

**TITLE: Maxillary and Periorbital Fractures**

**SOURCE: Grand Rounds Presentation, UTMB, Dept. of Otolaryngology**

**DATE: January 7, 2004**

**RESIDENT PHYSICIAN: Gordon Shields, MD**

**FACULTY PHYSICIAN: Francis B. Quinn, MD**

**SERIES EDITORS: Francis B. Quinn, Jr., MD and Matthew W. Ryan, MD**

---

*"This material was prepared by resident physicians in partial fulfillment of educational requirements established for the Postgraduate Training Program of the UTMB Department of Otolaryngology/Head and Neck Surgery and was not intended for clinical use in its present form. It was prepared for the purpose of stimulating group discussion in a conference setting. No warranties, either express or implied, are made with respect to its accuracy, completeness, or timeliness. The material does not necessarily reflect the current or past opinions of members of the UTMB faculty and should not be used for purposes of diagnosis or treatment without consulting appropriate literature sources and informed professional opinion."*

---

## **Introduction**

The management of maxillary and periorbital fractures has evolved over the past several decades away from closed reduction, maxillomandibular fixation and cranial suspension wires to extended access approaches with precise open reduction and rigid internal fixation using miniplates and screws. These fractures include maxillary or LeFort fractures, zygomaticomaxillary complex fractures, and associated orbital fractures. The use of computed tomography for accurate diagnosis and surgical planning has been invaluable in the development of treatment protocols for these injuries.

## **Mechanisms and Associated Injuries**

The peak incidence of midfacial trauma is between the ages of fifteen and thirty. Males make up 60-80% of those sustaining these injuries. The most common mechanisms of injury are motor vehicle accident, assault, falls, sports related injuries, gunshot wounds, and industrial accidents. Mechanisms are of two main types, high energy and low energy. Approximately 20% of all trauma patients have facial injuries. The zygoma is second only to the nasal bones in the most frequently fractured facial bones. High energy mechanisms like motor vehicle accidents result in the more severe, comminuted fractures while lower energy trauma, such as an assault, will result in less severe injuries.

Advances in the management of severe trauma patients have resulted in the higher rate of survival of patients with multisystem trauma. Midfacial injuries are associated with many other injuries. Haug et al reviewed the incidence of other injuries in 402 trauma patients with midfacial injuries. In patients with zygoma injuries 43% had lacerations, 32% had orthopedic injuries, 22% had additional facial fractures, 27% had neurological injury, pulmonary 7%, abdominal 4.1%, cardiac 1%. Those patients with maxillary fractures had the following percentage of associated injuries: lacerations and abrasions 75%, orthopedic injury 51%, other facial fractures 42%, neurologic injury 51%, pulmonary 13%, abdominal 5.7%, cardiac 3.8%. In a review by Brandt 59% of patients who sustained midfacial trauma caused by a motorvehicle accident had an intracranial injury. In those patients with fall or beating as the cause of injury

10% had intracranial injury.

Ocular injury is also commonly associated with midfacial trauma. Al-Qurainy in 1991 reported on 363 patients with midfacial trauma. In this series 90.1% of patients had some form of ocular injury. 63% had transient or minor ocular injury, 16% moderately severe injury, 12% severe ocular injury (angle recession, retinal or vitreous injury, optic nerve damage). In those patients with ocular injury 2.5% lost vision in the affected eye. This data stresses the need for a high index of suspicion for ocular injuries in patients with midfacial trauma.

## **Anatomy**

Understanding the anatomy of the midface is important in the evaluation and treatment of fractures in this area. The skeletal support system of the midface has been described as having vertical and horizontal buttresses of strong bone surrounding the weaker areas of the eyes, nose, mouth, sinuses. The vertical buttresses are the paired nasomaxillary, zygomaticomaxillary, and pterygomaxillary buttresses. The horizontal buttresses are the frontal bar, inferior orbital rims, zygomatic arch, and the maxillary alveolus/palate. These support structures are key components to reconstruct when repairing maxillary and periorbital fractures.

The zygomaticomaxillary complex (ZMC) is a key component in the facial structure. The malar prominence is produced by the zygoma and is an important feature in aesthetics of the face. There are four bony attachments of the ZMC: frontozygomatic suture, zygomaticomaxillary suture, zygomaticotemporal suture, zygomaticosphenoidal suture. Although there are actually four attachments these fractures are sometimes referred to as tripod fractures. The masseter muscle attaches to the inferior aspect of the zygoma and has been described as causing inferior rotation of the zygoma and distraction of fractures not fixed after reduction.

## **Fracture classification**

Maxillary fracture patterns were described by Rene LeFort in 1901 using cadaver skulls. This has resulted in the LeFort classification which describes the highest component of a fracture. A LeFort I fracture extends horizontally through the inferior portion of the maxilla separating the maxillary alveolus from the rest of the midface. The LeFort II fracture is a pyramidal shaped fracture pattern involving the nasal bones, frontal process of the maxilla, inferior orbital rim, and lateral maxillary sinus wall. The LeFort III fracture is also called craniofacial disjunction. This fracture results in separation of the midface from the cranium at the level of the nasofrontal sutures extending laterally through the orbits to the zygomatic arch and posteriorly through the pterygoid plates. True fracture patterns often do not follow these described levels. In many cases the fractures will be at a different level on each side of the face.

The LeFort classification has proven to be less than satisfactory to describe more complex fracture patterns. Donat et al described the limitations of the LeFort system and proposed a classification scheme that would allow more accurate description of midfacial fracture patterns. Limitations of the LeFort system are that it does not address the skeletal supports, describe the more comminuted, incomplete or combination maxillary fractures, or describe fractures of the part bearing the occlusal segment. They evaluated the medical records

of 170 patients and found only 11 could be identified as classic bilateral LeFort fractures of the same level. Their classification describes midfacial fractures by describing the involved portions of the vertical buttresses and horizontal beams of the face.

## **Evaluation and Imaging**

The approach to evaluating a patient with a suspected maxillary or periorbital fracture should begin with the same “ABC’s” (airway, breathing, circulation) as other victims of trauma. Due to the previously discussed high rates of associated injuries, a high index of suspicion for other injuries should be maintained throughout the process of evaluation. Cervical spine injury should be suspected until examination and/or x-rays are negative.

A thorough history is taken including mechanism of injury, time of injury, associated symptoms, and a complete medical history. Especially important to note are any visual disturbances, malocclusion, or parathesias. Physical examination begins with an inspection of the face for asymmetry, contusions, lacerations, or swelling. Palpation of the entire facial skeleton is then performed noting step-offs or areas of mobility. The mobility of the midface can be tested by grasping the maxillary alveolus and attempting movement. The LeFort I fracture may have mobility at the inferior portion of the maxilla, the LeFort II may be mobile at the level of the inferior orbital rims, while the LeFort III fracture may produce mobility of the entire midface. Examination of facial sensation is tested to determine any deficits, especially in the infraorbital nerve distribution. The oral cavity is inspected and any malocclusion should be documented. A thorough eye exam should be performed including visual acuity, inspection of the anterior chamber and the retina, pupillary reflexes, and extraocular movements. Due to the rate of associated ocular injury previously discussed, ophthalmologic consultation may be indicated in many situations.

Plain film xrays have largely been replaced by computed tomography in the evaluation of patients with maxillary and ZMC fractures. CT of the face with axial and coronal cuts allows more precise diagnosis of these facial fractures. If other injuries will not allow coronal cuts to be obtained, coronal reconstructions may be made from an axial scan. Evaluation of the CT scan includes noting location of fractures, displacement, comminution, status of vertical and horizontal buttresses, and condition of the orbit.

## **Treatment of maxillary fractures**

The treatment of maxillary fractures has moved away from delayed intervention and toward early repair via concealed incisions with open reduction and rigid plating with miniplates. A single stage procedure may be performed with bone grafting as necessary and resuspension of the soft tissues following repair.

Direct exposure of fractures may be obtained via several incisions. A hemicoronal or bicoronal approach provides access to the zygomatic arch, superior orbit and nasoethmoid area. An incision posterior to the hairline is dissected anteriorly just superficial to the superficial layer of deep temporal fascia. Approximately 2cm above the zygomatic arch the temporal fat pad is visualized. This is entered by incising the fascia and dissection is carried down over the arch in a subperiosteal plane protecting the frontal branch of the facial nerve. Access to the orbital floor

and infraorbital rim is obtained via a transconjunctival incision with lateral canthotomy/cantholysis as necessary for exposure. Use of this approach may have less risk of ectropion than a subciliary approach. The maxilla up to the orbital rims may be exposed via an incision in the upper gingivolabial sulcus which can be carried bilaterally. The entire midface may also be exposed by using a facial degloving approach where a circumvestibular incision is connected to transfixion and intercartilaginous incisions in the nose.

Following exposure of the fractured segments the fractures must be reduced to reconstruct the width, vertical height and projection of the face. Severely displaced fractures may be reduced with Rowe disimpaction forceps. If the height of the mandible is intact, than placing the patient in occlusion with maxillomandibular fixation provides a base to work from. Gruss has emphasized the importance of the zygomatic arch in reconstruction of midfacial fractures. The zygomatic arch in its position between the temporal bone and the zygoma determines the position of the zygoma in relation to the skullbase and provides an outer facial frame. Once the zygomatic arch has been reconstructed, this provides an outer facial frame from which reconstruction can proceed from lateral to medial. Rohrich and Shewmake have advocated the use of early bone grafting to replace missing or damaged bone taken from split calvarial or rib grafts. Following repair of the underlying facial skeleton the periosteum should be closed where possible and the soft tissue can be resuspended from the orbital rims through drill holes or to orbital rim plates.

## **Treatment of ZMC fractures**

Zygomaticomaxillary complex fractures range from nondisplaced fractures of one or more sutures to comminuted tetrapod fractures. Those fractures which are nondisplaced and nonmobile may be treated with a soft diet, protection of the malar eminence and close observation. Displaced fractures can be treated via open reduction and fixation at one more of the sutures as needed to provide a stable reduction. The use of plates and screws provides stability in all 3 planes. The use of a Carroll-Girard screw placed in the zygoma can be helpful in reducing these fractures. The lateral orbital wall at the sphenozygomatic suture provides the best three dimensional guide to reduction. The frontozygomatic suture may be exposed via hemicoronal, lateral brow or upper blepharoplasty incisions. The inferior orbital rim and orbital floor can be approached via a transconjunctival incision with or without lateral canthotomy/cantholysis. The zygomaticomaxillary suture is exposed through an intraoral incision. If the zygomatic arch is comminuted it may be approached via a **hemicoronal incision**.

## **Orbital Exploration**

Fractures of the maxilla and zygomaticomaxillary complex frequently involve the orbit. Failure to repair depressed floor fractures can lead to increased orbital volume with resultant enophthalmos and diplopia. Shumrick et al reviewed the indications for exploration of the orbital floor. In their report of 97 patients with either ZMC or midface fractures those explored using their criteria all had significant traumatic disruptions. There were no episodes of enophthalmos or diplopia in those not explored. The criteria were: 1) Persistent diplopia which failed to improve in 7 or more days, positive forced duction testing, and radiologic evidence of perimuscular tissue entrapment 2) Cosmetically significant and clinically apparent enophthalmos associated with radiological findings 3) Radiological evidence of significant comminution and/or displacement

of the orbital rim 4) Radiological evidence of significant displacement or comminution of greater than 50% of the orbital floor with herniation of soft tissue into the maxillary sinus 5) Combined orbital floor and medial wall defects with soft tissue displacement noted radiologically on CT scans 6) Radiological evidence of a fracture or comminution of the body of the zygoma itself as determined by CT 7) Physical or radiological evidence of exophthalmos or orbital content impingement caused by displaced periorbital fractures.

## **Orbital reconstruction**

The orbital floor is explored with subperiosteal dissection around the complete circumference of the defect. Any soft tissues entrapped are removed from the maxillary sinus. Defects of 50% or more of the orbital floor have a high incidence of enophthalmos and should be reconstructed. The options for reconstruction of the floor include use of autogenous tissue such as split calvarial bone, iliac crest bone, septal cartilage, or auricular cartilage or alloplastic implants such as gelfilm, polygalactin film, silastic, marlex mesh, Teflon, Prolene, porous polyethylene, or titanium. Autogenous tissues have the benefit of a lower risk of infection but have the disadvantages of additional operative time, donor site morbidity, and variable graft absorption. Alloplastic implants have the advantages of decreased operative time, no donor site morbidity, easy availability, and permanent materials have no absorption. The disadvantages include a risk of infection (0.4-7.0%) or implant migration. Whichever material is used in reconstruction, forced duction testing after insertion of the implant can demonstrate that orbital tissue has not become entrapped by the implant during the procedure.

## **Conclusions**

The management of maxillary and periorbital fractures has advanced in recent decades with accurate diagnosis by CT, extended access approaches via concealed incisions, and open reduction and fixation with plates and screws. Evaluation of involved buttresses in the facial skeleton allows operative planning for repair. With early, accurate repair of these injuries more patients will be returned to their pretraumatic state.

## Bibliography

1. Doerr TD, Mathog RH. LeFort Fractures. In: Papel ID, ed. *Facial Plastic and Reconstructive Surgery*, Second Edition. New York, Thieme, 2003:759-768.
2. Rohrich RJ et al. Optimizing the Management of Orbitozygomatic Fractures. *Clinics in Plastic Surgery* 1992;19(1):149-165.
3. Gruss et al. The Importance of the Zygomatic Arch in Complex Midfacial Fracture Repair and Correction of Posttraumatic Orbitozygomatic Deformities. *Plastic and Reconstructive Surgery* 1990;85(6):878-890.
4. Strong EB, Sykes JM. Zygoma Complex Fractures. *Facial Plastic Surgery* 1990;14(1):105-115.
5. Marciani RD. Management of Midface Fractures: fifty years later. *J Oral Maxillofac Surg* 1993;51:960-968.
6. Ellis E, Kittidumkerng W. Analysis of Treatment for Isolated Zygomaticomaxillary Complex Fractures. *J Oral Maxillofac Surg* 1996;54:386-400.
7. Al-Qurainy et al. The Characteristics of Midfacial Fractures and the Association With Ocular Injury: a prospective study. *British J Oral and Maxillofac Surg* 1991; 29:291-301.
8. Rohrich RJ, Shewmake KB. Evolving Concepts of Craniomaxillofacial Fracture Management. *Clinics in Plastic Surgery* 1992;19(1):1-10.
9. Manson PN. Some Thoughts on the Classification and Treatment of LeFort Fractures. *Annals of Plastic Surgery* 1986;17(5):356-363.
10. Haug RH et al. Comparison of the morbidity associated with maxillary fractures treated by maxillomandibular and rigid internal fixation. *Oral Surgery Oral Medicine Oral Pathology* 1995;80(6):629-637.
11. Haug RH, Buchbinder D. Incisions for Access to Craniomaxillofacial Fractures. *Atlas of the Oral and Maxillofacial Surgery Clinics of North America* 1993;1(2):1-29.
12. Ellis E, Tan Y. Assessment of Internal Orbital Reconstructions for Pure Blowout Fractures: Cranial Bone Grafts Versus Titanium Mesh. *J Oral Maxillofac Surg* 2003;61:442-453.
13. Patel BCK, Hoffman J. Management of Complex Orbital Fractures. *Facial Plastic Surgery* 1998;14(1):83-104.
14. Donat TL et al. Facial Fracture Classification According to Skeletal Support Mechanisms. *Arch Otolaryngol Head Neck Surg* 1998;124:1306-1314.
15. Shumrick KA et al. Criteria for Selective Management of the Orbital Rim and Floor in Zygomatic Complex and Midface Fractures. *Arch Otolaryngol Head Neck Surg* 1997;123(4):378-384.
16. Brandt KE et al. The Management of Mid-face Fractures with Intracranial Injury. *The Journal of Trauma* 1991;31(1):15-19.
17. Manson PN et al. Subunit Principles in Midface Fractures: The Importance of Sagittal Buttresses, Soft-Tissue Reductions, and Sequencing Treatment of Segmental Fractures. *Plastic and Reconstructive Surgery* 1999;103(4):1287-1306.
18. Baumann A, Ewers R. Use of the Preseptal Transconjunctival Approach in Orbit Reconstruction Surgery. *J Oral Maxillofac Surg* 2001;59:287-291.
19. Haug RH et al. An Epidemiologic Survey of Facial Fractures and Concomitant Injuries. *J Oral Maxillofac Surg* 1990;48:926-932.
20. Zingg M. et al. Treatment of Zygoma-Lateral Orbital Complex Fractures. *Arch Otolaryngol Head Neck Surg* 1991;117:611-622.

21. Shaw GY, Khan J. Precise Repair of Orbital Maxillary Zygomatic Fractures. *Arch Otolaryngol Head Neck Surg* 1994;120:613-619.
22. Champy M. et al. Attempt at systematization in the treatment of isolated fractures of the zygomatic bone: techniques and results. *The Journal of Otolaryngology* 1986;15(1):39-43.
23. Hollier LH et al. The Management of Orbitozygomatic Fractures. *Plastic and Reconstructive Surgery* 2003;111(7):2386-2392.
24. Rohrich RJ, Watumull D. Comparison of Rigid Plate versus Wire Fixation in the Management of Zygoma Fractures: A Long-Term Follow-up Clinical Study. *Plastic and Reconstructive Surgery* 1995;96(3):570-575.
25. Jensen J. et al. Rigid Fixation in Reconstruction of Craniofacial Fractures. *J Oral Maxillofac Surg* 1992;50:550-554.
26. Klotch DW, Gilliland R. Internal Fixation vs. Conventional Therapy in Midface Fractures. *The Journal of Trauma* 1987;27(10):1136-1145.
27. Stanley RB. The Zygomatic Arch as a Guide to Reconstruction of Comminuted Malar Fractures. *Arch Otolaryngol Head Neck Surg* 1989;115:1459-1462.
28. Stanley RB. Maxillary and Periorbital Fractures. In :Bailey BJ ed., *Head and Neck Surgery-Otolaryngology*, third edition, Philadelphia, Lippincott Williams & Wilkins 2001:777-792.
29. Celin SE. Fractures of the Upper Facial and Midfacial Skeleton. In: Myers EN ed., *Operative Otolaryngology Head and Neck Surgery*, Philadelphia, WB Saunders Company 1997:1143-1192.