

Computed Tomographic Imaging Appraisal of Traumatic Brain Injury in a Tertiary Hospital in South-South Nigeria: A 6-Year Review

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Abstract

Background: Computed tomography (CT) remains the gold standard in imaging evaluations of traumatic brain injury (TBI). TBI on its own has become a major concern in developing countries with its untoward effects. **Objectives:** The objective was to appraise the craniocerebral computed tomograms of patients who had TBIs. **Materials and Methods:** A retrospective study of patients who underwent craniocerebral CT on account of head injury in the University of Uyo Teaching Hospital, Uyo, Nigeria, from November 13, 2013 to May 31, 2019 was done. The duration was regardless of the disjointed periods of service interruption. Patients' demographic and CT features were evaluated with application of simple analysis of data. **Results:** Two hundred and thirty-two patients were evaluated with minimum and maximum ages of 6 months and 78 years, respectively. Males were predominant with a ratio of 2.74: 1. Most affected age ranges were 30–39 years (23.27%) and 20–29 (22.84%). Normal brain CT was seen in 44 patients (18.97%). The most frequent lesion in patients with abnormal CT was intracranial hemorrhages ($n = 188$, 81.03%). Here, extra-axial hemorrhages ($n = 100$, 53.19%) supersede intracerebral hemorrhages ($n = 88$, 46.81%). Half of the intracerebral hemorrhages were multiple. Calvarial fractures were seen in 34.48% ($n = 80$) of patients. The most common localization was the facial bones ($n = 24$, 30.00%), whereas the least site was the occipital bone ($n = 4$, 5.00%). Fifteen percent of the patients had multiple fractures which also included base of the skull. **Conclusion:** TBIs commonly occur among young active males. The most frequent lesion is intracranial hemorrhages with extra-axial bias.

Keywords: Brain, computed tomography, hemorrhages, trauma

INTRODUCTION

Traumatic brain injury (TBI) is a structural brain injury with or without physiological brain disruption.¹ The resultant clinical signs and symptoms include the loss or reduced level of consciousness, disorientation, posttraumatic amnesia, and neurological deficits. These are basically due to the accompanying intracranial lesions. Such intracranial lesions are variable in manifestations depending on whether the TBI is acute or chronic.

In general, TBI is a major cause of morbidity and mortality worldwide.²⁻⁹ In 2006, the World Health Organization in Geneva has projected that by 2020, head trauma from road traffic crashes alone will be the third-leading burden of diseases in developing countries.¹⁰ This is worrisome as the projected

year is here with us. Other causes of TBI are falls, violence, sports injuries, explosive blasts, and other combat injuries.

Computed tomography (CT) appears pivotal in the detection of primary injuries seen in TBI. These primary injuries include intracranial hemorrhages, contusion, traumatic axonal injuries, scalp injuries, and fractures.^{2,5,11} Detection of

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the latter, especially when involving the base of the skull, is the significant feature of CT. This is further facilitated with the exploit of bone algorithm CT or three-dimensional (3D) volumetric CT. CT, therefore, has become the consensus choice as it has a rapid imaging time, high sensitivity for calvarial fracture detection, and high potential for the detection of lodged radiopaque foreign bodies.^{2,5,12-15} Significantly, CT is optimal in triaging for neurosurgical intervention as well as predicting patient outcome. These advantages warrant the choice of CT in our appraisals of TBIs in our local environ.

Objectives

The objective was to appraise the craniocerebral computed tomograms of patients who had TBIs in terms of morphological abnormalities.

MATERIALS AND METHODS

This was a retrospective study of patients who underwent craniocerebral CT on account of head injury in the University of Uyo Teaching Hospital (UUTH), Uyo, Nigeria. Each CT examination was done with Toshiba Activion 16 helical CT machine, manufactured in Japan in December 2011. The period under review was from November 13, 2013 to May 31, 2019. However, there were interjection periods of CT service interruption.

Axial noncontrast scans were done from the base of the skull to the vertex using 3–5 mm slice tissue thickness. Images were reformatted into sagittal and coronal planes. Volume-rendered 3D-reformatted CT which aids in the detection of subtle intracranial hemorrhages and fractures was also employed.

Data were acquired from archived medical records in the Radiology Department, UUTH, Uyo, Nigeria. Radiologists' reports on any case with a clinical history of trauma to the head were collated. Inclusion criteria were CT evaluations and definitive diagnosis of head injury irrespective of severity or duration. Even CT examinations done in peripheral centers but sent to the department for radiological reports were included in this study. Cases without demographic documentations were excluded from the study. A simple analysis was done using the Statistical Package for the Social Sciences version 13.0 Inc., Chicago, IL, USA, 2011. Ethical approval was obtained from the UUTH Health Research and Ethics Committee.

RESULTS

Two hundred and thirty-two patients with head injuries that underwent craniocerebral CT were studied. The minimum age of the studied patients was 6 months, and the maximum age was 78 years. Males ($n = 170$) were more than females ($n = 62$) giving a ratio of 2.74:1. The age ranges most affected were 30–39 years ($n = 54$, 23.27%), 20–29 ($n = 53$, 22.84%), and 40–49 ($n = 45$, 19.40%). These three age ranges also showed the same male predominance of 2.18:1, 3.4:1, and 8:1, respectively [Table 1].

Normal CT findings were seen in 44 patients (18.97%). The most frequent lesion among abnormal CT findings was

intracranial hemorrhages ($n = 188$, 81.03%). Out of these, intra-axial hemorrhages ($n = 88$, 46.81%) were less than extra-axial hemorrhages ($n = 100$, 53.19%). The subtypes of extra-axial hemorrhages were epidural hemorrhages ($n = 40$, 40%) [Figure 1], subdural hemorrhages ($n = 40$, 40%), and intraventricular/subarachnoid hemorrhages ($n = 20$, 20%) [Table 1].

Half of all cases of intra-axial hemorrhages were multiple ($n = 44$, 50.00%). However, when solitary, the frontal and temporal lobes of the brain shared equal number of 12 cases each (13.64% each) [Figure 2]. The parietal and occipital lobes had eight cases each (9.09%). The least cases were seen in the cerebellum ($n = 4$, 4.54%) [Figure 3].

Other findings were cerebral edema ($n = 28$, 12.07%) and pneumatoceles ($n = 4$, 1.72%).

A total of 34.48% ($n = 80$) of studied patients had fracture(s) with most common fracture sites being facial ($n = 24$, 30.00%) and parietal bone ($n = 16$, 20.00%) [Figure 4]. Temporal bone fracture was seen in 12 cases ($n = 12$, 15%). The least site of localization was the occipital bone (5.00%) [Figure 5]. Fifteen percent of the patients had multiple fractures [Figure 1]. Observed fractures of the base of the skull were not isolated and therefore incorporated into the multiple subtypes.

DISCUSSION

It may not be coincidental that there is male predominance that cuts across almost all age groups. This is in addition to the peak age prevalence in this study that is in the age range of 20–49 years [Table 1]. The simple explanation for these two scenarios is the mobility of these young populations and male gender, since the active young males bore the responsibility of caring for their African families. This, thus, exposes them to the vagaries of our deplorable roads coupled with noncompliance to road codes. This is besides the continued usage of dilapidated

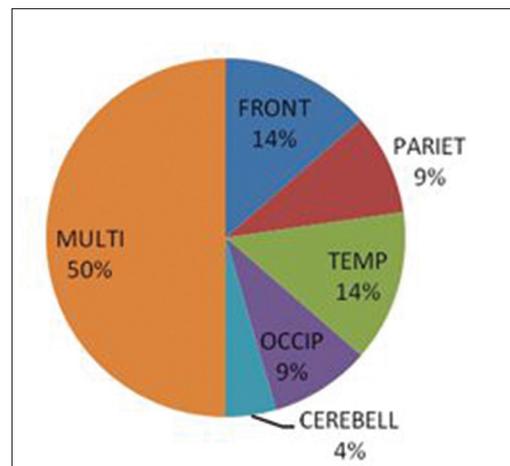


Figure 1: Pie chart showing the sub-types of intracranial haemorrhages in terms of localizations. (MULTI-Multiple haemorrhages, PARIET-Parietal haemorrhage, TEMP-Temporal haemorrhages, FRONT-Frontal haemorrhages, OCCIP-Occipital haemorrhages, CEREBELL-Cerebellar haemorrhages)

Table 1: Age range, sex distribution and computed tomographic features of traumatic brain injury in University of Uyo teaching hospital, Uyo, Nigeria

Age range	Sex distribution		CT findings							
	M	F	ICB	Epi	Sub	Ivh/s	Oed	Pne	Fra	N
0-9	12	4	0	4	12	0	0	0	4	0
10-19	4	8	0	0	0	0	8	0	13	8
20-29	41	12	20	8	8	4	4	4	10	12
30-39	37	17	20	8	8	0	4	0	14	16
40-49	40	5	12	4	4	8	8	0	10	0
50-59	8	8	20	0	0	0	4	0	0	4
60-69	20	4	4	12	4	4	0	0	25	4
70-79	8	4	12	4	0	4	0	0	4	0
Total	170	62	88	40	40	20	28	4	80	44

ICB – Intracranial bleed; Epi – Epidural haemorrhages; Sub – Subdural haemorrhages; Ivh/s – Intraventricular haemorrhages/subarachnoid haemorrhages; Oed – Oedema; Pne – pneumocephalus; Fra – Fractures; N – Normal

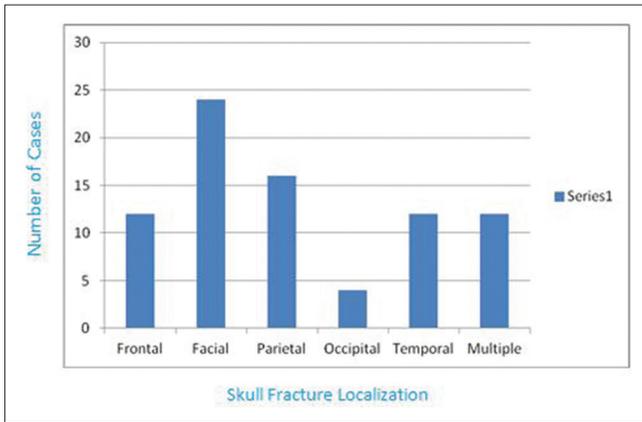


Figure 2: Bar chart showing the localization of skull fractures

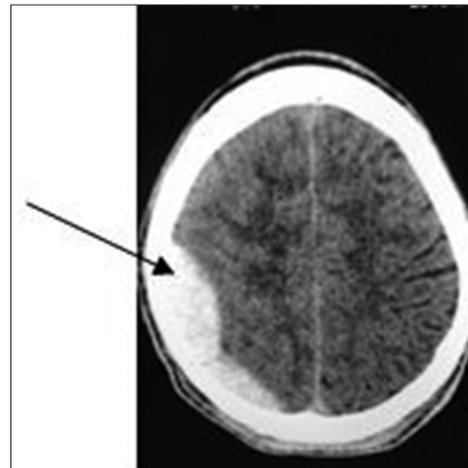


Figure 3: Axial brain computed tomogram showing biconvex hyperdense extra-axial lesion in the right parieto-occipital region of the skull (acute epidural hemorrhage)

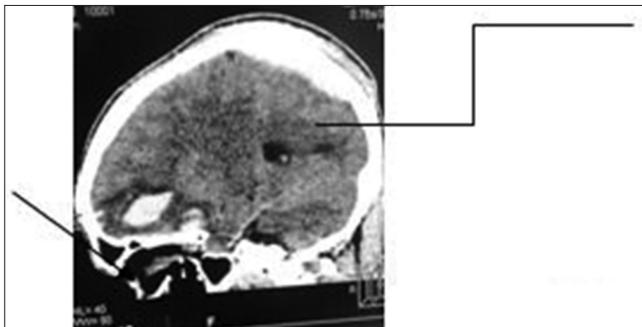


Figure 4: Midsagittal brain computed tomogram showing frontal intra-axial hemorrhage (straight arrow) and extra-axial hemorrhage (angled arrow) in the parietal region

cars in our society. This trend of involvement of young active males is corroborated by findings in other African cities such as Nnewi, Nigeria; Ibadan, Nigeria; Douala, Cameroon; and Port Harcourt, Nigeria.^{3,10,16,17} Furthermore, it is this same group of young active males that are involved in aggressive sporting activities and combative vocations. These are engagements that are prone to trauma.



Figure 5: Three-dimensional computed tomography image of a skull showing linear fracture affecting the parietal bone, frontal bone, and almost extending to the roof of the right orbit

The most frequent lesion is intracranial hemorrhages constituting 82.46% [Table 1 and Figures 1 and 2]. This is much higher than the 46% seen in a larger study of 15,754 patients¹⁸ and 58% obtained by Onwuchekwa and Alazigha.¹⁷ The reduced frequency in these mentioned studies could have been the effect of dilution from larger sample size. Interestingly, the extra-axial hemorrhages ($n = 100$, 53.19%) outnumbered intra-axial hemorrhages ($n = 88$, 46.81%) in our study giving a ratio of 1.14:1. Only a few studies on this topic harvested a similar predominance of extra-axial hemorrhages like Ogunseyinde *et al.*¹⁹ Majority had contrary observation of intra-axial predominance.^{3,10,16,17,20} Recall that extra-axial hemorrhages include epidural, subdural, subarachnoid, and intraventricular hemorrhages.

Half of the patients with intracerebral hemorrhages had multiple hemorrhages. It is noteworthy that our definition of multiplicity is two or more sites of intracerebral hemorrhages or a combination of intracerebral hemorrhage and any other type of extra-axial bleed. This multiplicity of hemorrhages in our study is comparable to 55% seen in the work of Perei *et al.*¹⁸ However, when the hemorrhage is solitary, the most common involved cerebral lobes were frontal (13.63%) and temporal (13.63%). This is followed by the parietal (9.09%) and occipital lobes (9.09%). The least site of intracerebral hemorrhages was the cerebellum (4.54%) [Figure 5]. Therefore, in descending order, the sequence is frontal, temporal, parietal, occipital, and cerebellum. This may not be unconnected with the tangent of impact and regional thinness of calvarium.

Normal brain CT scan was seen in 18.97% of our patients. This is slightly less than the observations by Adekanmi, who got 22.4%.¹⁰ This variation could be accounted for by their larger sample size and longer study span. Even higher values (35.81%) were documented by Onwuchekwa and Alazigha.¹⁷ It is gratifying that we recorded some normal CT examinations among TBI patients. This is because large epidural, subdural, or intracerebral hemorrhages have a substantially higher mortality than patients with either no bleeding or a small bleed or normal scan. However, a note of warning should be sounded against an intention of completely discountenancing normal CT scan when the clinical signs are not in consonance with the normal CT scan. This reason is that CT has low sensitivity in detecting diffuse axonal injury (DAI) as only 19% of nonhemorrhagic DAI are shown on CT.⁵ DAI usually shows on CT as focal areas of decreased attenuation secondary to edema. It could also appear as punctate foci of increased density at the gray-white matter junction, corpus callosum, and brain stem.⁵

We recorded that 34.48% of our patients had skull fractures with occipital bone being the least affected [Figure 5]. This is close to 38.98% of patients that had skull fractures with least affectation in the occipital bone in a study by Adekanmi *et al.*¹⁰ However, their highest frequencies were seen in the parietal bones and frontal bones.¹⁰ This is unlike our observation of the facial bones and parietal bones being most affected [Figure 4]. This is not surprising as the parietal and

some bones of the face are thin in nature. The most common age group affected in our study was the elderly at the sixth decade of life (31.25%). This could be the aftermath of age-related bone density reduction.

The strength of our study is the long study duration of 6 years and being a pioneer study in our locality. Moreover, this study has highlighted that the pattern of intracranial hemorrhages in our environs appears untypical of other cities as evidenced by many other studies as shown above.

However, the limitations of this study include the exposure of our poor archiving system, thus the limited number of cases available for evaluations. This is further worsened by epileptic power supply and frequent and prolonged equipment breakdown. However, the periods of equipment interruption were disjointed but included in this study. We permitted the inclusion because these periods of inactivity were compensated by some referrals from the peripheral centers for the second opinion on CT radiographs done in those centers. Nevertheless, this did not make up for the anticipated load of work if the CT machine is working at full capacity. All these factors significantly narrowed our studied population. Furthermore, we also believe that since this is a hospital-based study, most cases of TBI must have escaped clinical and CT evaluations due to the lack of finance or even death of patients.

CONCLUSION

TBI is common among young males in Uyo, Nigeria. The most common lesion seen in TBI in Uyo is intracranial hemorrhage with extra-axial hemorrhages surpassing intra-axial hemorrhages. However, in terms of descending order of intra-axial hemorrhages, the sequence is frontal, temporal, parietal, occipital, and cerebellar lobes.

The elderly in Uyo are more prone to calvarial fractures than younger age group with common localizations being facial and parietal bones.

Recommendations

A dedicated evaluation of craniocerebral CT of patients with TBIs should be done. This should include sagittal and coronal reformations as well as 3D volumetric analysis so as to identify even the subtle extra-axial hemorrhages and fractures.

Adequate and proper departmental archiving of images and reports should be mandatory. Picture archiving and communication system should be instituted as soon as possible.

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Conflicts of interest

There are no conflicts of interest.

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