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Patterns Of Calvaria Fractures Among Head Injury Patients In Enugu, South Eastern Nigeria

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Calvarial fracture occurs when biomechanical stresses applied to the skull exceed its tolerance. The patterns of fracture produced will depend on the location, direction and kinetic properties of the impact and also on the intrinsic features of the bone. The aim of the study is to determine the pattern of fractures of the calvaria among head injury patients in Enugu. A prospective cross - sectional study involving 150 head injured patients with fracture of the calvaria, who presented to the Accident and Emergency Department of Enugu State University Teaching Hospital between January, 2016 and December, 2018. Information was obtained from the patients' records and CT image findings. Data was analyzed using SPSS 20.0. Majority of the patients were aged 21-30years (29.6%). There is male preponderance (82.7%).Linear calvaria fracture accounted for the highest percentage of fracture patterns (47.3%), comminuted (18.7%), depressed (10.0%), multiple linear (8.7%) and others (15.3%). Comminuted fracture was the most associated with assault (7 out of 27 patients); linear fracture with fall from height, Basilar fracture with patients age between 31- 40years, and multiple comminuted between 41- 50 years. Frontal bone (41.9%) is the mostly affected. Road traffic accident (RTA) accounted for most head injuries with calvaria fractures (70.0%), followed by assault (18%). RTA is the most common cause of head injury in Enugu, with the frontal bone mostly affected and linear fracture being the commonest pattern of fractures of the calvaria in head injury patients.

Keywords*:* Patterns, fractures, Head injury, Calvaria.

INTRODUCTION:

The skull is the bone of the head, which consists of the neurocranium and the splanchnocranium. The neurocranium is the upper part which is also called the calvaria. This part forms a protective envelope around the cerebrum. The splanchnocranium is the lower part of the skull. It forms bony support of the face (Georgios et al. 2017). The skull is formed by the fusion of the flat bones which are held together by cranial sutures. These bones consist of thick outer table (spongy diploe) and thinner inner table. The inner table is lined by dura mater. The subdural space lies between the inner surface of the dura and the arachnoid mater (Moreira-Gonnzalez et al. 2006).

A skull fracture is a break in the continuity of the skull bone. It occurs as a result of direct impact (Charlotte, 2009). Skull fractures can be classified into the following types: Calvarial, non-calvarial, linear, comminuted, depressed, elevated and basilar (Samuel, 2015). The calvaria is about 6.3 mm in thickness (Moreira-Gonnzalez et al. 2006). Calvarial fractures can be classified into simple or compound, linear or communited, depressed or elevated and diasthestic fractures (widening of sutures in children) (Gordon, 2009; Ghebrehiwet et al. 2009).

The accurate incidence and prevalence of calvarial fracture is not known more so in our environment. However, in the 1.3 million patients with traumatic brain injuries seen in the United States of America each year, about a third will have associated skull fracture (Ghebrehiwet et al. 2009).

The objective of the study is to determine the patterns of calvarial fractures among the head injury patients in Enugu, South East, Nigeria.

MATERIALS AND METHOD

This study was a cross- sectional prospective type conducted in the department of surgery of the Enugu State University Teaching

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Hospital, Enugu, Nigeria, between 2016 and 2018, after an approval from the ethical committee of the hospital.

Patients who were managed for head injury with computed tomography scan evidence of calvarial fracture were included in the study. Patients with head injury without calvarial fracture or with base of skull fracture were excluded from the study. Clinico-demographic data of the patients were collected from the patients' folder as recorded. The brain non-contrast computed tomography scan with bone window of the patients were collected and analyzed in tandem with reports of a single radiologist. The data was analyzed on the Statistical Package for the Social Sciences (SPSSInc., Chicago, IL, USA) version 20.0.

RESULTS

A total of 150 patients were included in the study with most of the patients 21-30 years old as shown in table 1.

Table 1: Age distribution of head injury patients with calvarial fracture

Age (Years)	Frequency	Percentage (%)
1-10	17	11.6
11-20	20	13.6
21-30	43	29.6
31-40	33	22.4
41-50	18	12.2
51-60	9	6.1
61-70	6	4.1
71-80	4	0.4
TOTAL	**150**	**100**

More males had head injury and clavarial fracture than females and road traffic accident accounted for most of the causes of calvarial fractures as shown in table 2 and 3.

Table 2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	124	82.7
Female	26	17.3
TOTAL	**150**	**100**

Table 3: Causes of Calvarial Fracture

Cause of trauma	Frequency	Percentage (%)
Assault	27	18.0
Road Traffic Accident(RTA)	105	70.0
Fall	18	12.0
TOTAL	**150**	**100**

Road traffic accident was the most common cause of head injury in this study followed by assault, table 3 above. Linear fracture accounted for most of the calvarial fracture pattern seen in this study. This is followed closely by the comminuted and depressed fracture types. This is shown in table 4.

Table 4: Patterns of Calvarial Fracture.

Pattern of Calvarial Fracture	Frequency	Percentage (%)
Comminuted	28	18.7
Depressed comminuted	8	5.3
Linear	71	47.3
Depressed	15	10.0
Oblique	3	2.0
Linear-depressed-comminuted	5	3.3
Multiple linear	13	8.7
Multiple-comminuted	7	4.7
TOTAL	**150**	**100**

The frontal bone was found to be the most frequently fractured calvarial bone as shown in table 5.

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Table 5. Pattern of skull fracture based on calvaria bones.

			PATTERN 2							
			Comminuted fracture	Depressed Comminuted fracture	Linear fracture	Basilar fracture	Depressed fracture	Oblique fracture	Linear, depressed comminuted fracture	Total
CALVARIA.BONES	FRONTAL	Count	18	6	32	0	3	2	1	62
		% within CALVARIA.BONES	29.0%	9.7%	51.6%	0.0%	4.8%	3.2%	1.6%	100.0%
	PARIETAL	Count	5	2	12	0	4	4	0	27
		% within CALVARIA.BONES	18.5%	7.4%	44.4%	0.0%	14.8%	14.8%	0.0%	100.0%
	OCCIPITAL	Count	1	0	13	2	4	0	0	20
		% within CALVARIA.BONES	5.0%	0.0%	65.0%	10.0%	20.0%	0.0%	0.0%	100.0%
	PARIETO-OCCIPITAL	Count	0	1	2	0	2	0	0	5
		% within CALVARIA.BONES	0.0%	20.0%	40.0%	0.0%	40.0%	0.0%	0.0%	100.0%
	FRONTO-PARIETAL	Count	2	1	2	0	1	0	0	6
		% within CALVARIA.BONES	33.3%	16.7%	33.3%	0.0%	16.7%	0.0%	0.0%	100.0%
	TEMPORO-PARIETAL	Count	2	0	4	0	0	0	0	6
		% within CALVARIA.BONES	33.3%	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	100.0%
	TEMPORO-OCCIPTAL	Count	0	0	1	0	2	0	0	3
		% within CALVARIA.BONES	0.0%	0.0%	33.3%	0.0%	66.7%	0.0%	0.0%	100.0%
	FRONTO-TEMPORAL	Count	3	0	0	0	0	0	0	3
		% within CALVARIA.BONES	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	TEMPORAL	Count	2	0	9	0	4	1	0	16
		% within CALVARIA.BONES	12.5%	0.0%	56.3%	0.0%	25.0%	6.3%	0.0%	100.0%
Total		Count	33	10	75	2	20	7	1	148
		% within CALVARIA.BONE	22.3%	6.8%	50.7%	1.4%	13.5%	4.7%	.7%	100.0%

Table 5 shows that linear and comminuted fracture occurred most in the frontal bone with a frequency of 32 and 18 respectively. Depressed comminuted fracture occurs most in the frontal bone with a frequency of 6. Basilar fracture occurred most in the occipital bone with a frequency of 2. Depressed fracture occurred most in occipital, temporal and parietal bones

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with a frequency of 4 each. Oblique fracture occurred in parietal bone with a frequency of 4 while linear depressed comminuted fracture occurred once in frontal bone.

DISCUSSION

Calvarial fracture occurs when biomechanical stresses applied to it exceed its tolerance. The patterns of fracture produced will depend on the location, direction and kinetic properties of the impact and also on the intrinsic features of the bone (Kelly et al. 2002). Linear fractures usually result from wide, low-energy impact. Traumatic impact causing depressed fractures are usually concentrated on a small area of the calvaria. Low-energy-point impacts usually result in comminuted defect in the skull (Sandra et al. 20016).The neonatal skull has a higher proportion of non-ossified cartilaginous bones, fractures are thus more plastic. The radial fracture lines in the neonatal skull are usually more continuous rather than comminuted (defect is similar to a ping-pong ball). High-energy point trauma usually produce punched-out defect with sharp margins. Some fragments may be propelled into the brain tissue (Sandra et al. 2016). Simple fall can cause calvarial fractures in children and the elderly, while in the healthy adults, high energy impact trauma such as road traffic accident are the more common cause of calvarial fracture. Calvarial fractures are associated with penetrating injury to the underlining structures and intracranial haemorrhage (Ghebrehiwet et al. 2009). It is important to perform a careful examination of any patient with head injury to help stop or limit the extent of injury to the brain tissues which are enveloped by the calvaria. (Gordon et al. 2007). Skull fractures usually occur with concomitant intracranial hemorrhage and it is one of the components of the patient evaluation in traumatic brain injury (Dunn et al. 2009). The contents of the skull are deformed by localized impact, which may damage the cranial contents even when the skull does not fracture (Charlotte et al. 2009).

Most of the fractures of the calvaria are easily identified and characterized on computed tomography scan of the brain (Kelly et al. 2002; Gordon et al. 2007). It also helps in surgical planning and usually obtained at the same time the brain is being imaged (Kelly et al. 2002). Fractures should be distinguished from sutures, which have corticated margins. Fractures do not have corticated margins. Also imaging of the adjacent tissues should be studied for any soft tissue injury. Kelly et al. 2002).

Treatment depends on the type of fracture (Ghebrehiwet et al. 2009). Simple, linear, and non-depressed calvaria fracture may not require specific treatment, even though studies show that about 3% of patients with a skull fracture may deteriorate, as they are associated with mild brain injuries. Patients with calvarial fractures and mild brain injury need to be on admission for at least 12 hours (overnight) for observation (Gordon et al. 2007). A previous study stated that depressed calvarial fractures greater than 8-10mm should have surgical repair as it portends more severe intracranial injury (Sandra et al. 2016). Also open fractures require debridement to minimize infection (Gordon et al. 2007).

This study shows that the commonest pattern of calvarial fracture is the linear type of fracture line. It was seen in 71 of the 150 patients involved in the study and accounted for 47.3% of the fracture lines. This is similar to the finding in a study done by Sunil et al (2016) in an Indian Government hospital, where 56.14% had linear fracture as well as (Bibek et al. 2016).

Calvarial fracture is observed to occur more in patients aged 21-30 years. This may be due the fact that people in this age bracket are energetic and more involved in activities which may put them at risk of head injury and calvarial fracture.

Road traffic accident accounted for most of the calvarial fractures seen in this study. This may be due to the high energy impact usually encountered in road traffic accident, especially in head-on collision of vehicles. This is worse in developing countries like ours where the vehicles do not undergo routine maintenance in addition to other factors. The most common cause of the fractures in the present study is road traffic accident, and this was also reported as the commonest cause of head injury in studies by Sunil et al. (2016) and Bibek et al. (2016). However, our study differs from both the studies by Sunil et al (2016) and Bibek et al (2016) which

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reported the age group with the highest frequency in fracture as 31-40 years, in contrast to 21-30 years recorded in this study.

The frontal bone was observed to be the most fractured bone in this study. This is keeping with the observation made by both Sunil et al (2016) and Bibek et al (2016) in their various studies.

CONCLUSION

Calvarial fracture is most common in the youth age of 21-30 years. It is caused mostly by road traffic accident. The male gender and the frontal bone are the most affected in calvarial fractures. A re-orientation and sensitization of the youths about the dangers as well as preventions of road traffic accident in addition to maintenance of optimal road safety standards will reduce the incidence of head injury with its associated calvarial fractures especially in the developing countries.

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