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Computerized Tomography Imaging Features of Head Injury in Abuja, Nigeria's Capital

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Authors' contributions

This work was carried out in collaboration between both authors. Author HOKY was involved in data acquisition, concept and study design while author DUI performed the analysis, wrote the protocol, literature review and the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Trauma is global health epidemic and associated head injury is a major contributor to the high mortality. This necessitates the urgent use of neuroimaging for early diagnosis and patient care. Computer Tomography CT, scan is the imaging modality of choice in emergency situations because of its image acquisition speed and ability to accurately detect fractures and intracranial bleeds.
Aim: To document the CT imaging findings in head trauma patients in Abuja, Nigeria's Federal capital.
Methods: A retrospective, cross-sectional study of findings in 319 head trauma Nigerians visiting a referral hospital in the Federal Capital Territory Abuja from January 2014-October 2016. Numerical and graphical descriptors were used to summarize the data. In all statistical tests, significance level was set at an alpha level of 0.05.
Results: The mean age of the patients was 32.7±17 years with most between the ages of 24 – 35 years (n=99, 31.0%). More males than females participated in the study in a ratio of 5.8:1.
Road traffic accident, RTA was the commonest cause occurring in 280 (87.8%) cases (male=240, female=40), especially in the third and fourth decades.

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271(84.9%) had abnormal CT findings while 48(15.1%) were recorded as normal.
The most prevalent abnormal findings were complex lesions (including more than one type of intracranial pathology) in 112 (35.1%) cases. Hemorrhagic contusion was the commonest intracranial lesion in 65 (21%) patients cases while extra axial cerebrospinal space heamorrhages were the least detected in 3 (0.9%) cases. There were 132 (41.4%) recorded cases of fracture with only 25(8.8%) occurring without an associated intracranial lesion.
Conclusion: RTA is a major cause of head injury in the most productive age group in our environment with CT scan as an invaluable imaging tool in the investigation and management of these patients.

Keywords: Head injury; computed tomography; road traffic accident; haemorrhage.

1. INTRODUCTION

1. Traumatic brain injury (TBI) is a non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairments of cognitive, physical, and psychosocial functions with an associated diminished or altered state of consciousness [1].
2. Road traffic accident, RTA, is a major cause of head trauma. 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 [2]. Although both the developed and developing nations of the world have suffered from varying degrees of road accidents, the developing countries clearly dominates with Nigeria having the second highest rate of road accidents among 193 ranked countries of the world [3].
3. Many of the devastating effects of trauma are often from head injury and it is the cause of up to half of deaths arising from trauma [4].
4. Early diagnosis of head trauma by neuroimaging is therefore important to determine the presence and extent of the injury and aid in surgical management of the patients. Neuroimaging is also invaluable in follow up to identify the sequelae and in guiding rehabilitation of the patient where necessary.
5. In our institution, plain skull X-ray and clinical indices were initially relied upon in the management of head injured patients. This was of course grossly inadequate since intracranial lesions are not seen on plain X ray. The usefulness was limited to evaluation of fractures. 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 [5].
6. The introduction of CT scan into our hospital in 2014 opened up opportunities for accurate and quick diagnosis and immediate surgical intervention as is necessary.
7. Cranial CT provides accurate non-invasive diagnosis of fractures, intracranial hemorrhages and other sequelae of head injury, like cerebral edema [6]. It is very fast and therefore can be used in unstable patients. It is also compatible with most resuscitative equipment.
8. Our Hospital is located along an interstate highway which forms the gateway to the Federal Capital Territory and the Northern region of Nigeria. Thus, there is increased traffic and consequently road accidents which are worsened by the use of motorcycles as a major means of transportation in our locality. There is usually no provision of helmets for both the cyclist and the passengers who are in some cases more than two per motor cycle. This has increased the number of head injured patients in the environment. The use of seat belt is not customary in our environment and laws guiding road safety is hardly adhered to.
9. Neuroimaging is, of course rather expensive for the average patient especially in emergency situations. It therefore becomes necessary in this situation to consider clinical indices as an indication and guide for head CT. Certain circumstances suggest major injury and almost always merit imaging such as worsening level of consciousness, loss of consciousness for more than 5 min, focal neurological findings, seizure, failure of the

mental status to improve over time, penetrating skull injuries, signs of a basal or depressed skull fracture, or confusion or aggression on examination [7]. It has however been shown that even patients with the complete absence of clinical findings and high risk circumstances have been found to have intacerebral hemorrhage on imaging hence the increase in utility of CT imaging [8].

10. There is a paucity of data in our environment involving the demographics and radiologic findings in head injured patients hence the need for this study. We sought to document the varying patterns and severity of CT findings in head trauma patients who presented to a tertiary institution in Nigeria's Capital and demonstrates the importance of neuroimaging in the early diagnosis and management of the patients.

2. MATERIALS AND METHODS

This is a retrospective study of the reports of cranial CT scan of 319 head trauma patients referred to the Radiology Department of University of Abuja Teaching Hospital, between January 2014 and November 2016. Patients included the inpatients and referral cases from other hospitals.

All studies were performed with a Toshiba 16 slice CT scanner. 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. Intravenous contrast material was not administered to avoid masking any hyperdensity which is a typical CT appearance of acute hemorrhage. Records of the stored images and written reports were further analyzed. SAS software (SAS institute, Cary, North Carolina, USA) version 9.3 was used for analysis.

Numerical and graphical descriptors were used to summarize the data. Numerical descriptors include mean, standard deviation, minimum, median and maximum values for continuous variables while frequency and percentage were used to describe categorical variables. Differences in age between the male and female participants were compared with MWW (Mann–Whitney–Wilcoxon) two sample test, whereas differences in proportions of parameters were compared with the Chi-Square test.

In all statistical tests, significance level was set at an alpha level of .05.

3. RESULTS

3.1 Sociodemographic Characteristics

The age range of the patients in the study was 3 months-80 years with a mean of 32.7 ±17years. Most of the patients were between the ages of 24 – 35 years (n=99, 31.0%), followed by 36 – 47 years (n=64, 20.1%) with the least at 72 - 80 years (n=3, 0.9%). See Fig. 1.

There were more male patients (n=272, 85.3%) in the study than females (n=47, 14.7%) in a ratio of 5.8:1.

On the average, the male patients who visited the referral center were generally older (mean age was about 33 years and 9 months ±16.3SD) than the female patients (mean age was about 25 years and 8 months ±19.3).

Majority, 271(85%) had abnormal CT findings while 48(15.1%) were recorded as normal.

There is no significant difference between the ages of patients who had normal and positive CT findings (P 0.493).

Of all the causes of head injury documented, RTA was the commonest occurring in 280 (87.8%) cases (male=240, female=40), especially in the 24 – 35 years age group. Only 2 (0.6%) cases (men) suffered from other causes (bomb blast) in the 36 - 47 years age group (See Table 1).

3.2 Computed Tomography Findings

The most prevalent abnormal finding was complex lesions (including more than one type of intracranial lesion) in 112 (35.1%) cases. There were 132 cases of fractures of which 25(7.8%) occurred without any other intracranial lesion.

Haemorrhagic contusion was the commonest intracranial lesion seen in 67 (21%) cases and bleeding into the cerebrospinal fluid spaces (Intraventricular and subarachnoid) were rarely seen (0.9%). See Figs. 2, 3 and Table 2.

Table 1. Age distribution of patients in relation to causes of head trauma

Age (years)	Causes of head trauma				
	RTA	**Assault**	**Gunshot**	**Fall from height**	**Others**
0 - 11	27	1	1	8	0
12 - 23	54	2	1	2	0
24 - 35	88	7	3	1	0
36 - 47	59	0	0	3	2
48 - 59	27	2	0	1	0
60 - 71	24	2	0	1	0
72 - 80	1	0	1	1	0
Total (%)	280 (87.8)	14 (4.4)	6 (1.9)	17 (5.3)	2 (0.6)

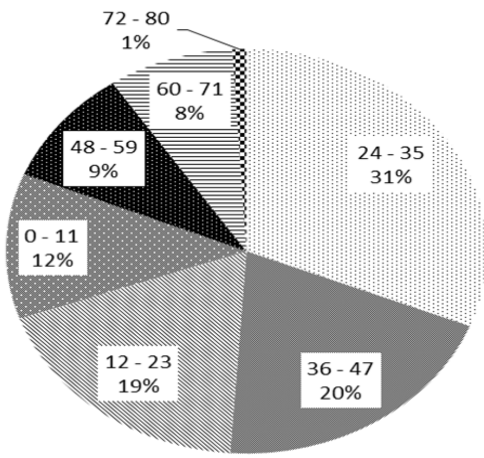

Fig. 1. Distribution of patients by age group

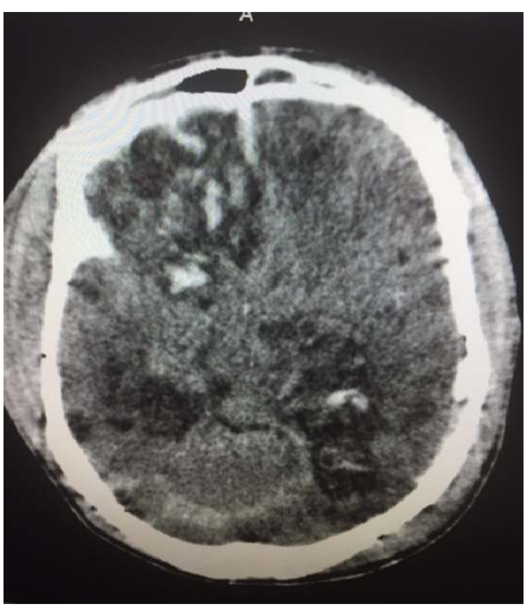

Fig. 2. Axial CT of the brain in brain window showing multiple patchy Hyperdensities in a background of edema suggestive of haemorrhagic contusion

Table 2. Findings in CT scan of the head among the study subjects

Findings	Number	%
Normal CT scan	48	15.1
Abnormal CT scan	271	84.9
Intracranial lesions		
*Complex lesions	112	35.1
Epidural hematoma	13	4.1
Subdural hematoma	10	3.1
Intraparenchymal hematoma	14	4.4
Subarachnoid/intraventricular hematoma	3	0.9
Diffuse axonal injury	10	3.1
Haemorrhagic contusion	67	21.0
Complications	17	5.3
Extracranial lesions		
Fractures(solitary)	25	7.8

*% is out of the 319 subjects.*complex lesions include more than one coexisting intracranial lesions*

A total of 132 cases of fracture was recorded with 25(7.8%) occurring without any associated intracranial lesion. The patients who had Epidural heamatoma and Complex lesions were more likely to be associated with skull fractures of any sort. See Table 3.

Table 3. Type of intracranial lesion and percentage associated with fractures

Type of lesion	N		%
	All	**Fracture**	
Epidural hematoma	13	9	69.2
Intraparenchymal hematoma	14	2	14.3
Subarachnoid/ intraventricular hematoma	3	0	0.0
Complications	17	4	23.5
Complex lesions	112	67	59.8
Haemorrhagic contusion	67	25	37.3
Diffuse axonal injury	10	0	0.00
Subdural haemorrhage	10	0	0.00

Of the specified location of fractures, frontal and skull base fractures were the commonest single occurring while 28(21.2%) fractures involved more than one cranial bone (multiple fracture). Maxillofacial fractures were seen in 18.2% of patients. See Table 4 and Fig. 4.

Table 4. Distribution of fractures by location

Location	N (%)
Parietal	8 (6.1)
Frontal	23 (17.4)
Temporal	10 (7.6)
Occipital	3 (2.3)
Skull base	23 (17.4)
Maxillofacial	24 (18.2)
Sutural diastasis	3 (2.3)
multiple	28 (21.2)
Unspecified	10 (7.6)
Total	132 (100)

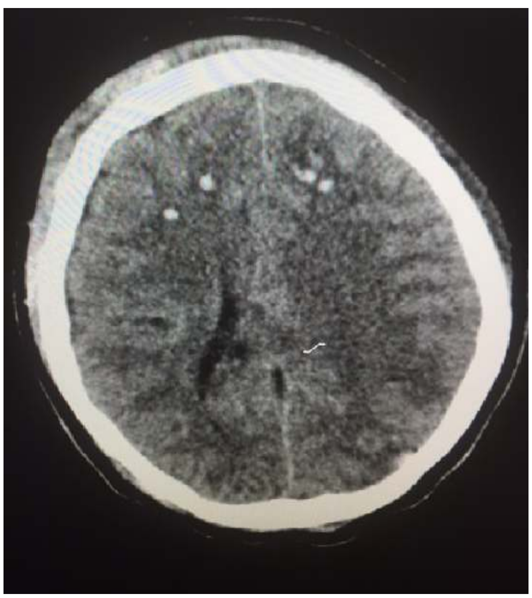

Fig. 3. Axial CT image of the brain in brain window showing multiple punctuate Hyperdense foci in the grey/white matter junction characteristic of diffuse axonal injury

4. DISCUSSION

Trauma is a common global health problem affecting mostly the productive age group. In our study of 319 patients, most were between the ages of 24-35 (n=99, 31.0%), followed by 36 – 47 years (n=64, 20.1%), This is closely related to findings from previous studies done in Nigeria and beyond Including Ohaegbulam et al. in Enugu (33.9%), Adeolu et al. in south-western population in Nigeria (23.3%) and Bordignon and Arruda (25.1%) in Brazil [4,9,10].

Fig. 4. Axial CT bone window at the level of the maxillary antra showing comminuted facial fractures with heamosinus

These form the most productive, active and mobile group who are engaged in outside activities and are therefore more prone to accidents.

The male: female ratio in our study, 5.8:1 is similar to findings by Obajimi et al. in Ghana [6] but somewhat higher than other data from the South east and south west regions of Nigeria [9,11,12].

This may be due to regional differences in culture with the conservative nature in Northern Nigeria where females are more likely to be engaged in indoor activities than in the more liberal South.

The consistent male preponderance in the different studies can be explained by the fact that males are more likely to be drivers than the females and also more males tend to have jobs that require commuting from one place to another.

On the average, the male patients who visited the referral center were generally older (mean age was about 33 years and 9 months) than the female patients (mean age was about 25 years and 8 months).

Of the reviewed cases, 271(85%) had abnormal finding while 48 (15.1%) were recorded as normal. These findings were similar to other studies done in Enugu [9] but slightly different in studies done by Akanji et al. in Lagos which shows a higher normalcy rate in 34.5% of cases and Obajimi et al. who reported 53.7% cases of head injury with normal CT [12,6].

The incidence of normal CT may be higher especially in patients with non heamorrhagic lesions which are better elucidated on MRI. Studies have shown that among patients eventually proven to have diffuse axonal injury, 50-80% demonstrate a normal CT scan upon presentation [13].

RTA was the commonest cause of head injury in 280 (87.8%) patients. This was corroborated by other Studies in Nigeria and Ghana which showed that road traffic accidents were the commonest causes of head injury [14,16]. An Eritrean study however differs in that falls were seen as the commonest cause in 36.4%, followed by Car accidents in 29% [15]. Falls constituted 5.3% in our study especially in children (0-11years). In a similar but older study in Brazil, aggression which includes assaults and fire arm injuries were the commonest cause of head trauma [16]. This contrasts with our finding of 4.4% in assault, 1.9% for gunshot and 0.6% in others (bomb explosion). Our figures are surprisingly low considering the recent increase in terrorism and crime in general.

The marked increase in the population of Nigeria over the past decades coupled with urbanization, the deplorable state of roads and recent use of motorcycles in public transport is largely responsible for the high incidence obtained in our study.

Our hospital, a tertiary healthcare institution is also located in an intercity state which serves as a gateway to the Federal capital and the north of Nigeria and is the only well-equipped referral center within the vicinity.

CT findings were classified as 'complex' when two or more intracranial pathologies are coexisting. This is because impart to the skull can affect different compartments of the cranial cavity with multiple abnormal findings on neuroimaging.

These complex type lesions were seen in 112 (35.1%) cases. These include coexisting fractures, intracranial bleeds, pneumosinus and Pneumocephalus at different degrees.

Haemorrhagic contusion was the most prevalent single occurring intracranial pathology occurring in 67(21.0%). These haemorrhagic contusions results 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 and are seen as patchy hemorrhagic foci within a background of edema [17].

Intracranial hematoma, ICH, appears on CT as largely homogenous, hyperdense collections with perilesional edema. It is more commonly located in the frontal lobe. Grupta et al. found 52.5% of intacerebral heamatoma in the frontal region and 26% in the temporal region [18], similar to our findings which showed frontal lobe preponderance and was seen in 4.4% of patients.

According to few studies both ICH and contusions simultaneously exist in the same case with ICH occurring more commonly and is more frequently associated with other post traumatic consequence [19].

Extra axial collections were uncommon as single lesions in this study with subdural collection in 10(3.4%) and epidural in 13(4.1%) cases respectively. Similar studies revealed higher percentages which may not be unconnected with our classification. They were however associated with other intracranial lesions to form the previously defined complex lesions. On CT, acute subdural heamatoma appears as a crescent-shaped, homogenously hyperdense extra axial collection which is usually associated with high incidence of mortality. Grupta et al. found subdural hematoma to be associated with mortality in 75% of cases in Pakistan [18].

The prognosis of epidural hematoma 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 [20].

Intraventricular and subarachnoid haemorrhages are usually rarely seen and occurred in only 3(0.9%) of our patients.

Other studies reported higher incidences. Rabie et al. reported 6.1% of subarachnoid hemorrhage in their research involving 131 subjects in South

Africa [21], Bordignon and Arruda reported 6.4% cases in Brazil [10].

Intraventricular haemorrhages can be due to deep penetrating wound and extension from Intraparenchymal bleeding and is usually associated with a grave prognosis. 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 [22].

Heamorrhagic type of diffuse axonal injury DAI, was recorded in 10(3.1%) cases and appeared as multiple hyperdense lesions in the grey/white matter junction and brainstem. Magnetic resonance imaging (MRI) is however the preferred examination for DAI (particularly with gradient-echo sequences), although CT scanning may demonstrate findings suggestive of DAI and is more practical and available [23,24].It is shearing injury caused by acceleration, deceleration and rotational forces which result in portions of the brain with different densities to move relative to each other resulting in the deformation of axons and disruption of axoplasmic transport [25].It is usually associated with poor prognosis and a high probability of the patient remaining in a vegetative condition.

Findings of fracture in our study (n=132, 41.4%) is closely related to other reported incidence of 2% - 42% from around the world [26,27].CT is the imaging modality of choice for detecting fractures and depending on their location and type prompt surgical intervention can be done in order to prevent CSF leakage, infection, heamorrhage or vascular compromise [28].

Fractures can involve the vault, skull base or facial skeleton and may be linear, depressed or comminuted types.

A fracture on radiography implies that a significant force has been applied to the bony vault. However, the lack of visualization of a fracture does not exclude a significant injury to the underlying brain; therefore, a skull fracture may or may not indicate a brain parenchyma injury [29].

Fractures were associated with all cases of Pneumocephalus (100%), Epidural heamatoma in 69.2%, Complex lesions (59.8%) and Heamosinus (87.9), while DAI and Subdural heamatoma were not associated with any fractures. This is comparable to the study by Akanji et al. which confirms that non visualization of fractures does not preclude the presence of significant brain injury [12].

Maxillofacial (n=24, 18.4%), Frontal bone (n=23, 17.8%) and skull base (n=23, 17.8%) were commonest locations of fracture while the occipital bone and sutural diastasis (n=3, 1.4%) was the least. This is most likely due the mechanism of injury especially the fact that seat belts are not commonly used by passengers in a motor vehicle. The convexity of the frontal bone could also be a contributor.

Findings noted as complications in this study include the chronic sequelae of trauma such as brain atrophy, encephalomalacia, infarct, hydrocephalus, Hygroma, leptomeningeal cyst and pellets were seen in 17 (5.3%) cases. In the chronic management of head trauma, imaging has several potential roles: identifying postoperative neurophysiologic sequelae, evaluating the underlying functional abnormalities associated with late complications of head trauma, predicting long-term prognosis, guiding rehabilitation, and developing new therapies to prevent secondary injury [7].

5. CONCLUSION

Road traffic accidents is a major contributor to traumatic brain injury in the productive age group in Abuja, and the high incidence of abnormal radiologic findings of cranial CT in these patients justifies its use in the investigation and management of head trauma.

We therefore recommended that neurosurgical trauma centers with CT scanners should be established in different locations within the country for emergency care of trauma patients especially the head injured and measures to reduce RTA should be urgently implemented.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Access to data and study approved by departmental head.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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