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Evaluation of results with three-point visualization of zygomaticomaxilllary complex fractures

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Objective. To retrospectively evaluate the results of three-point visualization and liberal rigid fixation for the treatment of unilateral zygomaticomaxillary fractures by assessing the incidence and severity of complications.
Study design. Fourteen patients were examined an average of 19 months after 3-point visualization with multiple points of rigid fixation for their unilateral zygomaticomaxillary fractures. Patients were evaluated for asymmetry in globe position, superior tarsal fold size, diplopia, lateral canthus height, and malar projection.
Results. The following were found: two patients with significant changes in globe position, none with diplopia in direct gaze, two with diplopia in extreme gazes, two with severe tarsal fold asymmetry, five with mild tarsal fold asymmetry, and two with noticeable malar asymmetry.
Conclusion. Three-point visualization and liberal rigid fixation for zygomaticomaxillary fracture treatment results in a low incidence of complications that are proportional in severity to the trauma sustained.
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Zygomaticomaxillary complex (ZMC) fractures are one of the more common types of maxillofacial injuries to treat.[1, 2] Because of the intimate relationship of the zygoma with numerous other structures of the face, stable reduction of ZMC fractures is paramount to restoring preinjury function and esthetics. A review of the literature shows that secondary repair of ZMC fractures is less successful at restoring their position and function than surgical repair soon after injury.[3-11] Many different treatment modalities have been advocated to repair ZMC fractures, each with differing success rates.[10, 12-15] With the advent of rigid fixation, there has been a philosophy that stresses wide visualization and accurate reduction combined with 3-point fixation to precisely approximate the fractured segments.[2-4, 7, 13, 16-20] It is felt that this more aggressive therapy will improve functional and esthetic results with fewer complications.

A review of articles on ZMC fracture management reveals a plethora of information on the anatomy, incidence, causes, categorization, associated injuries, and potential early and late complications of ZMC fractures.* The actual incidence of late complications of ZMC fracture repair has received scant attention.† In addition, there has been little attempt to correlate the severity of the injury with the degree of postoperative complications.

Obviously, ZMC fracture severity varies with the cause.[3, 14, 16] Similar to maxillary/midface fracture concepts, the ZMC may receive low- to high-energy trauma and sustain proportional injury.[3, 16] For example, the degree of complexity and displacement may vary between a ZMC fracture caused in a high-speed motor vehicle accident (MVA) versus one caused by a single closed-handed blow in an interpersonal altercation.[3]

Complications of ZMC fracture and repair include the following: limited mandibular range of motion, lack of malar projection, diplopia, enopthalmos, vertical globe displacement, canthal detachments, retrobulbar hemorrhage, ectropion, palpebral fold

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*3,6,10,12,14,17,20,21
†2,3,9,10,12,14,20

Table I. Results summary

	Severe injury group N = 8	*Mild to moderate injury group N = 6*	*Total group N = 14*	*Percentage 100%*
A-P globe position				
>2 mm asymmetry	1	0	1	(7%)
<2 mm asymmetry	7	6	13	(93%)
Vertical globe position				
>2 mm asymmetry	1	0	1	(7%)
<2 mm asymmetry	7	6	13	(93%)
Diplopia on examination				
in direct gaze	0	0	0	(0%)
in extreme gazes	1	1	2	(14%)
Canthal height				
>2 mm asymmetry	3	0	3	(23%)
<2 mm asymmetry	5	6	11	(77%)
Malar projection				
Symmetric	4	3	7	(51%)
Mild asymmetry	2	3	5	(35%)
Severe asymmetry	2	0	2	(14%)
Tarsal folds				
Symmetric	3	4	7	(51%)
Mild asymmetry	3	2	5	(35%)
Severe asymmetry	2*	0	2*	(14%)

*Both severe tarsal fold asymmetries have a superimposed facial nerve weakness affecting the observed asymmetry.

changes, epiphora, ptosis, entrapment of extraocular muscles, herniation of orbital fat, and more.* Various intraglobular injuries from corneal abrasions to open globe injuries are commonly encountered with ZMC trauma as well and necessitate a thorough physical exam.[9, 21, 22] The postoperative position of the globe is affected by two main variables: restoration of the three-dimensional position of the zygoma in space and the integrity of the orbital walls.[2-8, 10, 11, 16, 18] Therefore when a ZMC fracture is repaired, it is necessary to restore the complex to its original position and then explore the orbital walls and graft bony defects to return the orbital contents to their original position.[3, 5, 7, 11, 18]

Although the aforementioned lists of complications from ZMC fracture repair are quite heterogeneous, ocular problems involving anteroposterior (A-P) and vertical globe position, extraocular movements, lateral canthal position, and palpebral fold changes can be the most disfiguring and most difficult to correct.[3, 5, 6, 8, 10] Hence the purpose of this retrospective study was to evaluate the results of using a surgical technique of wide access in combination with three-point visualization and fixation by analyzing patient's postoperative zygoma and globe position.

MATERIAL AND METHODS

The charts of 100 patients who were treated for ZMC fractures by the Oral and Maxillofacial Surgery Department at University Hospital between August 1990 and January 1994 were reviewed. Fifty of these patients fulfilled the inclusion criteria of a unilateral ZMC fracture that was treated within 2 weeks of injury by three-point visualization or rigid fixation at the frontozygomatic suture, the infraorbital rim, and the zygomatic buttress regions. Fourteen of these patients were available for examination by an independent trained examiner who did not participate in any of the surgical procedures. The other patients were not able to be contacted or were otherwise unavailable for follow-up.

Patients with bilateral ZMC fractures were excluded to facilitate symmetry assessments. Isolated arch fractures were also excluded because of their limited impact on ocular changes. To differentiate between degrees of fracture severity, patients who required orbital reconstructions were considered to have severe fractures, whereas patients who received no orbital grafting were considered to have mild to moderate fractures (Table I).

Patients were asked to answer a questionnaire and were examined clinically for symmetry discrepancies involving A-P globe projection, vertical globe position, lateral canthal level, superior tarsal fold size, malar projection, and diplopia direct and extreme gazes. Questionnaires were used to evaluate the patient's perception of visual changes, sensation disturbances, and esthetic results and included a 100-mm visual analog scale to rate overall satisfaction.

A-P globe position was measured with a Hertell exopthalmometer (Marco, Jacksonville, Fla.). Vertical globe position and lateral canthal level were measured bilaterally from a line connecting the supraor-

*2,3,6-8,10,14,20,22

bital ridges. Malar projection, trigeminal sensation, and superior tarsal fold changes were evaluated subjectively by the independent examiner (G.J.M.). Diplopia was assessed in the six cardinal positions of gaze. Then the results of the clinical examination were compared with the medical record and the following complications were noted for the fractured side: enopthalmos versus exopthalmos, excessive superior versus inferior globe position, excessive superior versus inferior canthus displacement, malar projection excess or deficiency, superior tarsal fold excess or deficiency, and diplopia.

RESULTS

Fourteen patients, 11 men (78%) and 3 women (22%), with an average age of 27 (range, 14 to 46 years) were examined at an average of 19.5 months after surgery (range, 4 to 41 months). All patients examined had undergone open reduction and internal fixation of their unilateral ZMC fractures within 11 days after their injury (average, 5 days). Nine patients (64%) were involved in assaults, four patients (29%) in MVAs, and one patient in a sporting accident.

Three patients had additional facial trauma between their initial injury and follow-up appointments. These traumas were judged to have minimal impact on their previous ZMC surgery results and consisted of a nondisplaced nasal fracture in one male, a mandibular angle fracture in one female, and a mild facial impact from a low-speed MVA involving another male. In addition, four patients underwent facial surgery between their initial injury and follow-up appointments. Three of these procedures had minimal impact on the results of the ZMC fracture surgery and consisted of an elective rhinoplasty/dermabrasion, removal of an infraorbital rim plate 6 months postoperatively, and closed reduction of a mandibular angle fracture 12 months postoperatively. One patient with a severe injury required secondary reconstruction of his zygomatic region 8 months after his initial surgery. This patient's original injuries included permanent, complete, ipsilateral traumatic optic neuropathy, epidural hematoma, contralateral cranial nerve VII weakness, multiple facial lacerations, and ipsilateral mandible fracture.

All patients underwent direct visualization of their ZMC fractures at at least three points (the frontozygomatic suture, the infraorbital rim, and the zygomatic buttress) Eight (58%) patients received three points of fixation, three (21%) patients were treated at more than three points of fixation (usually as a result of multiple midface fracture lines), and three (21%) patients received two points of fixation.

Eight (58%) patients required orbital floor grafting and were placed in the severe injury group. The remaining six (42%) patients who did not receive orbital floor reconstruction were placed in the mild to moderate injury group (Table I). Freeze-dried demineralized bone and various alloplastic materials were used for orbital floor reconstruction.

Most patients appeared symmetric with respect to globe position in the A-P and vertical dimensions. Five (35%) patients had less than 2 mm of enopthalmus, four (29%) patients had equal A-P globe projection, and four (29%) patients had less than 2 mm of exopthalmus as compared with the nonfractured side. One (7%) patient who had 4 mm of enopthalmos also had severe initial injuries, a secondary zygomatic reconstruction, and ipsilateral traumatic blindness. Five (35%) patients had less than 2 mm of inferior globe displacement on the fractured side, seven (51%) patients had equal vertical globe levels, and one (7%) patient had less than 2 mm of superior globe displacement. One patient had 4 mm of inferior globe displacement on the fractured side. In summary, 13 (93%) patients had their A-P and vertical globe positions on the fractured side within 2 mm of the same positions on their unaffected side.

None of the patients exhibited diplopia in direct gaze or gross restriction of extraocular movements. When tested, two (14%) patients were found to have mild diplopia in extreme downward and convergent gazes. Another patient, in whom secondary gain was suspected, claimed to have double vision on occasion but not at the time of the examination.

Lateral canthus levels were compared bilaterally. Four (28%) patients had equal canthus heights, five (35%) patients had less than 2 mm of inferior displacement of the canthus on the fractured side, and two (14%) patients had less than 2 mm of superior displacement on the fractured side. The patients with severe injuries who had undergone two ZMC surgical procedures had 3 mm of superior canthal displacement, and another two patients who presented with a severe ipsilateral canthus lacerations had 3 mm of inferior canthal displacement. In summary, 11 (77%) patients had the vertical level of the canthus on their fractured side within 2 mm of the same position on the unaffected side.

Malar projection was estimated by palpating and viewing both zygomas from the submentovetex and superioraxial views. Seven (51%) patients appeared to have symmetric malar prominence and another five (35%) patients were mildly asymmetric. One (7%) patient was assessed with moderately excessive projection, and the patient with severe injuries and two surgeries had severely excessive zygomatic projection.

Superior tarsal fold size was assessed with patients in repose. Seven (51%) patients were observed to have essentially symmetric superior tarsal folds, whereas five (35%) patients had mild to moderate increases in the size of the superior tarsal fold on the fractured side. There were two patients with seventh cranial nerve weakness, one was ipsilateral and the other contralateral to the fractured side; these resulted in severe tarsal fold asymmetry.

Questionnaires included a variety of patient perception information and therefore had varied answers. Four (29%) patients had visual acuity complaints ranging from "floaters" and the new need for corrective lenses to complete ipsilateral blindness. Two patients, as noted earlier, complained of persistent double vision but only in the extreme downward and convergent gazes. An additional patient claimed to have sporadic double vision when his eyes begin to tire. Complaints about current or previous sensory changes in the cheek and upper lip seem to be ubiquitous (93%) throughout our patient pool and range in severity from mild occasional tingles to profound anesthesia that was always bothersome. Six (43%) patients report that portions of the fixation plates could be felt under the skin but were not a true nuisance. Four (29%) patients complained that weather and temperature changes cause pain, numbness, tightness, etc. and makes them more aware of their surgical site(s). Eight (58%) patients have reported increased difficulty with maxillary sinus congestion or allergies; two patients characterized this as severe. In addition, eight (58%) patients had complaints regarding their facial esthetics, ranging from subtle noticability of scars to complete displeasure with the entire result. Our overall satisfaction rating on the 100-mm visual analog scale averaged to 75% (range, 20% to 100%).

DISCUSSION

Because of this study's retrospective nature, it has several recognizable problems. First, treatment plans were not standardized, rather patients were randomly grouped into general categories on the basis of circumstantial similarities in treatment. Second, follow-up intervals were not prearranged, therefore final data were obtained at different postoperative times. Patients treated many months before by various surgeons had to be located and recalled for examination. Finally, the only control available was our negative historic experience with less aggressive approaches. It is obvious that many challenges similar to these are inherent to retrospective studies.

This study also encountered frustrations associated with trauma-based patient pools familiar to many training programs. Many of the patients could not miss time from work or family care for what they perceive to be frivolous reasons. in addition, many did not have phone numbers or permanent addresses. Several simply did not show up after being given multiple appointments.

Given the above situations it should be understandable how this study's largest shortcoming, low absolute patient number, arose. Nonetheless the data reveals trends that support the concept of extensive visualization and liberal fixation in the surgical management of ZMC fractures.[2-4, 7, 13, 16-30]

The evaluation of the treatment modalities used with trauma patients is very difficult because of the unique nature of each individual injury. The cause and severity of the injury as well as the existence of other injuries is far from standardized between patients, therefore true comparison between patients is impossible. It seemed logical to place patients into severe and mild to moderate fracture severity groups on the basis of their individual need for orbital floor reconstruction (Table I). This is because when compared with milder injuries trauma that disrupts the orbital floor tends to be of a higher energy and the resulting defect represents an additional mechanism for changes in globe position.[3, 16]

Overall, the vast majority of ocular and facial asymmetries observed in this study regarding A-P globe position, vertical globe position, diplopia, canthal height, malar projection, and tarsal fold size were at worst of minimal discrepancy (Table I). The differences between fractures and nonfractured sides were easily within acceptable limits. The few patients who had more marked asymmetry for a given facial feature were all members of the more severely injured group (Table I).

If one accepts that virtually every human face is mildly asymmetric then mild deviations from perfect symmetry are actually normal.[23] For example, A-P globe projection is one of the most important esthetic and functional symmetries of the human face.[3, 8, 10, 23] Normal variation in A-P globe projection between eyes in a healthy uninjured person has been found to be 2 mm or less.[24] Variation beyond 2 mm between eyes is associated with visual disturbances.[24, 25] If these "normal" perameters are applied to the various less sensitive characteristics observed in this study, not only would A-P globe projection be considered clinically acceptable in most (93%) patients but vertical globe position (93%), absence of significant diplopia (100%), lateral canthus position (77%), malar projection (86%), and superior tarsal fold size (86%) would also be considered within normal limits (Table I).

Answers to questionnaires were disappointing in this study. The worst complaints involved sensory disturbances in the distribution of the trigeminal nerve on the fractured side. Other complaints, primarily visual disturbances, were mild in nature and of little if any true annoyance. Two patients complained of greatly increased sinus congestion, and another two patients were markedly displeased with their facial esthetics. All four of these patients were from the more severe injury group and, in two, secondary gain was strongly suspected. The visual analog satisfaction percentage (75%) was 10 to 15 points below expected, but if patients in whom secondary gain is suspected are eliminated, the average increases to 81%.

Our rationale for using three-point visualization and liberal fixation to treat ZMC fractures comes from basic fracture management theories.* Studies as early as Karlan and Cassini[20] in 1979 have shown that one- and two-point access approaches do not allow for adequate restoration of the three- dimensional pattern of ZMC fractures. Stabilization with the later approaches often allows bony union to occur with skewed anatomy and the sequelae of increased orbital volume, enopthalmos, inferior globe displacement, diplopia, and malar projection deficiency.[2, 3, 16, 19, 20] These architectural changes can lead to functional and esthetic defects that are objectionable and very difficult to repair secondarily.[3-11]

The disadvantages of three-point fixation include increased surgical time, additional surgical scars, and additional hardware. We believe that these considerations are far outweighed by the advantages. Ample visualization with three well-placed incisions allows for as anatomic a reduction as possible.[2-4, 7, 16, 17, 19] Immediate graft placement is possible if reconstruction of the anterior maxillary wall is necessary as fracture/graft segments can be affixed to the buttress miniplate.[7, 19] Orbital rim and wall fragments are brought into their correct anatomic relationship from which orbital exploration and repair can proceed with a high degree of confidence and accuracy.[2, 3, 7, 8, 11, 17] Postoperative stabilization is unquestionable. No additional cutaneous incisions are necessary, and an extra buttress plate can be placed under a very inconspicuous soft tissue overlay.[2, 3, 7, 16] Although postoperative infection rates are theoretically higher for a number of reasons, it has been our experience that postoperative systemic antibiotics coupled with adequate hygiene and antibacterial mouthrinses result in infection rates similar to other modalities used to treat ZMC fractures.

In our results, we have reported a minimal incidence of marked A-P and vertical globe displacement, diplopia, projection deficiency, and ocular soft tissue changes with the use of the three-point visualization technique for repair of ZMC fractures. As expected, more severe and complex injuries correlated with increased difficulty of repair as well as increased incidence and severity of postoperative complications.

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