

Case Report Article

Motorcycle accidents and high energy midface fractures: a critical review and illustrative case

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Abstract

Introduction: Accidents involving motorcycle riders often result in maxillofacial injuries and fractures to the midfacial skeleton are common injuries in patients who sustain high-energy trauma to their face. **Objective:** The aims of this study were to perform a review of the relationship between motorcycle accidents and high energy trauma resulting in midface fractures and to report the case of a motorcycle accident victim who developed a complex fracture pattern of the midface structures. **Case report:** A 33 year-old man, victim of a motorcycle accident and developed a complex fracture of the midfacial skeleton is reported. Surgical planning included submental intubation using a nasofibroscope and several approaches were performed to the arrangement of the midface fractures. **Results/Discussion:** The rates of facial fractures caused by motorcycle accidents tend to increase, especially in developing countries. This increase is also associated with the use of motorcycles for commercial purposes. Young men are the group most involved in this type of accident. The use of helmets is related to lower morbidity in high energy trauma and facial injuries. **Conclusion:** Fracture patterns involving the midfacial skeleton are directly related to high-energy traumas such as those caused by motorcycle accidents. Prevention campaigns should be encouraged to reduce the high rates of facial injuries among motorcyclists.

Introduction

The incidence of maxillofacial injuries is on the rise due to the increase in the number of motor vehicle accidents. Road traffic accidents still remains the most common cause of these injuries, in developing countries, especially those involving motorcycle accidents [46]. The trauma caused by high-impact collisions typically observed in motorcycle accidents is directly related to higher percentages of soft tissue lacerations and complex injury patterns such as fractures to the midface skeleton [30, 31, 44].

Motorcycle use is popular in busy urban centers as a less expensive, affordable, and more fuel-efficient means of transportation, particularly in developing countries [4, 24, 27]. However, the increasing use of motorcycles for recreation and commercial purposes has led to an increased incidence of fatalities and injuries [17, 27]. Furthermore, in crashes involving motorcycles and cars, motorcyclists and their passengers are more prone to injury than motor vehicle occupants [1].

Accidents involving motorcycle riders often result in maxillofacial injuries. These injuries can occur alone or in combination with other injuries and can cause significant morbidity and even mortality. Head, cervical spine, orthopedic, thoracic and abdominal injuries are frequently associated with facial injuries [8]. The concomitant injuries suffered in road traffic accidents demands a high level of interspeciality cooperation and coordination to establish treatment priorities [10].

Fractures to the midfacial skeleton (zygomatic, naso-orbito-ethmoidal (NOE), and maxillary) are common injuries in patients who sustain high-energy trauma to their face [13]. As these complex fractures require high-energy trauma, midface injuries are common in motorcycle accidents [9]. Low, moderate, and highly comminuted fractures are identified at each anatomic location. In patients with injuries classified as high energy fractures, the degree of fragmentation, displacement and instability, usually demands extensive approaches to provide proper fixation [28].

The aims of this study were to perform a review of the relationship between motorcycle accidents and high energy trauma resulting in midface fractures and to report the case of a motorcycle accident victim who developed a complex fracture pattern of the midface structures.

Case report

A 33 year-old man, the victim of a motorcycle accident without helmet, was transferred to the emergency department of a private hospital in the city of Recife, Brazil, after spending 4 days in a public hospital. He had a history of loss of consciousness, no exposed fracture of the right clavicle, 4th lumbar spine and complex facial trauma. During clinical examination, the patient presented diffuse midface edema, bilateral periorbital hematoma, nasal splint with discrete serum-blood flow, palpable irregularities in both infra-orbital margins, mobility and crackling on nasal dorsum, apparent traumatic telecanthus and facial enlargement.

On ophthalmic examination showed a chaotic arrangement of soft tissues and an extensive laceration of the entire cornea and sclera with severe involvement of the right eye. Visual acuity in the right eye was compromised and there was no light perception. Ophthalmic examination of the left eye was normal. In view of the clinical conditions of the right eye, the team of ophthalmic surgeons chose to enucleate the right eyeball.

Examination of the jaws revealed intense maxillary mobility associated with malocclusion and severe limitation of mouth opening. There were no signs of mandible fracture. A computed tomographic (CT) scan with axial and coronal views was needed for accurate diagnosis. Additional sagittal and three-dimensional reconstructions may be helpful to plan the fracture reduction. The CT scan showed complex midface fractures involving the bilateral zygomatic complex, as well as maxillary (Le Fort III level and paramedian fracture) and NOE fracture (figure 1).



Figure 1 - Three-dimensional reconstruction CT showing complex midface fractures involving the bilateral zygomatic complex, as well as maxillary (Le Fort III level and paramedian fracture) and NOE fracture

Based on the clinical and tomographic diagnosis, the team of oral maxillofacial surgeons decided to perform surgery under general anesthesia to reduce and fix the fractures, as well as to reorganize the facial framework. Surgery occurred 14 days after the trauma.

Surgical planning included submental intubation using a nasofibroscope. Coronal incision with bilateral inferior extension anteriorly to the tragus level was chosen due to the arrangement of the midface fractures and the need for exposure of the zygomatic-orbital complexes and NOE region. Bilateral inferior extension of the coronal approach allows optimal visualization of both zygomatic arches as well as of the front and speno-zygomatic sutures, optimizing the reduction in these pillars. In order to obtain an adequate fracture reduction (figures 2 and 3). The surgical team also chose to access both inferior orbital rim through mid-eyelid incisions. The transoral vestibular approach allowed visualization of lower midface fractures.



Figures 2 and 3 - Bilateral inferior extension of the coronal approach allows optimal visualization of both zygomatic arches as well as of the front and speno-zygomatic sutures

Circumferential stainless-steel wires were installed in the paramedian maxillary fracture region during surgery to restore the arch perimeter. Erich's bars were installed for mandibulomaxillary fixation, ensuring satisfactory occlusion after mobilization of the maxilla with Rowe's forceps.

Fixation of the fractures started in the maxillary bone. Since the patient had no mandibular fracture, appropriate reduction of the maxillary bone was obtained by placing the mandible in correct occlusion preventing severe deformities. After reducing the maxillary fractures, the zygomatic body and arch were in order to reestablish the outer facial frame, then moving on to the NOE area. In total, nine 2.0-mm and five 1.5-mm plate and screw systems were used (figure 4). After reduction and fixation of the NOE fracture, the intercanthal distance was reestablished with 2-0 polypropylene suture.



Figure 4 - Three-dimensional reconstruction CT showing the arrangement of miniplates in order to reestablish the outer facial frame. In total, nine 2.0-mm and five 1.5-mm plate and screw systems were used

After fixation, abundant irrigations, hemostasis of the surgical wounds and, suture specifics for each approach were performed. After suturing the coronary access, a 10-vacuum drain was placed. A nasal splint was installed to prevent epistaxis and was removed after 5 days. After 2 years, the patient remains under postoperative follow-up, especially for prosthetic reconstruction of the right eye (figure 5).



Figure 5 - Facial frame reestablished after 2 years of follow-up

Results and Discussion

Maxillofacial injuries are a serious public health and economic problem as their treatment is expensive and requires long hospital stays and absence from work. These injuries are also often associated with functional limitations and psychological problems [2, 11]. In low-income countries in Africa, Latin America and Asia, the incidence of motorcycle related injuries remains high when compared to their counterparts in the developed world (table I).

Table I – Motorcycles accidents were the most prevalent in these studies carried out in the last 15 years. It is observed that young men in their 20s are most vulnerable to these types of accidents. All studies were carried out in low income countries or developing countries. In developed countries, interpersonal violence remains the main etiology of maxillofacial injuries

Abosadegh <i>et al.</i> [2]	Malaysia	Retrospective review	Men	11 to 20 years	Orbital walls
Aires <i>et al.</i> [6]	Brazil	Retrospective	Men	21 to 30 years	Mandible
Chuang <i>et al.</i> [16]	Taiwan	Retrospective	Men	20 to 59 years	Midface fractures
Rêgo <i>et al.</i> [41]	Brazil	Retrospective	Men	13 to 18 years	Zygoma
Obimakinde <i>et al.</i> [33]	Nigeria	Retrospective	Men	20 to 29 years	Mandible
Pita Neto <i>et al.</i> [38]	Brazil	Cross-sectional retrospective	Men	20 to 29 years	Mandible
Obimakinde <i>et al.</i> [34]	Nigeria	Retrospective	Men	20 to 30 years	Mandible
Ramos <i>et al.</i> [40]	Brazil	Retrospective	Men	20 to 29 years	Nasal
Yang <i>et al.</i> [47]	Taiwan	Cohort retrospective	Men	18 to 29 years	Midface fractures
Carneiro <i>et al.</i> [14]	Brazil	Cross-sectional retrospective	Men	17 to 29 years	Mandible
D'Avila <i>et al.</i> [19]	Brazil	Cross-sectional retrospective	Men	20 to 29 years	Mandible
Oginni <i>et al.</i> [35]	Nigeria	Retrospective	Men	21 to 30 years	Mandible
Aladelusi <i>et al.</i> [7]	Nigeria	Prospective	Men	31 to 40 years	Mandible
Agnihotri <i>et al.</i> [5]	India	Prospective	Men	21 to 30 years	Nasal
Hashim e Lqbal [20]	Malaysia	Cross-sectional retrospective	Men	20 to 29 years	Zygoma
Subhashraj <i>et al.</i> [45]	India	Retrospective	Men	21 to 30 years	Midface fractures
Oginni <i>et al.</i> [36]	Nigeria	Prospective	Men	20 to 29 years	Zygoma

Developing countries have a more chaotic road system, probably because of the disorganized means of transportation, poor regulation, incorrect use of personal protective equipment, particularly helmets, and lack of formal road traffic instructions [4]. The majority of road traffic accidents recorded

involve motorcycles. The motorcycle is the most unsafe vehicle, as the rider's body is exposed and unprotected, making the driver extremely vulnerable to accidents [19]. The prevailing economic circumstances in these countries, the prevailing economic circumstances have led to an upsurge in the use of motorcycles for private and commercial purposes (for example, "motoboys" and "mototaxis") with a steady increase in the number of motorcycle related maxillofacial injuries [1].

Most motorcycle-related injuries occur in young, productive and male drivers [29]. Besides the economic impact related to the absence of these victims from work, hospitalization and treatment costs must be taken into account. In a recent study, conducted in Brazil, the authors showed that the increasing numbers of victims with facial fractures, especially motorcycle accidents victims, result in considerable costs to public health services associated with the use of osteosynthesis materials [6]. Increased traffic control measures, better road conditions, speed limits and the use of personal protective equipment like helmets are important to reduce maxillofacial injuries [2, 39].

To address the growing problem of injuries among motorcyclists, the Asia Injury Prevention Foundation, founded in 1990 in Vietnam, launched the Global Helmet Vaccine Initiative (GHVI). The GHVI was established for the purpose of population-level changes in helmet use and to reduce motorcycle-related head injuries and included strategies targeting high-risk populations, such as access to helmets, public education, research policies, and monitoring and evaluation of efforts to improve helmet wearing. This approach was successfully used in Vietnam and the model was adapted and implemented in Cambodia and Uganda. Some authors believe that adaptation and expansion of this model in other countries may help support global goals and reduce motorcycle accidents [18].

Road traffic accidents have been commonly reported as the main etiology of midfacial traumas especially in developing countries [43]. High-energy mechanisms of injury increase the force to the face, resulting in larger zones of injury. These complex facial fractures are common among motorcycle trauma patients, especially in unhelmeted motorcycle drivers [3, 15]. It appears that the greater force generated by a high-speed motor vehicle crash creates more damage, thereby extending the fracture pattern of midface structures from the zygoma to the NOE segment [13]. Previous studies have shown an increase in malar and maxillary fractures and facial soft-tissue injuries,

including lacerations, contusions, and abrasions in motorcycle accident victims [3, 15]. The prevalence of midface fractures varies across different studies (table I). The degree of pneumatization of the paranasal sinuses and the prominent location of the zygoma and nose in the face are features that favor midface fractures [26].

Several studies have demonstrated the importance of helmet use [3, 15, 37]. In a recent study, patients who used a helmet had a significantly lower incidence of nasal fracture, orbital wall fracture, and maxillary sinus wall fracture than those who did not wear a helmet. The incidence of fractures to other maxillofacial bones was also lower in patients who wore helmets, although the differences were not significant [2]. Although these findings appear consistent with prior research, some authors found that fractures of midface bones were more common in the larger vehicle group with more protection [37].

Midface bones, especially the zygomaticomaxillary complex, can absorb a specific amount of energy before they fracture from their skeletal attachments [23]. If this energy limit is exceeded, fractures can occur in the infraorbital rim, the lateral maxillary buttress, the zygomaticosphenoidal suture, and the zygomatic arch. Zygomaticomaxillary complex fractures associated NOE fractures are common injuries in patients who sustain high-energy traumas to their face, such as those encountered in motor vehicle accidents [9, 13]. In a study on the patterns of facial injury suffered by road traffic accidents victims, fractures to the midfacial skeleton (Zygomatic, Nasoethmoidal, Orbital, Le Fort level) outnumbered fractures of the mandible by a factor of 4:1 [10].

This review identified concerns regarding the occurrence of complex trauma related to motorcycle accidents. Postoperative morbidity increases with increasing zone of injury despite surgical intervention. As the level of complexity increases, the ability to achieve a perfect reduction decrease, with a consequent increase in the risk of complications and postoperative deformities [13]. It is therefore necessary to raise the awareness of motorcyclists about the consequences of motorcycle accidents, especially of those who do not use protective equipment.

In the present illustrative case, the patient did not use a helmet, and suffered a motorcycle accident that resulted in a complex trauma affecting the midface. Helmets are the most important safety equipment because they protect against injuries to the head and brain but also against fractures of the maxillofacial bones [2].

Patients with major maxillofacial trauma usually pose a challenge to the anesthesiologist during surgery and the early postoperative periods [21]. A submental intubation was the method chosen for airway management. Submental intubation is a reasonable alternative for establishing and maintaining airway patency when treating panfacial fractures. It is relatively easy to carry out, safe and does not interfere with the surgical area [22]. In addition, submental intubation provides a secure airway and does not interfere with maxillomandibular fixation or access to naso-orbito-ethmoid fractures. Potential complications associated with nasotracheal intubation and tracheostomy in patients with multiple facial fractures can be avoided. Additionally, submental intubation obviates the need to alternate between oral and nasal intubation during surgery [21, 32].

Careful examination of the zygomaticomaxillary complex/NOE fracture patterns is needed to ensure that proper treatment is initiated. Failure to recognize a displaced segments results in improper reduction and fixation of the orbital rim, leading to malposition of the zygoma. This malposition can leave the patient with significant functional and aesthetic deformities [13]. Treatment of midface injuries should restore the function of the nose, eyes, and ideally the preinjury appearance [9].

In patients with high energy fractures, the degree of fragmentation, displacement and instability justify an extended open reduction with exposure of all buttress articulations [28]. When treating zygomaticomaxillary complex fractures, the surgeon uses multiple landmarks to attain perfect anatomical reduction and to reestablish the facial projection, facial width and orbital volume. Thus, the treatment of choice was open reduction using extensive approaches. A combination of coronal and bilateral inferior extension anteriorly to the tragus level plus mid-eyelid incisions and a transoral vestibular approach were the approaches used for the surgical treatment of the fractures. Evaluation of the surgical approach for this type of fracture revealed a higher prevalence of patients who underwent coronal incisions [13].

In the case reported here, the patient suffered a major trauma involving the orbits. The right eyeball was the most compromised and had to be enucleated resulting in blindness. The association between facial fractures and ocular complications due to midface fractures has been investigated by many authors. Ophthalmic injuries are often present concomitantly with other facial injuries like orbitozygomatic fractures and approximately

20% are diagnosed in the presence of panfacial fractures. Ophthalmic injuries are a relatively common complication of orbito-zygomatic fractures [41]. Blindness is an uncommon, yet documented complication of facial trauma, with a reported incidence of fractures of about 3%. All patients with facial fractures suspected to have ophthalmic injuries are usually sent for ophthalmic consultation and their injuries are documented in their records [12].

An important issue associated with the treatment of facial fractures is related to the timing of repair. There are many advantages of early fracture treatment. Unfortunately, in the case of patients who are medically unstable because of associated neurologic or systemic injuries, facial fracture repair may have to be delayed beyond a reasonable time. A delay of 2 weeks for definitive repair increases the difficulty in obtaining adequate reduction of fracture dislocations [25]. In the reported case, the maxillary bone had to be mobilized with Rowe's forceps. Due to his clinical conditions, the patient could only be operated on 2 weeks after the trauma.

After reduction of the maxillary fracture, fixation of the zygomatic complex and NOE fractures was completed. Most surgeons prefer to restore the zygomatic body and arch in order to reestablish the outer facial frame and then move to the NOE area. The latter has less reliable landmarks for orientation because it is comminuted or missing pieces of bone [22].

A large number of plates and screws were used in the present case, as expected after high-energy trauma. When the patient is treated in public health systems, this approach can be costly, especially in low-income countries, as shown in a recent study [6].

Conclusion

Fracture patterns involving the midfacial skeleton are directly related to the etiology of trauma, especially when caused by high-energy traumas such as those resulting from motorcycle accidents. Prevention campaigns should be encouraged to reduce the high rates of facial injuries among motorcyclists, especially in developing countries.

Conflict of interest

The authors declares that there is no conflict of interest.

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