ORIGINAL ARTICLE

Computed Tomography Evaluation of Orbital Wall Fractures among Head Injury Patients Following Vehicular Accidents in Anambra State, Nigeria: A Retrospective Review

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ABSTRACT

Background: Orbital trauma is a common cause of monocular blindness and impairment of vision, usually resulting from significant blunt force to the bony eye socket as may occur during vehicular accidents. Computed tomography is the ideal imaging modality for the assessment of traumatic head injury including orbital fractures.

Objective: To document the prevalence and pattern of orbital wall fractures as seen on CT among adult victims of passenger vehicular accidents at two health institutions in Anambra State, with documentation of possible co-existing craniofacial fractures and intracranial haemorrhage and establish associations if any.

Methodology: Cranial CT images for Sixty-three adult patients diagnosed with orbital fractures following vehicular accidents at two hospitals in Anambra State (Nnamdi Azikiwe University Teaching Hospital, Nnewi and Iyienu Mission Hospital, Ogidi) between 1st January, 2014 and 31st December, 2015 were reviewed.

Results: Study population comprised 36.4% of all cases of craniofacial fractures imaged during study period. 52 males (82.5%) and 11 females (17.5%) were affected, with mean age of 33.4years. Orbital wall fractures were lateral (60.3%), medial (49.2%), orbital roof (36.5%) and orbital floor (3.2%). Lateral orbital wall fractures show statistically significant association with ipsilateral zygomatic fractures (p-value = 0.00). Also, orbital roof and lateral orbital wall fractures show an association with acute subdural (*p*-value = 0.02) and epidural bleeds respectively (*p*-value = 0.04).

Conclusion: Orbital fractures constitute a fairly high proportion of craniofacial fractures following vehicular accidents in Anambra State affecting mainly the productive age group. Also, a large proportion of patients with orbital fractures have co-existing intracranial complications with likely worsened morbidity.

Keywords: *Imaging in head injury, Orbital injuries, Cranial CT, Monocular blindness, Vehicular Accidents*.

INTRODUCTION

Orbital trauma is a common cause of monocular blindness and impairment of vision, usually resulting from significant blunt force to the bony eye socket as may occur during vehicular accidents.[1,2] Worldwide, approximately 55million cases of orbital trauma are documented each year, often due to violence and road traffic accidents, with orbital fractures reportedly accounting for approximately 10 to 25 percent of all facial fractures.[1,3] In Nigeria, orbital injuries appear to be on the increase, with a study report from Zaria, northern Nigeria stating that blunt orbital trauma due to automobile accidents represents 20.4% of cases presenting at the tertiary institutions eye center.[1] Also, Adobamen *et al.* reported an increase in the incidence of orbital blowout fractures in Benin, southern Nigeria due to an increasing rate of violence and road traffic accidents.[4]

Patients with orbital fracture may sometimes appear not to constitute a significant proportion among cases of head injury. For instance, Adekanmi *et al.* reported orbital blowout fracture as the least common type of fracture (4.2%) among patients presenting with head injury over a 10 year period at Ibadan, south west Nigeria.[5] An impression that orbital fractures may be uncommon following vehicular accidents could result in a low index of suspicion among attending physicians for cases presenting with head injury showing no obvious features of orbital injury, resulting in missed diagnosis and untoward complications. Minor orbital fractures may also be missed on radiographic imaging.

Orbital fracture may be found in isolation or be a component of variety of fracture patterns including the Zygomatico-Malar-Complex (ZMC), the Le Fort II and III and the Naso-Orbito-Ethmoid fracture patterns. Fractures may involve the orbital rim with or without involvement of the orbital floor and other walls.[2] However, blow-out fractures affect the thin plates of bone at the medial orbital wall or the orbital floor and may spare the rim.[2] Also, depending on the degree of severity of blow to the head and orbit, there may be associated brain injury and intracranial hemorrhage with increased morbidity.

Early and accurate diagnosis of orbital wall fractures in patients with head injury following vehicular accidents is necessary to facilitate treatment and to avoid or minimize ocular complications or vision impairment. While orbital wall fractures may not necessarily result in such complications as ocular motility dysfunction or diplopia, orbital imaging is necessary to help predict future outcome and to decide on surgical intervention. Surgery, may be indicated in the entrapment of extraocular muscles to prevent symptoms due to oculo-cardiac reflex which may include bradycardia and syncope.[6] Also, it is important to identify posterior fractures involving the orbital apex due to possible damage to the optic nerve and the related neurovascular structures.[7]

Computed tomography (CT) is the ideal imaging modality for the assessment of traumatic head injury including orbital fractures. [5,6] Bone window axial images acquired using thin slices with coronal and sagittal reformatting allow proper evaluation of the thinnest orbital walls and facilitates the detection of blow-out fractures at the medial wall and floor of the orbit. Previous works have demonstrated the efficacy of CT in the detection of craniofacial fractures involving the orbital walls, as well as complications involving the soft tissue structures within the retro bulbar spaces and the intracranial compartment.[5,6]

Giving the rising incidence of orbital injury due to vehicular accidents reported from southern and northern regions of the country and the implications for orbital and ocular disorders amongst the population, there is a need to document the prevalence of orbital fractures and associated injuries involving other facial bones and the intracranial compartment following motor vehicle accidents in Anambra state, eastern Nigeria as seen on CT. The obtained data and findings will facilitate patient care regarding orbital and related injuries.

METHODOLOGY

This is a retrospective study carried out at the Radiology Department of Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, and the Radiology Unit of Iyienu Mission Hospital, Ogidi, both in Anambra State, Nigeria. All adult cases of passenger motor vehicle accidents sustaining head injury with orbital fracture referred for cranial CT scan between 1st January, 2014 and 31st December, 2015 were included in this study.

Excluded were pedestrians sustaining head injury due to involvement in road traffic accident, and Cranial CT images showing streak artifacts due to restlessness during image acquisition, with consequent degradation of image sensitivity.

Cranial CT was done at Nnamdi Azikiwe University Teaching Hospital, Nnewi using the General Electric Bright-Speed 4-slice CT scanner and at Iyienu Mission Hospital, Ogidi using the Toshiba Alexion 16-slice CT scanner. A multi slice protocol with 2.5 – 5.0mm cuts from the skull base to the vertex and range of 120 – 140 kvp and 250 – 300mAs were utilized for cranial CT scans. Axial images were acquired and sagittal and coronal reformatting done. CT Images were reviewed and reported by two consultant radiologists.

The demographic information about the patients was entered into a data-form. Also documented was the radiological findings which included nature and site of orbital fracture (bilateral and multiple, lateral and medial, orbital roof and orbital floor), the associated facial bone fractures (zygomatic, maxillary, ethmoid, sphenoid and frontal bones) and the presence of intracranial bleed (intracerebral, intra-ventricular, subarachnoid, subdural and epidural). Researchers adhered to ethical considerations, with numbers used in place of patients' names to preserve confidentiality.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS version 20.0, NY. IBM Corp). Data was presented using Charts and Tables.

RESULTS

Study population (63 patients) comprised 36.4% of cases of craniofacial fractures imaged during the study period. 52 males (82.5%) and 11 females (17.5%) were affected. The mean and median ages were 33.4years ±15.7 and 34.0years, respectively. As seen in Table1, the age range of highest and lowest frequency is 20 – 29 years (28.6%) and 70years and above (1.6%), respectively. As seen in Figure1, orbital wall fractures were multiple and bilateral in 34 cases (54%) and 20 cases (32.8%), respectively. Lateral orbital wall (60.3%), medial orbital wall (49.2%) and orbital roof (36.5%) fractures were more common than orbital floor fractures (3.2%). Co-existing facial bone fractures were shown in Table 2 and involve multiple bones in 56 cases (88.9%), affecting the zygomatic bone (58.7%), the maxillary sinus walls (41.3%), the sphenoid (41.3%) and ethmoid (17.5%) sinus walls and the frontal bone (49.2%).

Table 1.Age distribution of patients with Orbital fractures

Age (Years)	Frequency	Percentage
< 20	7	11.1
20 – 29	18	28.6
30 – 39	16	25.4
40 – 49	9	14.3
50 – 59	7	11.1
60 - 69	5	7.9
>70	1	1.6
Total	63	100.0

Table 2. Associated facial bone fractures

Facial Bone	Frequency	Location
Zygomatic	37	58.7
Maxillary sinus walls	26	41.3
Sphenoid sinus walls	26	41.3
Ethmoid sinus walls	11	17.5
Frontal bone	31	49.2
Multiple bone fractures	56	88.9

As shown in Figure 2, acute intracranial bleeds occurred in 51 cases (81.0%). These include 39 intracerebral hematomas (61.9%), 12 subdural hematomas (19.0%), and 7 epidural hematomas (11.1%). In Table 3, lateral orbital wall fractures show statistically significant association with ipsilateral zygomatic bone fractures (p-value = 0.00), while an observed relationship with maxillary fractures is however not statistically significant (p-value = 0.05). Also orbital roof and lateral orbital wall fractures show an association with acute subdural (p-value = 0.02) and epidural bleeds respectively (p-value = 0.04) as illustrated in Table 4.

Figure 1. Location of orbital fractures

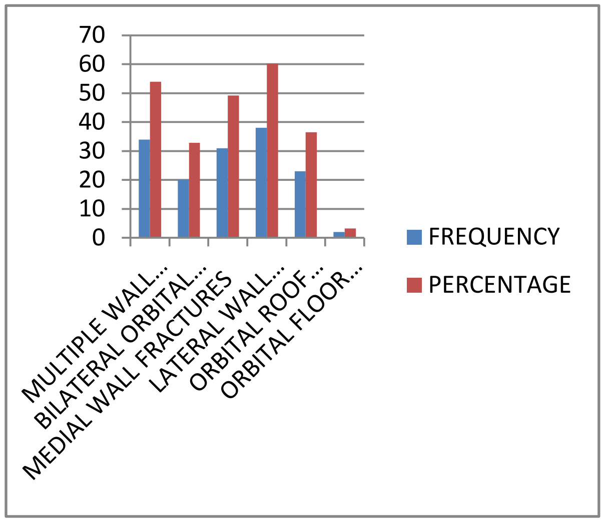

Figure 2. Orbit wall associated bleeds

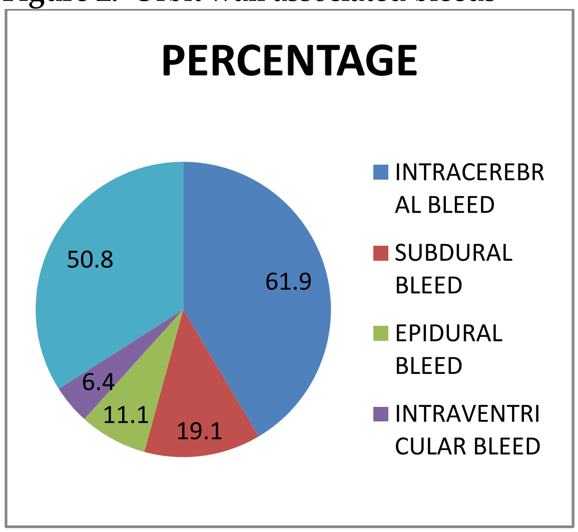

Table 3. Comparing orbital to other facial bone fractures

	Medial orbital wall fractures (No:31)	Orbital floor fractures (No:2)	Orbital roof fractures (No:23)	Orbital lateral wall fractures (No:38)
Zygomatic Bone Fractures	14	1	11	32(p= 0.00)
Maxillary Bone Fractures	11	1	7	21 (p=0.05)
Sphenoid Bone Fractures	11	0	9	17
Ethmoid Bone Fractures	7	1	2	9
Frontal Bone Fractures	2	0	4	6

Table 4. Orbital fractures versus acute intracranial bleeds

	Medial orbital wall fractures (No:31)	**Orbital floor fractures (No:2)**	**Orbital roof fractures (No:23)**	**Lateral orbital wall fractures (No:38)**
Subdural Bleed	8	1	8 (p-=0.02)	6
Epidural Bleed	2	0	1	7 (p= 0.04)
Intracerebral Bleed	4	0	1	2
Subarachnoid Bleed	16	1	11	20

DISCUSSION

Vehicular accidents are an increasingly important cause of morbidity and mortality worldwide, sometimes resulting in head injury involving the orbits. Vehicular accidents reportedly occur predominantly in developing countries such as Nigeria where reckless driving, motor mechanical faults and road defects among others add up to place the country at second highest in prevalence among 193 countries of the world.[8,9]

They are reportedly responsible for more than 50 percent of facial injuries (including orbital fractures) documented in developing nations compared with 5 to 15 percent in the developed world, possibly due to the predominant use of outdated automobiles and poor attitude to seat belt use as in the developing world.[10]

This study findings suggest that orbital wall fractures may not be uncommon among head injury patients following vehicular accidents in Anambra State, Nigeria (36.4% of cases) and is significantly higher in proportion than the 4.2% reported at Ibadan, Nigeria.[5] However, the study at Ibadan specifically reported the proportion of blow-out fractures among cases of head injury resulting from variety of causes including vehicular accidents.

More males than females were affected in this study population (4.7:1) at a ratio greater than the 3:1 reported from previous studies at Ibadan and Zaria in South-West and northern Nigeria, respectively and less than the M : F ratio of 6.5:1 reported from Nairobi Kenya.[1,5,11] The observed differences between findings may be explained by the variety of head injury causes in the referenced studies and may suggest that such non-vehicular causes of head injury like domestic violence, assault and falls may account for the observed variation in gender ratio. Also, the observed male dominance may suggest greater numbers of males among commuters, vehicle drivers and bus conductors.

This study population's median age of 33.4 years and peak age of 20 – 29 years appear fairly similar to the mean and peak ages documented in previous studies.[1,5,11,12]It again suggests that the very young and the elderly are less likely to sustain head and orbital injury due to vehicular accidents, being less outgoing and active.

More than half of the study population sustained multiple orbital wall fractures (involving more than one orbital wall), similar to reports from previous studies with bilateral orbital fractures observed in 33 percent of cases.[12,13] This may likely be due to the severity and direction of orbital impact during vehicular accidents. Orbital fractures related to vehicular accidents tend to be more destructive with greater likelihood of being multiple.[3]

Multiple and bilateral orbital fractures may result in ocular complications, as well as facial and skeletal problems.[14] Over 60% of the study population sustained a fracture of the lateral orbital wall, similar to the findings by Manawa *et al.* (71.7%) and Sabharwal *et al.* (76.35) among patients presenting with orbital trauma in Nairobi and India, respectively.[11,12]

The lateral orbital walls are reportedly the strongest of the orbital walls which form a four-sided bony cavity comprising several skull bones.[15,16] However, lateral orbital walls are commonly fractured at the spheno-zygomatic suture line following severe trauma to the face as may occur during vehicular accidents often with associated fractures of other facial bones.[15]

The zygomatic bones are the most commonly fractured facial bones among this study population with orbital fractures (57.8%). Also, there is statistically significant association between the lateral orbital wall fractures and the ipsilateral zygomatic bone (*p*-value 0.00), partially consistent with the so-called zygomatic-malar-complex (ZMC) fractures. However, an association between lateral orbital fractures and ipsilateral maxillary fractures was not statistically significant (*p*-value 0.05). The zygomatic bone forms the anterior aspect of the lateral orbital wall and retains a prominent position on the face making it susceptible to external trauma with possible associated visual impairment and neurological deficits due to ipsilateral ocular and intracranial injury.[15]

Fractures of the medial orbital wall (49.2%) and the orbital roof (36.5%) were seen in lesser frequency and show no statistically significant association with other facial bone fractures. Orbital floor (blow-out) fractures were the least common (3.2%), similar to findings at Ibadan, Nigeria (4.2%).[5] Reports from Uganda and the United States place the orbital floor and the medial wall high among orbital fracture sites.[11,17] The observed difference in this study may be due to directions of blow to the orbit in this study population comprising vehicle passengers and may be linked to the peculiar nature of the overcrowded rickety buses and tricycles dominating the public transportation system within Anambra state.

Head injury with orbital fracture may be complicated by intracranial haemorrhage with increased morbidity and mortality.[18] This study shows presence of intracranial haemorrhage in 79.4 percent of the study population, predominantly intracerebral bleeds (61.9%). Similar findings are documented in previous reports [5,18,19] and suggest intracranial haemorrhage as common consequence of traumatic head injury.

This study also shows a statistically significant association between lateral orbital wall fractures and epidural haematoma (*p*-value0.04), a well recognized secondary insult of traumatic brain injury (TBI).[20] Lateral orbital wall fractures commonly occur during vehicular accidents in association with severe facial trauma, sometimes with zygomatic and maxillary fractures involving region of the ipsilateral middle meningeal artery or its branches.[15] Epidural haematoma usually results from a torn middle meningeal artery with blood collection between the inner surface of the skull and the outer layer of the dura.[21] Epidural bleed may also co-exist with isolated lateral orbital wall fracture as reported by Di Muzio *et al*.[22]

Orbital roof fractures show statistically significant association with subdural haematoma (*p-value*0.02). The orbital roof forms a part of the anterior cranial fossa and is thus positioned for concomitant intracranial and ophthalmologic injury. There is a dearth of data associating orbital roof fractures to subdural haematoma. However, fractures of the orbital roof are usually associated with high energy impact to the facial region, with many affected patients suffering intracranial injury and haemorrhage.[23,24]

CONCLUSION

A fairly high proportion of craniofacial fractures affect the orbital walls among patients involved in vehicular accidents in Anambra State, affecting mainly adult males of productive age. Also, large proportion of head injury patients with orbital fractures have co-existing intracranial complications with likely worsened morbidity, to be kept in view during clinical and radiological evaluation.

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