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Surgical treatment of unilateral zygomaticomaxillary complex fractures: A 7-year observational study assessing treatment outcome in 153 cases

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A B S T R A C T

This study investigates treatment outcome in zygomaticomaxillary complex (ZMC) fracture repair.
Methods: The medical records and CT-images of patients that received treatment for a unilateral ZMC fracture in 2005–2011 were studied. ZMC fractures were categorised as incomplete (type A), tetrapod (type B) or comminuted (type C). The incidence of sequelae, wound infection and secondary surgical interventions was analysed per fracture category.
Results: A total of 153 patients were treated in the selected period. Persisting sensory disturbances in the area innervated by the infraorbital nerve were observed in 50 cases (37%), facial asymmetry in 19 cases (14%), enophthalmos in 10 cases (7%) and persisting diplopia in 9 cases (7%). Wound infection occurred in 6 cases (4%). Secondary surgical procedures of the ZMC, orbital floor, and/or extraocular muscles were performed in 14 cases (9%). C-type fractures were associated with more secondary corrections for ZMC malreduction (12%, $p = 0.03$), more secondary reconstructions of the orbital floor (10%, $p < 0.01$), and more functional corrections of diplopia by extraocular muscle correction (5%, $p = 0.02$).
Conclusion: Treatment outcome in C-type ZMC fractures is less favourable than treatment outcome in A-type and B-type fractures. Intraoperative imaging, surgical navigation devices and 3D-planning software may improve treatment outcome in C-type ZMC fractures.

1. Introduction

Zygomaticomaxillary complex (ZMC) fractures are common injuries in maxillofacial trauma patients (Gassner et al., 2003; Van Hout et al., 2013). ZMC fractures with no or minimal displacement can be treated conservatively. However, for ZMC fractures with dislocation, surgery is indicated (Salentijn et al., 2014).

The surgical technique is adapted to the fracture pattern and the patient. Mild cases can be treated in a minimally invasive method, the ZMC is reduced through a small incision and no fixation or 1 miniplate is required. Severe cases need several surgical approaches to both the zygoma and the orbital floor, miniplate fixation at multiple sites and reconstruction of the orbital floor (Ellis and Kittidumkerng, 1996).

Recent technological advances such as intraoperative conebeam computed tomography (CT) imaging, surgical navigation devices and 3D-planning software, offer the surgeon additional means to ensure a positive treatment outcome (Yu et al., 2010; Wilde et al., 2013; Van Hout et al., 2014). Application of these technological means in every ZMC fracture seems unnecessary, as good results are reported in the majority of patients treated without the use of these technical aids (Zingg et al., 1992; Ellis and Kittidumkerng, 1996).

This study was undertaken to investigate in which ZMC fractures treatment yields inadequate results when performed without the use of technological aids. In a retrospective cohort the ZMC fractures were categorised and the occurrence of sequelae, wound infection and secondary surgical procedures of the ZMC, orbital floor and extraocular muscles (functional diplopia correction) was analysed.

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1.1. ZMC fracture classification

Several classifications for ZMC fractures have been proposed in the literature. Manson et al. (1990), Ellis and Kittidumkerng (1996) and Zingg et al. (1992) proposed similar classifications for ZMC fractures based on the energy of the injury, the pattern of comminution, the degree of dislocation, and the number of fractured zygomatic pillars.

Based on these classifications, we made the following classification (Fig. 1):

A. Incomplete fractures – low-energy fractures in which at least one pillar of the ZMC remains intact.
B. Tetrapod fractures – all four pillars of the ZMC are fractured.
C. Comminuted fractures – high-energy fractures, the ZMC is divided into 2 or more fragments by additional fractures trough the zygomatic body, lateral orbit or infraorbital rim. If the paranasal part of the infraorbital rim or the triangular process of the frontal bone constitutes a loose fragment, the fracture is also considered comminuted. Fractures with minor fragmentation at a fractured point of articulation and W-type fractures of the zygomatic arch do not qualify as comminuted.

2. Materials and methods

A retrospective cohort study was conducted. The study was performed in accordance with the STROBE guidelines for reporting observational studies (Von Elm et al., 2008). The local ethics committee considered the study not subject to consent.

2.1. Data collection

Patients who were treated for a ZMC fracture between 2005 and 2011 were identified through the electronic hospital information system. Included were patients who received primary surgical therapy for a unilateral ZMC fracture.

Patient records, operative reports, radiology reports of maxillofacial imaging, and available maxillofacial radiographic images of all patients were studied.

The collected data included: gender, age, aetiology, concomitant other injuries, surgical treatment, sequelae upon follow-up, occurrence of wound infection, and secondary surgical procedures.

2.2. Fracture classification

In cases with available adequate CT-scans, CT-images were reviewed and the ZMC fracture was categorised following the classification outlined in the introduction. Two observers (WvH and EVC) assessed the CT-scans and categorised the fractures. The observers were blinded for treatment outcome. Consensus was reached regarding the findings.

2.3. Department treatment protocol

Treatment is performed under general anaesthesia. Antibiotic prophylaxis is administered at the induction of general anaesthesia or preoperatively.

In cases with no indication for orbital floor exploration, reduction without fixation is attempted primarily. If unstable, internal fixation is applied at the lateral orbital rim or at the zygomatico-alveolar crest, depending on fracture characteristics and the surgeon's preference. If indicated more points of internal fixation are applied in a stepwise progressive approach.

Primary orbital floor exploration is performed in case of significant internal orbit disruption.

In cases with indication for orbital floor exploration, open reduction and internal fixation (ORIF) of the ZMC is performed at one or several points, after which the orbital floor is explored and, if necessary, reconstructed.

At the end of the procedure, the forced-duction test is performed to check ocular mobility.

Postoperatively the patient is instructed to avoid pressure on the affected side of the face, and to avoid blowing the nose for 2–3 weeks. Postoperative antibiotic prophylaxis is prescribed on indication.

The patient is reviewed 1 week after discharge, several months postoperatively, and further on indication.

No intraoperative imaging, surgical navigation device or 3D-planning software was used in the study period.

2.4. Statistical analysis

Statistical analyses of the study results were performed with IBM SPSS Statistics for Windows Version 21.0 (IBM Corp., Armonk, NY, USA). Spearman's rank correlation test was used to determine correlation of treatment outcome and other injuries with the fracture classification. Pearson's chi square test was used to determine if treatment outcome and other injuries were associated with individual fracture categories.

In the discussion section, Pearson's chi-square test was used on the results published by Zingg et al. (1992), these calculations were made in Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA, USA).

Probabilities of 0.05 and less were accepted as statistically significant.

3. Results

A total of 153 patients were treated in the selected period. The cause of injury and involvement of intoxication are listed in Table 1.

3.1. Fracture classification

CT-images on which classification could be performed were present in 126 cases (82%), in 27 cases (18%) no (adequate) CT images were available.

There were 32 A-type fractures (25%), 52 B-type fractures (41%), and 42 C-type fractures (33%). Patient characteristics per fracture category are listed in Table 2.

Left-right distribution was 87:66.

3.2. Other injuries

Presence of other injuries per fracture category is listed in Table 2.

Concomitant maxillofacial fractures were present in 48 cases (31%). In 34 cases an isolated concomitant fracture of the mandible ($n = 13$), midface ($n = 15$), or frontal bone ($n = 6$) was present. In the other 14 cases the concomitant fractures entailed the mandible and midface ($n = 7$); the midface and frontal bone ($n = 5$); or the mandible, midface and frontal bone ($n = 2$). The presence of concomitant maxillofacial fractures correlated with fracture classification ($p < 0.01$) and was associated with C-type fractures ($p < 0.01$).

Concomitant non-maxillofacial injuries were present in 58 cases (38%). These included neurotrauma ($n = 26$, 17%), e.g. fractures of the cranial base, intracranial haemorrhage, need for intracranial pressure monitoring; spinal fractures ($n = 17$, 11%); fractures of extremities, including shoulder and pelvis ($n = 30$, 20%); thoraco-abdominal injuries ($n = 15$, 10%); and 1 brachial plexus lesion.