**Original Article**

Ophthalmic Injuries in Patients with Maxillofacial Trauma Presenting to a Teaching Hospital in North Central Nigeria

## Tenmang Elisha Panshak1, Benjamin Idemudia Akhiwu2,

**Abstract**

**Background:** Ophthalmic injuries in patients with maxillofacial trauma are potential causes of a permanent visual loss. These injuries can easily be missed; hence, there is a need for the ophthalmic evaluation of patients with maxillofacial trauma. The main objective of this study was to determine the prevalence, patterns, etiology, and risk factors of ophthalmic injuries in patients presenting with maxillofacial trauma in a teaching hospital in North Central Nigeria. **Materials and Methods:** The study was a hospital-based, descriptive, cross-sectional study of 67 patients with maxillofacial trauma recruited over a 6-month study period. Information on the sociodemographic and clinical characteristics of the study participants was obtained. The data were analysed using SPSS version 20 statistical software. Pearson’s chi-square test was used to test for statistical significance. **Results:** Ophthalmic involvement was seen in 77.6% of the study participants, with males and individuals aged 21–30 years being more commonly affected. The leading cause of ophthalmic injuries in patients with maxillofacial trauma was road traffic accident (RTA) (75.5%). Others included assaults and fall from heights. Amongst the RTA cases, 71.4% was due to motorcycle-related accident with 91.9% of the patients with ophthalmic injuries observed not to use helmet/seat belt. The use of alcohol and not wearing protective gears were seen as the risk factors. Simple zygomatic complex fracture was the most common trauma observed (44.2%). **Conclusion:** Ophthalmologic assessment should be conducted for all patients presenting with maxillofacial trauma. The laws on the use of protective gears such as helmets and seat belts should be enforced.

**Keywords:** *Head protective devices, maxillofacial injuries, ophthalmic injuries, risk factors*

**Alice Venyir Ramyil1, Naomi Saleh1, Patricia Wade1, Akinola Ladipo Ladeinde3,**

## Caleb Mpyet1

*1Ophthalmology Department, Jos University Teaching Hospital, 2Department of Oral and Maxillofacial Surgery, College of Health Sciences, University of Jos, Jos, Plateau State, 3Department of Oral and Maxillofacial Surgery, College of Medicine, University of Lagos, Lagos, Nigeria*

# Introduction

Head injuries, including facial trauma with ocular involvement, are significant causes of visual morbidity and mortality in patients.[1] Maxillofacial trauma is any form of physical trauma that has the potential to cause a disfigurement of the face. It could result in blindness and difficulty in moving the jaw and can adversely affect an individual’s quality of life.[2-5] The prevalence of maxillofacial trauma varies from 20% to 60% of all trauma cases worldwide; this large variation might be due to various factors such as environmental factors, socioeconomic conditions, cultural reasons, and traffic rules.[4,5] The fact that the face is exposed makes maxillofacial trauma and fractures common.[2,6,7] The main causative factors for trauma to the maxillofacial region are road traffic accidents (RTAs), interpersonal conflicts, sports, falls from height, and industrial trauma amongst

|  |
| --- |
| **Access this article online** |
| **Website:**[www.jwacs-jcoac.com](http://www.jwacs-jcoac.com/) |
| **DOI:** 10.4103/jwas.jwas\_91\_22 |
| **Quick Response Code:** |

others.[5,8] In developing countries such as Nigeria, RTA is the major cause of maxillofacial trauma.[9] This has been attributed to the heavy reliance on the road as the major route of transportation; also there has been a rapid increase in the number of vehicles over the development of good road transport infrastructure.[9] Increasing frequencies of communal conflicts have also increased the rate of ophthalmic injuries in adults; however, in children, these are commonly caused by falls and sport-related injuries.[10] Alcohol consumption also plays a crucial role in assault and RTA-related maxillofacial fractures.[11]

Maxillofacial injuries are either isolated or are associated with other concomitant injuries involving other organ systems.[12] Maxillofacial injuries include soft-tissue injuries, dental injuries, and maxillary, mandibular, and zygomatic fractures.[13] Ocular injuries often accompany facial

**Received:** 04-Apr-2022 **Accepted:** 08-Aug-2022 **Published:** 06-Oct-2022

***Address for correspondence:***

*Dr. Benjamin Idemudia Akhiwu, Department of Oral and Maxillofacial Surgery, College of Health Sciences, University of Jos, Jos, Plateau State, Nigeria.*

*E-mail:* *bakhiwu@yahoo.com*

 trauma, and they vary in severity.[2] Most

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial- ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

|  |
| --- |
| **How to cite this article:** Panshak TE, Akhiwu BI, |
| Ramyil AV, Saleh N, Wade P, Ladeinde AL, *et al.* |
| Ophthalmic injuries in patients with maxillofacial |
| trauma presenting to a teaching hospital in North |
| Central Nigeria. J West Afr Coll Surg 2022;12:17-23 |

**For reprints contact:** reprints@medknow.com

© 2022 Journal of the West African College of Surgeons | Published by Wolters Kluwer ‑ Medknow 17

of the trauma to the face, especially those above the level of the mouth, require a careful ocular examination, including an estimation of the visual acuity of each eye.[2,14] Eliciting the relevant signs and symptoms is usually important as they can be pointers in the diagnosis of ophthalmic injuries, most especially in patients who are unconscious and unable to describe their symptoms.[15] It is important to note that some ophthalmic injuries may not be apparent, and potentially blinding complications may easily be missed unless actively sought for.[2,7] On the other hand, inadequate care can result in blindness, with its attendant social and medico-legal implications.[4,8]

Blindness has been associated with maxillofacial trauma either directly as a result of zygomatic complex fractures or following some surgical interventions.[6] When blindness occurs, it may be as a result of an increase in intraorbital pressure, increase in intraocular pressure, direct trauma to the optic nerve, or the impairment of blood supply to the optic nerve. It can be prevented by early detection and management of these causes.[16]

Important ocular findings related to maxillofacial trauma have been divided into major and minor injuries based on the ability of such injuries to cause permanent visual loss.[3,17,18] Injuries considered to be minor include subconjunctival haemorrhage, periorbital ecchymosis, ptosis, diplopia, crepitation, and the laceration of the eyelids, whereas those considered as major include the laceration of the cornea and/or sclera, ophthalmic infections, injury to the optic nerve, globe rupture, the limitation of eye movement, enophthalmos, proptosis, blurred vision, diplopia, retinal haemorrhage, hyphaema, and permanent visual loss.[3,18]

There are insufficient data on the prevalence of ophthalmic injuries in patients with maxillofacial trauma in Plateau State. Thus, this study aims to determine the prevalence, common causes, and patterns of ophthalmic manifestations in patients with maxillofacial trauma with a view towards making recommendations on how to reduce the magnitude of such injuries and their burden in the hospital.

# Materials and Methods

The study was a hospital-based, descriptive, cross-sectional study carried out at a teaching hospital in North Central Nigeria. The study population constituted all patients diagnosed with a maxillofacial injury that presented to

the accident and emergency unit, maxillofacial outpatient clinic, or the eye clinic.

Inclusion criteria were all consenting patients with maxillofacial trauma who presented during the study period, whereas unconscious patients whose relations did not have adequate information and those who declined consent were excluded from the study.

A semi-structured, interviewer-administered questionnaire was used for data collection; other research materials used include: illuminated Snellen chart, illuminated tumbling E-chart, pin hole, pen torch, 0.5% amethocaine eye drop, 2% fluorescein strip, slit-lamp biomicroscope, 78D lens (Ocular Instruments Inc., Bellevue, WA, USA), 1% tropicamide eye drop, 5% phenylephrine eye drop, direct ophthalmoscope (Heine beta 200), cotton wool, and 78D indirect lens.

Ethical clearance was obtained from the Ethics and Research Committee of the Teaching Hospital, and written informed consent was obtained from each participant before enrollment into the study. Assent was obtained for children 7 years and above after having obtained consent from their parents. Confidentiality and voluntary participation without penalty for withdrawing from the study were adhered to. The Statistical Package for Social Science (SPSS) version 20 was used to analyse the data. Frequencies, mean, and standard deviations were used to present the pattern of variable distribution among the patients. Pearson’s chi-square test was used to test for statistical significance. A *P* value of ≤0.05 was considered significant.

# Results

A total of 67 participants were recruited for this study. The mean age of patients presenting with maxillofacial trauma was 31.9 ± 10.3 years (range = 18–58 years). Modal age was 25 years. Fifty-three (79.1%) were males, whereas 14 (20.9%) were females with a male to female ratio of 3.7:1.

Majority of the patients with maxillofacial trauma had an ophthalmic injury (52; 77.6%). Forty-two patients (80.8%) were male, whereas 10 (19.2%) were female (X2 = 0.389; *P* = 0.533). Ophthalmic injury was mostly seen in persons aged 21–30 years and least in the age group 51–60 years (X2 = 4.230; *P* = 0.373) [Table 1].

### Table 1: Distribution of ophthalmic injury by age

|  |  |
| --- | --- |
| **Age (years) Number of persons with ophthalmic involvement** | **Number of persons without ophthalmic involvement** |
| 11–20 8 (15.4) | 0 (0.0) |
| 21–30 20 (38.5) | 9 (60.0) |
| 31–40 14 (26.9) | 5 (33.3) |
| 41–50 6 (11.5) | 1 (6.7) |
| 51–60 4 (7.7) | 0 (0.0) |
| Total 52 (100.0) | 15 (100.0) |
| X2 = 4.230, *P* = 0.373 (Fisher’s exact test) |  |

**Table 2: Common causes of maxillofacial injury**

|  |  |  |
| --- | --- | --- |
| **Causes of trauma Had ophthalmic injury** | **No ophthalmic injury** | **Total** |
| Road traffic collision 37 (71.2) | 12 (80.0) | 49 (73.1) |
| Assault 14 (26.9) | 3 (20.0) | 17 (25.4) |
| Fall from height 1 (1.9) | 0 (0.0) | 1 (1.5) |
| Total 52 (100.0) | 15 (100.0) | 67 (100.0) |
| X2 = 0.718, *P* = 0.799 (Fisher’s exact test) |  |  |

### Table 3: Frequency of ophthalmic injury from RTA by the use of protective gear

**Use of protective gear Number of persons with ophthalmic involvement**

**Number of persons without ophthalmic involvement**

**N % N %**

Yes 3 8.1 1 8.2

No 34 91.9 11 91.7

Total 37 100.0 12 100.0

X2 = 0.001, *P* = 0.980 (Fishers exact test)

Number of patients (%)

**Figure 1: Vehicle of collision of RTA**

80

70

60

50

40

30

20

10

0

71.4

24.5

4.1

Motorcycle

Tricycle

Types of vehicle

Motorcar

The most common cause of maxillofacial injury was RTA seen in 73.1% (49 persons) followed by assault seen in 25.4% (17 persons), whereas one patient (1.5%) suffered injury as a result of fall from a height [see Table 2].

Ophthalmic involvement in patients with maxillofacial trauma was most common in RTA collision (71.2%; 37) followed by assault (26.9%; 14); the only patient who sustained injury from fall from height had an ophthalmic injury (1.9%) (X2 = 0.718; *P* = 0.799).

Eight (15.4%) of the 52 patients with ophthalmic injuries were under the influence of alcohol at the time of injury, and they were either the drivers of the car or motorcycle (*P* = 0.383). Out of the 37 patients who had RTA with an associated ophthalmic injury, 34 (91.9%) did not use protective gears (helmet/seat belt) at the time of injury (X2 = 0.001; *P* = 0.980) as shown in Table 3.

Out of 49 patients who had RTA, motorcycle accident was the most common with 35 persons (71.4%) followed by motorcar crash with 12 persons (24.5%) and lastly tricycle with only two persons (4.1%), where *P* = 0.258 [Figure 1].

### Table 4: Pattern of maxillofacial injury in patients with

 **ophthalmic injury (N = 52) Maxillofacial injuries N %** Soft-tissue injury 2 3.8

Nasal bone fracture 4 7.7

Comminuted zygomatic complex fracture 5 9.6

Maxillary complex fracture 6 11.5

Blow-out fracture 12 23.1

Total 52 100

An ophthalmic injury was commonly found in patients with a simple zygomatic complex fracture (44.2%) followed by blow-out fracture (23.1%); patients with a soft-tissue injury had the least (3.8%). Others are shown in Table 4.

Of all the patients seen, 91.0% had normal presenting visual acuity. For those with an ophthalmic injury, 65.4% of them had an ocular trauma score of 5, and the commonest cause of the visual impairment was a ruptured globe. Other details of the ocular findings are in Tables 5 and 6.

|  |  |  |
| --- | --- | --- |
|  | **Table 5: Details of ocular findings** |  |
| **Visual acuity (N = 67)** | **Right eye** | **Left eye** | **Both eyes** |
| Unaided 6/6–6/18 | 37 (55.2) | 29 (43.3) | 61 (91.0) |
| <6/18–6/60 | 6 (9.0) | 15 (22.4) | 2 (3.0) |
| <6/60–3/60 | 5 (7.5) | 14 (20.9) | 0 (0.0) |
| <3/60–NPL | 17 (25.4) | 7 (10.4) | 2 (3.0) |
| Uncooperative | 2 (3.0) | 2 (3.0) | 2 (3.0) |
| Total | 67 (100.0) | 67 (100.0) | 67 (100.0) |
| **Ocular trauma score (N = 52)** |  | **N** | **%** |
| 1 |  | 10 | 19.2 |
| 3 |  | 7 | 13.5 |
| 4 |  | 1 | 1.9 |
| 5 |  | 34 | 65.4 |
| Total |  | 52 | 100.0 |
| **\*Major causes of visual impairment (N = 24)** |  | **N** | **%** |
| Hyphaema |  | 1 | 4.2 |
| Vitreous haemorrhage |  | 3 | 12.5 |
| Retinal oedema |  | 4 | 16.7 |
| Blow-out fracture |  | 7 | 29.2 |
| Ruptured globe |  | 9 | 37.5 |
| **\*\*Side of eyes affected (N = 59 eyes)** |  | **N** | **%** |
| Right |  | 27 | 45.8 |
| Left |  | 32 | 54.2 |
| Total |  | 59 | 100 |
| Unilateral eye involvement |  | 48 | 81.4 |
| Bilateral eyes involvement |  | 11 | 18.6 |
| Total |  | 59 | 100 |
| **Presentation of the globe (N = 67)** |  | **N** | **%** |
| Normal |  | 43 | 64.2 |
| Enophthalmos |  | 14 | 20.9 |
| Ruptured globe |  | 7 | 10.4 |
| Proptosis |  | 1 | 1.5 |
| Deviation |  | 1 | 1.5 |
| Enophthalmos + deviation |  | 1 | 1.5 |
| Total |  | 67 | 100 |

\*Out of the 52 patients with ophthalmic injuries, only 24 of them had injuries significant enough to cause visual impairment

\*\*Out of the 52 patients with ophthalmic injuries, 59 eyes were affected NPL: no light perception

# Discussion

All the patients seen with maxillofacial trauma met the inclusion criteria and consented to participate in the study. This may have been due to the perceived potential benefit of having a complete eye examination and the anxiety associated with possible sight loss in these patients with maxillofacial trauma. There was preponderance of males in this study with a male to female ratio of 3.7:1. This may be due to the fact that males are more involved in outdoor activities than females as has been reported in other studies.[16,18]

A high prevalence of an ophthalmic injury was observed in this study (77.6%) in all participants; this is in agreement with other studies that have also reported a high prevalence of ophthalmic injuries in patients with maxillofacial trauma.[3,19,20] Facial fractures have been reported to increase the risk of developing an ocular injury by a factor of 6.7

when compared with major trauma in patients with no facial fractures.[21] In this study, a majority of the patients did not have serious brain injury and were fully conscious at the time of injury. This is similar to findings of Mackinnon *et al.*[22] An ophthalmic injury was seen to occur more in individuals between 21 and 30 years (38.5%). The high frequency in this age range is similar to that documented by Mittal *et al.*,[2] whereas Mark *et al.*[23] reported a bimodal peak age of 21–30 and 41–50 years. Left eyes were mostly affected (54.2%) in this study; this is similar to reports by Mackinnon *et al.*[22] who reported an ocular injury involving the left eye is seen more in patients with maxillofacial trauma.

RTA was found to be the commonest cause of injury in our study. It accounted for more than half of cases seen (73.1%). According to the World Health Organization (WHO), RTAs kill one million people annually and causes damage to 15–20 million people globally.[24] The high prevalence

 **Table 6: Other ocular injuries**

|  |  |
| --- | --- |
| **N** | **%** |
| **Ocular adnexa** |  |  |
| Normal | 12 | 9.0 |
| Lid laceration | 17 | 12.7 |
| Lid oedema | 33 | 24.6 |
| Ptosis | 6 | 4.5 |
| Ecchymosis | 14 | 10.4 |
| Conjunctival haemorrhage | 49 | 36.6 |
| Canalicula laceration | 1 | 0.7 |
| Detached canthal tendon | 2 | 1.5 |
| Total | 134 | 100 |
| Anterior segment injuries Normal | 96 | 71.6 |
| Traumatic mydriasis | 16 | 12.0 |
| Cornea laceration | 8 | 6.0 |
| Uveal prolapse | 6 | 4.5 |
| Hyphaema | 6 | 4.5 |
| Traumatic miosis | 1 | 0.7 |
| Cataract | 1 | 0.7 |
| Total | 134 | 100 |
| Posterior segment injuries |  |  |
| Normal | 95 | 71 |
| Retina oedema | 18 | 13.4 |
| Vitreous haemorrhage | 3 | 2.2 |
| Commotio retinae | 8 | 6.0 |
| Macula oedema | 1 | 0.7 |
| Optic atrophy | 1 | 0.7 |
| Relative afferent pupillary defect | 4 | 3.0 |
| Retinal haemorrhage | 4 | 3.0 |
|  Total 134 100  |

of RTA can be attributed to a lot of changes, which have taken place in our environment in recent times. Population growth, apparent financial empowerment, rapid rate of increase in motorisation (the availability of cars) without a commensurate development of good roads have all resulted in an astronomical increase in the number of vehicles on our roads.[25] Although the state of Nigerian roads is an important factor here, where years of neglect have created deep potholes, the WHO has also noted that unsafe road infrastructure has contributed to increased rates of RTAs.[26] Foroughi *et al.*[27] in Iran also found RTA as the commonest cause of trauma in 85.5% of cases, whereas Rajkumar *et al.* in India found 66.7%.[28]

Other causes of maxillofacial injuries found in this study were assault and fall from heights, which was also seen in other studies.[27,29] A study carried out in Bulgaria however found a higher rate of trauma occurring as a result of assault.

The persons involved in RTAs in this study were either the drivers or passengers who did not use their protective gear (seat belts or helmets). The lack of a form of restraint makes it easier for the eye to be injured during accidents as has been reported in other studies.[8,14,19]

The fitting and wearing of seat belts for drivers and front- seat passengers became mandatory in many western countries from the 1950s and much later in the developing countries.[8] From this study, more than two-thirds (91.9%) of the patients who had an ophthalmic injury did not use either seat belt or helmet at the time of injury. This is similar to findings by Akinbami in Rivers State, Nigeria,[30] whose study also showed a high rate of ophthalmic injuries in nonbelted front-seaters and suggested a change in pattern would be observed if they used seat belt. Even though the premorbid visual status of the patients in this study was not well known to be a contributing factor for the RTA, a study done in Niger Delta Nigeria had suggested other factors such as uncorrected refractive error and glaucoma to be responsible for RTA.[31]

Most motorcyclists hardly wear helmets when riding,[32] and only a few car drivers put on their seat belts. A study done in Nigeria showed that the use of seat belts reduces the fatality rate in RTA,[30] whereas the severity is five times more likely to be reduced with the use of a helmet compared with those not wearing helmets who are three times more likely to die.[33] However, another Nigerian study found that the use of protective devices made no significant difference in the severity of maxillofacial injuries.[34]

Eight (15.4%) of the 52 patients with ophthalmic injuries were under the influence of alcohol at the time of injury in this study, although there was no statistically significant difference in the prevalence of ophthalmic injury between drivers who took alcohol and those who did not take alcohol at the time of injury; this correlates with the findings of other studies that showed alcohol consumption played a less significant role in these injuries.[21,27] Although not all patients who had RTA were under the influence of alcohol at the time of injury, a study from Nigeria found that speed and alcohol acting alone or in combination are the two main contributory factors to the occurrence of RTA, and in 95% of cases, human error is culpable.[8]

This study showed a wide range of ophthalmic involvement amongst patients seen with maxillofacial trauma. Enophthalmos due to orbital fracture was the most common whole globe abnormality seen at presentation. This can be explained by the expansion of the orbital volume as seen with the displacement of the zygoma in facial fractures. This has also been documented in other studies.[2,11,27] Proptosis was found to be an uncommon globe abnormality in this study; this can also be explained from the type of injury seen as most patients had a simple undisplaced zygomatic complex fracture. This is in agreement with study carried out by Foroughi *et al.*[27] in Iran that showed a low rate of proptosis in patients with maxillofacial trauma.[18]

About one-third of our patients had orbital rim fracture; this is similar to findings by Mark *et al.*[23] who noted a high preponderance of pure blow-out fractures than the impure. Their study also found a higher prevalence of

ophthalmic injuries in patients with pure fractures as compared to the impure.

A majority of the patients had mild injuries to the adnexa with the eyelids and conjunctiva commonly affected. This is expected because of the anterior location of the structures and the protective nature of the eyelids.[17,35] The involvement of the conjunctiva was either in the form of haemorrhage or injection (the commonest presentation). Lid laceration and oedema were the next commonest types of ocular injury recorded. This is not surprising as many of the people involved in RTA were on motorcycle, and both the rider and passenger did not wear protective goggles or helmets. Lid oedema and subconjunctival haemorrhage were the commonest ophthalmic disorders observed in this and other studies.[2,18,28] Other adnexal injuries found were ptosis, which was mainly mechanical although one patient had neurogenic ptosis and canthal tendon detachment with resultant telecanthus in a patient with naso-orbital fracture.[28]

About one-third of the patients had traumatic mydriasis as a result of the force that traumatised the eye. This also contributed to blurring of vision in some of these patients. Mydriasis was the commonest anterior segment disorder seen, similar to results documented from other studies.[16,28]

Retinal oedema was the most common posterior segment manifestation, and most of this was seen in patients with simple zygomatic complex fracture. This can be related to force transmitted in fracturing the floor and walls of the orbit to the globe causing an increase in intraorbital pressure, which can result in the retinal oedema. However, Nabeela *et al.*[36] observed retinal oedema to occur more in patients with comminuted orbito-zygomatic fractures. In our study, patients with simple orbito-zygomatic fractures were more predisposed to having ophthalmic injuries in contrast to reports by Nabeela *et al.*[36] who found retinal oedema to occur more in patients with blow-out fractures. However, no reason could be found for this variation.

Globe rupture was found to be the major cause of visual impairment/blindness in this study. The ocular trauma score used in prognosticating was helpful in decision-making, though these patients were not followed up for the outcome because of the study design.

# Conclusions

Ophthalmic injuries mainly affected young active males and are a common finding in patients with maxillofacial trauma. Most ophthalmic injuries were mild involving the eyelids, conjunctiva, and retina. However, ruptured globe was seen to be the major cause of visual impairment.

RTA caused by motorcycle was the most common cause of accident seen in this study. A lack of compliance with the use of safety gear such as seat belts and crash helmets was the most common risk factor. Simple zygomatic complex

fracture was the most common type of maxillofacial injury seen in this study, which had no predilection to any side of the face.

### Recommendations

An ophthalmologic assessment should be conducted for all patients presenting with maxillofacial trauma. There is also the need for the relevant law enforcement agencies to ensure the use of protective gears such as helmets and seat belts by road users. The government has to ensure that other alternative means of transportation are provided to reduce the rate of dependence on motorcycle as a major means of transport as currently is the case. Public enlightenment on safe road usage is also necessary to help reduce the risk of RTA.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

# References

1. Okoye O, Magulike N, Chuka-Okosa C. Ocular complications among cases of head injury seen in a neurosurgical hospital in Southeastern Nigeria. Nigerian J Ophthalmol 2009;17:59-61.
2. Mittal G, Singh N, Suvarana S, Mittal SR. A prospective study on ophthalmic injuries related to maxillofacial trauma in Indian population. Natl J Maxillofac Surg 2012;3:152-8.
3. Jamal BT, Pfahler SM, Lane KA, Bilyk JR, Pribitkin EA, Diecidue RJ, *et al*. Ophthalmic injuries in patients with zygomaticomaxillary complex fractures requiring surgical repair. J Oral Maxillofac Surg 2009;67:986-9.
4. Ogundipe O, Afolabi A, Adebayo O. Maxillofacial fractures in Owo, South Western Nigeria. A 4 year retrospective review of pattern and treatment. Dentistry 2012;2:132.
5. Singaram M, Vijayabala SG, Udhayakumar RK. Prevalence, pattern, etiology and management of maxillofacial trauma in a developing country: A retrospective study. J Korean Assoc Oral Maxillofac Surg 2016;42:174-86.
6. Bossert RP, Girotto JA. Blindness following facial fracture: Treatment modalities and outcomes. Craniomaxillofac Trauma Reconstr 2009;2:117-24.
7. Ansari MH. Blindness after facial fractures: A 19-year retrospective study. J Oral Maxillofac Surg 2005;63:229-37.
8. Obuekwe ON, Ojo MA, Akpata O, Etetafia M. Maxillofacial trauma due to road traffic accidents in Benin City, Nigeria: A prospective study. Ann Afr Med 2003;2:58-63.
9. Obimakinde OS, Ogundipe KO, Rabiu TB, Okoje VN. Maxillofacial fractures in a budding teaching hospital: A study of pattern of presentation and care. Pan Afr Med J 2017;26:218.
10. Mao CJ, Yan H. [Clinical characteristics of mechanical ocular injury and application of ocular trauma score]. Zhonghua Yan Ke Za Zhi 2012;48:432-5.
11. Liudmil G, Martin R, Elitsa D. The role of alcohol involvement in maxillofacial trauma. J IMAB 2012;18:147-9.
12. Barry C, Coyle M, Idrees Z, Dwyer MH, Kearns G. Ocular findings in patients with orbitozygomatic complex fractures: A retrospective study. J Oral Maxillofac Surg 2008;66:888-92.
13. Yokoyama T, Motozawa Y, Sasaki T, Hitosugi M. A retrospective analysis of oral and maxillofacial injuries in motor vehicle accidents. J Oral Maxillofac Surg 2006;64:1731-5.
14. Malik AH, Shah AA, Ahmad I, Shah BA. Ocular injuries in patients of zygomatico-complex (ZMC) fractures. J Maxillofac Oral Surg 2017;16:243-7.
15. Sharma R, Chhabra N, Sharma P, Chhabra S. Evaluation of intra ocular pressure in zygomatico maxillary complex fractures. J Maxillofac Oral Surg 2015;14:226-33.
16. Popat H, Doyle PT, Davies SJ. Blindness following retrobulbar haemorrhage—It can be prevented. Br J Oral Maxillofac Surg 2007;45:163-4.
17. Simsek S, Simsek B, Abubaker AO, Laskin DM. A comparative study of mandibular fractures in the United States and Turkey. Int J Oral Maxillofac Surg 2007;36:395-7.
18. Riaz N, Chatha AA, Warraich RA, Hanif S, Chinar KA, Khan SR. Ophthalmic injuries in orbito-zygomatic fractures. J Coll Physicians Surg Pak 2014;24:649-52.
19. Enock ME, Dawodu OA, Osahon AI. Motorcycle related ocular injuries in Irrua Specialist Teaching Hospital, Irrua Edo State, Nigeria. A peer review. J Biomed Sci 2008;7:5-11.
20. He D, Blomquist P, Ellis E. Association between ocular injuries and internal orbital fractures. J Oral Maxillofac Surg 2007;65:713-20.
21. Guly CM, Guly HR, Bouamra O, Gray RH, Lecky FE. Ocular injuries in patients with major trauma. Emerg Med J 2006;23: 915-7.
22. MacKinnon CA, David DJ, Cooter RD. Blindness and severe visual impairment in facial fractures: An 11 year review. Br J Plast Surg 2002;55:1-7.
23. Mark SB, Willy KY, Richard DL. Concomitant ocular injuries with orbital fractures. J Craniomaxillofac Trauma 1999; 5:41-6.
24. Trindade PA, Vieira EH, Gabrielli MF, Pereira-Filho VA. Treatment and complication of orbito-zygomatic fractures. Int J Odontostomat 2012;6:255-62.
25. Osime OC, Ohanaka EC. Road traffic accidents in a semi- urban community in Edo State of Nigeria. J Med Biomed Res 2003;2:18-24.
26. World Health Organization. Road traffic injuries; 2022. Available from: [https://www](http://www.who.int/news-room/fact-sheets/detail/road-).who[.int/ne](http://www.who.int/news-room/fact-sheets/detail/road-)ws-r[oom/fact-sheets/detail/road-](http://www.who.int/news-room/fact-sheets/detail/road-) traffic-injuries. [Last accessed on 19 Jul 2022].
27. Foroughi R, Faghani F, Gharib S, Khafri S. Traumatic ophthalmic injuries in mid facial trauma: A decade long survey. J Craniomaxillofac Res 2015;2:128-32.
28. Rajkumar GC, Ashwin DP, Singh R, Prashanth R, Rudresh KB. Ocular injuries associated with midface fractures: A 5-year survey. J Maxillofac Oral Surg 2015;14:925-9.
29. Mason PN. Facial injuries. In: Mc Carthy JG, editor. Plastic Surgery. Philadelphia: Saunders; 1990. p. 868-72.
30. Akinbami BO. The role of seat belt in the prevention of fatalities and determination of fatality index of road traffic accident in Rivers State, Nigeria. Niger Health J 2013;13:158-65.
31. Pepple GF, Ejimadu C. Relationship between road traffic accident and visual status of commercial motor vehicle drivers in an urban area of Niger Delta Region of Nigeria. Ophthalmol Res: Int J 2019;10:1-7.
32. Weze K. Helmet use among motorcycle riders in Nigeria. Doctoral dissertation. Harvard T. H. Chan School of Public Health. Harvard Library Office for Scholarly Communication; 2019.
33. Bachulis BL, Sangster W, Gorrell GW, Long WB. Patterns of injury in helmeted and nonhelmeted motorcyclists. Am J Surg 1988;155:708-11.
34. Aladelusi T, Akinmoladun V, Olusanya A, Fasola A, Akadiri O. The impact of protective devices on the severity of road traffic maxillofacial injuries in Ibadan, Nigeria. J West Afr Coll Surg 2013;3:25-39.
35. Omoti AE. Ocular trauma in Benin City, Nigeria. Afr J Trauma Manage Outcom 2004;2:67-71.
36. Nabeela R, Asad AC, Riaz AW, Saba H, Chinar KA, Shammas RK. Ophthalmic injuries in orbito-zygomatic fractures. J Coll Physic Surg Pak 2014;24:649-52.