severity score was found in 16(16.5%) moderate in 16(16.5%) and mild in 63(64.5%) of the 95 cases who had known GCS and abnormal CT finding. Severe CT severity scores were found in 23(23.7%) of patients with abnormal CT finding. Five (83.3%) of deceased cases had abnormal CT findings. Normal CT finding was found in 34(26%) of cases. Twenty five(73.5%) of them had mild GCS, 7 (25.6%) moderate and 2(5.9%) severe GCS. Only 27(79.4%) of cases with normal findings had known outcome. Among them 1(3.7%) died, 23(85.2%) improved and 3(11.1%) had neurologic deficits. All 27 cases had CT severity score of 2.

Skull fracture was the most frequent abnormal CT finding(68=51.9%). There was depressed type of skull fracture in 26(19.8%) cases.Basal skull fracture was found in 25(19.2%) of patients. Thirty eight (55.9%) of cases with skull fracture were due to fighting followed by RTA (19=27.9%).

Brain contusion/hematoma was the most frequent intracranial CT finding in our patients 43(32.8%).Multiple contusions were found in 53.5% of our patients and solitary in 46.5%. Fighting was the most frequent mechanism of injury associated with contusion (58.1%). RTA in 27.9% and falling down injury 14.0% account for all the remaining cases. Mild in28 (66.7%) moderate in10 (23.8%) and severe in 4(9.5%) TBI were found in the brain contusion/hematoma cases. The CT severity score of 4 and above was seen in most (16 cases=37.2%) of brain contusions/hematoma cases (more in multiple (10/23) than solitary (6/20)) followed by a score of 2 in 13 cases. Neurologic deficits were the most common short term outcome(less than 12 weeks) in multiple brain contusions (16=12.2%).There was deceased case with multiple contusions/hematoma and none in solitary contusions.

Brain herniation was found in 39(29.8%) of patients. Midline shift ≥ 5 mm was found in 12(30.8%) of cases.Subfalcine and unilateral descending transtentorial herniation was found in 28.2% of cases. Fourteen (35.9% for each) of head injury patients with brain herniation were due to RTA and fighting. Mild GCS was found in 23 brain herniation cases (59%); 10(43.5%) out of them had CT severity score of 3.Moderate GCS was found in 7 (17.9%) of brain herniation cases; 6 out of them had severe CT severity scores. Severe GCS was found in 9(23.1%) brain herniation cases; 7 out of them had severe CT severity scores. Patients with CT severity score of 3 or more had midline shift of ≥ 5 mm. From the deceased patients four had brain herniations.

Subdural hematoma (SDH) was found in 30(22.9%) cases which was solitary in 24(80.0%) and multiple in the remaining 6(20.0%) of cases. Sixteen of SDH were less than 1cm in depth (53.3%).Twelve patients with SDH (12=46.2%) had associated mass effect with brain herniation (6). Fighting and RTA were the most common mechanisms of injury associated with SDH (each for 11 cases= 36.7%) and falling down injury was for the remaining cases (8=26.7%).Mild clinical severity score was found in 18(60%) of SDH case and moderate in 6(20%) and severe in 6(20%) scores of the cases. Severe CT severity score was found in 15(50%) of SDH cases. The CT severity score of 3 was found in 8(26.7%) and a score of 2 in 7(23.3%) of cases. Among the deceased cases 2 had SDH.Subarachnoid hemorrhage, diffuse axonal injury and brain contusion/hematoma were found in 11(36.7%), 7(23.3%) and 16(53.3%) of SDH cases respectively.

Subarachnoid hemorrhage (SAH) was found in 24 patients (18.3%) with focal cerebral sulci being the most common location (found in all 24 cases). Twelve (50%) patients had associated brain contusion/hematoma, 6 (25%) had DAI, 5 (20.8%) and 4 (16.7%) had EDH. (RTA was found in 12 (50.0%), fighting in 8 (33.3%) and fall down in 4 (16.7%) of cases. CT severity score of 3 was found in 14 (58.3%) and 4 and above in 8 (33.3%). Mild clinical severity score was found in 9, moderate in 8 and severe in 6 of the SAH who had known GCS scores. There were 2 deceased cases in SAH; one of them had EDH, SDH and brain contusion/hematoma. Neurologic deficits were found in 5 SAH cases.

Table 2: The outcome of subarachnoid hemorrhage patients

| | | outcome of injury | | | Total |
|-------------------------|-----|-------------------|----------|--------------------|-------|
| | | Died | Improved | neurologic deficit | |
| subarachnoid hemorrhage | yes | 2 | 6 | 5 | 13 |
| | no | 4 | 58 | 16 | 78 |
| Total | | 6 | 64 | 21 | 91 |

There was intraventricular hemorrhage (IVH) in 9 (6.9%) patients. Lateral ventricles were the most common location. Out of the nine patients who had IVH, 5 (55.5%) patients had both IVH and SAH. Fall down injuries and RTAs were equally the most common cause for IVH which was found in eight of the nine cases (4 for each). Severe clinical severity scores were found in 6 of the 9 IVH cases and moderate in the remaining 3 cases. Severe Rotterdam CT severity score (4 and above) was found in 66.7% of IVH cases. There was one deceased among IVH cases.

Diffuse axonal injury was found in 22 (16.8%) of patients. RTA (12 in cases) was the most common mechanism of injury followed by fighting (6 cases) and fall down (4 cases). Mild TBI was found in 10 (45.4%), moderate in 6 (27.3%) and severe in 6 (27.3%) of DAI cases. Rotterdam CT severity score of 3 or less were found in 19 patients. Four or more Rotterdam CT severity scores were found in the remaining 3 cases.

Table3: Clinical severity score (GCS) of diffuse axonal injury patients

| | | clinical severity score(GCS) | | | Total |
|-----------------------|-----|------------------------------|----------|-------|-------|
| | | mild | moderate | sever | |
| Diffuse axonal injury | Yes | 10 | 6 | 6 | 22 |
| | No | 77 | 18 | 12 | 107 |
| Total | | 87 | 24 | 18 | 129 |

Out of the known clinical outcomes of DAI patients death was found in 1, clinical improvement in 7 and neurologic deficits in 5 cases.

Epidural hematoma (EDH) found in 21(16.0%) patients. which was solitary in 13(61.9%) and multiple in 8(38.1%) of cases. Most of the EDH were more than >1.5cm in 10(47.6%), 1to 1.5cm in 5(23.8%) and less than 1cm in 6(28.6%).Nineteen (19=90.5%) patients had associated skull fractures with temporal bone being the most commonly fractured bone followed by parietal bone. Fighting was the most common mechanism of injury in 12(51.1%) EDH cases followed by RTA in 6(28.6%) of the cases .The clinical severity score was mild in 16 cases of EDH.Most patients with EDH who showed clinical improvements were found in most of EDH cases following both surgical interventions and conservative managements. Neurologic deficits were seen in 6(28.6%) of 21 cases.

Hemosinus was found in 9 (6.9%) of the 131 patients. Frontal sinus was involved in 3(33.3%) and maxillary and multiple paranasal sinuses each in 2(22.2%) of cases.

Pneumocephalus was seen in 21 patients. It was extra axial in 14(66.7%), intra-axial in 5(23.8%) and both intra and extra-axial and cisterns in 2(9.5%) of patients. Tension pneumocephalus was found in 5(only 3 had known outcome) out of 21 cases. Among all the cases who had known outcomes only 3 were found to have tension pneumocephalus. No of the cases with tension pneumocephalus had died and developed neurologic deficit. Associated paranasal fracture was found in most (60%) of the cases and compound fracture in the remaining

cases. Facial bone fracture was found in 26 patients. Fifteen (11.4%) patients had both skull and facial bone fractures. Zygomatic bone was the most commonly fractured facial bone followed by mandible.

Cervical spine injury was found in 4(3.1%) of our head injury patients.

Brain infarctions were found in 2(1.5%) of 131 patients.

Among all patients whose clinical severity scores were known, 67.4% had mild, 18.6% moderate and 14.0% severe scores. RTA was the most common mechanism of injury found in patients with severe GCS followed by fall down accidents.

Table 4. Clinical severity scores (GCS)

| | No cases | Percent |
|----------|----------|---------|
| Mild | 87 | 67.4 |
| moderate | 24 | 18.6 |
| Severe | 18 | 14.0 |
| Total | 129 | 100.0 |

As the clinical severity score (GCS) of patients decrease, the number of patients with bad outcome was found to increase.

Table 5: Correlation of outcome and known clinical severity scores (GCS)

| | | clinical severity score(GCS) | | | Total |
|----------------------|-----------------------|------------------------------|--------------|--------|-------|
| | | mild | Modera te | severe | |
| outcome of injury | Died | 2 | 0 | 4 | 6 |
| | Improved | 47 | 13 | 4 | 64 |
| | neurologic deficit | 14 | 3 | 4 | 21 |
| | Unknown | 24 | 8 | 6 | 38 |
| Total | | 87 | 24 | 18 | 129 |

The CT severity score of 1 was found in 1 (4.6%), 2 in 75 (58.1%), 3 in 25 (19.4%) and more than 4 (severe) in 23 (17.8%) of cases who had known GCS. Severe (4 or more) CT severity scores were found in patients whose MOI was road traffic accident or fighting. Most patients who died (4=66.7% of cases) had severe both CT severity and clinical severity scores.

Neurologic deficits (21=23.1%) were the most frequent immediate neurologic outcomes in most patients with CT severity score of 2. The majority (85 cases) of the patients had clinical severity scores of mild.

Table 6: Correlation of Rotterdam CT severity score and clinical severity score (GCS)

| | | clinical severity score(GCS) | | | Total |
|-----------------------------|---|------------------------------|----------|--------|-------|
| | | Mild | Moderate | severe | |
| Rotterdam CT severity score | 1 | 5 | 1 | 0 | 6 |
| | 2 | 59 | 13 | 3 | 75 |
| | 3 | 16 | 4 | 5 | 25 |
| | 4 | 4 | 2 | 5 | 11 |
| | 5 | 3 | 2 | 4 | 9 |
| | 6 | 0 | 2 | 1 | 3 |
| Total | | 87 | 24 | 18 | 129 |

Four of the 6 deceased patients had CT severity score 4 and above. Among 64 cases that were improved, the Rotterdam CT severity score of 3 or less than 3 was found in 56 (87.5%) cases and severe score found in the remaining 8(12.5%) cases. Among 21 patients who had neurologic deficits CT severity score of 3 and less than 3 was found in 15(71.4%) cases.

Table 7: Correlation of Rotterdam CT severity score and known outcomes of injury

| | | outcome of injury | | | Total |
|-----------------------------|---|-------------------|----------|--------------------|-------|
| | | died | Improved | neurologic deficit | |
| Rotterdam CT severity score | 1 | 0 | 3 | 2 | 5 |
| | 2 | 1 | 43 | 9 | 53 |
| | 3 | 1 | 10 | 4 | 15 |
| | 4 | 1 | 5 | 3 | 9 |
| | 5 | 3 | 2 | 2 | 7 |
| | 6 | 0 | 1 | 1 | 2 |
| Total | | 6 | 64 | 21 | 91 |

Rotterdam CT severity score of 2 was found in 37(60.6%) of the 61 cases who had RTA followed by 22(52.8%) of the 42 cases who sustained fighting injury.

Table 8: Mechanism of injury and Rotterdam CT severity score

| | | Rotterdam CT severity score | | | | | | Total |
|-----|----------------|-----------------------------|----|----|---|---|---|-------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | |
| MOI | RTA | 2 | 37 | 14 | 5 | 2 | 1 | 61 |
| | fall down | 0 | 14 | 4 | 3 | 2 | 2 | 25 |
| | Fighting | 4 | 22 | 8 | 3 | 5 | 0 | 42 |
| | Work place inj | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | electrical inj | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| | | | | | | | | |

| | | | | | | | |
|-------|---|----|----|----|---|---|-----|
| Total | 6 | 76 | 26 | 11 | 9 | 3 | 131 |
|-------|---|----|----|----|---|---|-----|

6.0 Discussions

In this study the age of patients varied from 6months to 80years. The mean age was 30.9years. The male to female proportion was 5:1. This higher proportion of males is due to high outdoor activities in males than females predisposes for accidents. Most of the patients (54.2%) who sustained head injury were between 21 and 40 years; this is because this age group is the most active part of the society involved in active transportations and different physical activities. Only 6.1% of the study populations were above the age of 60years. This is consistent with the study done at College of Medical Sciences and teaching hospital, Bharatpur, India.

In this study road traffic accident was the most common mechanism of head injury accounting for 46.6% of cases. This agrees with the study done in Brazil where it accounts 52.9% of mechanism of head injury. The most severe TBI were recorded from road traffic accident mechanism of injury (55.6%) followed by fall down injuries (27.8%). This is consistent with the study done at College of Medical Sciences and teaching hospital, Bharatpur, India. The most severe CT findings (measured with Rotterdam CT severity scores) were due to road traffic accidents or fighting. As to the author's knowledge, no studies were done to correlate mechanism of injury and CT severity scores. Most of the deaths in this study were from fall down injuries (3=50% of cases) which is inconsistent with studies done in other countries where road traffic accident is the most common mechanism of injury associated with poor outcome. This can be explained by the fact that, in this study most falling down injuries were found in ages above 60 which is the age category prone to fall down injuries.

The most frequent abnormal CT finding in this study was skull fracture (51.8%) with linear pattern of fracture being the commonest type (37% of fractures). This agrees with study done at College of Medical Sciences and teaching hospital, Bharatpur, India and Ibadan, Nigeria where it accounted 48.8% and 50.3% of CT findings respectively.

In this study patients with multiple brain contusions/hematoma have severe CT severity scores and none in solitary lesions. But there was insufficient statistical evidence to conclude that multiple lesions are correlated with poor outcome (P-value = 0.152). This can be explained by the fact that unlike in other literatures which had involved large study populations, this study had small number of patients. So, lack of actual correlation may be attributed to small study population. Subjects with multiple contusions had severe GCS and all were died. This study showed strong correlation between GCS and outcome of head injury (P-value=0.025). This finding is consistent with study conducted at Chitwan Medical College and teaching Hospital, Bharatpur, Nepal.

Midline shift ≥ 5 mm was found in 12(30.8%) of cases with brain herniations. This agrees with study done in India which was found in 24.3% of cases.

Diffuse axonal injury was found in 16.8% of patients. In this study, most patients (10=45.4%) were found to have mild clinical severity score (GCS). We found that strong correlation between CT severity scores (which is indicator of severity of CT findings) and clinical severity scores (GCS). Therefore, high GCS in diffuse axonal injury (finding suggestive of severe brain injury and hence poor outcome) may be attributed to inadvertent over scoring of GCS in some of patients with diffuse axonal injury.

Subarachnoid and intraventricular hemorrhages were the CT finding mentioned for highest mortality in the study done at Lagos state university teaching hospital in Nigeria where 100% patients with IVH and 57.1% with SAH were died. But in this study, the fact that most patients had unknown outcomes caused difficulties to conclude their actual correlation with outcome of injury. But it was found that patients with intraventricular hemorrhage had high risk of associated subarachnoid hemorrhage (P-value=0.010) and high risk of having both severe clinical and CT severity scores (P-value=0.001 for both).

In this study most head injury patients were found to have CT severity score of 2(58%) and 4&above in 17.6%. Significant positive correlation was found between the Rotterdam CT

severity and clinical severity scores (the P-value was <0.001). Therefore CT severity scores showed inverse correlation with clinical severity scores (GCS) of patients. It was also found to have positive correlation with mechanism of injury and poor outcome of patients (P-value = 0.02). In this study the poorest outcome was found in patients who had severe CT severity scores. Four (4=66.7%) of the six deceased cases had the severest CT severity score of 5 & 6. As to the author's knowledge, rather than correlating specific CT findings such as IVH, SAH and midline shift etc. with patient outcomes, no study was found which had correlated the specific (numeric) CT severity scores with the patients' clinical scores and outcomes.

We have observed that 67.4% of subjects in this study had mild clinical (GCS) score and moderate in 18.6% and severe 14% of the cases. This finding agrees with study done in Tehran, Iran which was 77.1% mild, 11.0% moderate and 11.9% severe. In current study 14.0% of subjects had severe clinical severity score. There were two deaths in mild TBI patients. No study was found consistent with this finding. But this finding can be explained by the fact that the cause for death may be trauma at other sites or its complication such as anemia, systemic hypotension or the patients with severe intracranial injuries might have been clinically over scored.

In this study significant correlation was found between the mechanism of injury and Rotterdam CT severity score (P-value=0.044). There was also significant correlation between the clinical (GCS) severity score and mechanism of head injury (P-value= 0.01). The highest mortality was contributed from falling down injury followed by road traffic accident. This finding is inconsistent with most literatures where road traffic accident was the commonest mechanism of injury to cause poor outcome. This can be explained by high proportion of deaths in age above 60 years which is age category prone to fall down injuries.

7.0 Conclusions

The highest mortality (12.5%) occurred above the age of 60 years. This can be due to increased risk of death in elderly head injury patients.

The Rotterdam CT score of 2 was found in most of our cases. Significant correlation (P-value <0.001) was found between the Rotterdam CT severity scores and clinical severity scores (GCS). The CT severity scores showed inverse correlation with clinical severity scores (GCS) of patients and found to be strong predictor of outcome. The CT severity score was also found to have positive correlation with mechanism of injury (P-value=0.044). It was also shown that significant association was found between the outcome of study subjects and Rotterdam CT severity scores (P-value =0.02). Inverse correlation was also found between outcome of injury and clinical severity scores (P-value= 0.025). The most severe clinical and CT severity scores were found in road traffic accident cases.

8.0 Limitations of the study

There was poor documentation of the patients' medical records and immediate referral of patients to other hospitals, so that the immediate outcomes of the study subjects were not known.

9.0 Recommendations

- The reason for immediate referral of head injury patients was lack of bed in the hospital, further expansion of the hospital to increase its capacity is recommended.
- Proper chart keeping and file documentation is recommended
- Further similar studies should be conducted to strengthen new findings in this study (specifically correlations between the specific CT severity scores with MOI and outcomes).
- As part of the thematic research in the school of medicine, the identified limitations should be reported for improving patient management and giving feedback for the ongoing thematic research.

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11.ANNEX

Table 9. Summary of CT findings and correlation with CT and clinical severity scores

| CT findings | Rotterdam CT severity scores | | | | | | | GCS | | | |
|-------------------------|------------------------------|----|----|---|---|---|-------------|------|----------|--------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | Total cases | mild | moderate | severe | Total |
| Contusion/hematoma | 4 | 13 | 10 | 8 | 6 | 2 | 43 | 28 | 10 | 4 | 42 |
| Diffuse axonal injury | 1 | 9 | 9 | 2 | 1 | 0 | 22 | 10 | 6 | 6 | 22 |
| Subarchinoid hemorrhage | 0 | 2 | 14 | 3 | 2 | 3 | 24 | 9 | 8 | 6 | 23 |
| Subdural hematoma | 0 | 7 | 8 | 6 | 6 | 3 | 30 | 18 | 6 | 6 | 30 |
| Epidural hematoma | 5 | 9 | 4 | 2 | 1 | 0 | 21 | 16 | 3 | 2 | 21 |
| Brain herniation | 1 | 7 | 12 | 7 | 9 | 3 | 39 | 23 | 7 | 9 | 39 |
| Brain edema | 1 | 9 | 12 | 8 | 6 | 2 | 38 | 23 | 8 | 6 | 37 |
| Pneumocranium | 1 | 10 | 4 | 5 | 0 | 1 | 21 | 16 | 2 | 3 | 21 |

Questionnaire

1. Socio-demographic data

Medical record number _____, phone No _____ serial No _____

Age _____ Sex _____

Residency (circle one) 1. Urban 2. Rural 3. Unknown

Marital status (circle one) 1. married 2. Single 3. Divorced 4. If any other
(specify) _____

Habit 1. No 2. yes If yes specify (excessive drinking, drug use (abuse), smoking...)

Educational level 1. Illiterate 2. Literate (specify)

Occupation _____

2. Mechanism of head injury

Pedestrian run over (by car, tricycle, fallen object etc...)

Passenger (car, tricycle, animal etc...)

Fall down accident (Specify estimated height etc...) _____

Fighting injury (stick, stone, bullet, stab, arrow injury to the head etc...)

Self inflicted

Sports injury- Specify

Others (if any specify)

3-Clinical findings

3.1 Clinical severity score

-Mild

-Moderate

- Severe

3.2 - Neurologic deficit 1-Yes 2 . No

3.3- Loss of consciousness, headache and /or vomiting 1.yes 2. No 3. If other (s)
(specify) _____

3.4 outcome of injury (circle one) 1.Improved 2.Death 3.Permanent disability (visual loss, hearing loss, body weakness etc.)

4. Imaging findings

4.1 –Extra-axial lesions

A. Skull fractures 1.yes 2.No

If yes Type- (Circle) – Linear, depressed, ping pong, comminuted, Diastatic

-Compound, Closed

Site and side (Circle)- Frontal, Parietal, Occipital, Temporal

1. Right 2.Left 3.Both

If depressed fracture- depth of significant depression – A. < 5 mm

B.>= 5mm

Basal skull fracture 1- yes 2 –No

If yes Specify (circle one or more)-, ethmoid, mastoid, sphenoid, orbital bone

Crossing carotid canal 1-yes 2.No

If yes, 1.Right 2.Left

Crossing dural sinus 1-yes 2.No

If yes specify (circle one or more)-sagittal, transverse, sigmoid, sphenoparietal, other 1.Right 2.Left 3.Both

B. Scalp soft tissue injury 1.yes 2.No 3. If yes specify (swelling, foreign body, subcutaneous emphysema, avulsion, subgaleal hematoma etc.)

C. extra axial hemorrhage

i- Epidural hematoma 1 – yes 2- No

If yes 1.Age 1.1 – Acute 1.2- Subacute 1.3- Chronic

2. Number 2.1- Solitary EDH 2.2.- Multiple EDH

3. Site of EDH – Frontal, parietal, temporal, vertex, basal, occipital posterior fossa

1. Right 2.-Left 3.Both

4. 3D volume _____

Maximum depth 1) <1cm 2) 1-1.5cm 3) >1.5cm

5. Adjacent bone fracture – 1- Yes

2-No

If yes site of adjacent skull bone fracture- frontal, temporal, parietal, occipital

6. Mass effect, brain herniation-(circle one or more)

Midline shift 1. <5mm 2.)>=5mm

Uncal herniation, transtentorial herniation, foramen magnum herniation,

7. Other associated findings, specify

ii-Subdural hematoma 1 – yes 2- No

If yes 1.Age 1.1 – Acute 1.2- Subacute 1.3- Chronic

2. Number 2.1- Solitary SDH 2.2.- Multiple SDH

3. Site of SDH – Frontal, parietal, temporal, occipital (if other specify)

1. Right 2.-Left 3-Both

4. 3D volume _____

Maximum depth 1) <1cm 2) 1-1.5cm 3) >1.5cm

5. Adjacent bone fracture 1- Yes 2-No

If yes site of adjacent skull bone fracture- frontal, temporal, parietal, occipital

6. Mass effect, brain herniation-(circle one or more)

Midline shift 1.<5mm 2.)>=5mm

Uncal herniation, transtentorial herniation, trasforamen magnum herniation,

7. Other associated findings, specify

iii. Subarachnoid hemorrhage – 1.Yes 2. No

If yes 1-focal site 1.1-sulcal-convexity, sylvian fissure, inferior frontal, other (specify)

1.2-Cisternal- interpeduncular, ambient, other, (specify)

2-Diffuse (subarachnoid spaces and basal cisterns)

3 -Size (thickness) 1- <5mm 2. - >=5mm

4 - Other lesion(s) 1-yes 2.No

If yes -1-contusion, 2-epidural hematoma 3-Subdural hematoma 4-skull fracture

5. Intraventricular hemorrhage 1. Yes 2. No 3. If yes (specify location)

6. Other –acute hydrocephalus, specify

D, Hemosinus 1.yes 2.No 3.if yes specify (location)

E.Pneumocranium 1.yes 2.No

If yes specify site-intra-axial, extra-axial, and intraventricular, intravascular

Tension Pneumocephalus, 1-Yes 2-No If yes specify site and mass effect

Associated fracture if yes specify site 1-Ethmoid 2-Frontal 3-Sphenoid sinus 4-Mastoid

4.2 Intra-axial lesions

A. **Brain contusion, hematoma-** 1- yes 2 – No

If yes1- Hemorrhagic (Mixed density lesion), Non-hemorrhagic

2-single, multiple

3-Site –coup, counter coup, unilateral, bilateral

-Frontal, Temporal, parietal, Occipital, Cerebellar

-Anterior, inferior, posterior, parasagittal, other (specify)

4-size, 3D measurement (volume)_____

B. **Brain stem injury, (Circle one)-** 1-Yes 2 No

If yes type- Hemorrhagic, non-hemorrhagic

C. **diffuse brain injury** 1-Yes 2- No

If yes detected lesion type – Punctate to 15mm foci of bleeding at the

- GWJ-Frontal, Temporal, parietal, Occipital

-Callosal-posterior body, splenium, anterior body

-Deep grey matter

- Brain stem-Dorso lateral, mid brain, upper pons

4.3 Secondary injuries

A-**Brain edema** 1 – Yes 2- No

If yes (circle one or more)-effaced lateral ventricles, third ventricle, 4th ventricle

-Effaced basal cisterns, brain parenchyma low attenuation

-Loss of GM-WM interfaces

B-**Brain herniation (Circle one)** 1 – Yes 2 - No

If yes type (Circle)

Subfalcine- Midline shift (circle one)-1.<5mm 2->=5mm

Unilateral descending transtentorial

Bilateral descending transtentorial

Ascending transtentorial

Trasforamen magnum (tonsillar herniation >5mm)

Trasdural/Trascranial

C-Infarction- 1- yes 2- No 3. If yes (specify location)

D) Basal Cisterns 1) Normal 2) compressed 3) Absent

E) Vascular injury: AV fistula, Dissection 1- yes 2- No 3. If yes (specify location and type)

F). Facial bone fracture 1 – yes 2- No 3. If yes (specify type and location)

G Cervical spine injury 1 – yes 2- No 3. If yes (specify type and location)

H). others (if any specify)

H). Rotterdam CT severity score 1) 1 2) ,2 3) .3 4) 4 5).5 6.)6

5. Follow up, -at 3 months,6 months ,Clinical plus or-imaging

- Imaging – 1. Yes 2.No if yes describe the lesion change

Clinical- a) Death, (within1 week) if yes date of death, and if possible cause of death b) Neurologic deficit (3 -6months) - If yes type

c) Normal