Management of Mid-Facial Fracture with Ophthalmic Injury

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ABSTRACT Background: Trauma affecting mid-face often leads to lesions of soft tissues, teeth and bone, damaging the integrity of the orbital skeletons, and is frequently complicated by ophthalmic injury. Careful injury assessment and its complications are essential to make an optimal treatment decision. The aim of this paper is to present a case of mid-facial fracture with a brief review of the risk of ophthalmic injury and its surgical management preferred by the authors.

Case Report: A 19 year-old man was brought to the emergency room with swelling and multiple wounds at facial region after he was involved in a motorcycle accident 30 minutes earlier. Primary survey performed according to Advanced Trauma Life Support (ATLS) showed no live threatening condition. There was asymmetrical face with edema at left cheek and eye. We found no wound intra-orally and teeth occlusion was not possible. After careful physical examinations, we assessed his condition with the following injuries: mid-facial fracture with suspect muscle entrapment of his left eyeball. Laboratory and radiographic imaging were taken to support the diagnostic. The surgical reposition and fixation of the fracture were performed under general anesthesia by an oral maxillofacial surgeon and an ophthalmologist. Reduction using interdental wiring and fixation using plate and screw at facial buttress successfully returned the patient facial contour to its former condition and occlusion was achieved. A catheter balloon was inserted to his left maxillary sinus to obtain normal sinus volume and hold his eyeball to its position. Then the patient was followed up at 1 day, 1 week, and 1 month.

Discussion: Treatment of mid-facial fracture focuses on reductions to achieve exact orbital rim alignment, preserve ophthalmic function and normal dental occlusion. Immobilization of fracture requires various combinations of interdental wiring, inter-maxillary fixation, and open reduction with internal fixation. Conclusion: Dealing with mid-facial fracture needs a sharp investigation to produce proper diagnosis. Ophthalmic injury is one of the common injuries accompanying mid-facial injury. Early surgical treatment is preferred to reduce risk of irreversible globe injury and maximizes the functional and cosmetic results.

KEYWORDS Maxillofacial fracture, ophthalmic injury
underdeveloped or developing areas of the world followed by assaults and other reasons, including warfare.[1,2,3,4,5] Trauma is the leading cause of deaths occurred in the first 40 years of life, and it is well known that MF injuries are frequently seen in poly-trauma victims, damaging the integrity of the orbital skeleton and are frequently complicated by ophthalmic injury.[1,2,3,5] MF region includes organs executing essential functions of the body like respiration, speech, mastication, vision and smell. Therefore special attention must be paid in the case of facial trauma.[1]

Lesions of teeth commonly accompany the trauma of the mid-face, soft tissue and bony structures of the skull including the zygomatic bone, the maxilla, the naso-ethmoid (NOE) complex and naso-orbital as well as supraorbital structures. Not rarely, those lesions on the mid-face area combined with injuries of other parts of the body.[6,7,8] Ophthalmic complications vary from minor injuries, such as subconjunctival bleeds and hematomas, to major injuries, such as blow out of the globe or nerve injury, exophthalmos, entophthalmos, restriction of eye movements, traumatic neuropathy, eyelid injuries, lacrimal muscle injuries, and duct injuries.[2] Patients with mid-facial fracture who do not undergo successful or appropriate treatment may suffer from significant long-term consequences such as disfiguring scars, bony deformities, and even loss of vision.[6]

Injuries of the lateral mid-face occur more frequently than of central mid-face. Males are affected more often than females. There is a peak age in the 2nd and 3rd decade of life. Street accidents occur more often than sports accidents. Independent from the severity and the fracture type, the basis for successful therapy of mid-facial fracture is the restoration of the supporting pillar of the mid-face, the bony prominences, the bone cavities (e.g. orbit) and correct occlusion.[4,6,7,8]

The mid-face consists of the following bony structures: nasal bones, lacrimal bone, ethmoid, sphenoid, maxilla, zygomatic bone, and palatine bone. The sites where vessels and nerves emerge are of major importance in traumatology, as they pose structural weak points that influence fracture lines. In the area of the anterior skull base, the following foramina are concerned:

- The foramina of the cribriform plate where the olfactory fibres emerge.
- The pathway of the anterior and posterior ethmoid arteries.
- The optic canal.
- The superior orbital fissure with the nerve responsible for oculomotor functions, that however plays only a direct role in extreme injuries.
- The infra- and supraorbital foramen with its respective portions of the trigeminal nerve. Fractures affecting those foramina indicate surgery based on clinically apparent hypoaesthesia.[6]

Diagnosis and management of facial injury are a challenge, particularly in the setting of coexisting polytrauma in the emergency department.[1,4] As with any initial evaluation, the greatest priority is the primary survey, which consists of the ABCs (airway, breathing, and circulation). Once these are secured, a detailed history of the event should be ascertained from the patient, witnesses, or first responders.[4] To correctly diagnose a fracture, a careful examination of the patient has to be performed together with an assessment of the history of the accident.[3,6]

Examination of the patient’s occlusion is vital and should be done in a neutral position. Ask the patient to open and close his jaw, and then clench the jaw and see if there is any sensation of the bite being “off”. [4] A CT scan offers distinct advantages over other imaging modalities. The size and morphology of the fracture can be determined, which aids in not only clinical assessment but also surgical planning. A CT scan can also help detect entrapment of the orbital rectus muscles, recognized by displacement of the muscle into the fracture site, with or without bone displacement.[9]

Zygoma fractures are mostly seen in young male patients whose lifestyle are at high risk for trauma.[1] Diagnosis of complex zygomatic fractures is usually clinical, with radiographic confirmation.[10] Fractures of the zygomatic bone complex are rather frequent because of the prominence of the zygomatic bone. Fracture line passed through the anterior wall of the maxillary sinus and in general through the infraorbital foramen to the zygomatico-alveolar crest. From there, the fracture line reaches the inferior orbital fissure cranial to the lateral and posterior wall of the maxillary sinus. The orbital floor is nearly always affected in cases of fracture of the zygomatic bone. After an impact of high violence, also a comminuted fracture of the zygomatic complex may result and part of the zygomatic bone may dislocate into the maxillary sinus. Concomitant injuries of the zygomatic complex often affect the ocular globe and optic nerve.[4,6,7,8]

For mid-facial fracture, the fracture should be treated within the first two weeks. If not treated within these two weeks, the beginning of bone absorption at the fragment surfaces and the beginning of callus formation will lead to difficulty in repositioning to its anatomically correct position. After an interval of 2 weeks, the treatment is considered as delayed and is based on the principle of secondary post-traumatic treatment. Primary care for fracture should be performed as soon as the general condition of the patient allows therapy to be done. The limiting factor for immediate treatment of the fracture is mostly not the fracture itself but the patient’s general condition.[6]

Sagittal fractures of the maxilla or palate, either in the midline or paramedian region, often resulting in oronasal communication. Early stabilization of these fractures prevents the functional impairments and life-threatening situations, such as continuous hemorrhage from the traumatized nasal mucosa and nasal regurgitation of food leading to the risk of aspiration.[11]

The morphogenesis of mid-facial processes requires the coordination of a variety of cellular functions of both mesenchymal and epithelial cells to develop complex structures.[12] The palatal bone is thicker anteriorly and progressively thins as the soft palate is approached. Ignoring the crest at the midline, the hard palate is relatively thin in the sagittal and parasagittal regions but becomes progressively thicker towards the alveolus. At the alveolus, the thicknesses of the palatal bone are 12 to 14 mm. The average thickness of the palatal platform, however, is 4.5 mm.[13] The medial wall of orbital rim comprises the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoid bone, and the sphenoid body. The area damaged most easily by trauma is the very thin lamina papyracea (0.2-0.4 mm thick), which separates the orbit from the ethmoidal sinuses. The lacrimal sac lies anteriorly along the medial wall in the lacrimal groove formed by the maxilla and lacrimal bones.[9]

Direct trauma of face can involve the medial wall of the orbital rim, but the orbital floor is involved more commonly. The cause of this type of fracture is thought to be from increased intraorbital pressure, which causes the orbital bones to break at their weakest point.[9]

Fracture morphology in the central mid-face is documented by fragmentation, displacement, and bone loss. The number of
fracture lines determines the fragmentation within the partitions as 0 = nonfragmented (single straight or twisted fracture line) or 1 = fragmented (more than a single fracture line). So-called multifragmentary or, in outmoded parlance, comminuted fractures, representing fractures in which bone is shattered, splintered or crushed into many pieces, are included in the latter category. Displacement is attested whenever the fragments have moved out of their original location and lack alignment to the skeletal superstructure regardless of the metric amount. Traumatic bone loss, also referred to as bone defect, applies to deficits ranging from small fragments to large sections. Without distinction of the potential spectrum of the deficit, it is either negated (0 = no bone loss) or affirmed (1 = bone loss).[14]

The zygoma and its anatomical sub-regions constitute the lateral mid-face attached to each side of the maxillary portions of the central mid-face pyramid in the transition to the greater sphenoid wing, the frontal bone, and the temporal bone. Five articulations extending from the body of the zygoma connect to the adjacent bones: [3,8,14]

- Frontal process or lateral orbital rim
- Zygomaticomaxillary buttress or zygomaticomaxillary crest
- Inferior orbital process of the zygoma
- Lateral orbital process (facies orbitalis or zygomaticosphenoid flange) of the zygoma (anterior portion of the lateral orbital wall)
- Temporal process is continuous with the zygomatic arch.

Fractures of the orbital floor occur either in the context of fractures of the zygomatic bone complex and other mid-facial fractures or as isolated findings. Clinical symptoms of orbital fractures are hyposphagma, epistaxis, sensitivity disturbances in the area of the infraorbital nerve, enophthalmos, hypophthalmus, diplopia, disturbed eye motility, rounded canthus (cow’s eye) in case of ruptured canthal ligament.[6,7,8]

The periorbital and the bony orbital floor together comprise the orbital floor complex. Herniation of the peri-orbital tissue, fat, the inferior rectus muscle, and the peri-orbita also leads to the clinical signs of motility disorders, diplopia, and enophthalmos.[15]

An ophthalmic examination is an indispensable part of the clinical examination after maxillofacial trauma. Whenever communication is possible with the patient, a clinical evaluation is mandatory. In non-responsive patients, it is challenging to evaluate visual acuity. Pupillary reaction to light is often the only parameter. Oedema and hematoma compromise correct evaluation of proptosis or enophthalmos.[2]

The fracturing of the anterior wall of the maxillary sinus is often included in a zygomaticomaxillary complex (ZMC) fracture; an isolated anterior wall of the maxillary sinus fractures account for 1.3% of facial bone fractures. The most common indication for surgery in ZMC fractures is displacement and rotation. Three-dimensional displacement usually occurs in ZMC fracture, meaning that malar eminence can be displaced into medial-lateral, superior-inferior, and anterior-posterior directions.[16,17,18] Most surgeons agree that conservative treatment of ZMC fractures is appropriate in situations with no displacement of the fracture segments.[19,20]

The individual approach depends on the underlying fracture: a transoral approach, transconjunctival incisions, an intranasal approach, or transcutaneous approaches may be appropriate. The access is chosen for optimal overview to facilitate reposition and osteosynthesis. At the same time, the incisions should be performed in an esthetically discreet way.[6,9,7,20] Reduction should be performed for displaced fractures that result in trismus, contour asymmetry, or significant orbital floor disruption. The zygomaticomaxillary buttress can be accessed through a gingivobuccal sulcus incision.[19,20]

There is no standard treatment for ophthalmic injuries following mid-facial trauma.[2,17] The surgical access to the orbital floor is usually performed in a transconjunctival or transfacial way in the area of the lower eyelid. Using this incision, a good exposition with the possibility of extension and favourable postoperative scarring is possible. The most frequently used access is performed via the oral vestibule.[6,7]

It is unclear which tissue types (peri-orbital content such as fat, septa, periosteam, or muscle) are responsible for late motility disorders, and it should be specified whether the inferior rectus muscle or the inferior oblique muscle contributes most to motility limitations.[21]

At the junction of the medial wall and orbital roof are the anterior and posterior ethmoidal foramina in which the anterior and posterior ethmoidal arteries and nerves course from the orbit to the anterior cranial fossa. These structures can be injured directly at the time of trauma, awareness of this location during repair helps prevent intraoperative bleeding.[9] The surgical repositioning of fractures and osteosynthesis of patients with midfacial fractures is typically performed under general anaesthesia. Generally, the bone fragments should be repositioned in their anatomically correct position and secured safely. The objective is the reconstruction of the shape and function of all structures of the mid-face, as atraumatic as possible. The reconstruction of the correct occlusion is one of the most important objectives of surgical treatment of mid-facial fractures affecting the teeth-bearing parts of the mid-face.[6]

Surgical treatment of an isolated anterior wall of the maxillary sinus fracture is open reduction and internal fixation. Large fragments can be fixed with plates and screws, and small fragments can either be positioned at the bony defect or removed. When the defect cannot be covered by using bony fragments, another method is to restore using titanium meshes and other resorbable materials.[16]

The medial rectus muscle is one of the most important anatomical structures which are intimately related to the medial wall. One of the most obvious signs of medial orbit wall fracture is a motility disturbance, usually addiction or abduction, caused by damage to or entrapment of the medial rectus. Other significant, medially located structures that must be accounted for in medial orbit wall trauma include the medial canthal tendon, trochlea, and lacrimal drainage system.[9]

Intermaxillary fixation (IMF) may be maintained if instability of other fractures of the craniofacial skeleton requires it. Motion and soft diet are permitted in the immediate postoperative period. The locking plate(s) and screw(s) assembly is readily removed some 8 to 12 weeks after its application, under local or general anesthesia.[13]

The patient should be instructed on the care for IMF and proper oral hygiene and placed on a full liquid, followed by a soft diet until the IMF is removed. Rigid IMF is to be removed within 3 to 4 weeks and transitioned to elastic IMF. The occlusion must be assessed at each follow-up appointment. After six weeks, the IMF may be removed, provided preinjury occlusion is achieved.[4]

Postoperative infection is rare in maxillary fractures compared with mandibular fractures. Infections are more likely to occur in the setting of maxillary sinus obstruction and pre-
Figure 1 Clinical appearance at admission.

Figure 2 3D CT-Scan Maxillofacial.

Figure 3 Interdental wiring at the upper and lower jaw.

existing sinus disease. A nasal-antral window may be used if the maxillary sinuses are obstructed. Prophylactic antibiotics should be used as indicated. Chlorhexidine mouthwashes should be used and analgesics prescribed as necessary.[4]

Any orbital surgery carries with it a potential for complications. Failure to diagnose fractures that require early treatment may result in intra-operative or post-operative complications due to fibrosis, contracture, and unsatisfactory union. Other postoperative complications may include loss of vision, traumatic optic neuropathy, diplopia, overcorrection or undercorrection of enophthalmos, lower eyelid retraction, bleeding, infection, protrusion of an orbital implant, infraorbital nerve damage with resultant hypoesthesia, orbital congestion, and epiphora. A complete eye examination is needed postoperatively to assess for the sequela of these complications adequately.[9]

Case report

A 19-year-old man was brought to the emergency room with swelling and multiple wounds on his face after he was involved in a motorcycle accident 30 minutes earlier. He was riding a motorcycle with medium speed without wearing his safety helm. Then another motorcycle coming from the opposite direction hit him. He lost his balance and fell from the motorcycle with his face down. He was conscious all the time up to admission. The primary survey performed according to Advanced Trauma Live Support (ATLS) showed no live threatening condition. There was no history of alcohol consumption, nausea and vomiting. Multiple abrasive wounds were found on his face, left flank, both hands and both feet. There was asymmetrical face with oedema at the left cheek and left eye, ecchymosis at left lower eyelid with blurred vision and restricted eye movement following left subconjunctival bleeding and normal light reflex. We found no wound intra-orally but there was no teeth occlusion and hematoma at left upper vestibule (Figure 1).

After careful physical examinations, we assessed his condition with mid-facial fracture (left maxilla, left zygoma, left orbital rim inferior and lateral aspect) with suspect muscle entrapment of his left eyeball. Laboratory and radiographic imaging were taken to support the diagnostic (Figure 2). Immediate treatment was performed to control bleeding, reduce pain, prevent infection and adjust occlusal displacement with interdental wiring using the arch bar (Figure 3). Then the patient was prepared for open reduction and internal fixation (ORIF). The surgical reposition and fixation of the fractures were performed under general anesthesia by an oral maxillofacial surgeon and an ophthalmologist. Standard surgical kits for mid-facial fractures were used, completed by osteosynthetic material. Included were typical mini-plates of different shapes with different screw’s lengths. The titanium plates and screws were stored in re-sterilized sets.

The surgery was performed in the supine position with fixation of head. The incision was made at oral vestibule for aesthetics reason. After removing oral mucosa and muscle adjacent to maxillary bone, we found comminuted fracture at the anterior wall of the left maxillary sinus. Fixation using mini-plates and screws at facial buttress (Figure 4) successfully returned the patient facial contour to its former condition and occlusion was achieved.

A catheter balloon was inserted to the anterior side of left maxillary sinus through the widened ostium to obtain normal sinus volume and hold eyeball to its position using a 14-French urinary balloon catheter (Figure 5), then injected with 10 mL of physiological saline solution to expand the balloon.

Forced duction test was performed after plate and screw had been placed to check the possibility of eye movement. The intraoral incision was sutured using Vicryl 4.0. At 21 day post-operative, we removed the urinary balloon catheters. We place mandibulo-maxillary fixation (MMF) in order to secure the occlusion and maintain for 14 days. The patient was followed up at one day, seven days and one month.

The patient was advised not to blow his nose for several
weeks post-surgery to prevent emphysema at the orbital region. Nasal decongestant sprays and corticosteroid were prescribed. We used prophylactic antibiotics to prevent surgical site infection.

Discussion

Careful assessment of the trauma and considering possible injury complication are essential steps before deciding fracture treatment.[2]

Initial assessment of maxillofacial trauma must follow advanced trauma life support (ATLS) principles as in all trauma victims. The first and most crucial sequence is maintaining airway patency. Airway compromise might occur due to failing tongue, foreign bodies, hemorrhage at the oropharyngeal region, and mid-facial fractures itself.[1,4]

Assessment of soft and hard tissues, radiographic examination, and history taking of the eye struck by a large object commonly associated with blowout fracture. Direct force to the lateral side of the face can be related to suspected zygomatic fracture.[2,9] Treatment of fracture required careful examination. Osteosynthesis can be performed after all fracture fragments were identified. Otherwise malposition of fixation the fragments might happen. The number, size, and position of plates and screws are depend on the anatomical and biomechanical properties of the individual fracture and must follow Champy law.[6]

Four air sinuses are lying in a human face. These sinuses serve as shock breaker to trauma, reduce facial skeleton weight, and help generate voice resonance. In normal condition, the maxillary sinus is the most significant air sinus and is located inside the cheekbone. It has thin and small anterior wall and are prone to fractures caused by direct trauma to the face such as in sports injury, violence and traffic accidents. Many problems arise if the fractured anterior wall of the maxillary sinus was untreated, like persistent epistaxis, rhinitis, intrusion of bone fragments, sinusitis, prolapse of the soft tissue from the cheeks into the sinus, and mucosa irritation.[16]

Management of patients with orbital fractures is challenging and is still debated. There are still many controversies regarding the timing, material, indications and contraindication for surgery.[21]

On almost every mid-facial trauma with a suspected eye injury, an ophthalmologist was always consulted for diagnostic evaluation and treatment advice.[2]

Limited movement of eyeball might have been caused by entrapment of the perimuscular fascia or the inferior rectus into the fracture site. In the case of possible entrapment, one must assess for the signs of the oculocardiac reflex: bradycardia, nausea, and syncope. Another complication following muscle entrapment is the limitation of extraocular muscle motility due to oedema at orbital region or traumatic palsy of the third nerve branch to the inferior rectus may cause decreased extraocular movements.[9,18]

Indications for surgical treatment are divided into aesthetic or functional reasons. Most functional issues are related to entrapment of the inferior rectus muscle or adjacent periorbital soft tissue. Aesthetic indications for surgical interventions involve globe malposition. The severity of these conditions dictates the need for an observation period of about two weeks. Recent literature recommend early surgical repair because it gives a better outcome and patient comfort.[7]

According to other publications by many authors, as per literature documented, there are various techniques used for the treatment of zygomatic bone and arch fracture. American and European maxillofacial surgeons are still debating on whether the reduction of a displaced and or fractured zygoma should be open or closed.[5]

The high level of unpredictability was amongst the influenced factor challenging orbital reconstruction. A precise anatomical reconstruction does not guarantee a perfect outcome because soft tissue involvement poses difficulties in predicting the long-term effect on function and aesthetics.[7,21]

In blowout fractures cases, early revision and repair have been considered the first-line treatment for optimal surgical outcome. Major clinical outcome parameters in patients with orbital fractures include cosmetic disturbance (enophthalmos), functional impairment (vision, extraocular muscle motility disorders, and diplopia), and infraorbital hypeaesthesia.[21] If the patients are children, muscle fibrosis and persistent diplopia may occur if
there is muscle entrapment left untreated, even a minor muscle. If there is muscle entrapment known after surgery, intervention within 2–4 days is required.[2]

Eyelid retraction sometimes occurs after surgery. This condition can be solved by removing osteosynthesis material, in this case, the plate and screw, after 3 to 6 months from the surgery.[2]

Literature shows that patients with multiple fractures face a greater risk for ophthalmic injuries, while the incidence of the ophthalmic problem is lower in cases of combined mandibular and mid-facial fractures because the mandible acts as an absorbent to the impact.[2]

Conclusion

Maxillofacial trauma planning is sometimes challenging and often involves a multidisciplinary approach. The first step in assessing a trauma patient, especially for those who are involved in multi-organ injuries, requires close evaluation and monitoring of airway, breathing, and circulatory condition. In this case, planning immediate surgical correction has given more comforting benefit, reduce risk of malunion and prolonged eye injury, also increase patient comfort. Aesthetics and functional goal must both be taken into account for facial reconstruction. Vision-threatening conditions should always be treated immediately before stabilizing the fracture site.

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Conflict of Interest

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