

Original Article

Cranial computed tomography scan findings in head trauma patients in Enugu, Nigeria

Samuel C. Ohaegbulam, Wilfred C. Mezue¹, Chika A. Ndubuisi, Uwadiogwu A. Erechukwu, Chinenye O. Ani

Department of Neurosurgery, Memfys Hospital for Neurosurgery, ¹Neurosurgery Unit, University of Nigeria Teaching Hospital, Enugu, Nigeria

E-mail: *Samuel C. Ohaegbulam - samcohaegbulam@hotmail.com; Wilfred C. Mezue - mezuec@hotmail.com; Chika A. Ndubuisi - chikandu@yahoo.com; Uwadiogwu A. Erechukwu - erexirasmile@yahoo.com; Chinenye O. Ani - chinenyeani@yahoo.com

*Corresponding author

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Abstract

Background: The choice of radiological investigations in head trauma in Africa is influenced by factors such as cost. Some patients who require computed tomography (CT) scan elsewhere are either managed blindly or do not present for it at the appropriate time. This paper evaluates the CT scan findings as they are obtained in cases of head trauma in a region of Nigeria.

Methods: Prospectively recorded data of all head injury patients who presented for CT scan between January 2009 and April 2010 at Memfys Hospital for Neurosurgery (MHN), Enugu, Nigeria, were analyzed. Mobile CereTom 8-Slice CT was used in all cases. New and follow-up cases were included.

Results: There were 204 CT scans for head trauma (171 new, 33 follow-up), accounting for about 34% of all head CT scans performed with this unit. The male to female ratio was 3.5:1. About 33.9% of the patients were in the third and fourth decades of life. In 19.9% cases, CT was unremarkable, while 80.1% cases had abnormal CT findings. The CT diagnosis was not in keeping with the indication of head trauma in 7%, and 13% had more than one finding. The most common CT findings were: subdural hematoma 30%, cerebral contusions and edema 30.7%, skull fractures 23.4% and extradural hematoma 8.0%. About 64% of the CT findings required surgical interventions. The overall mortality was 11.1%, but amongst the 137 patients who had abnormal CT findings, it was 13.9%.

Conclusion: The high yield and diversity of CT scan findings in head trauma patients support the indication for the appropriate use of CT in diagnosis and management of head trauma even in developing countries.

Key Words: CT scan, geographical neurosurgery, head injury, mobile CereTom CT

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INTRODUCTION

Head injury is a major health problem worldwide. In developing countries, the management is further worsened by factors like poverty, lack of medical insurance

cover, availability and affordability of investigative and treatment modalities. The hospital where this study was carried out is located in Enugu with a population of about 723,000 (2006 National Census).^[27] Enugu is a referral center for the five south eastern states of

Nigeria, but patients are also referred from other parts of Nigeria, especially the contiguous south–south and northern states. In the catchment area, there are only four centers with computed tomography (CT) service and four neurosurgical centers, but only Memfys Hospital for Neurosurgery (MHN) and the University of Nigeria Teaching Hospital (UNTH), both in Enugu, offer CT and neurosurgical services. A CT scan is cheaper at MHN, but treatment cost is higher than at UNTH. Besides, UNTH is located far from the city center, thereby making it easier for patients to access MHN that is in the city center, especially at night. MHN serves a large population of mixed socioeconomic status. The catchment population is over 20 million^[27] [Table 1]. The minimum wage for workers is about N18, 000.00 (\$120) per month, but majority earn much less than that. The cost of a CT scan is about N40, 000 (\$300), thereby making it unaffordable to most people. However, many patients in need are financially assisted by friends, extended family and charitable organizations. An evolving National Health Insurance scheme at present only provides limited cover for federal public servants and few individuals from the organized private sector.

A compounding factor for scarce resource allocation is that the young and the low income earners are more likely to engage in occupational and social risks that predispose to head injury.^[5] It has been established that the morbidity and mortality associated with significant intracranial injury may be ameliorated by early diagnosis and treatment.^[9] In the past, skull radiographs were indispensable in the management of head-injured patients. In a previous study at Enugu in the pre-CT era, only 15% of head-injured patients who were X-rayed had skull fracture, and skull fracture was associated with intracranial hematoma in 18% of cases.^[20] The advent of CT in the early 1970s revolutionized the diagnosis and management of head trauma patients. However,

despite the frequent occurrence of head injury, diagnostic strategies differ among individual health care providers and their institutions.^[7,16]

The early detection of extra-axial hematomas made possible by CT results in early surgical intervention with marked improvement in morbidity and mortality in head trauma patients. A previous study in Nigeria had observed that the lack of CT scan facilities in a center contributed a great deal to a high mortality rate of 19.8% in head trauma.^[6]

In this local environment, the prevalence of head injuries had consistently risen over the decades.^[1,2,5,19] Unfortunately, many of these patients in numerous centers in developing countries are still managed based on pre-CT era protocols, resulting in high mortality and morbidity. This is only partly due to financial constraints as many physicians fail to consider early referral of head injury patients for CT scan. Some patients who require imaging investigation are either managed blindly or do not present for CT scan at the appropriate time.

Various factors are responsible for this failure. There are few CT scan centers and they are not easily accessible to many of the referring doctors. Most of the doctors in Nigeria are trained in centers without CT scan facilities, and therefore lack adequate knowledge about the value of CT scanning in the management of head trauma. Some doctors are unwilling to refer their patients to other colleagues for fear of losing the patients. There is also the false impression that because CT scan is expensive, it is an avoidable financial burden to poor families. The pitiable transport facilities and unavailability of ambulance services make the transfer of ill patients to other hospitals particularly challenging.

Against this socioeconomic background, the aim of this study was to evaluate CT scan findings in head injury patients in Enugu, Nigeria.

Table 1: Populations of catchment area states^[27]

States in S E Nigeria	Population 2006 census (in millions)	No. of neurosurgery centers	No. of CT scanners
Abia	2.8	1	0
Anambra	4.2	1	1
Ebonyi	2.2	0	0
Enugu	3.3	2	3
Imo	3.9	0	0
Neighboring states			
Rivers	5.2	1	3
Delta	4.1	0	1
Cross River	2.9	0	0
Akwa Ibom	3.9	0	0
Bayelsa	1.7	0	0
Benue	4.2	0	0

MATERIALS AND METHODS

This is an analysis of prospectively recorded data of all head injury patients who presented for CT scanning between January 2009 and April 2010 at MHN. The initial clinical examination was performed by a neurosurgical resident. The Glasgow Coma Score (GCS) used for the analysis was recorded by a senior neurosurgical resident after resuscitation and stabilization of the patient. CT scan was recommended for all patients with moderate and severe head injury (GCS 3–12). Patients who were graded GCS 13–15 were recommended for CT scan if there was clinical suspicion of intracranial complications such as focal neurological deficit, seizures and skull fractures or if the patients were intoxicated. Most patients seen at MHN had been evaluated in other hospitals before referral.

CT scan was performed within 1 hour of arrival to the facility, but generally patients presented from 3 hours to 40 days post trauma. All scans were performed with 8-slice mobile CT scanner (CereTom CT by NeuroLogica Corporation, Danvers, MA, USA). The protocol used contiguous axial 5-mm sections without contrast from about the level of C3 vertebra to the vertex. Without further radiation given to the patient, the software was used to reformat the scan in thinner slices of 2.5 mm. The images were then viewed in brain and bone windows with multiplanar reconstructions (MPR) in coronal and sagittal planes and reported by a Consultant Radiologist as well as by a Neurosurgeon. The findings were carefully recorded. Additional information documented included age, gender, time of injury, cause of injury, clinical classification of injury into mild, moderate and severe, GCS, CT findings, source of referral and whether first or follow-up CT scan.

Follow-up CT was not routinely performed, but when clinically indicated, was done only for patients who could afford the additional cost, between days 4 and 7. Urgent follow-up CT scan was done whenever unexplained clinical or neurological deterioration occurred. MHN has CT angiography (CTA), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) facilities and these were subsequently used whenever clinically indicated, provided the additional cost was acceptable to the family of the patient. The treatment and outcome were included in this study. Glasgow Outcome Scale (GOS) was used to assess clinical outcome at the time of discharge or death and at 1 month from injury. The GOS was obtained by a senior neurosurgical resident.

RESULTS

A total of 603 cranial CT scans were performed in the period under investigation and 204 (33.8%) including 33 follow-up cases were done for trauma. The male to female ratio was 3.5:1. In this study, about 33.9% of the patients were in the third and fourth decades of life [Table 2]. The major causes of head injury were Road Traffic Accidents (RTAs; 59%), falls (18.7%) and assaults (12.9%) [Table 3]. Majority of the injuries were of moderate severity with GCS 9–12 [Table 3].

In this series, 19.9% of patients had a normal CT finding while 80.1% had abnormal CT findings. About 7% had findings not in keeping with traumatic lesions and 3.5% were found to have suspiciously atypical hemorrhage, which was subsequently confirmed to be a preceding aneurismal hemorrhage or non-traumatic cerebrovascular accident. About 13% had more than one finding in their CT scan, but 4% yielded results related to trauma.

The most common CT findings due to head injury were: cerebral contusions and edema in 30.7%, subdural

Table 2: Demography

Age (years)	Male	Female	Total	%
0–10	11	01	12	7.0
11–20	16	06	22	12.9
21–30	29	04	33	19.3
31–40	19	06	25	14.6
41–50	16	03	19	11.1
51–60	14	07	21	12.3
61–70	12	07	19	11.1
71–80	11	02	13	7.6
>80	05	02	07	4.1
Total	133	38	171	
%	77.8	22.2	100	

Mean age: 43 years

hematoma in 27%, skull fractures in 23.4% and extradural hematoma in 8.0% [Table 3]. About 64% of the CT findings were serious enough to require surgical intervention [Table 4]. Burr hole drainage of subdural hematoma was the most frequently performed operation in 27% (37/137) of the patients. Other operative procedures were decompressive craniotomy, elevation of depressed fracture or craniotomy for evacuation of epidural, acute subdural or intracerebral hematomas and external CSF drainage [Table 4]. At 1 month post injury, there were 19 (M18, F1) deaths giving an overall mortality of 11.1% (19/171) or 13.9% of the 137 patients, who had abnormal CT findings. Six of the patients who died had not undergone surgery because of the severity of their condition and the delay in presentation. Postoperative mortality was 14.9% (13/87). There were two deaths from epidural hematoma. One patient died before surgery could be done and the other patient who had bi-frontal epidural hematomas and a GCS 6 and died 6 days after surgery. The five deaths from chronic subdural hematoma (CSH) occurred mostly in elderly patients who presented late. Using GOS, about 43.8% made good recovery, 12.9% had only a mild disability, 11.7% had severe disability and 0.6% was vegetative [Table 4].

In this study, only 33 patients had a follow-up CT scan and 6 of them were satisfactory. However, the rest had the following findings: intracerebral hemorrhage (ICH) in 3 patients, re-bleeding in 4 patients, new complications like edema, pneumocephalus or hydrocephalus in 7 patients, and residual hematoma in 13 patients.

DISCUSSION

Head injury is a major health problem and a frequent cause of death and disability. In developing countries, the incidence of traumatic brain injury is increasing as traffic increases, besides other confounding factors such as industrialization, falls and ballistic trauma.^[5,7]

Table 3: Head injury causes, severity and CT findings

Causes				CT findings	GCS 3-8 (n = 32)	GCS 9-12 (n = 102)	GCS 13-15 (n = 37)	Total (N = 171)	% of N = 171	% +ve CTs (n = 137)
RTA	Falls	Assault	Other							
15	9	7	3	No trauma abnormality	-	27	7	34	19.9	-
28	6	5	3	Brain contusion/edema	16	18	8	42	24.6	30.7
30	5	2	-	Subacute and CSH	2	25	10	37	21.6	27
2	1	-	1	Acute subdural hematoma	3	1	-	4	2.3	2.9
13	7	2	1	Skull fractures Depressed and linear	2	14	7	23	13.4	16.8
5	2	4	-	Epidural hematoma	3	6	2	11	6.4	8
6	2	1	-	Skull base fracture	4	3	2	9	5.3	6.6
2	-	1	6	ICH	2	6	1	9	5.3	6.6
-	-	-	2	IVH	-	2	-	2	1.2	1.4
101	32	22	16							
59	18.7	12.9	9.4	%	19%	59%	22%		100%	100%
Percentages										

Table 4: Treatment and outcome

CT findings	No.	Surgical procedure	Yes	No	Glasgow outcome scale				
					5	4	3	2	1
Subacute/CSH	37	Burr hole drainage	37	-	30	2	-	-	5
Acute subdural hematoma	4	Craniotomy/trauma flap	4	-		1	1		2
Brain contusion/edema	42	Trauma flap	14	28	11	8	15	1	7
Skull fractures Depressed # (13)	23	Elevation		10	15	6	2	-	-
Epidural hematoma	11	Craniotomy/evacuation	9	2	7	2	-	-	2
ICH	9	Craniotomy/evacuation	6	3	5	1	1	-	2
Skull base fractures	9	Craniotomy to repair CSF fistula	2	7	7	2	-	-	-
IVH	2	EVD	2	-	-	-	1	-	1
Total	137		87	50	75	22	20	1	19
% of positive CTs (n = 137)	100		63.5	36.5	54.7	16.1	14.6	0.7	13.9
% of total population (n = 171)	80.1		50.9	29.2	43.8	12.9	11.7	0.6	11.1

Radiographic examination of the skull is an essential part of management of head trauma,^[20] but its limitations in plain radiographs are now recognized even in diagnosis of skull fractures.^[18] CT facilitates a comprehensive diagnosis and permits early and targeted intervention.

The majority of our patients were found to be in the third, fourth and second decades of life. This age group is the most active and productive group of our society and are more likely to be exposed to both occupational and social risks. The male:female ratio in our study was 3.5:1. This demographic pattern is similar to other data from our region.^[2,6]

The mobile CT scanner used in this study has been shown to be easy to use, safe and provides adequate radiological quality for diagnosis.^[21]

In this study, 80.1% had a pathological CT scan finding

while 19.9% revealed a “normal” CT scan finding. The subgroup of patients with apparently normal CT scan finding and clinical evidence of severe head trauma often has diffuse axonal injury. This is frequently not easily diagnosed with CT scan.^[10,14] A subsequent follow-up MRI scan may be necessary in these patients for a full evaluation.^[11,15] Repeat CT scan may reveal an earlier missed diagnosis, especially when clinical details later on reveal a lateralizing sign. The phenomenon of ultra early CT missing a significant surgical lesion in the head-injured patient has provoked the debate as to whether serial repeat CT should be adopted and if such a practice is cost effective.^[3,12,25,26] In this environment, delayed CT is unfortunately the rule rather than an exception and the ultra early CT is rarely done. Follow-up CT is very useful whenever it is indicated, especially in monitoring postoperative patients or those who have not achieved the expected clinical improvement on non-operative

management.^[26] In this study, the financial burden of a repeat CT restricted its use to only 33 patients who could afford a follow-up scan; yet, on those films, 4 patients had fresh hemorrhage compared to their previous scan while 7 other patients developed new complications.

In a recent epidemiological study in Germany, the time elapsing between the accident and initial hospital assessment was less than 1 hour in 63%, and about 19.3% of patients received CT.^[22] Geographical location of a hospital was found to be a significant predictor of CT use in Canada as urban location favored CT use.^[13] It is suspected that the same may be true for this locality.

In developed countries, a CT scan is even recommended for patients with mild head injury because one in five patients will have an acute lesion detectable by CT scanning.^[24] However, this is not universally accepted. Some authors believe that a thorough clinical examination of the patient may obviate the need for what they feel is an inefficient use of CT scan in head injury.^[17] Others support the view that clinical examination in head-injured patients may not reliably predict the eventual CT scan findings.^[4,8] Interestingly, increasing concern is being expressed about the hazards of CT and the need for moderation in its use even in head injuries.^[23] An earlier study from Nigeria in patients with moderate to severe head injury showed that 87% of patients had abnormal CT findings.^[2] In this study, 80.1% had abnormal findings due to trauma, but this included all cases with head injury. These differences may be explained by the differences in methodology.

In this study, 7% of patients had a diagnosis that was not in keeping with head trauma. About 3.5% of the patients referred to this center as head injury were found to have atypical features and subsequent CTA confirmed that they have had a preceding ruptured intracranial arterial aneurysm or non-traumatic cerebrovascular accident. In these cases, the ictus preceded the accident and the head injury was spurious. Obviously, the management of such conditions differs from that of head injury. This finding buttresses the importance of early CT scan in the planning of treatment for suspected head injury patients.

This study reveals that 13% of patients had more than one finding on CT. These findings may all be related to trauma as was the case for the 4% with a combination of intracerebral hematoma, contusion and acute subdural hematoma. In others, traumatic lesions occur in association with a potentially primary event such as cerebrovascular accidents and it becomes difficult to determine the primary pathology. A high index of suspicion, a good history and follow-up imaging with MRI if possible will often resolve this.

The early detection of extra-axial hematomas, as made possible by CT scan, results in early surgical intervention with marked improvement in morbidity and mortality in

head trauma patients.^[6] Regrettably, some patients with extra-axial bleeds present for imaging investigation and management after long delays, thus greatly impacting the final outcome. Reasons for this include delays on conservative management in non-specialized hospitals.

CSH (27%) was the second most common abnormal finding in this study and contributed to the high rate of surgical intervention (63.5%) in the series. This is another pointer to late presentation for CT scanning. CSH is more common in the older age group and often follows minor head trauma. These patients will benefit from early diagnosis and prompt evacuation of any significant accumulation before neurologic and metabolic consequences set in. This was not the case in this study and the five deaths from CSH as well as the two deaths from epidural hematoma may have been prevented had the patients presented earlier for CT.

There is very limited utilization of CT scanning in the management of head trauma in Nigeria. The number of CT scan centers is small; they are widely apart and therefore not easily accessible for emergencies. The cost of installation and running a CT scan service is high. For prospective investors in CT scanning facilities as a business, bank loans are difficult to secure and remain unattractive because of very high interest rates that exceed 20% per year. These factors contribute to the high cost of obtaining a CT scan in Nigeria. Additionally, most doctors are trained in centers without CT facilities and are therefore not well informed about the utility of CT. Ignorance about CT technology in the setting of head injury is widespread in Nigeria and public awareness campaigns are slowly developing. There is also the tendency for some private medical practitioners to selfishly deny their patients the benefit of better care in a superior medical facility. The Nigerian Medical Council is confronting these challenges and Continuing Medical Education Certification Programs are being introduced and hopefully will make a difference. International Organizations could help by donating CT scanners to hospitals so as to increase the CT availability. The private sector and non-governmental organizations (NGOs) have an important role to play by supplementing government efforts as exemplified by MHN. Private/public sector initiatives are now being encouraged by the Nigerian government and have already materialized in some hospitals across the country. Furthermore, NGOs could assist indigent patients to pay for their CT and subsequent treatment. These measures might increase the volume of CT scans performed, and therefore contribute to a reduction in the cost of scanning.

Unfortunately, these measures would also increase the burden of providing neurosurgical treatment to the increased number of patients with positive CT scan findings. Patients who cannot afford the cost of CT scan obviously cannot afford the cost of the follow-up

treatment, especially if surgery is indicated. From our experience, families and friends, when confronted with life-threatening CT scan findings, are more motivated to give financial assistance. Indeed, it is easier to convince families to pay for treatment than to pay for CT scan. Moreover, MHN in such situations would provide the emergency care and then appeal to the families to pay later. Most of them would ultimately honor their obligations, especially in cases with a satisfactory outcome.

The findings of cerebral contusions and edema in 30.7%, skull fractures in 16.8% and extradural hematoma in 8.0% are consistent with those from other studies.^[7,24] This study indicates that in about 51% of patients, the CT scan findings suggest a benefit from early surgical intervention. In this regard, cost becomes only a secondary consideration. The mortality from head injury was 11.1% of the 171 patients who had CT or 13.9% of the 137 patients who had abnormal CT findings. This is slightly better than the 15.1% and 19.8% mortality from head injury previously reported from this locality.^[5,6] The better result might be due to the availability and routine use of CT scan in the management of head injuries at MHN, which was not the case in the reports from other locations.

CONCLUSION

The high yield and diversity of CT scan findings in head trauma patients justifies the appropriate use of CT in diagnosis and management of suspected head trauma patients even in a developing country such as Nigeria. Although cost considerations are important, the patient should be given the chance of an appropriate work up early rather than later and this should not be prevented by the assumption that CT scanning is unaffordable. In our experience, when given the choice, patients and their families will likely opt for life and a good outcome. To achieve this, the patient may get financial assistance from the traditional extended family, friends, government agencies, churches and charitable organizations for the CT and any subsequent treatment. Ultimately, the answer to the cost problem may be in the universal health insurance scheme that is currently evolving over many years.

More research is needed to determine the causes of delayed referrals of head-injured patients for work up via CT, the consequences of this delay and what can be done to shorten the delay, to ultimately yield better therapeutic outcomes.

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