A Rare Fracture Pattern with Extensive Disruption of the Zygomatico-Orbito-Maxillary Complex

Priya Jeyaraj
Commanding Officer Military Dental Centre (Gough Lines), Secunderabad, Telangana, India

Abstract

A case of an unusually oriented fracture pattern and significant disruption of the right Zygomatico-orbito-maxillary complex, with severe comminution and gross displacement of its skeletal components, is described. Wide surgical access to all the fracture sites was provided by a combination of hemicoronal and intraoral surgical approaches. This enabled successful reduction, precise reapproximation, and stable fixation of the multiple displaced fracture fragments. An excellent restoration of the skeletal morphology and orbital volume to their original, preinjury status was achieved, obviating the development of any residual facial deformity, functional deficit or ocular complications.

Keywords: Hemicoronal approach, rare maxillofacial fracture pattern, zygomatic complex fracture

INTRODUCTION

The zygomatico-orbito-maxillary complex plays a key role in the structure, function, and esthetic appearance of the facial skeleton.[1] It provides normal cheek contour and separates the orbital contents from the temporal fossa and the maxillary sinus.[2] The prominence of the zygomatic region predisposes it to bear the brunt of the facial injuries.[3] Due to its prominent position, it is the second-most common mid-facial bone likely to be fractured, following the nasal bones and overall represents 13% of all cranio-maxillofacial fractures. The etiology of such injuries includes interpersonal trauma, road traffic collisions, falls, and contact sports.[4]

Reducing zygomatic complex fractures can become increasingly challenging if they are comminuted or involve multiple buttresses.[5] Precise repositioning of the malar complex with a three dimensional accuracy is imperative to obviate the possibility of residual facial deformity, ocular complications and debilitating functional deficits. These unfavorable outcomes could require secondary procedures, including redo surgeries, which usually result in unsatisfactory esthetic and functional outcomes. Further, owing to the proximity of branches of the facial nerve to both the site of injury as well as the field of surgery and dissection, neurological deficits are often a troublesome sequela of surgical management of these injuries. Careful attention to the surgical anatomy and a meticulous surgical technique are imperative for successful long-term results.

CASE REPORT

A 27-year-old male patient reported with maxillofacial injuries sustained in a fall from a two-wheeler. He complained of pain and swelling of the right side of the face, extreme difficulty in opening his mouth and a grating sound from the right side of his jaw when he attempted to do so. He also complained of double vision, watering from the right eye and an inability to bite or chew. History revealed that the patient had not been wearing a helmet at the time of the accident, and had been struck on the right side of his face by the handlebar of his two-wheeler, as he fell. There was no history of vomiting or loss of consciousness, however there had been bleeding from the right nostril, which abated in a few hours.

Address for correspondence: Dr. Priya Jeyaraj, Commanding Officer Military Dental Centre (Gough Lines), Secunderabad, Telangana, India. E-mail: jeyarajpriya@yahoo.com

How to cite this article: Jeyaraj P. A rare fracture pattern with extensive disruption of the zygomatico-orbito-maxillary complex. Ann Maxillofac Surg 2020;10:220-6.
On examination, the patient presented with a large, firm and
tender dome-shaped swelling of the right cheek. There was
extensive periorbital edema, and subconjunctival ecchymosis of
the right eye, as well evidence of enophthalmos [Figure 1a–e].
Ocular movements were restricted on the right side and there
was monococular diplopia. Although there was no derangement
of occlusion, there was severe restriction in mouth opening
[Figure 1f]. Oral hygiene was poor, with calculus deposits
and generalized gingivitis [Figure 1f and g]. On palpation,
there was tenderness, crepitus and step deformity at the
frontozygomatic suture region, the infraorbital rim and the
zygomatic arch region on the right side. Intraorally, buccal
vestibular palpation revealed tenderness and step deformity
at the zygomatic buttress region. The patient demonstrated a
weakness and paresis of the marginal mandibular division of
the facial nerve on the right side, which was attributed to the
trauma sustained in the fall.

Imaging studies
Radiographs (Orthopantomogram, Lateral View Skull and
Water’s View Skull) [Figure 2a, c and e] revealed a right
zygomatico-orbito-maxillary complex fracture with extensive
comminution of the right zygomatic arch and an unusual
fracture pattern which ran horizontally across the body
of the zygomatic bone with severe downward displacement
of its lower half, together with significant disruption of the
right maxillary antrum and zygomatic buttress region. There
was a gross separation at the right frontozygomatic suture
causing a downward descent of the lateral orbital wall, as well
as fracture of the orbital floor with a downward displacement
of the entire malar complex, resulting in an increase in the
orbital volume.

Non-contrast computed tomographic scans (NCCT)
of the craniofacial region (axial, coronal and sagittal sections with three-dimensional reformatting)
[Figures 1h and 3] revealed an unusual pattern and orientation
of fracture lines involving multiple areas of the entire right
zygomatico-orbito-maxillary complex, associated with severe
comminution and extensive displacement of the numerous
fracture fragments. There was gross comminution of the right
zygomatic arch into multiple small fragments in association
with disjunction and separation between the zygomatic
process of the temporal bone from the temporal process of the
zygomatic bone. The body of the right zygoma had a horizontal
fracture line running across its entire breadth with severe
downward displacement of its lower half and wide separation
between the upper and lower fragments [Figure 3]. The lateral
orbital rim was fractured at the frontozygomatic suture region,
with inferior displacement of the lower fragment. The inferior
orbital rim too was fractured with a downward displacement of
the lateral two-third of the orbital floor, resulting in an increase
in the orbital volume.

There was observed severe comminution and displacement
of both, the anterolateral as well as posterolateral walls of
the right maxillary antrum and disruption with separation at
the zygomatic buttress region. In addition to hemosinus, the
interior of the antrum was filled with multiple fragments and
spicules of bone collapsed and detached from the antral walls
[Figure 3].

The patient was planned for open reduction and internal
fixation of the displaced and comminuted fractures of
the right zygomatico-orbito-maxillary complex under
general anaesthesia (GA), through a combination of a

![Figure 1: Maxillofacial injuries sustained in a fall from a 2-wheeler. (a-e) Swelling of the right cheek region, periorbital edema, and ecchymosis with subconjunctival hemorrhage and marked enophthalmos with epiphora, restriction in ocular movements and diplopia. (f) Severely restricted interincisal mouth opening (g) No derangement on occlusion noted. (h) Non-contrast computed tomographic of craniofacial region demonstrating grossly displaced and comminuted fracture of the right zygomatico-orbito-maxillary complex region]
right hemicoronal and intraoral upper buccal vestibular approaches. A thorough systemic evaluation of the patient was carried out. Routine investigations including hematological and urine analysis, electrocardiogram, and chest radiographs were performed to rule out any comorbidities. Standard preoperative preparation of the patient for surgery under GA was carried out, which included a complete head shave.

Figure 3: Preoperative non-contrast computed tomographic scans. (a) Three dimensional images showing an unusual fracture pattern of the right zygomatico-orbito-maxillary complex. A horizontally oriented displaced fracture running across the body of zygoma. (b) Sagittal sections showing disjunction at all the articulations of the zygoma. (c) Coronal sections showing the grossly increased right orbital volume. (d) Axial sections showing gross comminution of the right zygomatic arch, disruption of the anterolateral and posterolateral walls of the right maxillary antrum, with hemosinus...
Operative procedure

Owing to the severe restriction in mouth opening, GA was administered through fiberoptic assisted nasoendotracheal intubation. The patient was scrubbed and draped. The hemicoronal incision line was marked \[Figure 4A\] and 2% lignocaine with 1:100,000 adrenaline was infiltrated subcutaneously along this line. Hemostatic sutures were placed on both sides of the proposed incision line to reduce bleeding from the edges of the scalp flap \[Figure 4B and C\]. The incision was placed through the skin, closely adherent subcutaneous tissue and the galea underneath, up to the level of the loose areolar tissue. As the incision proceeded laterally toward the temporal region, the incision was carried through the temporoparietal fascia, taking due care not to incise the temporalis fascia. A large curved hemostat was introduced into the upper end of the incision, and spread open in the subgaleal plane. Dissection then proceeded using the blunt finger dissection method by easy separation of the scalp flap from the underlying pericranium in a forward direction. Once the correct, relatively avascular subgaleal plane was established, the separation of the scalp flap proceeded effortlessly up to the helix of the ear \[Figure 4D and E\]. Thereafter, a combination of sharp and blunt dissection was used to proceed inferiorly in the same plane as the upper part of the incision, namely the plane just below the temporoparietal fascia and above the temporalis fascia. The lateral orbital wall, supraorbital rim, and zygomatic arch were easily palpable through the intervening tissues. The yellowish temporal fat pad was visible through the thin glistening superficial layer of the temporalis fascial. As the dissection proceeded inferiorly, branches of the auricular and middle temporal vessels were ligated when encountered. The end of the incision was at the level of the ear lobe, in order to permit adequate inferior exposure as well as ease to turn over the scalp flap downward and forward to access the full length of the zygomatic arch, body, lateral orbital wall and frontozygomatic regions.

A long incision was placed beginning from the root of the zygomatic arch and carried forward at an angle of 45° through the superficial layer of the temporal fascia, exposing the temporal fat
Jeyaraj: A rare fracture pattern of the zygomatic complex

Figure 5: (a-d) Postoperative non-contrast computed tomographic scans. (a) Three-dimensional images showing precisely reduced and well-aligned fracture fragments. (b) Sagittal sections showing precise reapproximation and fixation at the frontozygomatic suture region, lateral orbital wall, infraorbital rim, and zygomatic arch. (c) Coronal sections depicting restoration of the orbital volume. (d) Axial sections showing reapproximation of the multiple comminuted fracture fragments of the right zygomatic arch, precise realignment of the lateral wall of the right orbit and frontozygomatic region, fixed in place with micro- and minibone plates and screws.

Figure 6: (a) Restoration of facial symmetry, balance and esthetics. Successful correction of enophthalmos of the right eye, with achievement of bilaterally symmetrical ocular levels, full, free, and unrestricted ocular movements and absence of diplopia in all gazes. (b and c) Hemicoronal incision scar healing well and well camouflaged within the hairline. (d-f) Absence of any neurological deficit involving the frontal and temporal divisions of the facial nerve, evidenced by unaffected eye closure and normal raising of eyebrows and forehead wrinkling on looking upwards.

pad in the pocket just beneath this layer [Figure 4F and G]. This incision was extended up to the upper border of the lateral orbital wall. This flap was turned over, the periosteum over the lateral orbital wall and the fragmented zygomatic arch was carefully incised and elevated using sharp periosteal elevators. Difficulty was encountered in exposing the arch as it was displaced inferiorly and shattered into multiple small fragments. The displaced fracture of the lateral orbital wall, at the frontozygomatic suture region, was carefully reduced, reapproximated, and fixed using 4-hole titanium minibone plates and screws [Figure 4H], thereby restoring the orbital volume. Upon meticulous exploration of the lateral orbital wall, there was seen a perfect alignment, precise approximation and interdigitation at the zygomatico-sphenoid suture region. Furthermore, following the reduction of the upper half of the horizontally fractured zygoma, the orbital floor and rim were reconstituted precisely and without any defect. Hence, there was no need for a graft or implant for reconstruction of the orbital floor. Next, the multiple, delicate fragments of the shattered arch were exposed [Figure 4I-L], carefully grasped, meticulously reduced, realigned, held in place using mosquito artery forceps [Figure 4M] and fixed using a long, low profile (1.7 mm thick) titanium microplate, and screws [Figure 4N-R]. Dissection was now directed medially and inferiorly, to expose the horizontal fracture across the body of the zygoma. Downward displacement of the lower half of the zygoma was noted with a large intervening...
gap between the upper and lower halves. An intraoral upper vestibular incision was placed following local infiltration of 2% lignocaine with 1:80,000 adrenaline, to expose the anterolateral wall of the maxillary antrum and the zygomatic buttress region on the right side. The descended half of the body of the zygoma was pushed upward by finger pressure applied intraorally against the zygomatic buttress and simultaneous fixation of the body of the zygoma was carried out through the hemiconoral incision site [Figure 4S-U], retaining the upward finger pressure intraorally. In this way, reduction of the horizontally fractured zygoma was via the intraoral approach, while its fixation was via the hemiconoral approach. The comminuted fracture of the anterolateral wall of the right maxillary antrum was then reduced and fixed intraorally using a three-dimensional 4-hole titanium plate and screws [Figure 4V-X].

After ensuring adequate hemostasis, the hemiconoral incision was meticulously closed in layers after placement of a MiniVac closed suction drain and an extraoral pressure dressing was applied [Figure 4Y-AD’]. The intraoral incision was closed using interrupted Vicryl 3-0 sutures.

**Postoperative management**

Postoperative recovery was smooth and uneventful. The patient was placed on injectable analgesics and antibiotics for the first 3 days which were thereafter changed to oral medications for three additional days. The suction drain was removed on the 2nd postoperative day. There was mild postoperative periobital edema which resolved spontaneously over a period of 4 days. There was an immediate and complete resolution of restriction in mouth opening following surgery, due to elimination of the mechanical obstruction in the movement of the coronoid process by the hitherto severely displaced zygomatic arch and body.

Postoperative radiographs [Figure 2b, d and f] and NCCT of the craniomaxillofacial region [Figure 5] demonstrated a good reduction, re-alignment, and approximation of the grossly displaced and severely comminuted fracture of the right zygomatico-orbito-maxillary complex, with restoration of the orbital volume to normal.

Postoperative esthetic and functional results were gratifying [Figure 6] with frontozygomatic suture restoration of ideal facial balance, projection and symmetry, unrestricted interincisal mouth opening, satisfactory masticatory efficiency, and successful correction of the enopthalmos and diplopia. There were nil neurological deficits other than the preexisting paresis of the right marginal mandibular nerve, which was attributable to the trauma of the injury sustained.

**DISCUSSION**

Fractures of the zygomatico-orbito-maxillary complex are commonly observed maxillofacial injuries, resulting from road traffic accidents, sporting accidents, interpersonal violence and falls. The zygoma articulates with the adjacent bones of the craniomaxillofacial skeleton at the zygomatico-maxillary, fronto-zygomatic, zygomatico-temporal or zygomatico-sphenoidal sutural lines. The usual fracture pattern involves the typical “Tetrapod” fracture lines through four distinct regions, the frontozygomatic region, zygomatic buttress, zygomatic arch and infraorbital rim. Except for the frontozygomatic region, the directions of the fracture lines are usually vertical or oblique, running from top to bottom, often accompanied by rotation along either a vertical or rarely, a horizontal axis.

Unusual fracture orientations of the zygomatic complex have occasionally been reported in literature. The architectural pattern of zygomatic bone allows it to withstand blows of great forces without fracturing. An intrinsic strength of the zygoma is such that blows to the cheek usually result in fractures of the zygomatic complex at the suture lines, rarely of the zygomatic bone itself. Even heavy forces cause the zygomatic bone to get separated from adjacent bone at or near the suture lines, rather than being fractured itself. It may be separated from its four articulations, resulting in a zygomatico-maxillary complex, orbito-zygomatic, or zygomatic-orbito-maxillary complex fracture. However, in the case presented, the force and direction of the blow had caused the body of the zygoma itself to be fractured all across its breadth in addition to comminution of the arch and separation at all the suture articulations of the zygomatic bone as well, accompanied by significant displacement.

The extremely unusual fracture pattern involved major fracture lines oriented along a horizontal plane though the zygomatic bone, with a downward and inferior descent of the arch and half of the body of the zygoma as well as the lateral wall and floor of the orbit, with a consequent increase in the orbital volume. In addition, there were multiple comminuted fractures of the arch. This rather rare fracture orientation and degree of disruption could be attributed to the direction of force of the impact and the trauma caused by the handle bar of the two-wheeler, when it struck the patients face as he fell.

The hemiconoral approach is most ideally suited for gaining adequate exposure and access to the region, including the lateral wall of the orbit, zygomatic arch, and body of the zygoma. This permits adequate disimpaction, mobilization, and reduction of grossly displaced fracture fragments. This in turn aids precise realignment, re-approximation and stable fixation of the comminuted fracture fragments. It can be supplemented with the intraoral upper buccal sulcus/vestibular approach to access, reduce, and fix the zygomatic buttress region, ensuring stability of the entire complex. The intraoral approach also allows visualization, reduction, and fixation of the fractured anterolateral wall of the maxillary antrum, as was carried out in this case as well. The postero-lateral wall of the maxillary antrum is usually inaccessible and its fracture can be safely ignored without any adverse sequelae.

Considering zygomatic complex fracture as a tetrapod fracture, as per the modern treatment strategies, it has been recommended that for laterally displaced and unstable fractures rigid internal fixation should be done at least three points using mini- or micro-plates, or combinations of the two.
A variety of fixation implants can be used in such fractures, depending upon the location, site, orientation and degree of comminution of the fracture; thickness and amount of bone available to accommodate the implant; the extent of muscle pull upon the fragments; and also on the subsequent load on the region such as the masticatory stresses. In this case, a low profile titanium microplate of 1.7 mm thickness and 1.7 mm diameter screws were used for the comminuted zygomatic arch region, a 4-hole minibone plate of 2 mm profile and 2 mm diameter screws for the frontozygomatic region and the lateral wall of the orbit, another 4-hole mini bone plate for the horizontal fracture through the body of the zygoma, and a three-dimensional 4-hole microplate (of 1.2 mm thickness) with 1.2 mm diameter screws, for the comminuted fracture of the thin anterolateral wall of the maxillary antrum. Shorter screws of 4 mm length were attempted for the delicate anterolateral wall of the maxillary antrum, but as the desired stability of the comminuted fragments could not be achieved, they were replaced by 6 mm screws.

The intact zygomatic complex is crucial in maintaining facial contours and also significantly contributes to orbital integrity.[4,10] In a retrospective study of 1343 patients operated for zygomatic complex fractures over a 10-year period from 2001 to 2011, it was found that postoperative complications occurred in 19%, the most common being prolonged parasthesia, followed by infection, ocular problems (0.74%) residual aesthetic problems (0.67%) and unsatisfactory reduction requiring redo surgery (0.53%).[4]

The fracture of the zygomatic bone can result in restricted mouth opening due to impingement on the coronoid process. Disruption of the zygomatic position also carries psychological, aesthetic and functional significance, causing impairment of ocular, and mandibular function. Therefore, for both cosmetic and functional reasons, it is mandatory that zygomatic bone injury is properly diagnosed and adequately managed.[11]

In the case presented, despite the magnitude of injuries sustained from the trauma and the extent of the surgical procedure carried out, there were seen nil postoperative complications. The postoperative results and outcomes were gratifying from both esthetic as well as functional point of view. There was no residual facial deformity that could have otherwise resulted from a severely sagging zygomatic complex. There were also nil functional deficits. Precise restoration of the zygoma and arch to their correct positions restored normal, unhindered movement of the coronoid process of the mandible upon opening and closing of the mouth, thus eliminating restriction in the interincisal opening. In addition, diplopia and enophthalmos resulting from the inward displacement of the eye ball (globe) owing to the severely displaced lateral orbital wall and floor, was successfully corrected by restoring the correct orbital morphology and volume, with nil ocular complications.

**Conclusion**

A case of significant disruption of the entire zygomatico-orbito-maxillary complex caused by an unusual fracture pattern, sustained in a road traffic accident has been described. A debilitating functional deficit of restricted mandibular movements and reduced mouth opening caused by impingement of the inferiorly displaced zygoma and shattered zygomatic arch against the coronoid process, could be successfully prevented; a severe residual facial deformity caused by the sagging zygomatic complex could be averted; and severe enophthalmos and diplopia caused by the increased intraorbital volume resulting from an excessive descent of the lateral wall and floor of the orbit, could be prevented by an immediate and aggressive surgical management.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understand that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Bogusiak K, Arkuszewski P. Characteristics and epidemiology of zygomaticomaxillary complex fractures. J Craniofac Surg 2010;21:1018‑23.
2. Ho JP, Scheurs R, Aydi S, Rezai R, Maal TJ, van Wijk AJ, et al. Natural variation of the zygomaticomaxillary complex symmetry in normal individuals. J Craniofac Surg 2017;45:1927‑33.
3. Chowdhury SR, Menon PS. Etiology and management of zygomaticomaxillary complex fractures in the armed forces. Med J Armed Forces India 2005;61:238‑40.
4. McBride S, Barry T. Fractures of the zygomatic complex – A comprehensive review over 10 years of surgical management. Br J Oral Maxillofac Surg 2015;53:72‑5.
5. Steele P, Bujtar P, Holland I, Halsnad M. The buttress-guide: A direct positioning tool for difficult zygomatic complex fracture alignment. Br J Oral Maxillofac Surg 2015;53:73‑4.
6. Soodan KS, Priyadarshini P, Das D, Gupta M. Zygomatic fractures and its management. Acta Sci Dent Sci 2012;2:88‑91.
7. Rana M, Warraich R, Tahir S, Iqbal A, von See C, Eckardt AM, et al. Surgical treatment of zygomatic bone fracture using two points fixation versus three point fixation – A randomised prospective clinical trial. Trials 2012;13:36.
8. Price JD, Kalamchi S. Fracture of the zygomatic complex – An unusual presentation. Br J Oral Maxillofac Surg 1986;24:221‑4.
9. Naveen Shankar A, Naveen Shankar V, Hegde N, Sharma, Prasad R. The pattern of the maxillofacial fractures – A multicentre retrospective study. J Craniofac Surg 2012;40:675‑9.
10. 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.
11. Nayyar MS. Management of zygomatic complex fracture. J Coll Physicians Surg Pak 2002;12:700‑5.