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Original Article

Surgically treated head injury: a review of injury pattern and treatment outcomes

Babagana Usman,[1, 2, 3] Wadinga D. Wadinga,[4] Usman Daibu,[1, 2] Babagana Mohammed.[1]

[1] Surgery Department, University of Maiduguri and the University of Maiduguri Teaching Hospital, Borno State, Nigeria. [2] Visiting Neurosurgeon to the Surgery Department, Modibbo Adama University Teaching Hospital (MAUTH), Yola, Adamawa State, Nigeria.[3] Visiting Neurosurgeon to the Surgery Department, State Specialist Hospital, Maiduguri, Borno State, Nigeria. [4] Surgery Department, Modibbo Adama University Teaching Hospital (MAUTH), Yola, Adamawa State, Nigeria,

Correspondence to: Dr Usman Babagana, Surgery Department, University of Maiduguri and the University of Maiduguri Teaching Hospital, Borno state, Nigeria. **Email:** babaganau@yahoo.com , **Phone:** +2348035951137. **Orcid number:** https://orcid.org/0000-0002-2728-6067

Abstract

Introduction: Head injuries are commonly referred to as traumatic brain injury (TBI), depending on the extent of the head trauma. It may be caused by a blunt or penetrating trauma. It is a major contributor to the health care burden, especially in resource-poor countries. **Methodology:** A 10–year multicentric, retrospective study between January 2015 and December 2024, across northeastern Nigeria. Data on the demographics (age, sex), mechanism of injury (closed/opened), aetiology, results of available radiological investigations, types of surgery done, and the outcomes at 6 and 12-month post-operative periods were extracted. **Result:** A total of 428 (11.3 % of all head-injured patients) had surgery, with 326 (75.9 %) for closed-head injuries and 102 (24.1 %) for open-head injuries. Mostly males, with a M: F ratio of 5:1. Ages ranged from 6 months to 76 years, with adults (≥ 17 years) constituting 72.8 %. Aetiology included road traffic accidents (81.1%), falls from heights (7.9 %), gunshots (4%), IEDs (3.3 %), arrows (1.4 %), dagger/knife (1.2 %), and undocumented (0.4%). Surgeries were for various haematoma evacuations in 216 (50.4%), foreign body extractions in 78 (18.3%), skull fractures in 42 (9.7%), CSF leak in 15 (3.5%), debridement and dura closures in 51 (12%), and brain abscess drainages in 2 (0.4%). Outcomes were good in 65.4%, with severe disability in 0.8%, and mortalities of 27.7%. **Conclusion:** RTA was the leading cause of head injuries among young males with several penetrating injuries. Good outcomes are achievable with surgical interventions when indicated. Strict preventive legislation among road users and conflict resolutions is highly recommended to reduce this burden.

Keywords: *Head injury, Outcomes, Pattern, Surgery, TBI*

Introduction

Head injury (HI) is a broad term that describes a vast array of injuries that occur to the scalp, skull, brain, and underlying tissue and blood vessels in the head. Head injuries are also commonly referred to as brain injury, or traumatic brain injury (TBI), depending on the extent of the head trauma.[1] Head injury may be caused by a bump, blow, jolt, or a penetrating wound.[2] It may either be classified as closed or open (includes penetrating). Head injuries may cause bleeding into the brain tissue, in the layers that surround the brain (subarachnoid haemorrhage, subdural haematoma, epidural haematoma).[3.]

Based on the Global Burden of Disease study in 2016, over 27 million new cases of traumatic brain injury (TBI) are said to occur worldwide.[4] It occurs in higher frequencies tri-modally among the paediatric population (0-4 years), the adolescent and young population (15-24 years), and the elderly population (65 years and above).[5]

Men are at a higher risk of sustaining traumatic brain

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injuries than women, with a male-to-female (M: F) ratio of 2:1.[6] A study conducted across six major hospitals in Tanzania revealed road traffic accidents to be the leading cause of Head injuries, accounting for about 47 % of all cases, [7, 8] A non-contrast-computed tomography (CT) of the head has been the standard initial imaging study for moderate-severe TBI. CTs have high sensitivity and specificity for intracranial haemorrhage, oedema, midline shift, herniation, and skull fractures. They are quick studies that are readily available, and they lack major contraindications. [9] A magnetic resonance imaging (MRI) study is indicated in situations where a non-contrast head CT is not available, and most importantly unable to provide images that correlate to neurological deficits. MRI is more sensitive at demonstrating diffuse axonal injury, grading intracranial haemorrhage, and detecting contusions, microhaemorrhages, and brainstem injuries.[10]

Ideally, ICP monitoring is recommended in patients with severe TBI who undergo surgical evacuation if the patient meets any of the following conditions: preoperative GCS motor response score of 5 or less, preoperative hemodynamic instability, concerning signs on preoperative CT imaging (compressed basal cisterns, midline shift greater than 5 mm), preoperative anisocoria or bilateral mydriasis, intraoperative cerebral oedema, or new lesions on postoperative CT imaging.[11]

Many TBI survivors suffer from permanent disabilities that impact their physical and psychosocial well-being. Furthermore, there exists a substantial financial burden that TBI imposes on survivors, their caregivers, and the healthcare system. Similar to other types of injuries, TBI disproportionally burdens low- and middle-income countries (LMICs) with nearly three times more reported TBI cases compared to high-income countries.[12] The World Health Organisation estimates that each year more than 10 million people in the world sustain TBIs, resulting in death, disabilities, or extensive hospitalisation. [13]

In low-income and middle-income countries (LMICs), almost 4·5 million TBI cases are estimated to require operative management every year. [14] Surgical interventions may be needed in about 5% of hospitalised TBI cases.[15] This necessitated the World Bank’s Disease Control Priorities report to include operative management for TBI as one of the surgical procedures considered essential to be available on an emergency basis to everyone worldwide. [16]

Global estimates show that male TBI-related mortality is three to four times higher among males than women [17, 18], as most often the injuries are secondary to interpersonal violence and motor vehicle collisions, where the main victims are males. From a systematic review in the Middle East and North Africa (MENA) regions, it has been found that mortalities from severe TBIs may range between 9-46%. [19] Though a lesser mortality rate had been reported from a study in Lebanon (1.4%). [20]

Improved outcomes result when secondary delayed insults that reduce cerebral perfusion to the injured brain are prevented or overcome. This has been shown to reduce mortality from severe TBI from as high as 50% to under 25% over the last 30 years, even when adjusted for injury severity, age, and other prognostic factors.[21] It has been found that the odds of having an unfavourable outcome are two folds higher among patients with severe Glasgow coma scale [AOR = 2.142; 95% CI (1.196- 3.836], likewise the odds of having unfavourable outcome from TBI were 2.2 times higher for those patients with moderate Glasgow coma scale [AOR = 2.276;95% CI (1.308- 3.960] as compared to those who had mild Glasgow coma scale.[22, 23] The increasing availability of radiological imaging (CT scans), early resuscitation, and surgical interventions has resulted in decreasing mortalities in recent years.[24] So far, no previous report on the pattern and outcomes of surgically treated head injuries in north-eastern Nigeria.

Materials and methods

We carried out a 10-year retrospective observational study between January 2015 and December 2024 in three (3) major hospitals spread across northeastern Nigeria. The hospitals were the University of Maiduguri Teaching Hospital (UMTH) in Maiduguri, Borno State, Modibbo Adama University Teaching Hospital, Yola (MAUTHY), Adamawa State, and the State Specialist Hospital, Maiduguri (SSHM), Borno State. UMTH is the major referral hospital in Northeastern Nigeria. The 3 hospitals have an Accident and Emergency (A and E) department, functional Intensive Care Units (ICU), and a high dependency unit (HDU). Additionally, UMTH has a trauma centre. All have a functional radiology department with a 128-slice Computed Tomography Scanner (CT Scanner) and a 1.5 T MRI.

A structured questionnaire was used to extract the data from the patient's medical records. Data collected include those of the Demography (age, sex), Mechanism of injury (closed, opened), aetiology, available radiological investigations, types of surgery done, and the outcomes at 6 and 12-month postoperative periods. SPSS (Statistical Package for Social Sciences) version 24.0 was used to analyse the data. Descriptive statistics were presented in the form of frequencies, percentages, and proportions for categorical variables. Means and standard deviations for normally distributed continuous variables, and median and interquartile range (IQR) for non-continuous variables were used. A p-value of ≤ 0.05 was considered to be statistically significant.

Ethical approval for the study was obtained from 1 of the hospital's Research Ethics Committees. Informed consent was not needed for this study.

Result

A total of 3,742 head-injured patients were treated during the study period. From this number, 520 (13.9 %) patients had surgical treatment (surgery) for their head injuries. From the total operated, those that met the inclusion criteria for this study were 428 (82.3 % of 520) patients across the three hospitals, while 92 (17.7 %) were excluded from the study because of either incomplete records, duplicate records, wrongly coded procedures, multi-trauma (polytrauma) patient, those lost to follow-ups, and those who had only scalp suturing as the only surgery. This is depicted in Figure 1, below.

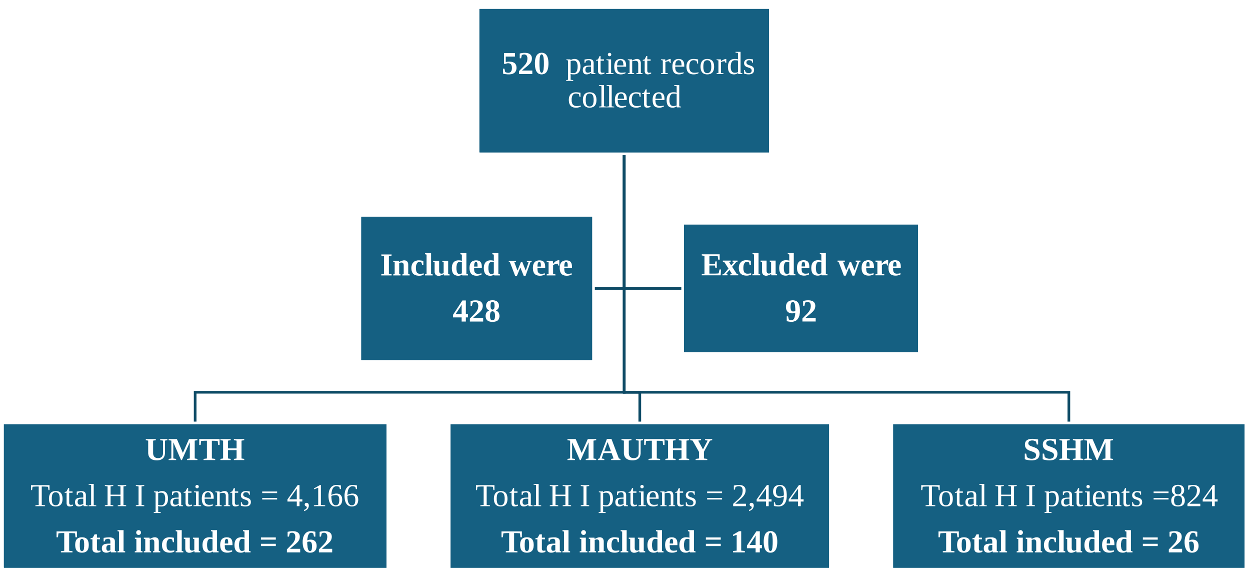

Figure 1: The Above shows the total number of head-injured patients and those operated on in the 3 hospitals

The total number of patients that had definitive surgical interventions was 11.4 % of the 3,742 patients with head injuries.

Their ages ranged from 6 months to 76 years, with a mean age of 30.1 years, with 78% of them were within the ages of 15 to 40 years. Adults constituted 72.8 %, while children were 27.2 %. There were 357 males and 71 females with a male-to-female ratio (M: F) of 5:1.

Regarding the mechanism of injuries, a total of 326 (75.9%) had closed-head injuries, while 102 (24.1%) patients had open-head injuries. Aetiologically, of the 428 patients, road traffic accident victims accounted for (347, 81.1 %), falls from heights (34, 7.9 %), gunshots/bullets (17, 4 %), improvised explosive devices (IEDs) shrapnel (14, 3.3 %), arrow shots (6, 1.4 %), dagger/knife (5, 1.2 %), assault (3, 0.7 %), and other undocumented causes (2, 0.4 %).

The mechanisms of injury and the implicated etiological factors are shown in Table 1.Their clinical severity was assessed using the Glasgow Coma Scale (GCS) Score, and the available imaging modalities are shown in Table 2,.

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Table 1 shows the aetiological factors based on the mechanisms of injury.

MECHANISM OF INJURY	AETIOLOGY	NUMBER (%)
Closed Head injury (n = 326)	Road traffic accidents (RTA)	301 (92.4)
	Fall from heights	21 (6.3)
	Assaults	3 (1.1)
	Others	1 (0.2)
Open Head injury (n = 102)	Road traffic accidents (RTA)	46 (45.6)
	Fall from heights	13 (12.6)
	Gunshot (Bullet)	16 (16.1)
	IED (Shrapnel)	14 (13.8)
	Arrow	6 (5.4)
	Dagger/knife	5 (4.6)
	Others	2 (1.9)

Table 2: Below shows the head injury severities among the patients and the various available diagnostic imaging modalities.

PARAMETERS	FINDINGS	NUMBERS (%)
Glasgow Coma Scale (GCS)	Mild	80 (18.6)
	Moderate	112 (26.1)
	Severe	236 (55.3)
Availability of imaging	Skull X-ray	407 (95.2%)
	CT scan	223 (52.0%)
	MRI	1 (0.3%)
	None	21 (4.9 %)

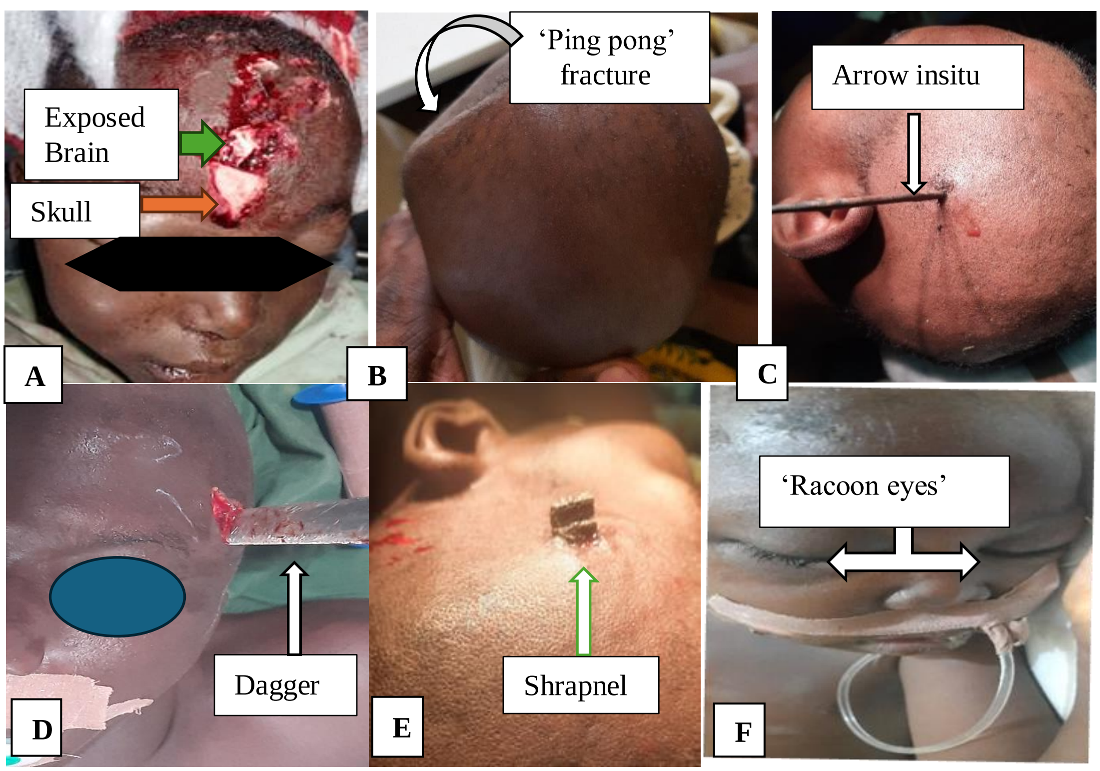

Figure 2: Above are clinical pictures showing some of the patients at presentation. An opened mid–frontal injury with an extruded brain (green arrow) tissue (**A**), A right parieto-occipital depressed skull fracture in a child (**B**), A left parietal-temporal arrow insitu (**C**), A penetrating left frontotemporal dagger/knife insitu (**D**), Left parietal-temporal, impacted shrapnel from an Improvised Explosive Device (**E**), Bilateral "racoon eyes" in a child with anterior skull base fracture with feeding nasogastric tube insitu (**F**).

Patients had radiological investigations, confirming the diagnosis. Some of the common radiological findings are shown in Figure 3, below

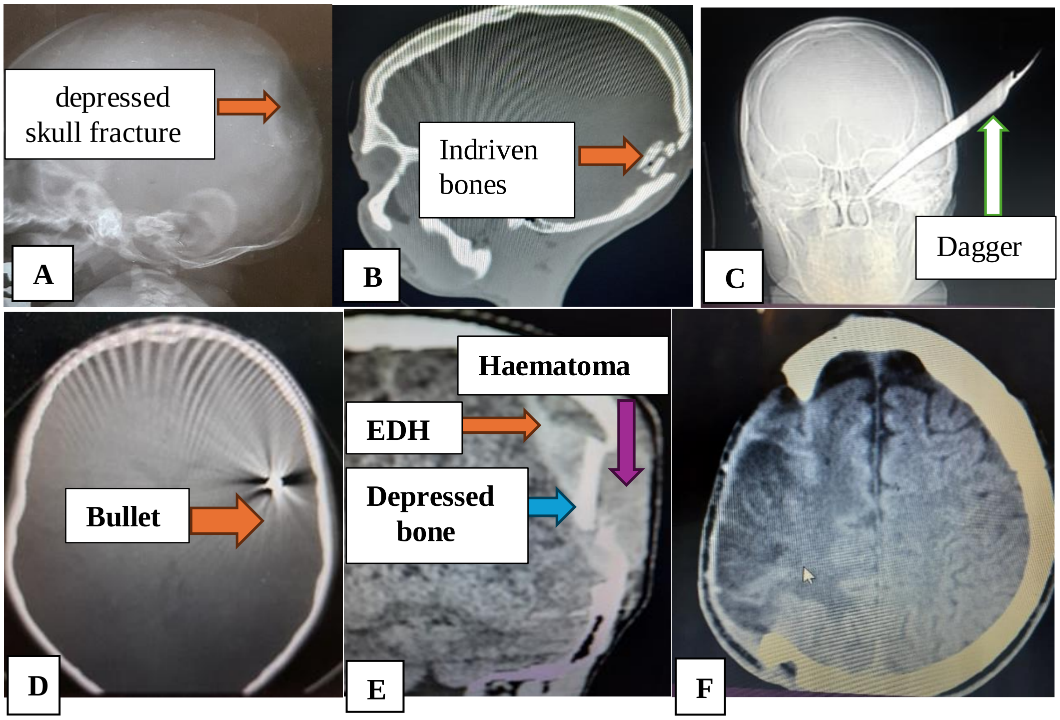

Figure 3: The Above shows some of the radiological findings. Plain Skull X-ray showing right occipital depressed (' Ping pong') fracture indicated by pink arrow (**A**), Sagittal bone window of Computed Tomography showing occipital comminated skull fracture with in-driven skull fragments indicated by pink arrow (**B**), An AP view of the skull X-ray of the patient in figure 2 D showing the intracranial dagger insitu, passing through the left frontal – temporal bone (and obliquely downward) through the skull base (**C**), An axial view of a computed tomography (bone window) showing an intracranial bullet with Characteristic 'scatter effect' indicated by pink arrow (**D**), Coronal view of a Computed Tomography showing a left depressed skull fracture (pink arrow) with an overlying haematoma (purple arrow) and an underlying Extradural haematoma (EDH) indicated by blue arrow (**E**), A post-operative, axial computed tomography of a patient who had right Decompressive Craniectomy (DECRA) for calcitrant brain oedema (**F**). Various surgical interventions were carried out on 428 (11.4 % of 3,742) of the patients as indicated clinically and radiologically. Some patients had multiple indications for surgeries and, therefore, had multiple surgeries. The various indications and types of surgery done are as shown in Table 3, below.

Table 3: Showing the various indications and surgeries done. **N=428**

TYPE OF SURGERY	NUMBER OF PATIENTS (%)
Haematoma evacuations: Via a craniotomy or burr hole appropriately (extradural, subdural, intraparenchymal, intraventricular)	216 (50.4)
Haemorrhagic contusion: including Decompressive Craniectomy (DECRA)	24 (5.7)
Foreign body extractions: (arrow, dagger, bullet, shrapnel, gravel, glass thorn, stick, etc.)	78 (18.3)
Skull fracture: elevation/depression of an elevated skull fracture	42 (9.7)
CSF fistula repair	15 (3.5)
Debridement and dura closure	51 (12)
Post-traumatic Brain abscess surgery	02 (0.4)

Overall outcomes, irrespective of the patients' admitting GCSs, were determined at 12 months of follow-up, this is as shown in Table 4, below.

Table 3: Shows the patient's overall outcomes at 12 months of follow-up.

Outcomes	Number of patients (n=428)	Percentage (%)
Good	280	65.4%
Mild Disability	19	4.4%
Moderate Disability	7	1.7%
Severe Disability	3	0.8%
Overall mortalities	119	27.7%

The overall mortalities based on the severity of their admitting GCSs were: Mild HI (8, 7%), Moderate HI (38, 32%), and Severe HI (73, 61%). Worthy of note are the mortalities based on their GCSs at 6 months and 12 months post-surgery: Mild HI (6%), Moderate HI (27%), Severe HI (52.3 %), and Mild HI (1 %), Moderate HI (5%), Severe HI (8.7%), respectively. The corresponding number of mortalities at 6 and 12 months based on the GCSs of the patients is shown in Figure 4, below.

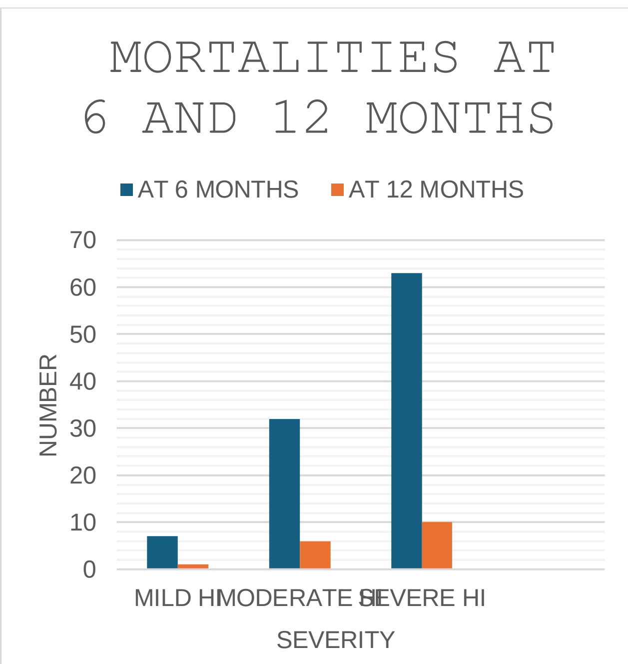

Figure 4: Showing mortalities at 6 (Blue colour) and 12 (Peach colour) months based on their admitting post-resuscitation Glasgow Coma Scale (GCS) scores.

Discussion

The mean age of our patients was 30.1. meaning that most of them were in the younger age brackets. Furthermore, patients aged 15 – 40 years formed 78% of our patients. Most studies have revealed that most of the patients are young, like ours. [22,25]

Most of our patients were males with a male-to-female ratio of 5:1. This is very similar to a study done in Pakistan [25] that found a male-to-female ratio of 4.9:1. Higher male-to-female ratios of 6:1 and 9:1 have been reported in Tanzania,[26] and the Benin Republic [15]

Lesser ratios of 4:1, 3:1, and 2:1 have been reported [27, 28, 29], but still with male dominance, respectively. This large-scale involvement of males has to do with them being the breadwinners of their families, most of the time travelling by road for business, and the religious and cultural practices of keeping women as full-time housewives, which reduces the likelihood of their involvement in RTAs.

Overall, a Road traffic accident was the leading cause of head injuries in our study (347, 81.1%), leading to closed head injuries (86.5%) and a lesser number of open head injuries (13.5%). Studies from Muhimbili Orthopaedic Institute (MOI) in Tanzania [26] and from the Benin Republic [15] (80.6%) concurred with our finding of RTA as a leading cause of HI. Our finding of 81.1% is much more than what was reported from Ethiopia [22] and Pakistan (58.4%). [25]

Our findings may be explained by the fact that the most common means of transport in Nigeria is the use of motor vehicles (road transport), coupled with deplorable conditions of our roads, speeding by drivers, overloading, and poor compliance with the use of a self-restraint system (seat belts). Other important causes we found apart from RTA include falls from height (7.8%), and a good number from explosions of improvised explosive devices (IEDs) / bomb blasts (3.3%). However, a study from Lebanon[30], despite the Arab – Israeli conflicts, found that injuries from falls (44.3%) outnumbered their road traffic accidents, with explosives-related injuries (4%) slightly higher than ours.

A bulk (76.2 %) of our patients had closed head injuries. A study by Ghandour (92.7%)[30], and by Santiago [31] observed a larger number of closed head injuries with very few open head injuries compared to ours. Our relatively higher cases of open head injury may be explained by a higher incidence of terrorism (Boko Haram) related injuries at the early stage of this study.

Almost all our patients had Skull X-rays (95%), with

CT scans in more than half (52.0%) and very few MRIs (0.3%). Ghandour[30], in Lebanon, found lesser use of imaging (X-ray in 49.6%, CT scan in 29.2%) than ours, except that his use of MRI is higher than ours (1.7%).
Our operation rate of 14.5% is less than half of the number operated by Arfa[26] in Pakistan (36.2%). We presume that his cases might have included those patients who had minor surgeries like scalp suturing.
Haematoma evacuation was our main indication (50.4%) for surgery. The evacuation of hematoma also carries the highest indications from a Benin Republic study (75.8%).[15]
In contrast to our haematoma evacuation findings, a Global Neurotrauma Outcomes Study found that surgery for the elevation of depressed skull fractures is the most common (45%).[32]
We carried out surgeries for the removal of various foreign bodies, including arrows, daggers, bullets, shrapnel, gravel, glasses, etc., in 18.3% of our patients. These are more when compared to the removal of Wood, metal, and glass reported by Levine. [33]
CSF leak repair was carried out in 38 (3.5%). All were males; among them were 3 (8%) boys.
This finding among males is corroborated by Ismail.[34] Findings among children as young as 3 years old have been reported by Tahir from Pakistan.[35] Despite this, we found few involvements of children in our study compared to adults; this is similar to the study by Ferraria.[36] Our childhood findings are higher than the findings of Ferraria [36], who found an incidence of CSF leak repair of 0.2–0.3%. Its rarity may be explained by the flexibility of the skull among children, which results in fewer fractures and subsequent dura mater tears.
The outcome was good in 64.5% of our patients. This is an improvement over the findings from the Benin Republic (54.9%)[15] and Ethiopia (57.3%).[22] We found overall postoperative mortality to be 27.7%. This finding is less than the postoperative mortality (29%) finding of Holden in the Benin Republic, 15, but higher than the 24.8% found in Ethiopia.[22] However, this falls short of the overall mortality of 37% reported by Frohlich [27]
Our overall mortalities based on head injury severities (GCS) were mild (7%), Moderate (32%), and severe (61%). Frohlich [27] found lower (15%) mortalities in the moderate and within severe (54%) groups, respectively.
We equally found that mortalities were proportionately higher at 6 and 12 months with increasing severity of the head injury, as follows: Mild (6 %), Moderate (27 %), Severe (52.3%), and Mild (1 %), Moderate (5 %), Severe (8.7 %) respectively.
We found that low GCS (moderate to severe HI) on admission was a significant contributor to mortalities with a P-value of < 0.05. This is the same as the finding of Chiewvit. [37]
We found that the mortalities continued through 12 months, like a report by Jiang[38] et. al.

Limitations of the study
This study is limited by being a retrospective study with a likelihood of misclassification bias and a high rate of data loss.

Conclusion and recommendations
Young men, within the economically active age group, fending for their families and society, are most of the patients. Patients admitted with low GCS have a higher likelihood of dying. Surgical interventions for head injuries are critical in their management when indicated and may improve outcomes.
Our good outcomes are because of adequate resuscitation and prompt referral from health facilities established by numerous Non-Governmental Organisations (NGOs) as a result of the Boko Haram insurgency in our region.
Hence, we recommend that there is a need for urgent public policy response with special interest in the prevention and emergency care of road traffic crash victims with head injuries. This may include legislative backing to include head injury as part of primary health care.

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Conflict of interest
None to declare.

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