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Computerized tomography scan and head injury: The experience in a tertiary hospital in Nigeria: A cross sectional study

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Trauma is the leading cause of death in all age groups, and head trauma is 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 country, skull x ray was the main mode of investigating head trauma until recently when computerized tomography (CT) scans became the modality of choice in the initial work up of patients. In this study, we sought to document the various posttraumatic CT scan findings following head injury in a tertiary hospital in Lagos and determine the sociodemographic and radiological characteristics of such patients. This was a descriptive, prospective, cross-sectional study of the CT scan findings of 400 cases with acute head trauma, from June 2010 to October 2011. 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 to 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. 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 most common cause, while the most frequent lesion was cerebral contusion.

Key words: Computerized tomography scan, head trauma, Lagos.

INTRODUCTION

Trauma is a preventable epidemic neglected by many governments, especially in developing countries (Adeolu et al., 2005). Many of the devastating effects of trauma are often from head injury (Adeolu et al., 2005). Up to half

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of trauma deaths are due to head injuries which also accounts for most cases of permanent disability after injury (Jennett, 1996). Head trauma is any injury that causes lesion or functional damage to the cranium, meninges and brain (Bordignon and Arruda, 2002). 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 (Chalya et al., 2011; Emejulu et al., 2009). Besides, other factors like industrialization, falls and ballistic trauma contribute to the increased incidence of brain injury (Emejulu, 1996).

There are two general categories of head injuries: closed and penetrating. 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 (John, 2008; Steudel and Hacker, 1989). Historically, imaging of the head-injured patient relied on skull radiographs (Emejulu et al., 2009). 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 (John, 2008). Clinical assessment appears to be a better guide and this in turn guides the need for computed tomography (CT). Thus the role of skull radiography has greatly diminished (John, 2008). The introduction of computed tomography in 1973 opened new opportunities in the investigation of head injury and is now the investigation of choice (Shehu, 2002). Cranial CT has been established as an accurate diagnostic modality in neuroradiology (Ogunseyinde et al., 1999). It provides accurate non-invasive diagnosis of fractures, intracranial hemorrhages and other sequelae of head injury, like cerebral oedema (Obajimi et al., 2002).

Magnetic resonance imaging (MRI) is playing an increasingly important role in the evaluation of head trauma (Wasenko and Hochauser, 2003). 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 (Wasenko and Hochauser, 2003). Disadvantages of MRI that precludes its use in the evaluation of acute head injury include long scan time and its inability to detect fractures, sub-arachnoid hemorrhages and hyper acute hemorrhages (Wasenko and Hochauser, 2003). MRI is however 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 (Wasenko and Hochauser, 2003). However, CT is still preferred over MRI in the evaluation of acute head trauma (Emejulu and Malomo, 2008).

This study was carried out to assess and document the pattern of CT findings in head trauma in Lagos State University Teaching Hospital and comparison was done with findings from previous works in other centers. This study was also intended to elicit the age, sex, social, radiological characteristics of patients present 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.

MATERIALS AND 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). 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 and consent was also obtained from the patients or relatives depending on the state of consciousness and age of participants. The study was carried out in compliance with the Helsinki Declaration.

All studies were performed with a GE 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 5 mm slice thickness at interval of 3 mm. No intravenous contrast material was administered, to avoid masking any hyperdensity which is a typical CT appearance of acute hemorrhage. The centre of this study does not routinely measure blood or breathe alcohol on admittance in trauma subjects. 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, pneumocephalous, haemosinus, oedema and brain swelling, diffuse axonal injury, subcutaneous emphysema, soft tissue swelling, foreign bodies and subgaleal hematoma. 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

Demography

A total of 400 CT scan images of patients that sustained head injury were analyzed. Just less than three quarter,

Table 1. Age distribution of study subjects in relation to causes of head injury.

Age (years)	Causes of head injury					
	RTA	Fall	Assault	Gunshot	Others	Total
0-10	28	24	0	0	1	53
11-20	31	8	5	0	2	46
21-30	72	7	14	1	1	95
31-40	59	7	10	1	2	79
41-50	49	7	5	1	2	64
51-60	19	5	3	3	2	32
61-70	13	5	1	0	1	20
71-80	4	4	0	0	2	10
81-90	1	0	0	0	0	1
Total	276	67	38	6	13	400

Table 2. CT scan findings in the study subjects.

Findings	Frequency	%
Normal CT scan	138	34.5
Fractures		
Linear	91	22.8
Depressed	37	9.3
Basilar	16	4.0
Intracranial bleeds		
Cerebral contusion	140	35.0
Epidural haematoma	32	8.0
Subdural haematoma	60	15.0
Intracerebral	45	11.3
Subarachnoid	29	7.3
Intraventricular	17	4.3
Pneumocephalus	30	7.5
Haemosinus	77	19.3
Oedema and brain swelling	41	10.3
Diffuse axonal injury	14	3.5
Subcutaneous emphysema	29	7.3
Soft tissue swelling	32	8.0
Foreign body (bullets/shrapnels)	6	1.5
Subgaleal haematoma	23	5.8

71.8% of the study subjects were male while 28.3% were female, with a male to female ratio of 2.5:1. Their age ranged from 1 to 87 years, with a mean age of 32.7± 18.2 years (mean±standard deviation). The median and modal age was 31 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 to 30 years, 23.8%. Road traffic accident was the most common 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

Figure 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.

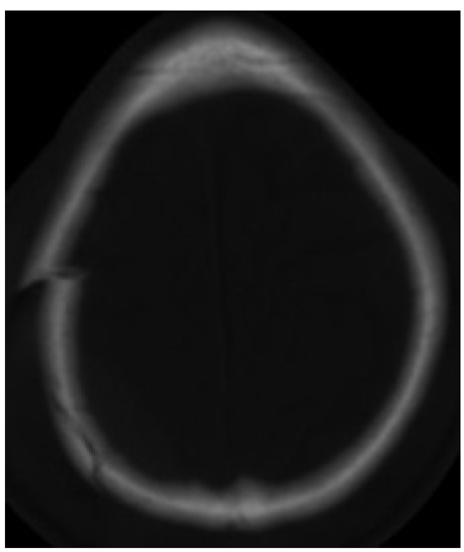

Figure 2. Bone window axial CT scan showing a depressed right parietal and a linear fracture close to the occiput.

different lesions related to head trauma detected. Cerebral contusions (Figure 1) were the most common finding (140 subjects) followed by fractures (137 subjects), linear being the most frequent. The fractures include skull base fractures (4.0%) and vault skull fracture, which was both linear (22.8%), and depressed (9.3%). Haemosinus 19.3% (Figure 2), pneumocephalous 7.5% (Figure 3), and foreign bodies 1.5% (Figure 4), as

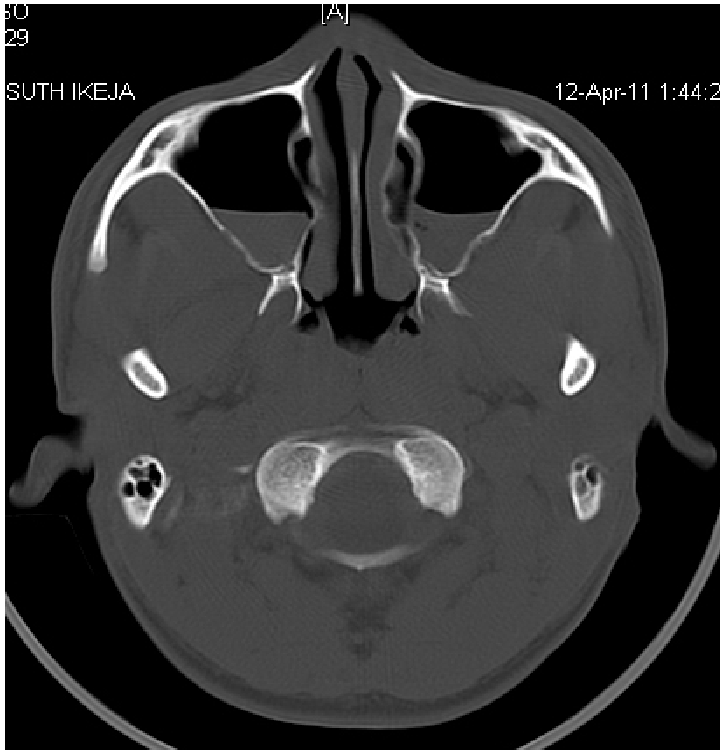

Figure 3. Axial CT scan showing soft tissue density in the maxillary sinuses with an air-fluid levels indicative of haemosinus.

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

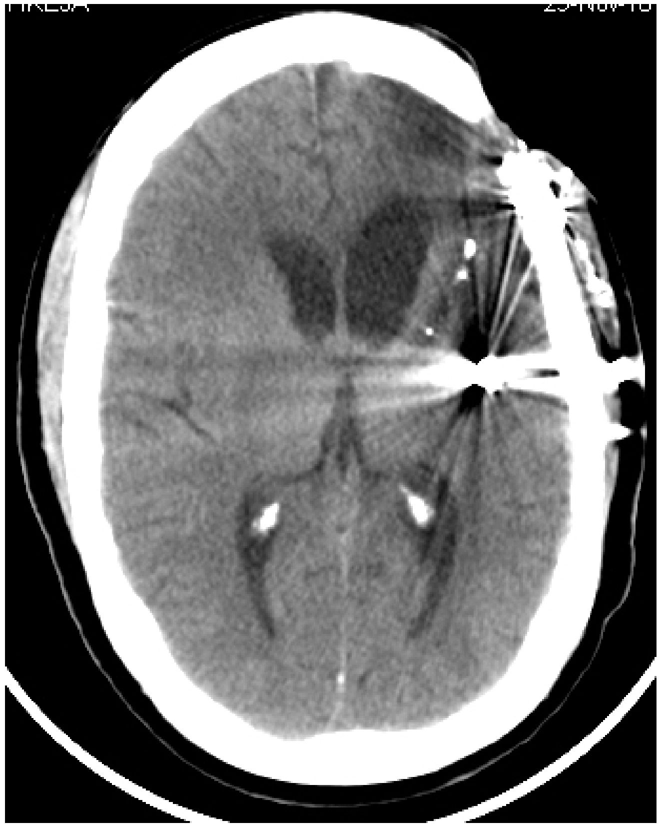

Figure 5. Axial CT scan shows a metallic foreign body in a gunshot head injury with artifacts from the shrapnel. Note the associated right frontal bone fracture, bony defect, fragments and pneumocephalus.

well as pellets from gunshot injury (Figure 5), 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 as 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 hematoma (Figure 6) has the maximal association with fracture (84.4%) followed by intracerebral (55.5%) (Figure 7), subarachnoid ‘48.3%’ (Figure 8), subdural ‘36.7%’ while intraventricular (Figure 9) had the least association (23.5%).

Fractures

The various types of fractures and the percentage associated with haemosinus and pneumocephalous is as 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 pneumocephalous 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 most common site for cerebral contusions (61.3%), epidural

Table 3. Causes of head trauma and indications for CT scan versus percentage with positive ct findings.

Parameter	No. of patients (%)	No. with positive CT findings (%)
Causes		
Road traffic accident	276 (69)	203 (73.6)
Fall	67 (16.8)	32 (47.8)
Assault	38 (9.5)	19 (50)
Gunshot	6 (1.5)	6 (100)
Others	13 (3.3)	4 (30.8)
Indications		
Unconsciousness	99 (24.8)	80 (80.8)
Change in clinical status	57 (14.3)	41 (71.9)
Neurological deficit	31 (7.8)	22 (71)
Headache	33 (8.3)	13 (39.4)
Head injury	180 (45)	106 (58.9)
Total	400 (100)	262 (65.5)

No.: Number.

Table 4. Type of hemorrhage and percent associated with fractures.

Type of hemorrhage	Frequency	No. with fracture	%
Epidural	32	27	84.4
Subdural	60	22	36.7
Intracerebral	45	25	55.6
Intraventricular	17	4	23.5
Subarachnoid	29	14	48.3

No.: Number.

Table 5. Type of fracture and % associated with haemosinus and pneumocephalus.

Type of fracture	No.	No. with haemosinus (%)	No. with pneumocephalus (%)
Linear vault	91	35 (38.4)	15 (16.5)
Depressed vault	37	13 (35.1)	12 (32.4)
Base of skull	16	10 (62.5)	3 (18.8)

Table 6. Site of fracture in 137 patients.

Site	Frequency (%)
Parietal bone	51 (35.4)
Frontal bone	48 (33.3)
Temporal bone	12 (8.3)
Occipital bone	17 (11.8)
Base of skull	16 (11.1)
Total	144 (100)

haematoma (59.6%), subdural haematoma (51.7%), intracerebral haematoma (44.7%) and pneumocephalous (90.9%). Subarachnoid hemorrhage (54.8%) and intraventricular hemorrhage (80%) were the most commonly seen in the temporal lobes. Positive findings were least in the occipital.

Figure 6. Axial CT scan shows a biconvex acute epidural haematoma in the right fronto-parietal region.

Figure 7. 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.

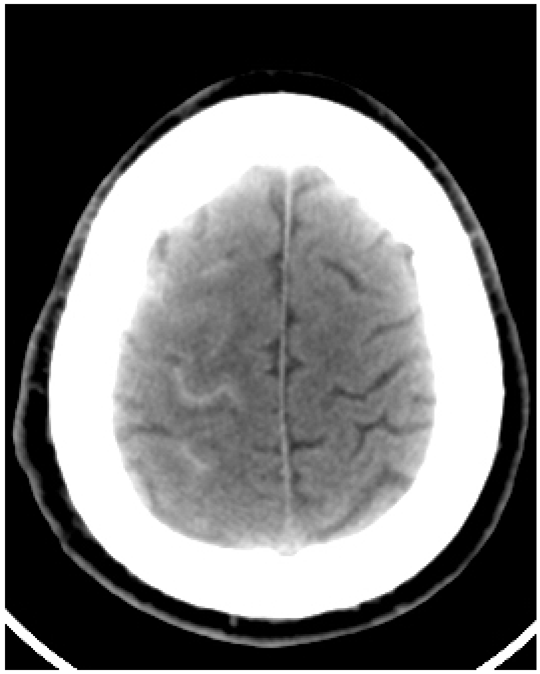

Figure 8. Axial CT scan shows hyperdensity in the cortical sulci of the right cerebral hemisphere indicative of subarachnoid haemorrhage.

Figure 9. Axial CT scan shows bilateral intraventricular haemorrhage with a fluid-fluid level. An intracerebral bleed is also noted in the left thalamus.

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 with drivers (71.7%). Back seaters had more positive findings (76.8%) as compared to subjects sitting in the front (73.7%). There were also more positive findings in subjects that did not use seatbelts (76.3%) as compared to those that did (74.6%). Daytime accidents had more positive findings (75%) as 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 the rate of positive findings as the GCS score decreases. GCS score of 3 to 11 were associated with negative 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 the highest in subjects with intraventricular hemorrhage (100%), pneumocephalous (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 to 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. (1999) in Ibadan (21.2%), Ohaegbulam et al. (2011) in Enugu (33.9%), Adeolu et al. (2005) in their study on south-western population in Nigeria (23.3%) and Bordignon and Arruda (2002), 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 decreased 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 ± 18.2 years) and a male:female ratio (2.5:1) are consistent with the observed pattern in other studies done by Bordignon and Arruda (2002) in Brazil (30.8 ± 19 years; M:F 2:1) and Mebrahtu-Ghebrehiwet et al. (2009) in Eritrea (32.5 ± 20.9 years; M:F 3:1), respectively. Obajimi et al. (2002) 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. (2002) as the most common cause of head injury in 43.9% Ghanaian children. In Nigeria, Ohaegbulam et al. (2011) found 59% in Enugu, while Adeolu et al. (2005) reported 73.4% in South-Western Nigeria. The present study corroborates these findings as RTA was the most common 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 (Chalya et al., 2011; Chieregato et al., 2005).

Similar to reports by Adeolu et al. (2005) and Ohaegbulam et al. (2011) 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 the cases of head injury. Falls was observed as the second most common cause of head injury in this study. Adeolu et al. (2005), 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 pediatrics age group is a call for concern. It may imply negligence and poor supervision of children by adults.

Bordignon and Arruda (2002) found aggression which includes assaults and firearms injury as the most common 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. (1999) and Obajimi et al. (2002) reported 39.4 and 53.7% cases of head injury with normal CT scan result, respectively. Ogunseyinde et al. (1999) 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 varies 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 are comparable to the findings by Ogunseyinde et al. (1999), 60.6% and Isyaku et al. (2006) in Sokoto, 78.4% but is much less in Ghana by Obajimi et al. (2002), 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 (Mauricio, 2006; Stacey and Leach, 2008; Wasenko et al., 2003). Cerebral contusion was found in more of the subjects (35%) in this study than that by Ohaegbulam (2011) as the most common 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) (Stacey and Leach, 2008). 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 (Steudel and Hacker, 1989) as was seen in this study.

Ogunseyinde et al. (1999) 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 (Paolo et al., 2005). 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. (9) 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%.

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 (Paolo et al., 2005). They are not necessarily superficial in location and may be multiple. They result from severe blunt or penetrating trauma (Paolo et al., 2005). CT shows them as large, hyperdense lesions surrounded by perilesional oedema (Paolo et al., 2005; Wasenko and Hochauser, 2003).

According to Hirsh (1979), intracerebral haematoma of frontal and temporal lobe was the most common in head injury, while Grupta et al. (2011) 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).

Intracerebal haematoma was associated with mortality in 49.7% of patients (Grupta et al., 2011). 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 (Klauber et al., 1989).

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 the cases. Zimmerman et al. (1978) found epidural haematoma associated with skull fracture in 83.3% cases, while Obajimi et al. (2002) found 100% cases.

Gruptal et al. (2011) 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 to 60% has been observed (Zimmerman et al., 1978).

Intraventricular hemorrhage 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 hemorrhage 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 (Paolo et al., 2005). CT shows increased attenuation within the ventricular system, sometimes associated with blood fluid layering (Paolo et al., 2005). The rare occurrence of intravenricular hemorrhage may be due to the fact that it becomes isodense relatively more rapidly and may disappear completely within a week (Asaleye et al., 2005).

Rabie et al. (2010) reported 6.1% of subarachnoid hemorrhage in their research involving 131 subjects in South Africa; Bordignon and Arruda (2002) reported 6.4% cases in Brazil and 7.3% in this study. It usually results from damage to leptomeningeal or cerebral surface vessels (Paolo et al., 2005). 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 (Paolo et al., 2005). On CT, acute subarachnoid hemorrhage appears as increased attenuation in the subarachnoid space.

Grupta et al. (2011) 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 (Chieregato et al., 2005).

The incidence of skull fracture in patients with head injury varies from 17.4 (Emejulu et al., 2009) to 62.0% (Grupta et al., 2011) 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 (Bordignon and Arruda, 2002; Ogunseyinde et al., 1999). 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 (Ogunseyinde et al., 1999). 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 (Li et al., 2006). 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 (Mauricio, 2006; Paolo et al., 2005). 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 (Paolo et al., 2005). 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 (Paolo et al., 2005).

Most skull fractures have no underlying brain injuries while most severe brain injuries have no skull fractures (Donnelly, 2001; Mauricio, 2006). 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 and frontal regions, 35.4 and 33.3%, respectively, similar to the findings by Obajimi et al. (2002) and Ogunseyinde et al. (1999). The latter attributed this to the convexity of the parietal and frontal bone.

The incidence of pneumocephalus varied in the literature from 1.5 to 16.8% (Rabie et al., 2010). All the cases of pnuemocephalus 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 (Leong et al., 2008; Vitali and le Roux, 2003).

The most commont site of pneumocephalus is the frontal region, 90.9% in this study as was also observed by Grupta et al. (2011) 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 (Steudel and Hacker, 1989).

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. (Taheri et al., 2007) 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 (Taheri et al., 2007). It is observed more commonly in children than in adults (Obajimi et al., 2002; Ogunseyinde et al., 1999; Paolo et al., 2005). Zweinberg and Muizelar (1999) 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 (Paolo et al., 2005). Oedema is evident as decrease in 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 24 h after injury, increases and becomes maximal at 3 to 5 days, then gradually resolves (Wasenko and Hochauser, 2003).

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 hemorrhages (Scheid et al., 2003; Smith et al., 2003). 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 (Scheid et al., 2003). 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 1.5 cm in diameter or when present in the corona radiata or internal capsule (Haibo et al., 2003).

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 (Maria et al., 2003). Soft tissue swelling was seen in 8% of cases in this study, comparable to reports by Bordignon and Arruda (2002), 8.9%. However, a higher number of subgaleal haematoma, 5.8% was seen in this study contrary to reports by Bordignon and Arruda (2002) 2.4%. Subcutaneous emphysema was revealed in 7.3% of patients in this study.

Ogunseyinde et al. (1999) 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 (Wasenko and Hochauser, 2003). 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 (Wasenko and Hochauser, 2003). Non-ferromagnetic missiles are a contraindication to MRI when they contain ferromagnetic contaminants (Wasenko and Hochauser, 2003). Any metal distorts the local magnetic field, the magnitude of which depends on the degree of ferromagnetism of the metal alloy (Wasenko and Hochauser, 2003). Therefore, CT is the modality of choice in gunshot injuries.

Stein and Ross (1992) 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. (2002) and Membrahtu et al. (2009).

The likelihood of injury on CT correlated inversely with the GCS (Asaleye et al., 2005; Taheri et al., 2007) as was confirmed by this study. There was a clear association between incidence of positive CT scan findings and GCS. Negative CT scan findings were seen in all patients that had GCS score of 3 to 11, while positive findings were seen at GCS 12, in only one case, GCS 13 in three cases, GCS 14, in eight cases and GCS 15, in one hundred and twenty two cases. The outcome was monitored for a period of one month. Mortality was inversely related to GCS score as there was increased mortality as the GCS score decreases.

The culture of seat belt use is very low in our environment (Iribhogbe and Osime, 2008). Only 67 (46.9%) subjects out of the 143 patients involved in motor vehicular accidents used seat belt, agreeing with Iribhogbe and Osime (2008) 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 (Li et al., 2006). This study shows a higher association with positive CT scan findings and non use of seatbelts (76.3%) when compared 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 as 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. (2007) 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 increased activities on road during day time such as commercial activities, street hawking and attending schools, colleges and offices.

Conclusion

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

The most common 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.

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.

Conflict of interest

The authors declare no conflict of interest.

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