A Radiology Perspective: The Effectiveness of Safety Devices in Patients with Traumatic Head Injury at NAUTH, Nnewi

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ABSTRACT

Background: Road traffic accidents in Nigeria remain the leading cause of head injuries. The use of helmets, seat belts, and car seats for young children has been advocated to reduce the severity of traumatic head injury (TBI) but the implementation of these gadgets is yet to come into full effect. **Objectives**: We aim to determine the association between the use of safety devices with the Glasgow coma scale (GCS) and Rotterdam CT score in patients with TBI. **Materials and Methods:** A total of 170 participants with a traumatic brain injury (TBI) were recruited. A quick GCS examination, and a brain computed tomography (CT) scan was done. **Results:** A total of 137(80.6%) participants had abnormal CT findings while 33(19.4%) had normal CT findings. 58 participants did not use safety helmets and 14 had a Rotterdam score of 1. All 14 participants who used safety helmets had a Rotterdam score of 1. Rotterdam score of 2-3 was seen in 16(27.6%) participants who did not use safety helmets. The Rotterdam score of 4-6 was recorded in 30(31.7%) participants in patients without safety gear. There was a statistically significant correlation between the use of safety devices and the severity of head injury (assessed by GCS and Rotterdam score) in MCRTA and MVRTA ($p < 0.001$). A greater proportion without safety devices had severe head injuries. **Conclusion**: With the use of safety devices, the severity of traumatic head injuries was less.

Keywords: GCS, Head Injuries, Participants, Rotterdam Score, Safety Devices.

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INTRODUCTION

Trauma is the leading cause of death among all age groups, with head trauma being the cause of death in up to 50% of cases and also accounting for most cases of permanent disability after injury.[1] Thousands of patients are involved annually with young males mostly affected. Head injury poses a major health challenge thus placing a huge burden on our health resources and services. In developing countries such as Nigeria, accident rates in general and traumatic brain injury in particular, are on the rise because of the increasing traffic load, with increased use of motorcycles and the deplorable state of the roads.[2,3] The financial incapacity to buy more modern vehicles with protective devices and safety gadgets and the lack of strict implementation of traffic laws and regulations are reasons for the high prevalence rate of head injury in developing countries.[4]

Head injury is defined as any injury that causes lesions or functional damage to the cranium, meninges, and brain. It accounts for death in more than 50% of cases of trauma worldwide.[4] Common causes of head injury include road traffic accidents (RTA), assaults, falls from height, and stab wounds. Head injury is considered a major health problem and a frequent cause of death and disability, thus placing considerable demands on health services.[2] In developing countries, including Nigeria, the prevalence of traumatic brain injury is on the rise due to an increase in industrialization, falls, and ballistic trauma as some of the confounding factors.[2,3,5] Road traffic accident (RTA) remains Nigeria's leading cause of head injuries. Cranial computed tomography (CT) has been established as an accurate, fast, and non-invasive diagnostic modality in the detection of skull fractures, intracranial haemorrhage, and other sequelae of head injury.[6] Most head injuries are preventable, for instance, if motorcyclists with passengers and motor vehicle users strictly adhere to safety practices such as obeying traffic regulations and wearing helmets or seat belts, most road traffic accident (RTA) outcomes would be less severe.

The use of safety gear cannot be over-emphasized due to the protection it provides for the user should an accident occur. Motorcyclists with their passengers and motorist who use helmets and seat beats stand a better chance of survival when they are involved in an accident. Safety devices like helmets and seat belts prevent direct injury to the head, chest, and upper abdomen while the airbag protects the driver from serious chest/sternal injuries. In this study, we aim to determine the association between the use of safety devices with the Glasgow coma scale and Rotterdam CT score in patients with traumatic head injuries.

METHODS AND MATERIALS

A prospective study of 170 patients with head injuries presenting for CT scan, was carried out over 24 months in the Radiology department of the Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi. Ethical clearance was acquired from the Ethical board of the institution with a reference number NAUTH/CS/66/Vol 9/88. All patients who presented in the department following head injury and who gave consent were evaluated. Informed, written, and signed consent was acquired from the patient or next of kin. Relevant clinical history was obtained from the patient, relatives, or the patient's folder.

All patients were scanned using a 4 slice/gantry rotation capacity CT (General Electric), HANGWEI Medical Systems Company Limited – Bright Speed Excel 4 Slices CT Scanner, Model number 2335179-2, S/N 176142HMB, manufactured in October 2007 in Beijing, China).

A quick examination of the patient was done, especially for the level of consciousness using the Glasgow Coma Score (GCS), before the commencement of the CT scan. The patient was positioned supine on the couch, head first into the gantry, and head placed firmly strapped in the head holder to reduce movement. Scout film/scanograms and serial non-contrast images were acquired at 5 mm intervals from just below the skull base to the vertex with the gantry angled parallel to the supraorbital meatal line to avoid ocular lens exposure.[4] Reformatted images of 2.5 mm were viewed in brain and bone windows with Multi-planar Reformatting (MPR) in coronal and sagittal planes.[6] The findings were broadly classified into normal and abnormal.[8]

Data obtained from the study pro-forma and the cranial CT findings of subjects were entered and analyzed using IBM SPSS (Statistical Package for Social Sciences), version 20.0. Armonk, NY, U.S.A, 2011. Analysis was done using simple descriptive statistics.

RESULTS

A total of 170 patients referred to the Radiology

Department of the NAUTH, Nnewi, on account of head injury, were included in this study. This showed a high prevalence of TBI accounting for 44 per 100,000 persons. Males accounted for 77.6% of all head injury cases while females accounted for 22.4%, with an approximate male-to-female ratio of 3.5: 1. The mean age of the participants was 34.3 ± 2 years. The predominant age group affected was 21 – 30 years (23.5%) followed by the 31 – 40 years age group (18.2%) which was seen mainly in males. The predominant age group affected in the males was 21 – 30 years, accounting for 21.1% of the study population, while that of females was 0 -10 years (6.4%). The least common age range affected was the 81 – 90 years (1.7%) age group, they were all men.

Table 1: The age and gender distribution of the participants as well as the mean values of age among male and female patients

Age group (years)	Gender		Total (%)
	Male (%)	Female (%)	
0-10	19 (11.2)	11 (6.4)	30 (17.6)
11-20	9 (5.3)	2 (1.1)	11 (6.4)
21-30	36 (21.1)	4 (2.4)	40 (23.5)
31-40	26 (15.3)	5 (2.9)	31 (18.2)
41-50	16 (9.4)	5 (2.9)	21 (12.3)
51-60	12 (7.1)	5 (2.9)	17 (10)
61-70	7 (4.1)	1 (0.6)	8 (4.7)
71-80	4 (2.4)	5 (2.9)	9 (5.3)
81-90	3 (1.7)	0	3 (1.7)
TOTAL	**132 (77.6)**	**38 (22.4)**	**170(100)**
Age (years)			
Mean ± STD	34.0 ± 2	35.3 ± 2	34.3 ± 2
Minimum	0.5	0.5	
Maximum	90	80	

Thirty-three (19.4%) patients had normal CT findings while 137 (80.6%) patients had abnormal CT findings with some of these patients having multiple abnormal CT findings.

Table 2 : showing the frequency distribution of CT findings among the head trauma study population

CT findings* (n=170)	Frequency	Percentage
Normal	33	19.4
Abnormal (n=487)	137	80.6

The patterns of abnormalities showed that the commonest CT findings were intracranial bleeding. The most common type of intra-axial haemorrhage was acute contusional haemorrhage, accounting for 60% (57/95), followed by acute intraventricular haemorrhage at 20% (19/95), then intracerebral haemorrhage (19%) and lastly brainstem haemorrhage (1%).

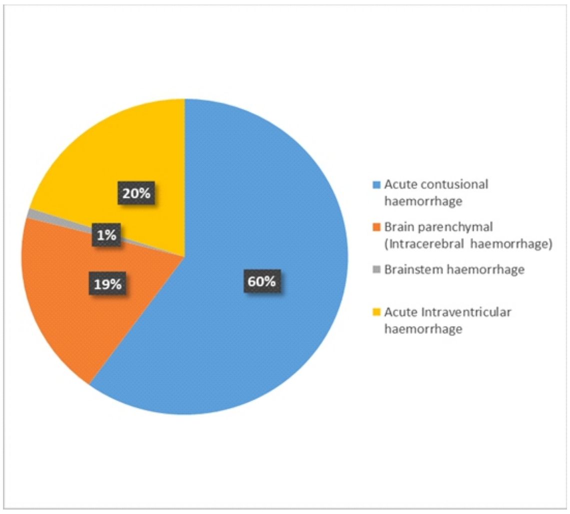

Figure 1: Pie chart showing the different proportions of Intra-axial haemorrhage among the study population

A total of 58 participants without safety helmets were recorded and 14 participants with safety hlmets. These 14 participants with helmets had a Rotterdam CT score of 1. Only 12 of the 58 participants without safety helmets had a Rotterdam score of 1. The remaining 46 participants without helmets had a Rotterdam score of 2-6. The bulk of these participants (30) showed a high score of 4-6 while 16 showed a low score of 2-3.

Table 3: Showing the relationship between the use of safety helmet and severity of head injury using Rotterdam in patients with motor-cycle RTA

The severity of head injury using Rotterdam Score	Use of Helmet		Total (%)
	No	Yes	
Score 1	12 (20.7)	14 (100)	26 (120.7)
Score 2	8 (13.8)	0	8 (13.8)
Score 3	8 (13.8)	0	8 (13.8)
Score 4	13 (22.4)	0	13 (22.4)
Score 5	12 (20.7)	0	12 (20.7)
Score 6	5 (8.6)	0	5 (8.6)

Using the Glasgow Coma score evaluation, all 14 participants who used helmets had mild head injuries with a GCS of 13-15. While 28 of the 58 participants without helmets also had mild head injuries (GCS 13-15). There were 16 participants with moderate head injuries with GCS 9-12 and 14 participants with severe head injuries with GCS <8. No participant with a helmet was recorded with a moderate or severe head injury.

Table 4: Showing the relationship between the use of a safety helmet and severity of head injury using GCS score in patients with Motorcycle RTA.

The severity of head injury using GCS	Use of helmet		TOTAL
	No (%)	Yes (%)	(%)
Mild	28(48.3)	14(100)	42(148.3)
Moderate	16 (27.6)	0 (0)	16 (27.6)
Severe	14(24.1)	0 (0)	14 (24.1)
Total	58 (100)	14 (100)	72 (200)

Using the Rotterdam CT score, 21 participants without seat belts and 9 with seat belts were recorded. None of the participants that did not use seat belts had a Rotterdam CT score of 1 while 7 of the 9 participants with seat belts had a Rotterdam CT score of 1. Two participants with seat belts were reported with Rotterdam scores of 2 and 4 (low and high risk). Rotterdam CT score of 2-3 was seen in 9 participants while a Rotterdam CT score of 4-6 was seen in 12 participants, all without seat belts. There was a participant that used seat belts in each group of Rotterdam CT scores of 2 and 4.

Table 5: Showing the relationship between the use of seat belts and severity of head injury using Rotterdam score in patients with Motor vehicle RTA

The severity of head injury using Rotterdam Score	Use of Seat belt		Total (%)
	No	Yes	
Score 1	0	7 (77.8)	7 (77.8)
Score 2	4 (19)	1 (11.1)	5 (30.1)
Score 3	5 (23.8)	0	5 (23.8)
Score 4	9 (42.9)	1 (11.1)	10 (54)
Score 5	2 (9.5)	0	2 (9.5)
Score 6	1 (4.8)	0	1 (4.8)

A total of 21 participants without safety belts were recorded and 9 participants with safety belts. With the use of seat/safety belts, all 9 participants who used safety belts showed mild head injury with GCS of 13-15, while 6 of the 21 participants who did not use safety belts also showed mild head injury. All the participants with moderate (7) and severe (8) head injuries did not use safety belts and their corresponding GCS was 9-12 and GCS <8 respectively.

Table 6: Showing the relationship between the use of seat belts and severity of head injury using GCS score in patients with Motor-vehicle RTA.

The severity of head injury using GCS	Use of seat belt		Total (%)
	No (%)	Yes (%)	
Mild	6 (28.6)	9 (100)	15 (128.6)
Moderate	7 (33.3)	0 (0)	7 (33.3)
Severe	8 (38.1)	0 (0)	8 (38.1)
Total	21 (100)	9 (100)	30 (200)

χ^2= 24.247; df=10; p<0.001*

DISCUSSION

Head injury remains the leading cause of death following trauma worldwide, with particularly high mortality and morbidity in developing countries, due to poor health infrastructure. [5,9] Radiological imaging especially CT, brings about a detailed diagnosis that enables prompt and targeted management.

The age of the participants ranged from 6 months to 90 years but the 3rd and 4th decades of life (21–30 years) were predominantly affected. This age group has been described as the active, productive, and adventurous group in society and is more predisposed to head injury.[10] Males were predominantly affected and comprised 132 (77.6%) patients while females were far fewer, comprising 38 (22.4%) with a male-to-female ratio of 3.5: 1. The predilection by age of young males 21 to 30 years was seen in this study and it is similar to the findings observed by several authors.[3,7,8, 11, 12-18]This is so because of the greater exposure of males to traffic and outdoor activities than is seen in females.[18]

Thirty-three (19.4%) patients in this study had normal CT findings which were close to that observed by Eze et al[15] of 16.4% in their study. While 137 (80.6%) patients had abnormal CT findings. The abnormal findings align with the figures observed by Adeyekun et al,[8] Ashaleye et al,[10] Ogunseyinde et al,[15] as well as Adekanmi et al[16] which were 77.8%, 78%, 74%, and 60.6% respectively. The finding of a high incidence of abnormalities is due to a lack of the ban on motorcycles in our setting, apathy, disobedience to road traffic rules, and non-compliance of most of the motorcyclists to the use of safety helmets, amongst other reasons.

According to Ohaegbulam et al,[7] a CT scan was recommended for all patients with Glasgow Coma Score (GCS) of 3 – 12 and patients with GCS of 13-15 in which there was a clinical suspicion of intracranial complications such as a focal neurological deficit, seizures, and skull fractures. Studies have shown that GCS is an important prognostic factor in head injury as observed by some authors who noted that mortality was inversely related to GCS as there was increased mortality as the GCS decreased.[4,10]

Similarly, Emejulu et al[12] reported that the delay in transfer from the accident and emergency department to the ward and incidence of mortality was inversely proportional to the GCS, while discharges from the hospital and good outcomes were directly proportional to GCS, meaning that as the GCS increased, survival was better and the number of patients discharged also increased.

Motorcycles are a hazardous form of motor vehicle transportation. A lack of a physical barrier around the motorcycle compared to occupants of cars and trucks, combined with less stability contributes to the risk of crashes, injuries, and fatalities. In the event of a crash, motorcyclists require adequate head protection to prevent head injuries. Motorcycle helmets are 37% (for riders) and 41% (for passengers) effective in preventing death.[19] To reduce the rate of head injury accidents in Nigeria, the Federal Road Safety Commission (FRSC) implemented the compulsory use of helmets on the 1st of January 2009. The problem that is observed is the strict enforcement of the law. Motorcycle helmets can save lives and reduce injury.[19] The economic cost of injuries as a result of motorcycle accidents and death is significant.[19] These costs also include the emotional and physical cost to the family as a result of injury or death. The National Highway Traffic Safety Administration (NHTSA) estimates that helmets saved the lives of 1872 motorcyclists in 2017 and that 749 more lives in all states could have been saved if more motorcyclists had worn helmets. They established that for every 100 motorcyclists killed in crashes while not wearing helmets, 37 riders could have been saved if helmets had been worn.[20]

Helmets have been reported to reduce the risk of head injury by 69% and the risk of death by 42%.[21] In some states in the U.S. that do not have universal helmet laws, 57% of motorcyclists killed in 2019 were not wearing helmets, as compared to 9% in the states with universal helmet laws.[19] Offner et al,[22] Brandt et al, [23] and Keng et al[24] reported that the use of motorcycle helmets has decreased the overall death rate of motorcycle crashes when compared with non-helmeted riders. Helmets have been recognized to be effective in head injury prevention (WHO, 2006). Non-use of helmets has been recognized as a specific factor leading to head injury and fatalities resulting from motorcycle crashes.[25]

By using seat belts, death and injuries can be reduced drastically because seat belts retain occupants in their seats and prevent them from hitting objects in the vehicle, and from being ejected from the vehicle.[26] It has been estimated that using seat belts can reduce the risk of fatalities in RTA by 40-50% among front-seat occupants and 25-75% among rear-seat car occupants.[27, 28] The effectiveness of seat belts in reducing the severity of injury in vehicle occupants involved in collisions has been proven all over the world.[26-32]

In this study, there was a statistically significant association between the use of a safety helmet /seat belt and the severity of head injury (accessed by GCS and Rotterdam scores) in Motorcyclist road traffic accidents and motor vehicle road traffic accidents with a $p < 0.001$. A significant proportion of participants who used safety helmets/seat belts had normal CT findings and mild head injury (21patients of 23 patients) that used safety devices had normal CT findings, with one participant having a low Rotterdam score (2) and another one with a high Rotterdam score (4). While a far greater proportion of participants (79) that did not use these safety devices, had moderate to severe head injury and higher Rotterdam CT scores.

The strength of the study is that the CT findings and GCS have been compared to the use of safety devices and differences in the severity of the injuries have been recorded. Some of the limitations of the study include that there was a delay in presentation for a CT scan, mainly because patients usually present first at private hospitals without facilities and are then referred. The patients evaluated consist only of a head trauma population referred to the Radiology department of the hospital for CT evaluation over the study period, thus may not be viewed as representative of the larger head trauma population in our environment most of whom did not have CT evaluation due to several factors. Lastly, patients with diffuse axonal injury may show normal CT findings unless the injuries are larger than 1.5 cm in diameter or when they are present in the corona radiata or internal capsule.

CONCLUSION

The use of safety gear showed a direct relationship with the degree of injury using GCS and Rotterdam CT score. This implies that the use of safety devices directly impacts the severity of head injury. Therefore, safety devices provide good protection to individuals involved in a traumatic collision and are then deemed effective and very useful. This goes to emphasize the recommendation of strict adherence to the rules governing the use of safety gear which will greatly help to reduce the severity and possible sequelae of traumatic brain injury. It may be expedient to begin a massive campaign on the use of helmets and seat belts. After which the threat of enforcement and actual enforcement should be embarked upon. There should be strict implementation of seat belts, car seats, and safety helmets to forestall the effects of traumatic brain injury in our workforce and children. Government should provide alternate means of transportation in the rural and suburban regions to reduce the use of motorcycles. There should be better maintenance of the roads available and more roads should be carved out to reduce congestion which promotes bad driving and the use of motorcycles. There is a need for the government to provide other means of land transportation as is seen in developed countries. (Subways, trains)

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Data availability: The anonymized data for the study are available on request from the corresponding author.

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Conflict of interest -- None

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