Computerised Tomography Scan and Head injury: The experience in a tertiary hospital in Lagos. A cross sectional study.

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Abstract

**Background:** Trauma is the leading cause of death in all age groups, and head trauma contributes to the cause of death in more than 50% of cases. Head injury reduces the level of physical and mental health of a community, ultimately increasing the socioeconomic burden. In our resource limited community, skull x ray was the main mode of investigating head trauma until recently when CT scans became the modality of choice in the initial work up of patients with head trauma, providing an accurate non-invasive diagnosis of the sequelae of head injuries.

With the increasing acquisition of modern imaging equipment (CT and MRI) in Nigeria, and the dependence of neurosurgeons on CT Scan and MRI results to make informed and accurate decisions on the management of their patients, CT has actually impacted the management of head injuries which have become a universal problem that constitutes a major public health problem in terms of morbidity and mortality.

This study sought to document the various posttraumatic CT scan findings following head injury in a tertiary hospital in Lagos. We also hope to determine the sociodemographic and radiological characteristics of patients presenting with head injuries at our center.

**Methods:** This was a descriptive, prospective, cross-sectional study of the computed tomography scan findings of 400 cases with acute head trauma, from June 2010 to October 2011. A G.E hi speed dual CT scanner®, (General Electric co. Milwaukee Wisconsin USA, 2006) was used to acquire the images that were assessed.

**Results:** The mean age of the participants was 32.7 ±18.2 years with a male to female ratio of 2.5:1. Majority, 65.5% of the study subjects had positive CT findings while the remaining, 34.5% had normal CT findings. Road traffic accident (RTA) was found to be the most common cause of head
injury, occurring in 69% cases, especially in the 21-30 years age group. Cerebral contusions, 35.5% and skull fractures, 34.3% were the most common lesions found while foreign body, 1.5% were the least.

**Conclusion:** This study confirmed the versatility of CT scan in detecting both intracranial and extra cranial lesions in patients with head injury from RTA which is the commonest cause, while the most frequent lesion was cerebral contusion.

**Key Words:** Computerized Tomography Scan, Head trauma. Lagos
Trauma is a preventable epidemic neglected by many governments, especially in developing countries[1]. Many of the devastating effects of trauma are often from head injury[1]. Up to half of trauma deaths are due to head injuries, also accounting for most cases of permanent disability after injury[2]. Head trauma is any injury that causes lesion or functional damage to the cranium, meninges and brain[3]. It is considered a major health problem causing death and disability, thus having considerable demands on health services. In developing countries, including Nigeria, accident rates in general and traumatic brain injury in particular are increasing because of the increasing traffic load, poor states of the roads and the use of motorcycles as one of the major means of transportation[4,5]. Besides, other factors like industrialization, falls and ballistic trauma contribute to the increased incidence of brain injury[2].

Two general categories of head injuries; Closed and Penetrating are identified.

A closed injury is one in which the skull is not broken open (no skull fracture) unlike the penetrating injury where the skull is broken open[6,7]. Various mechanisms result in closed head injury such as motor vehicle and motor cycle accidents, falls from heights and assaults. Penetrating injury is however often due to gun shots, knife stabs, but sometimes other types of blunt objects can violate the skull[8].

Historically, imaging of the head-injured patient relied on skull radiographs[5]. Detection of fractures of the cranial vault by plain radiography of the skull is now appreciated to be less useful in assessing the probability of intracranial hemorrhages than had been previously suggested[7]. Clinical assessment appears to be a better guide and this in turn guides the need for CT. Thus the role of skull radiography has greatly diminished[7] The introduction of computed tomography in 1973 opened
new opportunities in the investigation of head injury and is now the investigation of choice[9]. Cranial Computed Tomography has been established as an accurate diagnostic modality in neuroradiology[10]. It provides accurate non-invasive diagnosis of fractures, intracranial hemorrhages and other sequelae of head injury, like cerebral oedema[11].

Magnetic Resonance Imaging (MRI) is playing an increasingly important role in the evaluation of head trauma[12]. It has proved more sensitive than CT in the detection of non hemorrhagic contusions, diffuse axonal injuries and subdural haematomas but it is equivalent to CT in the depiction of hemorrhagic contusions [12]. Disadvantages of MRI that precludes its use in the evaluation of acute head injury include; long scan time and its inability to detect fractures, subarachnoid hemorrhages and hyper acute haemorrhages[12]. MRI is the modality of choice in the sub acute and chronic stages of head injury, because it is more sensitive than CT in the detection of both hemorrhagic and non hemorrhagic lesion[12].

CT is still preferred over MRI in the evaluation of acute head trauma[13]. MRI is indicated for evaluation in non acute setting for patients in stable conditions because of its better soft tissue contrast resolution in detecting hemorrhagic and non hemorrhagic lesions. MRI is more sensitive than CT in detecting brain stem injury, diffuse axonal injury, small extra fluid collections. MRI is also useful in predicting long-term outcome in patients with head injury therefore, examination must be performed within 2-3weeks[13]. For detecting hemorrhage, spin echo sequences and gradients echo are recommended because they have increased sensitivity for blood products[13]. However CT scan is preferred for evaluation of post traumatic deafness, ossicles damage[13] while MRI can distinguish the causes of post traumatic insufficiency (direct injury of pituitary gland, stalk transaction and hypothalamic injury)[13].

This study was to assess and document the pattern of CT findings in head trauma in Lagos State University Teaching Hospital. It would be comparing findings with previous works done in other
centers. We also hope to elicit the age, sex, social, radiological characteristics of patients presenting with head injuries at our center and to identify the relationship between the biophysical data and the other characteristics, and etiologic factors of head injury.

Methods

The CT scan of the head of 400 consecutive patients referred to the Radiology department of Lagos State University Teaching Hospital, specifically for evaluation of head trauma between June 2010 and October 2011 were prospectively reviewed.

The study subjects presented for imaging from one hour up to 14 days post trauma. Only the initial CT scan performed on each patient was analyzed. The following information were retrieved from the case notes, request cards or directly from the patient at the time of initial visit; age, gender, mode of injury (road traffic accident, fall, assaults and gunshot injury), time of injury, clinical indication and Glasgow Coma Score (GCS). The information concerning the subjects whether he or she was a driver or passenger, front seater or back seater and the use of seatbelt were also noted. Survivals and mortalities following head trauma were also documented.

The Health Research and Ethics Committee, Lagos State University Teaching Hospital, Ikeja Lagos, Nigeria approved the study (Ref. No. LREC/10/05/132) and consent was also obtained from the patients or relatives depending on the state of consciousness and age of participants. It was carried out in compliance with the Helsinki Declaration.

All studies were performed with a G.E hi speed dual CT scanner®, (General Electric co. Milwaukee Wisconsin USA, 2006). The study subjects were placed in supine position in the CT scanner gantry and scanned from the skull base to the vertex with contiguous axial slices parallel to the inferior orbitomeatal line using 5mm slice thickness at interval of 3mm. No intravenous contrast material was administered, to avoid masking any hyperdensity which is a typical CT appearance of acute
hemorrhage. Images stored in the Picture archiving and communication system (PACS) were then analyzed for lesions by the radiologist. The radiological features and anatomical distribution of the lesions on the CT images acquired were assessed and documented. These include contusions, fractures, intracranial hemorrhages, pneumocephalus, haemosinus, oedema and brain swelling; diffuse axonal injury, subcutaneous emphysema, soft tissue swelling, foreign bodies and subgaleal haematoma. Data was entered into Microsoft office excel spread sheet, coded to mask patients’ identities and then exported into IBM statistical package for social science software (SPSS) version 19.0 Chicago, Illinois for analysis. Analysis was done using simple descriptive statistics. Descriptive statistics (mean, median, mode, standard deviation and percentages) was calculated for appropriate variables. Pearson’s chi-square was used to assess relationships and statistical significance between categorical variables. P-value less than 0.05 was considered to be statistically significant (confidence level =95%).

Results and Discussion

Demography

A total of 400 CT scan images of patients that sustained head injury were analyzed. Just less than three quarter, 71.8% of the study subjects were male while 28.3% were female, with a male to female ratio 2.5:1. Their age ranged from 1 to 87 years, with a mean age of 32.7 years ± SD 18.2 years. The median and modal age was 31 years and 35 years respectively.

Age distribution and etiology

Table 1 shows the age distribution and the etiology of injuries amongst the 400 subjects with head injury. Head trauma occurred more commonly in the 21-30 years, 23.8%. Road traffic accident was the commonest cause of head injury, 69% in all age groups.

CT findings in the study group
Table 2 shows the CT findings in the study group. About 34.5% had a normal CT images while 65.5% had 10 different lesions related to head trauma detected. Cerebral contusions, (Fig. 1) were the commonest finding (140 subjects) followed by fractures (137 subjects), linear being the most frequent. The fractures includes skull base fractures, 4.0% and vault skull fracture, which were both linear, 22.8%, and depressed, 9.3% (Fig.2). Haemosinus (Fig. 3), 19.3%, Pneumocephalus (Fig.4), 7.5% and foreign bodies (Fig. 5), 1.5% as pellets from gunshot injury, were some of the other findings.

**Causes of head injury and their clinical indications**

Patients were more likely to have a positive CT finding, if the injury was sustained from gunshot injury, 100% and RTA, 73.6% while there is less likelihood of a positive finding if the cause of injury is from assault, 50.0% and falls, 47.8%. Other causes of head injury observed in the study are shown in Table 3. CT abnormalities were seen more in subjects who were unconscious, occurring in 80.81% while patient presenting with headaches, 39.39% had the least CT findings,

**Intracranial bleeds**

Table 4 shows the various types of intracranial hemorrhage and the percentage associated with fracture. Epidural haematoma (Fig. 6a) has the maximal association with fracture (84.4%) followed by intracerebral (55.5%) (Fig. 6b), subarachnoid (48.3%) (Fig. 6c), subdural (36.7%) while intraventricular (Fig. 6d) had the least association (23.5%).

**Fractures**

The various types of fractures and the percentage associated with Haemosinus and Pneumocephalous is shown in Table 5. Basal fracture had the maximal association with Haemosinus while the depressed fracture has the least association. All the 30 cases of pneumocephalus were associated with fracture. Depressed fracture had the maximal association. There were 144 fracture sites in 137
patients as shown in Table 6. Seven patients had multiple fracture sites. The parietal bone (35.4%) and frontal bone (33.3%) were the most involved sites while the base of the skull, (11.1%) was the least.

**Anatomical distribution of intracranial lesions**

This study revealed that the frontal lobe was the commonest site for cerebral contusions, 61.3%, epidural haematoma, 59.6%, subdural haematoma, 51.7%, intracerebral haematoma, 44.7% and pneumocephalus, 90.9%. Subarachnoid hemorrhage, 54.8% and intraventricular hemorrhage, 80% were most commonly seen in the temporal lobes. Positive findings were least in the occipital.

**Factors that affect findings in road traffic accident**

Of 275 study subjects, motor vehicular accidents and motor bike accidents were seen in 51.8% and 20.1% subjects respectively while 25.7% were involved in pedestrian road traffic accidents. One patient could not be accounted for. Positive findings were mostly seen in passengers, 77.1% when compared to drivers 71.7%. Back seaters had more positive findings, 76.8% compared to subjects sitting in the front, 73.7%. There were also more positive findings in subjects that did not use seatbelts, 76.3% compared to those that did, 74.6%. Daytime accidents had more positive findings 75% compared to accidents at night 70.6%.

**Relationship between GCS and CT scan findings**

Of the 204 subjects that had GCS recorded, a clear association was found between incidence of positive CT scan findings and GCS (P=0.000), showing an increase in rate of positive findings as the GCS score decreases. GCS score of 3 to 11 were associated with positive findings in all cases.

**Relationship between outcome of trauma and CT findings**
Only 204 subjects were assessed in this category. All subjects with normal CT findings, 100% survived. Mortality was highest in subjects with intraventricular haemorrhage, 100%, pneumocephalus, 100% and depressed skull fracture, 100%.

**Relationship between GCS and outcome of trauma**

There was an increase in mortality as the GCS score decreases.

**Discussion**

Head injury is a cause of morbidity and mortality in all age groups as was verified in this study where the age ranged from 1-87 years. The peak incidence of head injury was in the third decade, 23.8%, similar to findings from previous studies by Ogunseyinde et al[10] in Ibadan, 21.2%, Ohaegbulam et al[14] in Enugu, 33.9%, Adeolu et al[1] in their study on south-western population in Nigeria, 23.3% and Bordignon et al[3], 25.1% of head injury in the third decade in their study in Brazil. The next vulnerable age groups were in the fourth and fifth decades. The third, fourth and fifth decade groups consist of students and working class individuals, who spend most of their time in outdoor activities outside of their homes, making them more prone to accidents. The decline in cases of head injury in the latter decades of life could be attributed to decrease outdoor activity and mobility as age increases, thus making them less prone to road traffic accident.

The mean age of the study subjects, 32.7± 18.2years and a male: female ratio (2.5:1) are consistent with the observed pattern in other studies done by Bordignon et al[3] in Brazil (30.8±19years; M:F 2:1) and Mebraththu et al[8] in Eritrea (32.5± 20.9years; M:F 3:1) respectively. Obajimi et al[11] also found a similar trend with a ratio of 5:3 in their study in Ghana. The male preponderance can be explained by the fact that males are more involved in outdoor activities than females and the fact that there are more male drivers compared to female drivers.
Road traffic accidents had been shown to be the most important cause of head injury in several reports as was reported by Obajimi et al[11] as the commonest cause of head injury in 43.9% Ghanaian children. In Nigeria, Ohaegbulam et al[14] found 59% in Enugu, while Adeolu et al[1] reported 73.4% in south-western Nigeria. The present study corroborates these findings as RTA was the commonest cause of head injury in 69% of cases. The large number of head injury caused by RTA has been linked to poor car maintenance, poor state of our roads, reckless driving as well as the use of illicit drugs and alcohol and of motorcycles as one of the major means of transportation[4,25].

Similar to reports by Adeolu et al[1] and Ohaegbulam et al[14] who found falls as the cause of head injury in 16.4% and 18.7% of subjects respectively, this study found falls in 16.8% of cases of head injury. Falls was observed as the second most common cause of head injury in this study. Adeolu et al[1], found amongst patients with fall, that 20.8% of them were in the first decade, less than in this study where 35.8% subjects were in the first decade. The high incidence of falls in paediatric age group is a call for concern. It may imply negligence and poor supervision of children by adults.

Bordignon et al[3] found aggression which includes assaults and firearms injury as the commonest cause of head injury, 17.9% which is at variance with this study where assault accounted for 9.5% while gunshot injury was noted in 1.5%. The relatively lower incidence of gunshot injury in our environment is probably because citizens are not allowed to carry guns in Nigeria. The few cases found were most likely due to armed robbery attacks.

Normal CT scan was found in 34.5% of cases in this study. Ogunseyinde et al[10] and Obajimi et al[11] reported 39.4% and 53.7% cases of head injury with normal CT scan result respectively. Ogunseyinde et al[10] attributed this to the timing of examination or axonal injury that may not be detected by computerized tomography on an initial scan.

The incidence of positive CT scan findings vary from one study to the other in literature. This could be attributed to the level of transportation, states of the roads, use of illicit drugs and alcohol and the
increase in arbitrary use of deadly weapons (guns/knives). This study found 65.5% positive findings
which is comparable to the findings by Ogunseyinde et al[10], 60.6%, Isyaku et al[15] in Sokoto,
78.4% and in Ghana by Obajimi et al[11], 46.3%.

A contusion may be described as an intracerebral haematoma if the lesion contains a large amount of
fresh blood and therefore appears uniformly hyperdense on non contrast enhanced images[12,16,17].
Cerebral contusion was found in more of the subjects, 35% in this study than that by
Ohaegbulam[14] as the commonest finding in head injury. Contusions are the most commonly
encountered lesion caused by head trauma and result from brain being damaged by impacting against
skull either at the point of impact (the coup) or on the other side of the head (contre coup) or as the
brain slide forward over the ridge cranial fossa floor (most often affecting the inferior frontal lobes
and temporal lobes) [16]. This mechanism of injury could be explained by the findings in this study
where cerebral contusion was seen in 61.3% cases at the frontal lobe and 38.7% cases in the temporal
lobe. On CT scan, contusion appears heterogeneous with mixed areas of high and low densities[6]as
was seen in this study.

Ogunseyinde et al[10] found 17.4% of subdural haematoma, 15.9% of intracerebral bleed and 5.7%
of epidural bleed. Comparable figures of 15.0%, 11.3% and 8.0% respectively were revealed in this
study. Subdural haematoma results from bleeding into the potential space between the inner layer of
the dura and arachnoid. They are typically crescent-shaped, more extensive than epidural
haematoma, and may cross the suture lines but not the dura attachments. They result from bridging
cortical veins that cross the subdural space into an adjacent dural sinus[18]. On CT, acute subdural
haematoma appear as a crescent-shaped, homogenously hyperdense extraaxial collection that spreads
diffusely over the affected hemisphere. They are usually associated with high incidence of mortality.
Grupta et al[19] found subdural haematoma to be associated with mortality in 75% of cases in
Pakistan similar to the present study which found a comparable figure, 68.4%. 

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Cerebral haematomas result from large lacerations that involve larger caliber vessels than in hemorrhagic contusions, resulting in the accumulation of large amount of blood within the brain parenchyma[18]. They are not necessarily superficial in location and may be multiple. They result from severe blunt or penetrating trauma[18]. CT show them as large, hyperdense lesions surrounded by perilesional oedema[12,18].

According to Hirsh[20], intracerebral haematoma of frontal and temporal lobe was the commonest in head injury, while Grupta et al[19] found 52.5% of intracerebral haematoma in the frontal region and 26% in the temporal region and a similar pattern was observed in this study with 44.9% (frontal) and 36.2% (temporal).

Intracerebral haematoma was associated with mortality in 49.7% of patients[19]. This was much more than what was revealed in this study, 38.1%. Expeditious evaluation and adequate management of patients who initially seem at low risk are the most important factors to reduce their mortality[21].

There was a positive correlation between epidural haematoma and skull fracture in this study (P=0.000). Epidural haematoma was associated with skull fracture in 84.4% of cases. Zimmerman et al[22] found epidural haematoma associated with skull fracture in 83.3% cases, while Obajimi et al[11] found 100% cases.

Gruptal et al[19] in their study found an association of 24% between epidural haematoma and mortality. The findings in the present study were much higher, 75%. The higher association of epidural haematoma with mortality in our series may be attributed to delay and bureaucracy in patient management because of prohibitive cost of CT scan procedure in our resource limited environment. The prognosis of epidural haematoma is poor but with prompt identification of localized or multifocal collection on CT scan and direct surgical drainage within four hours of trauma, a remarkable decrease in mortality by about 30-60% has been observed[22].
Intraventricular haemorrhage is found in less than 5% of patients with traumatic brain injury as was confirmed in this study (4.3%); and usually portends a poor prognosis. All the cases with intraventricular haemorrhage were associated with mortality in this study. It is typically related to extension from intraparenchymal bleeding, deep penetrating wounds, tearing of subependymal veins or diffusion from subarachnoid haemorrhage[18]. CT shows increased attenuation within the ventricular system, sometimes associated with blood fluid layering[18]. The rare occurrence of intraventricular hemorrhage may be due to the fact that it becomes isodense relatively more rapidly and may disappear completely within a week[23].

Rabie et al[24] reported 6.1% of subarachnoid hemorrhage in their research involving 131 subjects in South Africa, Bordignon et al[3], 6.4% cases in Brazil and 7.3% in this study. It usually results from damage to leptomeningeal or cerebral surface vessels[18]. Less common mechanisms include cerebral contusion with blood leaking into the subarachnoid space from a contused brain surface, intraventricular haemorrhage with reflux through the fourth ventricular foramina into the subarachnoid space, and rupture of intracerebral vessels[18]. On CT, acute subarachnoid hemorrhage appears as increased attenuation in the subarachnoid space.

Gupta et al[19] found subarachnoid haemorrhage associated with mortality in 78% of patients. Subarachnoid haemorrhage was associated with mortality in 57.1% of cases in this study. The outcome of patients with traumatic subarachnoid haemorrhage is related in a logistic regression analysis to the admission GCS and to the amount of subarachnoid blood[25].

The incidence of skull fracture in patients with head injury varies from 17.4%[5] – 62.0% [19] and findings from the present study were within this range, 34.3%. Fractures may involve the skull base or the vault. The vault fracture could be linear, depressed or combined,[3,10]. Basal fracture was seen in 4% cases while depressed and linear fractures of the vault were seen in 9.3% and 22.8% cases respectively in this study. Multiple fractures were seen in 1.8% cases.
Linear fractures were more associated with subdural, epidural and intracerebral haematomas while depressed skull fractures were more associated with contusions[10]. Contrary to this claim, this study confirmed that cerebral contusion was mostly associated with both linear and depressed fracture. Depressed skull fractures cause more associated mortality compared to linear and base of skull fracture. Linear skull fractures, are clearly seen on skull x-rays, appearing as a line of decreased density on plain radiographs[18]. Although they are usually well detected on CT, some linear non-displaced fractures (especially those aligned on the horizontal plane) may be missed on routine axial CT[17,18]. Therefore, the scout view should be carefully examined in injured patients. On CT, skull fractures appear as a line of decreased density and are of a lower density than that of a closed cranial sutures or vascular grooves[18]. Depressed skull fractures, are well documented by CT, which defines the extent of bone displacement and the presence of complications, including dural tears, haematomas, cerebral contusions and retained osseous fragments[18].

Most skull fractures have no underlying brain injuries while most severe brain injuries have no skull fractures[26,17]. Epidural, subdural, intracerebral, intraventricular and subarachnoid hemorrhages were found to be associated with fracture in 84.4%, 36.7%, 55.6%, 23.5% and 48.3% cases respectively in this study. Thus confirming that, the non visualization of a fracture does not preclude significant injury of the brain.

In the present study skull fracture was present in the parietal region and frontal region, 35.4% and 33.3% respectively, similar to the findings by Obajimi et al[11] and Ogunseyinde et al[10]. The latter attributed this to the convexity of the parietal and frontal bone.

The incidence of pneumocephalus varied in the literature from 1.52% to 16.8%[24]. All the cases of pneumocephalus were associated with fracture in this study. The development of pneumocephalus follows two theories that can be called the ‘the ball valve’ and the ‘inverted bottle’ mechanisms. The ball valve mechanisms implies that positive pressure events such as sneezing, coughing and valsava
maneuvers, force air through a cranial defect, which then resists the spontaneous movement of air. Significant resistance to the outflow of air leads to tension pneumocephalus. In the inverted bottle theory, drainage of cerebrospinal fluid leads to a negative intracranial pressure gradient which is relieved by influx of air[27,28].

The commonest site of pneumocephalus is the frontal region, 90.9% in this study as was also observed by Grupta et al[19] who found 60% cases frontal region. The predilection for the frontal region may be explained by the fact that air rises up while patient lie supine.

Pneumocephalus was associated with mortality in 100% of cases in this study. The prognosis is largely related to the type of injury and the number of air bubbles or pockets, but it has been shown that a pneumocephalus with multiple air bubbles is prognostically unfavourable regardless of mechanism of injury[6].

Haemosinus is seen as a soft tissue density in the paranasal sinuses, with or without an air fluid level. Most are usually associated with base of skull fracture as was confirmed in this study. This study found 19.3% of cases with haemosinus which is comparable to the findings by Taheri et al[29] in Iran where they found 16% of cases with haemosinus out of their 708 patients.

Brain swelling and oedema occur commonly in patients with head trauma[29]. It is observed more commonly in children than in adults [11,10,18]. Zwieneberg et al[30] attributed this to disruption of blood brain barrier resulting in hyperemia and cerebrovascular engorgement. It was seen in 10.3% cases in this study. CT findings consist of compression of the lateral and third ventricles and perimesencephalic cistern. It has been documented that serial CT scans show the gradual resolution of brain swelling over a period of 3 to 5 days[18]. Oedema is evident as decrease density within and surrounding areas of contusion and intraparenchymal haematoma. Oedema may occur as an isolated finding, appearing as area of decrease density. Cerebral oedema typically appears 24hrs after injury, increases and becomes maximal at 3 to 5 days, then gradually resolves[12].
Diffuse axonal injury was found in 3.5% of cases in this study. It is an important pathologic finding of traumatic brain injury. It is accompanied by tissue tear haemorrhages\cite{31,32}. The susceptibility of axons to mechanical injury appears to be due to both their viscoelastic properties and high organization in white matter tracts. Although axons are supple under normal conditions, they become brittle when exposed to rapid deformations associated with brain trauma\cite{31}. Diffuse axonal injury caused by deceleration and rotation of brain or shearing injuries is seen as a small area of petechial haemorrhage or focal region of decreased density commonly located at the grey-white junctions, basal ganglia, splenium of corpus callosum and dorsal midbrain. MRI is more sensitive than CT in detection of diffuse axonal injury. Lesions are readily demonstrated by MRI in patients in whom CT scan show no abnormality as hyperintensity on T2 weighted image. The injuries are demonstrated with CT only when larger than 1.5cm in diameter or when present in the corona radiata or internal capsule\cite{33}.

Scalp injury may manifest as bleeding or oedema involving the skin and subcutaneous tissue. Bleeding may occur into subcutaneous fat, beneath the galea aponeurotica or beneath the periosteum. Cephalhaematoma is seen in young patients and is limited by the sutures. Subgaleal haematoma tends to spread over a large area of the scalp\cite{34}. Soft tissue swelling was seen in 8% of cases in this study, comparable to reports by Bordignon et al\cite{3}, 8.9%. However a higher number of subgaleal haematoma, 5.8% was seen in this study contrary to reports by Bordignon et al\cite{3}, 2.4%. Subcutaneous emphysema was revealed in 7.3% of patients in this study.

Ogunseyinde et al\cite{10} reported about 2% of foreign body mostly from bullets /shrapnel. In this study comparable pattern was found accounting for 1.5% cases. Gunshot wounds are a common cause of penetrating head injury. CT scans allow one to rapidly locate the position of a missile and determine the extent of intracranial injury. The missile, its track and fragments, and skull fracture and displaced intraparenchymal bone fragments are readily identified with the high density artifacts from the shrapnel. Haematoma along the missile tracts, intraventricular haemorrhage and subarachnoid
haemorrhage, diffuse oedema, and pneumocephalus both extracerebral and intracerebral are frequently seen on CT scans[12]. The presence of metal projectiles is a contra indication to an MRI study because projectiles containing steel are deflected when placed in a magnetic field[12]. Non-ferromagnetic missiles are a contraindication to MRI when they contain ferromagnetic contaminants[12]. Any metal distorts the local magnetic field, the magnitude of which depends on the degree of ferromagnetism of the metal alloy[12]. Therefore, CT is the modality of choice in gunshot injuries.

Stein and Ross[35] recommend CT for all cases of head trauma patients even if other physical findings are normal. The incidence of CT findings was high in unconsciousness 80.8%, change in clinical status 72.0% and neurological deficit 71.0%. CT scan done for headaches however was of less diagnostics value 39.3%, similar to findings by Obajimi et al[11] and Membrahtu et al[8].

The likelihood of injury on CT correlated inversely with the GCS[24,29 ]as was confirmed by this study. There was a clear association between incidence of positive CT scan findings and GCS, showing an increase in the rate of positive findings as the GCS score decreases. GCS score of 3 to 11 were associated with positive CT scan findings in all cases. Mortality was inversely related to GCS score as there was increase mortality as the GCS score decreases.

The culture of seat belt use is very low in our environment[36]. Only Sixty seven (46.9%) subjects out of the 143 patients involved in motor vehicular accidents used seat belt, agreeing with Iribhoge et al[36] who found a low compliance with the use of seatbelts at Benin City. This may be attributed to ignorance and latitude in our law enforcement.

Correct use of passenger seatbelts help to prevent injuries and reduce morbidity and mortality following road traffic accidents[37]. This study shows a higher association with positive CT scan findings and non use of seatbelts, 76.3% compared to with the use of seatbelt, 74.6%. Seatbelt holds
the body in place creating less space for the head to gain momentum before falling back to strike the
seat.

The incidence of positive CT scan findings was higher in subjects who were passengers, 77.1% and
back sitters, 73.7%. This is most likely due to the fact that subjects that are drivers and front sitters
are most likely to use seatbelts compared to the back sitters and passengers. Also, a driver would
instinctively protect himself when he sees that an accident is inevitable, controlling the vehicle in
such a way that he would be less affected.

Khan et al[38] found 60% of road traffic accidents occurring in the day time in their study involving
150 cases in Pakistan as corroborated by this study in which 81.1% of road traffic accidents occurred
in the day time. The high proportion of road traffic accidents during the day time can be attributed to
increase activities on road during day time such as commercial activities, street hawking and
attending schools, colleges and offices.

Recommendations

1. Government should promote educational campaigns on the use of seat belts, crash helmets,
illicit drugs and alcohol.

2. Federal road safety commission and the police should intensify monitoring, to ensure
compliance with seatbelt, crash helmet usage and drunken driving.

3. Appropriate medical care facilities including neurosurgical centers need to be established at
teaching hospitals with availability of modern CT scan.

4. The Federal Government should see to provision of motorable roads, good transportation, and
refurbishment of railroads to reduce the traffic on our roads, ban motorbike use as a means of
transportation.
5. Trauma centers should be sited at strategic spots on the highway.

**Conclusion**

This study has found the major cause of head injury to be road traffic accident. Vehicular motor accident is the commonest cause and most occur during the daytime. Fall from heights contribute significantly to the cause of head injury in children.

The commonest CT scan finding in this series was cerebral contusion. Brain lesions occurred even if there was no visible fracture and lesions might be missed if CT scan was not done. Most patients with low GCS died.

The high incidence of CT scan finding in head trauma justifies the use of CT scan in head trauma.

**Competing interests:** Nil. The authors report no conflict of interest regarding the materials and methods used in this study or its findings.

**Authors’ contribution**

<table>
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<th>RA</th>
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<th>AO</th>
<th>OM</th>
<th>MA</th>
<th>GO</th>
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AO, Consultant Radiologist. FWACS

RA, Associate Professor of Radiology. FWACS, FMCR

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Acknowledgement: Nil

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**Figure Legends**

Fig 1: Axial CT scan showing a hyperdense lesion with surrounding hypodensity suggesting an acute left frontal hemorrhagic contusion with surrounding oedema and shift of the falx cerebri to the right.

Fig 2: Bone window Axial CT scan showing a depressed right parietal and a linear fracture close to the occiput.

Fig 3: Axial CT scan showing soft tissue density in the maxillary sinuses with an air-fluid levels indicative of Haemosinus.

Fig 4: Axial CT scan showing a crescentic lucency in the left frontal region with multiple air loculi in the brain parenchyma indicative of pneumocephalus.

Fig 5: Axial CT scan shows a metallic foreign body in a gunshot head injury with artifacts from the shrapnel. Note the associated right frontal bone fracture, bony defect, fragments and pneumocephalus.
Fig 6a: Axial CT scan shows a biconvex acute epidural haematoma in the right fronto-parietal region.

Fig 6b: Axial CT scan shows an irregular hyperdensity with surrounding oedema suggesting an acute left hemispheric intracerebral haematoma with mass effect and midline shift to the right. A small acute epidural haematoma (biconvex) is also noted on the right.

Fig 6c: Axial CT scan shows hyperdensity in the cortical sulci of the right cerebral hemisphere indicative of subarachnoid haemorrhage.

Fig 6d: Axial CT scan shows bilateral intraventricular haemorrhage with a fluid-fluid level. An intracerebral bleed is also noted in the left thalamus.
TABLE 1: AGE DISTRIBUTION OF STUDY SUBJECTS IN RELATION TO CAUSES OF HEAD INJURY

<table>
<thead>
<tr>
<th>AGE (years)</th>
<th>CAUSES OF HEAD INJURY</th>
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<tr>
<td></td>
<td>RTA</td>
</tr>
<tr>
<td>0-10</td>
<td>28</td>
</tr>
<tr>
<td>11-20</td>
<td>31</td>
</tr>
<tr>
<td>21-30</td>
<td>72</td>
</tr>
<tr>
<td>31-40</td>
<td>59</td>
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<tr>
<td>41-50</td>
<td>49</td>
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<td>51-60</td>
<td>19</td>
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<tr>
<td>61-70</td>
<td>13</td>
</tr>
<tr>
<td>71-80</td>
<td>4</td>
</tr>
<tr>
<td>81-90</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>276</td>
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**TABLE 2: CT SCAN FINDINGS IN THE STUDY SUBJECTS**

<table>
<thead>
<tr>
<th>CT FINDINGS</th>
<th>FREQUENCY</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>Normal CT Scan</td>
<td>138</td>
<td>34.5</td>
</tr>
<tr>
<td>Fractures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Linear</td>
<td>91</td>
<td>22.8</td>
</tr>
<tr>
<td>(b) Depressed</td>
<td>37</td>
<td>9.3</td>
</tr>
<tr>
<td>(c) Basilar</td>
<td>16</td>
<td>4.0</td>
</tr>
<tr>
<td>Intracranial bleeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Cerebral contusion</td>
<td>140</td>
<td>35.0</td>
</tr>
<tr>
<td>(b) Epidural haematoma</td>
<td>32</td>
<td>8.0</td>
</tr>
<tr>
<td>(c) Subdural haematoma</td>
<td>60</td>
<td>15.0</td>
</tr>
<tr>
<td>(d) Intracerebral</td>
<td>45</td>
<td>11.3</td>
</tr>
<tr>
<td>(e) Subarachnoid</td>
<td>29</td>
<td>7.3</td>
</tr>
<tr>
<td>(f) Intraventricular</td>
<td>17</td>
<td>4.3</td>
</tr>
<tr>
<td>Pneumocephalus</td>
<td>30</td>
<td>7.5</td>
</tr>
<tr>
<td>Haemosinus</td>
<td>77</td>
<td>19.3</td>
</tr>
<tr>
<td>Oedema &amp; Brain swelling</td>
<td>41</td>
<td>10.3</td>
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<tr>
<td>Diffuse axonal injury</td>
<td>14</td>
<td>3.5</td>
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<tr>
<td>Subcutaneous emphysema</td>
<td>29</td>
<td>7.3</td>
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<tr>
<td>Soft tissue swelling</td>
<td>32</td>
<td>8.0</td>
</tr>
<tr>
<td>Foreign body (bullets/shrapnels)</td>
<td>6</td>
<td>1.5</td>
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<tr>
<td>Subgaleal haematoma</td>
<td>23</td>
<td>5.8</td>
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### TABLE 3: CAUSES OF HEAD TRAUMA AND INDICATIONS FOR CT SCAN VERSUS PERCENTAGE WITH POSITIVE CT FINDINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>NO. OF PATIENTS</th>
<th>%</th>
<th>NO. WITH POSITIVE CT FINDINGS</th>
<th>%</th>
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<tbody>
<tr>
<td><strong>CAUSES</strong></td>
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<td></td>
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<tr>
<td>ROAD TRAFFIC ACCIDENT</td>
<td>276</td>
<td>69%</td>
<td>203</td>
<td>73.6%</td>
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<tr>
<td>FALL</td>
<td>67</td>
<td>16.8%</td>
<td>32</td>
<td>47.8%</td>
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<tr>
<td>ASSAULT</td>
<td>38</td>
<td>9.5%</td>
<td>19</td>
<td>50%</td>
</tr>
<tr>
<td>GUNSHOT</td>
<td>6</td>
<td>1.5%</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>OTHERS</td>
<td>13</td>
<td>3.3%</td>
<td>4</td>
<td>30.8%</td>
</tr>
<tr>
<td><strong>INDICATIONS</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNCONSCIOUSNESS</td>
<td>99</td>
<td>24.8%</td>
<td>80</td>
<td>80.8%</td>
</tr>
<tr>
<td>CHANGE IN CLINICAL STATUS</td>
<td>57</td>
<td>14.3%</td>
<td>41</td>
<td>71.9%</td>
</tr>
<tr>
<td>NEUROLOGICAL DEFICIT</td>
<td>31</td>
<td>7.8%</td>
<td>22</td>
<td>71%</td>
</tr>
<tr>
<td>HEADACHE</td>
<td>33</td>
<td>8.3%</td>
<td>13</td>
<td>39.4%</td>
</tr>
<tr>
<td>HEAD INJURY</td>
<td>180</td>
<td>45%</td>
<td>106</td>
<td>58.9%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>400</td>
<td>100%</td>
<td>262</td>
<td>65.5%</td>
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**NO.** - Number
TABLE 4: TYPE OF HAEMORAGE AND % ASSOCIATED WITH FRACTURES

<table>
<thead>
<tr>
<th>TYPE OF HEMORHAGE</th>
<th>FREQUENCY</th>
<th>NO. WITH FRACTURE</th>
<th>%</th>
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<tbody>
<tr>
<td>EPIDURAL</td>
<td>32</td>
<td>27</td>
<td>84.4%</td>
</tr>
<tr>
<td>SUBDURAL</td>
<td>60</td>
<td>22</td>
<td>36.7%</td>
</tr>
<tr>
<td>INTRACEREBRAL</td>
<td>45</td>
<td>25</td>
<td>55.6%</td>
</tr>
<tr>
<td>INTRAVENTRICULAR</td>
<td>17</td>
<td>4</td>
<td>23.5%</td>
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<tr>
<td>SUBARACHNOID</td>
<td>29</td>
<td>14</td>
<td>48.3%</td>
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NO. - Number
## TABLE 5: TYPE OF FRACTURE AND % ASSOCIATED WITH HAEMOSINUS AND PNEUMOCEPHALUS

<table>
<thead>
<tr>
<th>TYPE OF FRACTURE</th>
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<th>NO. WITH HAEMOSINUS</th>
<th>NO. WITH PNEUMOCEPHALUS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
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<tr>
<td>LINEAR VAULT</td>
<td>91</td>
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<td>38.4%</td>
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<tr>
<td>DEPRESSED VAULT</td>
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<tr>
<td>BASE OF SKULL</td>
<td>16</td>
<td>10</td>
<td>62.5%</td>
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**NO.** - Number
### TABLE 6: SITE OF FRACTURE IN 137 PATIENTS

<table>
<thead>
<tr>
<th>SITE</th>
<th>FREQUENCY</th>
<th>%</th>
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<tbody>
<tr>
<td>PARIETAL BONE</td>
<td>51</td>
<td>35.4%</td>
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<td>FRONTAL BONE</td>
<td>48</td>
<td>33.3%</td>
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<tr>
<td>TEMPORAL BONE</td>
<td>12</td>
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<tr>
<td>OCCIPITAL BONE</td>
<td>17</td>
<td>11.8%</td>
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<tr>
<td>BASE OF SKULL</td>
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<td>11.1%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>144</strong></td>
<td><strong>100%</strong></td>
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7 patients had multiple fracture sites.