Original Article

Role of computed tomography scan in assessment of skull fracture patterns among motorcycle road traffic accident patients in South Western Nigeria

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Abstract

Background: Commercial motorcycling is a common means of transportation in Nigeria, and motorcycle road traffic accidents (MCRTAs) are commonly associated with multiple skull fractures. Cranial computed tomography (CT) scan is the standard imaging modality of patients with head injury.

Aim: The aim of this study is to describe the pattern of skull fractures on cranial CT scan in patients with head injury following MCRTA.

Patients and Methods: This was a descriptive cross-sectional study conducted at the University College Hospital, Ibadan, between June and October 2016. Noncontrast cranial CT scan was performed on 190 patients who presented with head injury following MCRTAs.

Results: Over half (n = 59.8%) of the patients were within the ages of 20–39 years with a mean age of 33 ± 14.37 years. A total of 183 patients did not use crash helmet at the time of accident, out of which 168 (n = 88.4%) sustained skull fractures. Six different skull fracture patterns were identified on cranial CT scan of these patients. The most common fracture pattern seen was the combined calvarial, facial, and base of skull fractures representing 22.1% while the least fracture pattern was the base of skull fracture (n = 4.7%). Most of the patients with calvarial fractures were without helmet at the time of injury (n = 98.3%) compared to 1.7% of patients who wore helmet at the time of injury. This was statistically significant (P = 0.040).

Conclusion: This study further underscores the usefulness of cranial CT scan in identifying and evaluating patients with skull fractures following MCRTA in our environment, thus guiding proper medical and surgical management of such patients in a low-resource setting.

Keywords: Cranial computed tomography scan, crash helmet, motorcycle road traffic accident, skull fracture

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INTRODUCTION

Ibadan is an ancient city and one of the most populous cities in Africa with population of over three million inhabitants.[1] Commercial motorcycling is a common means of transportation in Ibadan and serves as a major source of income, especially among those with very low social economic status. This form of transportation is further necessitated by the poor state of roads and high rate of unemployment among the youths.[2] This development

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has unfortunately resulted in increased motorcycle road traffic accidents (MCRTAs) due to noncompliance to the traffic rules, reckless riding, overspeeding, passenger overload, and riding under the influence of drugs and alcohol. These are further compounded by inadequate riders' training and poor supervision by the traffic law enforcement agencies.[3,4]

Head injuries resulting from MCRTAs are associated with 5- to 6-fold chances of death relative to those caused by other vehicles.[5] Multiple skull fractures with underlying intraparenchymal injuries are seen more in those without crash helmet at the time of injury. Nwadiaro *et al*. attributed increased skull fractures and mortality among victims of MCRTAs to the nonuse of these crash helmets at the time of injury.[4] Riders of motorcycle involved in RTA are also more likely to sustain head injury when compared with their passengers or an involved pedestrian as observed in most local studies.[2,4,6,7]

Effective management of these patients is hampered by factors such as unavailability of essential diagnostic equipment such as computed tomography (CT) scan machines in many hospitals, inadequate number of skilled professionals, and deficient emergency rescue system in the emergency care. These inevitably translate to loss of lives, prolonged hospital stay, and increased medical expenses on both the patients' families and the health-care system.[2]

Cranial CT scan is the gold standard in the evaluation of skull fractures in patients with head injury because it has the ability to rapidly acquire cross-sectional images of the skull and intracranial structures.[8] These can be reformatted to obtain excellent bony details of skull fractures using both bone window and three-dimensional reconstruction. It also has a good sensitivity for detection of associated underlying intracranial injuries which ultimately provides the useful clinical information aimed at efficient and effective neurosurgical management of these patients.[9-11]

The purpose of this study was to describe and classify the pattern of skull fractures on cranial CT scan among patients involved in MCRTA. This will help determine the severity and characterization of these fractures which will guide the surgical managing team with appropriate decision-making and ultimately prevent complications in these patients.

PATIENTS AND METHODS

This was a descriptive cross-sectional study. A total of 351 patients with head injury presented at the Accident and Emergency Unit of the University College Hospital, Ibadan, between June and October 2016. Two hundred and one cases (n = 57.3%) were due to MCRTA. One hundred and ninety patients who fulfilled the inclusion criteria (i.e., those with head injury resulting from MCRTA, who had consented or whose relatives had given consent to participate in the study) were recruited.

The cranial CT scan images were acquired by Aquilion American model 64-slice CT scanner using the multislice helical technique. Each scan procedure took about 5–10 min, and uncooperative patients and children were adequately sedated with intravenous diazepam and intramuscular (IM) paraldehyde, respectively. The gantry (with a diameter of about 72 cm) was angulated at 15°–20° to the orbitomeatal line to reduce the radiation to the eyes. Contiguous axial 0.5-mm sections, pitch of 0.5 mm without contrast from the level of T2 vertebra to the vertex of the skull, 120 kV and 120 mAs minimum tube current, 512 × 512 matrix, and 15-cm field of view were used. Axial and reformatted images acquired were reviewed using the brain and bone windows, and the findings were documented.

Data collected was entered using the Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 17 and analyzed. All outcome variables were determined using univariate analysis for mean, median, and standard deviations, and all statistical tests were considered statistically significant at $P < 0.05$.

Ethical approval for the study was obtained from the Institute for Advanced Medical Research and Training Board of College of Medicine, University of Ibadan.

RESULTS

The age range of the patients was between 7 and 82 years with a mean age of 33 years ± 14.37 standard deviation. Majority of the patients (n = 59.8%) were within the age group of 20–39 years [Table 1].

One hundred and fifty-three patients were male accounting for 81.0% while 37 were female (n = 19%). About half of the patients (n = 49.5%) were passengers, 68 were riders (n = 35.8%), and 28 were pedestrians (n = 14.7%), as shown in Table 1. There was no female rider recorded. Most of the patients were not wearing a crash helmet at the time of accident (n = 96.2%). Motorcycle-to-vehicle collision was the highest accounting for 64.5% of collision while lone motorcycle accident was the lowest, seen among only 8 patients accounting for 4.3%.

One hundred and sixty-eight patients had skull fractures of varying types and patterns (n = 88.4%). The pattern

of skull fractures on cranial CT bone window showed that the combined calvarial, base of skull, and facial bone fractures were the most common accounting for 22.1% (*n* = 37 patients) while the least common fracture was that of the base of skull alone (*n* = 4.7%), as shown in Figure 1. The parietal bone was the most common site of calvarial fracture seen in 91 patients (*n* = 75.3%), and the occipital bone was the least fractured site noted in 44 patients (*n* = 36.1%). Multiple calvarial fractures were found in 67 patients (*n* = 55.4%) while single fracture was seen in 54 patients (*n* = 44.6%). Those who sustained undisplaced fractures (*n* = 56.3%) were more than those who sustained depressed fractures which accounted for 43.7%. Majority had closed fractures (*n* = 97.5%) while the remaining had open fractures (*n* = 2.5%), as shown in Table 2.

Among those with base of skull fractures, single fractures accounted for 74.7% (*n* = 71 patients), as seen in Figure 2.

Table 1: Some sociodemographic characteristics

Variables	Frequency, *n* (%)
Age	
19 below	25 (13.2)
20-39	113 (59.8)
40-59	43 (22.8)
60-79	6 (3.1)
80+	3 (1.1)
Total	190 (100)
Sex	
Female	153 (81)
Male	37 (19)
Patient's status	
Rider	68 (35.8)
Passenger	94 (49.5)
Pedestrian	28 (14.7)
Total	190 (100)
Use of helmet	
Yes	7 (3.7)
No	183 (96.3)
Total	190 (100)

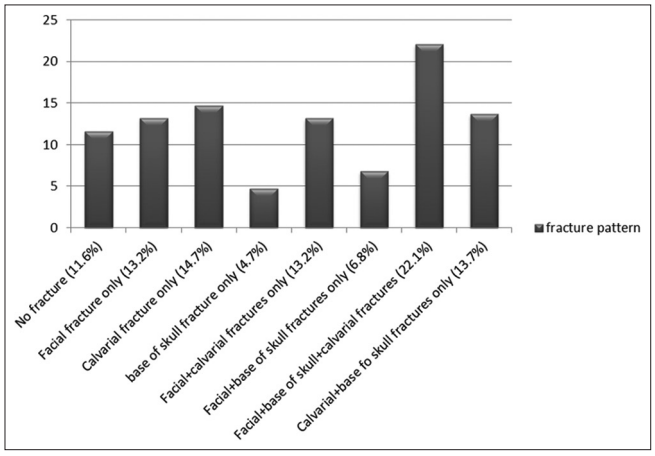

Figure 1: Chart showing various skull fracture patterns among the motorcycle road traffic accident patients on cranial computed tomography

The petrous part of the temporal bone was the most common basal site accounting for 43.3%. The least fractured site was the cribriform plate which accounted for 2.1% [Table 2].

More patients had multiple facial fractures (*n* = 73.5%). The maxillary and zygomatic bones were the most common sites accounting for 59.8% and 19.6%, respectively, while the least common sites were the nasal and mandibular bones which both accounted for 0.9% [Table 2]. A total of 132 patients had intracavitary hematoma (*n* = 69.8%).

Most of the patients with calvarial fractures were without helmet at the time of injury (*n* = 98.3%) compared to 1.7% of patients who wore helmet at the time of injury. There was a statistically significant relationship among those who sustained calvarial fractures and the use of helmet (*P* = 0.040), as seen in Table 3.

One hundred and fifty-five patients had intracranial injuries accounting for 81.6%. Some of these victims (*n* = 62.6%) had cerebral contusion [Table 4]. Cerebral edema was found in most of these patients with intracranial injuries accounting for 86.8%. Subdural, subarachnoid, and epidural hemorrhages were observed in 53 (*n* = 28.5%), 41 (*n* = 22.2%), and 40 patients (*n* = 21.5%), respectively. Only 7 of these patients had an intraventricular extension of the bleed (*n* = 3.8%). Eighteen patients had pneumocephalus with tension pneumocephalus seen in only 5 of them [Table 4].

DISCUSSION

Over the past three decades, the use of motorcycles has increased in most Nigerian urban cities such as Ibadan (where this study was conducted) as a source of livelihood.[2,4]

In this study, majority of the patients with MCRTA were aged between 20 and 39 years (*n* = 59.8%) with a mean

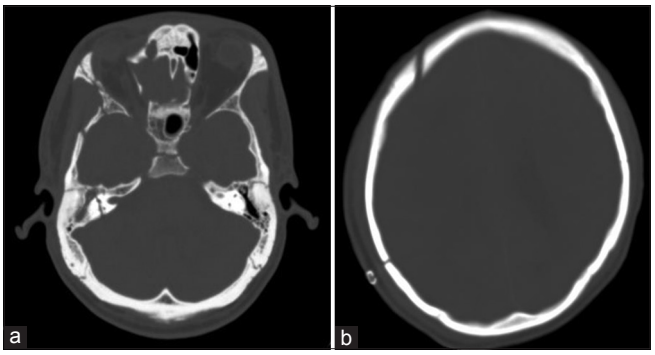

Figure 2: Axial cranial computed tomography scan in bone window showing (a) multiple fractures of the base of skull on the right and (b) simple linear fractures of the right frontal and parietal bones

Table 2: Computed tomography findings showing the frequency distribution of skull fractures

	Frequency, *n* (%)
Skull fractures	
Yes	168 (88.4)
No	22 (11.6)
Total	190 (100)
Fracture site	
Calvarial fracture*	
Parietal	91 (75.3)
Frontal	82 (67.9)
Temporal	66 (54.2)
Occipital	44 (36.1)
Number of calvarial fracture	
Single	54 (44.6)
Multiple	67 (55.4)
Form of calvarial fracture	
Undisplaced	67 (56.3)
Depressed	52 (43.7)
Type of calvarial fracture	
Open	3 (2.5)
Closed	116 (97.5)
Facial fractures	
Maxillary	70 (59.8)
Zygomatic	23 (19.6)
Bony orbit	10 (8.5)
Ethmoidal	7 (6.0)
Frontal	5 (4.3)
Nasal	1 (0.9)
Mandibular	1 (0.9)
Base of skull fracture	
Temporal component	41 (43.2)
Sphenoid bone	39 (41.1)
Occipital component	13 (13.7)
Cribriform plate	2 (2.1)
Number of base of skull fracture	
Single	71 (74.7)
Multiple	24 (25.3)

*Some patients had multiple fracture sites

Table 3: Correlation of skull fractures on cranial computed tomography with use of crash helmet

Variable	Use of helmet		Total	*P*
	Yes	No		
Facial	3 (3.0)	102 (97.0)	105 (100)	0.605
Calvarium	5 (1.7)	278 (98.3)	283 (100)	0.040
Base skull	2 (2.3)	93 (97.7)	95 (100)	0.275

Table 4: Computed tomography findings of intracranial injuries

Variables	Frequency, *n* (%)*
Cerebral contusion	119 (62.6)
Intraventricular hematoma	7 (3.8)
Cerebral edema	164 (86.8)
Epidural hematoma	40 (21.5)
Subdural hematoma	53 (28.5)
Subarachnoid hematoma	41 (22.2)
Pneumocephalus	18 (9.5)

*Some patients had multiple injuries

age of 29.5 years. The mean age recorded is similar to studies done by Umebese[11] who reported the mean age of 30 and Nwadiaro *et al*.[4] and Solagberu *et al*.[5] who both reported 21–30 as the mean age. This age group is the active, youthful, and productive group who is more likely to engage in reckless and risky riding, overspeeding, and riding under the influence of drugs/alcohol.[3,4] In Finland, however, the peak age incidence was reported in the younger age group of 16–19 years.[12] This is probably because teenagers ride motorcycle in their country for leisure or sporting activities unlike in Nigeria where it is used mostly as a means of livelihood.

There is male sex preponderance as male-to-female ratio was 4.3:1. This finding is consistent with a study done by Nwadiaro *et al*.[4] among patients with motorcycle injury in Jos University Teaching Hospital where they reported a male-to-female ratio of 4.8-1. The females in this study were either passengers or pedestrians as there was no single female rider. This, however, differs from a study by Chalya *et al*. in Tanzania where they reported a lower male-to-female ratio of 2.3-1[3] and another study done in Finland by Hofling *et al*. where female riders accounted for 10% of patients involved in MCRTAs.[12] These differences are largely due to variance in sociocultural norms and practice; more females are involved in motorcycling for business activities and leisure purposes in countries such as Tanzania and Finland, while in most part of Nigeria, females riding motorcycle are seen as strange and extreme.

Nearly half of the injuries in this study involved the passengers (n = 49.5%) while the riders accounted for 35.8%. This is consistent with the finding of Adeyinka *et al*. where more passengers (n = 52%) were involved in MCRTAs; they attributed this to the poor state of roads and lack of enforcement of traffic laws.[10] Our finding is, however, at variance to a study done by Chalya *et al*. in Tanzania where over half of the injuries were sustained by riders (n = 55.2%), followed by passengers (n = 33.9%) and pedestrians (n = 10.9%).[3] In addition to the poor state of the road and lack of enforcement of traffic laws, there is also the problem of overspeeding and overloading by the riders in order to make more money within a shorter time.

This study shows that only 7 patients used crash helmet at the time of injury (n = 3.7%), and this is largely due to the nonenforcement of traffic rules and regulation by the law enforcement agents. In addition to these, there is the sociocultural belief that wearing or sharing of crash helmets may predispose them to being hypnotized, charmed, or lured into danger and can also lead to transfer of brain diseases including psychiatric illnesses to one another, coupled with the fact that the crash helmets are unaffordable to the riders who are struggling to make ends meet.[5] The noncompliance with the use of crash helmet in MCRTAs is further corroborated in a study done by Nwadiaro *et al*. in North Western Nigeria where no single

victim among the total of 485 motorcycle injuries used helmet at the time of injury.[4] However, the prevalence of crash helmet use was higher (n = 22.7%) in a study done by Chalya *et al*. in Tanzania.[3]

Previous studies done by Adeyinka *et al*.,[10] Akanji *et al*.,[6] and Eze and Mazeli[7] on victims of RTA recorded 59.8%, 34.3%, and 34.4% skull fractures, respectively, on cranial CT scan. In this study, however, we recorded a higher percentage of 88.4 which is likely due to the more homogenous cohort of patients (MCRTA victims alone).

The combined facial, base of skull, and calvarial fractures accounted for the highest fracture pattern (n = 22.1%) in this study. The parietal bone was the most fractured calvarial bone accounting for 75.3%. This may be explained by the angle of impact of the head of the victims with the road surfaces as many are often thrown off the motorcycles making an obtuse angle between the head and the ground.[13] Adeyinka *et al*., however, reported temporal bone as the most common fractured bone and the occipital bone as the least fractured bone.[10] The occipital bone was also found as the least fractured site in this study accounting for 36.1%. This is so because the occipital bone is the thickest calvarial bone and is more resilient to trauma. Victims also seldom hit the ground with the occiput.[10] Considering the different fracture sites (facial, calvarial, and base of skull), the use of helmet was found to be protective in all as there were far more cases among those who did not wear helmet compared to those who wore. However, a significant statistical relationship was seen only among those with calvarial fractures (P = 0.040). The maxillary and zygomatic bones were the most common facial bones fractured accounting for 59.8% and 19.6%, respectively. This is consistent with a study done by Osuagwu *et al*. where maxillary and zygomatic bone fractures accounted for majority of facial fractures.[14] The high incidence of fractures of these bones is due to the anterior anatomical location and prominence of these bones.

The prevalence of intracranial injury in this study was 81.6%. This is high relative to Crandon *et al*.'s study in Jamaica[15] where they reported 48.8%. This wide statistical gap can be explained by the difference in the use of helmet in our study (n = 3.7%) and that conducted by Crandon *et al*. (n = 34.3%).

CONCLUSION

Our study reveals poor use of crash helmet among motorcycle users which invariably culminated in the high cases of skull fractures and intracranial injuries among the study population. The injury patterns were excellently characterized with cranial CT which is a diagnostic fulcrum in the management of patients with head injury. It gave the opportunity for a prompt diagnosis and characterization of skull fracture patterns, thus reflecting the invaluable role of the CT scan in the optimal management of such patients. It is, therefore, paramount that more functional CT scan machines should be made available in health facilities across the country with adequately skilled workforce to operate them and adequately trained neuroradiologists to interpret the study. This will greatly reduce the morbidity and mortality indices of patients with motorcycle-related RTAs. It is also advised that motorcyclists use the crash helmets and adhere to road traffic rules and regulation.

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Conflicts of interest

There are no conflicts of interest.

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