

OPEN REDUCTION AND INTERNAL FIXATION OF ZYGOMATICOMAXILLARY COMPLEX FRACTURES: A CASE SERIES AND REVIEW OF CURRENT CONCEPTS

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ABSTRACT

Background: Zygomaticomaxillary complex (ZMC) fractures are common midface injuries that may compromise facial projection, orbital anatomy, and maxillary sinus integrity. Because the ZMC forms important vertical and horizontal facial buttresses and borders the maxillary sinus, associated sinus involvement may accompany skeletal disruption. This case series describes the clinical presentation, computed tomography findings, surgical approaches, and fixation strategies used for the management of ZMC fractures with open reduction and internal fixation (ORIF).

Case Presentation: Four male patients aged 16–31 years presented with ZMC fractures following road traffic accidents or fall-related trauma, 4 days to 1 week after injury. All patients had periorbital ecchymosis and/or subconjunctival haemorrhage with a palpable facial step deformity. None had diplopia, restricted extraocular movements, or enophthalmos at presentation. Computed tomography confirmed the fracture pattern and guided operative planning. All patients underwent ORIF using titanium miniplate fixation. Surgical exposure was individualized according to fracture configuration and included the Gillies temporal, subciliary, and maxillary vestibular approaches, either individually or in combination. Fixation ranged from two-point to five-point constructs depending on fracture stability, displacement, and comminution.

Discussion: The cases demonstrate the heterogeneity of ZMC fracture patterns and the need to tailor surgical exposure and fixation to individual fracture characteristics. Less complex fractures were managed with limited exposure and two-point fixation, whereas more unstable or comminuted fractures required multiple approaches and additional fixation points. The close anatomical relationship between the ZMC and maxillary sinus also highlights the importance of assessing sinus involvement on preoperative computed tomography. However, the present four-patient series cannot establish whether routine endoscopic drainage of traumatic hemosinus improves clinical outcomes.

Conclusion: Individualized ORIF with titanium miniplate fixation provided satisfactory reduction across the range of ZMC fractures represented in this case series. Surgical approach and fixation should be guided by fracture displacement, stability, and comminution. Preoperative assessment should also include careful evaluation of associated maxillary sinus involvement. Larger prospective studies are required to determine the clinical significance of traumatic hemosinus and the role of routine ENT intervention.

KEYWORDS: Zygomaticomaxillary complex fracture; Open reduction and internal fixation; Facial trauma; Maxillary sinus; Hemosinus; Titanium miniplate; Case series

INTRODUCTION

Facial skeletal trauma is a common consequence of road traffic accidents, falls, interpersonal violence, sports-related injuries, and occupational accidents. Midfacial injuries may involve multiple anatomical structures, making careful clinical assessment and computed tomography important for defining fracture morphology, associated orbital involvement, and the extent of displacement. The zygomaticomaxillary complex (ZMC) is a major structural component of the midface and contributes to facial width and projection, orbital contour, and the transmission of masticatory forces. ZMC fractures may present with periorbital swelling and ecchymosis, malar flattening, palpable bony step deformity, infraorbital nerve disturbance, trismus, diplopia, restricted ocular movements, and enophthalmos, depending on the severity and anatomical extent of the injury [1].

Management of ZMC fractures is determined by the degree of displacement, instability, comminution, orbital involvement, and associated functional or cosmetic abnormalities. While selected minimally displaced fractures can be managed conservatively, displaced or unstable fractures may require open reduction and internal fixation (ORIF) to restore facial projection, orbital anatomy, and midfacial structural stability. Surgical exposure should be individualized according to fracture configuration and the anatomical sites requiring visualization. Common approaches include the Gillies temporal approach, lower-eyelid approaches, and intraoral maxillary vestibular approaches. The number and location of fixation points should similarly be tailored to fracture morphology and stability rather than applied according to a single universal protocol [1,2].

The relationship of the ZMC to the maxillary sinus is also clinically relevant because fractures involving the zygomaticomaxillary buttress, orbital floor, and maxillary sinus walls may result in sinus communication and post-traumatic fluid or blood within the sinus. Computed tomography provides important information regarding these associated findings and can assist in comprehensive operative planning. However, the clinical significance and optimal management of traumatic hemosinus in patients undergoing ZMC fixation remain insufficiently established. Recent evidence emphasizes individualized fixation and postoperative assessment while supporting the need for further evaluation of factors influencing stability and clinical outcomes [2,3].

In this case series, we describe four patients with ZMC fractures managed with ORIF, focusing on their clinical presentation, imaging findings, surgical approaches, fixation strategies, and early postoperative outcomes. The series also highlights the importance of systematic assessment of associated maxillary sinus involvement during the evaluation and surgical planning of ZMC fractures.

Case Presentation
Four male patients with ZMC fractures were managed with open reduction and internal fixation using titanium miniplate systems. The patients ranged in age from 16 to 31 years. Two patients sustained injuries following road traffic accidents and two following skid-and-fall incidents. The interval between injury and presentation ranged from 4 days to 1 week. Across the series, the predominant clinical findings were periorbital or facial swelling, subconjunctival haemorrhage, and palpable step deformity. None of the patients had documented diplopia, extraocular movement restriction, or enophthalmos at presentation. The surgical approach and number of fixation points were individualized according to the clinical and radiological characteristics of each fracture.

Case 1

A 31-year-old man presented 4 days after a road traffic accident with swelling over the left infraorbital region. Clinical examination demonstrated periorbital ecchymosis, subconjunctival haemorrhage, and a palpable step deformity. Ocular examination revealed no diplopia, restriction of extraocular movements, or enophthalmos. Mouth opening was unrestricted, with no clinical evidence of trismus.

Computed tomography confirmed a left ZMC fracture. Based on the fracture configuration and the requirement for direct access to the relevant fracture sites, open reduction was performed through combined subciliary and maxillary vestibular approaches. Two-point fixation was achieved using a titanium miniplate system, with restoration of the zygomaticomaxillary buttress and infraorbital rim continuity. This represented the least extensive fixation construct in the series and was used in a clinically stable fracture without documented ocular or sensory deficits.

Case 2

A 29-year-old man presented 1 week after a road traffic accident with abrasion and swelling over the left side of the face. Examination demonstrated facial ecchymosis, subconjunctival haemorrhage, and a palpable step deformity. Infraorbital nerve sensation was preserved, and there was no restriction of mouth opening. No diplopia or other major ocular functional deficit was documented.

Computed tomography with axial and coronal sections demonstrated a ZMC fracture pattern. Compared with Case 1, the fracture required more extensive exposure and fixation. A combination of the Gillies temporal, maxillary vestibular, and subciliary approaches was used to obtain access to the involved fracture sites. Fixation was performed using a titanium miniplate system, with fixation documented at two-, four-, and five-point levels according to the operative requirements. Postoperative radiography demonstrated satisfactory reduction and appropriate plate position.

This case represented the most extensive operative management in the series, reflecting the greater complexity and instability of the fracture compared with the more limited two-point constructs used in Cases 1 and 3.

Case 3

A 16-year-old boy presented 1 week after a skid-and-fall injury with swelling over the left infraorbital region. Examination showed subconjunctival haemorrhage and a palpable step deformity. There was no diplopia, restriction of extraocular movements, or enophthalmos. Infraorbital nerve examination showed no sensory deficit.

Computed tomography with axial sections and three-dimensional reconstruction confirmed the ZMC fracture. The fracture was managed through a Gillies temporal approach with two-point fixation using a titanium miniplate system. Postoperative radiography demonstrated adequate fracture reduction.

Among the four cases, Case 3 was notable for the patient's younger age and a relatively limited operative approach and fixation construct. Similar to Case 1, two-point fixation was considered sufficient, in contrast to the more extensive multi-point fixation required in Cases 2 and 4.

Case 4

A 22-year-old man presented 1 week after a skid-and-fall injury with swelling over the frontal region. Examination revealed subconjunctival haemorrhage and a palpable step deformity. There was no diplopia, restriction of extraocular movements, or enophthalmos, and infraorbital nerve sensation was preserved.

Computed tomography with axial sections confirmed the ZMC fracture. In view of the documented instability of the fracture, four-point fixation was performed using a titanium miniplate system. The greater number of fixation points compared with Cases 1 and 3 reflected the need for additional stabilization of the unstable fracture.



Figure 1. Intraoperative photograph demonstrating exposure and titanium miniplate fixation of the zygomaticomaxillary complex fracture.



Figure 2. Intraoperative photograph showing placement of a titanium miniplate following reduction of the ZMC fracture through the operative exposure.



Figure 3. Intraoperative intraoral view demonstrating reduction and titanium miniplate fixation at the zygomaticomaxillary buttress.



Figure 4. Intraoperative photograph demonstrating titanium miniplate fixation at the zygomatic region following fracture reduction.



Figure 5. Intraoperative photograph showing fixation of the frontozygomatic region with a titanium miniplate.



Figure 6. Intraoperative photograph demonstrating titanium miniplate fixation of the zygomaticomaxillary complex following anatomical reduction.

Comparative Summary

The four cases demonstrated a spectrum of ZMC fracture presentations and operative requirements. The patients were predominantly young adult males, with road traffic accidents and skid-and-fall injuries accounting equally for the mechanisms of trauma. The interval between injury and presentation was relatively short, ranging from 4 days to 1 week. A palpable step deformity was present in all four patients, while subconjunctival haemorrhage was documented in all cases. Importantly, none of the patients had diplopia, restricted extraocular movements, or enophthalmos at presentation. Infraorbital nerve sensation was specifically documented as normal in Cases 2, 3, and 4; a sensory deficit was not reported in Case 1. Mouth opening was unrestricted in the cases in which it was specifically documented.

The operative strategy varied according to fracture complexity. Cases 1 and 3 were managed with two-point fixation, although the surgical approaches differed: Case 1 required combined subciliary and maxillary vestibular exposure, whereas Case 3 was managed through a Gillies approach alone. Case 2 required the most extensive exposure, combining Gillies, maxillary vestibular, and subciliary approaches, with two-, four-, and five-point fixation documented during management. Case 4 required four-point fixation because of fracture instability.

Thus, the series demonstrates that fixation was not applied according to a uniform number of points. Instead, the operative strategy was individualized according to fracture stability, complexity, and the anatomical sites requiring access. Limited two-point fixation was sufficient in Cases 1 and 3, whereas the more complex or unstable fractures in Cases 2 and 4 required broader exposure and additional fixation points. Postoperative radiographic assessment documented satisfactory reduction in Cases 1–3; the available case documentation for Case 4 records the four-point fixation but does not provide a standardized postoperative radiographic outcome.

Table 1. Clinical and Operative Characteristics of the Four Cases

Variable	Case 1	Case 2	Case 3	Case 4
Age/Sex	31/M	29/M	16/M	22/M
Mechanism	Road traffic accident	Road traffic accident	Skid and fall	Skid and fall
Presentation	4 days	1 week	1 week	1 week
Main presenting feature	Left infraorbital swelling	Left facial abrasion and swelling	Infraorbital swelling	Frontal swelling
Ecchymosis	Present	Present	Not specifically documented	Not specifically documented
Subconjunctival haemorrhage	Present	Present	Present	Present
Step deformity	Present	Present	Present	Present
Diplopia	Absent	Not documented	Absent	Absent
EOM restriction	Absent	Not documented	Absent	Absent
Enophthalmos	Absent	Not documented	Absent	Absent
Infraorbital nerve deficit	Not documented	Absent	Absent	Absent
Trismus/mouth-opening restriction	Absent	Absent	Not documented	Not documented
CT assessment	ZMC fracture	Axial + coronal CT	Axial + 3-D reconstruction	Axial CT
Surgical approach	Subciliary + maxillary vestibular	Gillies + maxillary vestibular + subciliary	Gillies	Not specified in available case record
Fixation	2-point	2-, 4- and 5-point	2-point	4-point
Implant	Titanium miniplate	Titanium miniplate	Titanium miniplate	Titanium miniplate
Postoperative radiographic assessment	Satisfactory reduction documented	Satisfactory reduction and plate position	Adequate reduction documented	Not specifically documented in available text

Table 2. Comparative Operative Strategy

Case	Fracture/operative characteristic	Exposure	Fixation	Interpretation
1	Relatively limited operative requirement	Subciliary + maxillary vestibular	2-point	Limited construct with direct access to required fracture sites
2	Greater complexity	Gillies + maxillary vestibular + subciliary	2-, 4-, and 5-point	Most extensive operative strategy in the series
3	Limited operative requirement	Gillies	2-point	Least extensive exposure and fixation
4	Documented instability	Not specified	4-point	Additional fixation used for stabilization

Overall, the series demonstrates a graded operative approach, ranging from limited two-point fixation to more extensive multi-point fixation. The variation in surgical exposure and fixation points supports an individualized strategy rather than a fixed protocol for all ZMC fractures. However, because this is a four-patient descriptive case series without standardized fracture classification, quantitative comparison of surgical techniques or determination of superiority of one fixation strategy over another is not possible.

DISCUSSION

All four patients in this series were young males aged 16–31 years, with road traffic accidents and skid-and-fall injuries accounting equally for the mechanisms of trauma. Periorbital or facial swelling, subconjunctival haemorrhage, and palpable step deformity were the predominant findings. None had documented diplopia, extraocular movement restriction, or enophthalmos at presentation. These findings are consistent with the variable clinical spectrum of ZMC fractures described in contemporary literature, where the extent of functional and aesthetic impairment depends on fracture morphology and associated orbital involvement [4].

Fixation strategy varied from two-point to five-point constructs. Cases 1 and 3 were managed with two-point fixation, whereas Case 2 required two-, four-, and five-point fixation and Case 4 underwent four-point fixation because of documented instability. This variation supports individualized fixation according to fracture stability and anatomical requirements rather than a uniform protocol. Elkahwagi et al. demonstrated that limited single-point stabilization can be successful in carefully selected ZMC fractures, supporting the principle that extensive fixation is not required in every case [5]. Conversely, more unstable or complex fractures may require additional fixation points to maintain reduction.

The findings are also consistent with evidence comparing different fixation strategies. Nainoor et al., in a systematic review and meta-analysis, reported no significant overall difference between two-point and three-point fixation, suggesting that the choice of fixation should be guided by fracture characteristics rather than a predetermined number of fixation points [7]. Rahbin et al., in a long-term follow-up of 136 ZMC fractures, similarly found that greater surgical invasiveness and number of fixation points were not necessarily associated with greater patient satisfaction [6]. These findings support a balanced approach aimed at achieving stable anatomical reduction while minimizing unnecessary surgical exposure.

The surgical approaches in our series were similarly individualized. Case 3 required only a Gillies approach, whereas Cases 1 and 2 required additional subciliary and/or maxillary vestibular exposure. This variation reflects the need to obtain adequate access to the specific fracture sites while limiting unnecessary surgical morbidity. The systematic review by Raghoobar et al. reported that multiple approaches may improve visualization but can increase approach-related morbidity [2].

Maxillary sinus involvement is an important consideration because ZMC fractures may communicate with the sinus and produce post-traumatic fluid or hemosinus. However, standardized documentation of sinus involvement and subsequent sinus-related outcomes was not available for all four patients. Therefore, this series cannot establish the clinical benefit of routine endoscopic drainage. CT assessment of sinus involvement may nevertheless be incorporated into preoperative evaluation, with ENT intervention considered selectively when clinically indicated.

The principal limitations are the very small sample size, single-centre retrospective design, absence of a control group, non-standardized follow-up, and lack of formal fracture classification for each patient. Consequently, the findings should be considered descriptive rather than comparative. Nevertheless, the series illustrates the practical importance of tailoring surgical exposure and fixation to individual ZMC fracture characteristics.

CONCLUSION

ORIF using titanium miniplate fixation achieved satisfactory reduction in the four ZMC fractures described in this series. The surgical approach and number of fixation points varied according to fracture stability and operative requirements, supporting an individualized rather than uniform fixation strategy. Limited two-point fixation was adequate in selected cases, while more extensive fixation was used for unstable or more complex injuries. CT remains essential for defining fracture morphology and guiding surgical planning, including assessment of associated maxillary sinus involvement. However, this small retrospective series cannot establish the superiority of any particular fixation strategy or demonstrate a benefit from routine endoscopic drainage of traumatic hemosinus. Larger prospective studies with standardized fracture classification, postoperative functional assessment, and systematic evaluation of sinus involvement are required to develop evidence-based management pathways.

Learning Points

- CT-based assessment is essential for defining ZMC fracture morphology, displacement, comminution, and associated orbital or sinus involvement.
- ORIF should be individualized according to fracture stability, displacement, and anatomical involvement rather than using a fixed fixation protocol.
- Two-point fixation may be adequate in selected stable fractures, whereas unstable or complex fractures may require additional fixation points.
- Surgical exposure should be fracture-specific, balancing adequate visualization and reduction against approach-related morbidity.
- Maxillary sinus involvement should be actively assessed on CT in ZMC fractures; however, routine endoscopic drainage of traumatic hemosinus cannot be recommended based on this small case series.
- Standardized postoperative and long-term assessment is important, particularly for diplopia, enophthalmos, facial asymmetry, infraorbital nerve dysfunction, and patient-reported outcomes.
- Larger prospective studies are needed to determine the optimal fixation strategy and clarify the clinical significance and management of associated hemosinus.

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