**Original Research Article**

**Clinical Impact of Treatment Modalities for Zygomatic Fractures on Infraorbital Nerve Sensory Recovery: A Cross-Sectional Observational Study**

**Abstract**

**Background:** Lesions of the infraorbital nerve are common sequelae of zygomatic complex fractures, significantly compromising patients' quality of life. This study aimed to identify the most effective treatment method for zygomatic fractures, minimizing sequelae such as persistent numbness, which can significantly affect patients' quality of life. To this end, conservative and surgical approaches and one- and two-point fixation techniques were compared, considering the influence of fracture location on neurosensory and functional prognosis. **Material and Methods:** This retrospective, cross-sectional study evaluated the medical records of patients with zygomatic complex fractures. The sample consisted of all medical records of patients from the Federal University of the Jequitinhonha and Mucuri Valleys treated for zygomatic complex fractures between January 2016 and December 2018, **evaluating sensory recovery over a 12 months follow-up**. **Results:** 126 medical records were evaluated, with 147 facial fractures, of which zygomatic complex fractures had the highest incidence (31.29%). Most patients were male, with a mean age of 42.5 years. The primary etiology was traffic accidents. In zygomatic complex fractures, the most common signs and symptoms were altered neurosensory function of the infraorbital nerve (78.26%) and infraorbital rim step-off (54.34%). The conservative or non-surgical method was the most used (34.78%), followed by open reduction and internal fixation of the frontozygomatic process and infraorbital rim (32.6%), open reduction and internal fixation of the frontozygomatic process (19.56%), and open reduction and internal fixation of the infraorbital rim (13.04%). Complete resolution of infraorbital nerve sensory disturbances was observed in only 33.33% of patients, of whom 66.7% were treated by open reduction with internal fixation. **Conclusions:** Thus, open reduction with internal fixation of the infraorbital rim and frontozygomatic process has proven to be a practical approach, promoting better fracture reduction, re-establishment of the orbital contour, and superior aesthetic and functional results, in addition to increasing the chances of neurosensory recovery of the infraorbital nerve.

**Keywords:** Facial injuries; Fracture fixation; Maxillofacial injuries; Nerve injury; Zygomatic fractures.

**Introduction**

The zygomaticomaxillary complex (ZMC) is one of the most frequently fractured facial structures, second only to the nasal bones due to its anatomic prominence.1–3 In these cases, individuals with ZMC fractures may present specific signs and symptoms, including facial depression, pain, periorbital ecchymosis, subconjunctival hemorrhage, trismus, visual complaints, ophthalmoplegia, and irregularities of the orbital, infraorbital, and frontozygomatic rims.4 Also, one of the most specific complaints associated with ZMC fractures is alterations of the neurosensory function of the infraorbital nerve (ION). 1,2,4

Typically, ZMC fractures occur in the frontal process of the zygoma, zygomatic arch, zygomatic pillar, and infraorbital rim.5,6 Along its course, the maxillary nerve passes below the orbital floor. It emerges on the face as the infraorbital nerve when it passes through the foramen of the same name, and thus, ends up being affected in these cases of fractures involving the infraorbital rim, possibly becoming entrapped and resulting in the interruption of the transmission of nerve impulses. When this situation occurs, patients may complain of a numb sensation in the lower eyelid, cheek, upper lip, lateral portion of the nose, teeth, and gums on the ipsilateral side.2

In the acute phase of trauma, the prevalence of patients with ZMC fractures complaining of ION numbness ranges from 20% to 60%.4,6–8 The usual time for numbness remission is 6 months to a year; however, in some cases, it may be permanent.3,9 Thus, ION injury with sensory loss is reported as one of the central sequelae or complications of ZMC fractures.1 Research has shown that surgical procedures for reducing and fixing ZMC fractures minimized the sensation of persistent ION numbness.10,11 However, these results are directly related to the type and displacement of the fracture.3 Conversely, when the neurosensory disorder is persistent, the surgeon may treat it using low-intensity laser or medications such as Etna® (hydroxocobalamin, cytidine, uridine) or pregabalin. These resources may accelerate the recovery of ION anesthesia sensation.12,13

ZMC fractures are not always treated surgically. Surgical procedures are indicated when patients present with aesthetic complaints or functional disturbances, as reported by Noor, Ishaq, and Anwar (2017).2 Depending on the fracture type, it may vary from non-surgical treatment, open reduction without fixation, and open reduction with internal fixation (ORIF).3,4 Thus, identifying treatment methods for zygomaticomaxillary complex (ZMC) fractures that increase the likelihood of infraorbital nerve (ION) sensory recovery is essential to support clinical decision-making and improve post-traumatic quality of life.14,15 Therefore, the present study aims to evaluate whether different therapeutic approaches for ZMC fractures lead to distinct outcomes regarding ION neurosensory alterations to determine the most effective treatment strategy.

**Methods**

**This retrospective, cross-sectional study analyzed the medical records of patients who had sustained ZMC fractures between 206-2018, evaluating sensory recovery over a 12 months follow-up.** Patients were seen at the Oral and Maxillofacial Surgery outpatient clinic of the Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM) between 2016 and 2018. This research was approved by the university's Research Ethics Committee (CAAE: 53538016.3.0000.5108). Inclusion criteria were medical records of patients who had sustained any ZMC fracture involving the ION, as evidenced by imaging studies (computed tomography). Exclusion criteria were medical records of patients with systemic diseases and previous ZMC fractures with neurosensory loss.

Data collection was performed by three researchers (EMGB, MRFS, and PAC). These researchers reviewed all medical records from the oral and maxillofacial surgery and trauma clinic from 2016 to 2018. Records that met the eligibility criteria were evaluated, and the following data were extracted: sex, age, etiology of trauma, signs and symptoms, ION sensory alteration, and treatment method employed.

During evaluation, all patients with ZMC fractures were questioned about sensation in the region innervated by the ION. Additionally, areas such as the nose, upper lip, cheek, and gingiva were stimulated by fingertip touch to ensure the patient understood the evaluators' questions. All reported information was recorded in the university's medical record. This information about sensory loss was extracted from the university's medical records for surgical and non-surgical patients with ZMC fractures at two time points. In the initial consultation, records were reviewed to identify the presence of any degree of neurosensory loss. Clinical progress notes were read to assess the resolution of the ION nerve alteration postoperatively. When the description of the resolution of the condition was not present in the medical records, the patient was contacted by telephone for clarification.

All information was coded and compiled into a pre-prepared record. Records were numbered to maintain patient confidentiality. Data analysis was performed using descriptive and analytical statistical methods, utilizing the Microsoft Office Excel version 2013 program. The resolution of sensory nerve loss was evaluated for each ZMC fracture treatment method.

**Results**

A total of 126 medical records were analyzed, encompassing 147 facial fractures. ZMC fractures were the most prevalent (n=46, 31.29%), followed by mandibular (n=42, 28.57%), nasal (n=30, 20.40%), maxillary (n=16, 10.88%), orbital floor (n=9, 6.12%), and others (n=4, 2.72%) (Figure 1). The sample comprised 46 ZMC fractures, with a male-to-female ratio of 8:1 (n=41, 89.13% vs. n=5, 10.86%, respectively). The mean age was 42.5 years. The most common etiology of trauma was motorcycle accidents (n=13, 28.26%), followed by falls (n=5, 10.86%), interpersonal violence (n=5, 10.86%), animal-related accidents (n=4, 8.69%), sports (n=4, 8.69%), automobile accidents (n=3, 6.52%), bicycle accidents (n=3, 6.52%), and others (n=9, 19.56%) (Figure 1).

At the initial medical consultation, the most common clinical signs and complaints were altered neurosensory function of the infraorbital nerve (ION) (n=36, 78.26%), infraorbital rim irregularity (n=25, 54.34%), ecchymosis (n=24, 52.17%), periorbital hematoma (n=13, 28.26%), subconjunctival hemorrhage (n=13, 28.26%), laceration (n=13, 28.26%), and abrasion (n=12, 26.08%) (Table 1).

The most indicated treatment method for ZMC fractures was a surgical intervention with open reduction and internal fixation (ORIF) (n=30, 65.21%), followed by conservative or non-surgical treatment (n=16, 34.78%). No cases were treated with open reduction without fixation. Surgical cases were conducted with ORIF performed on the frontozygomatic process and infraorbital rim (n=15, 32.6%), the frontozygomatic process only (n=9, 19.56%), and infraorbital rim only (n=6, 13.04%). The mean waiting time from trauma to surgery was 11.22 days, and 72% of patients underwent surgery within 15 days of the injury.

Neurosensory alterations of the ION were present in 78.26% (n=36) of patients with ZMC fractures. Of these, 12 patients (33.33%) received conservative treatment; 9 (25%) received ORIF on the frontozygomatic process only; 3 (8.33%) received ORIF on the infraorbital rim only; and 12 (33.33%) received ORIF on both the frontozygomatic process and the infraorbital rim.

Of the 36 patients who reported sensory alterations in the ION, 12 (33.33%) experienced complete resolution of the condition, with the return of nerve sensation. Among these, 5 (13.88%) underwent ORIF on the frontozygomatic process and infraorbital rim; 1 (2.77%) underwent ORIF only on the infraorbital rim; 2 (5.55%) underwent ORIF only on the frontozygomatic process; and 4 (11.11%) received conservative treatment. Additionally, 13 patients (36.11%) presented partial resolution, reporting mild persistent numbness. Among these, 4 (11.11%) underwent ORIF on the frontozygomatic process and infraorbital rim; 2 (5.55%) underwent ORIF only on the infraorbital rim; 5 (13.88%) underwent ORIF only on the frontozygomatic process; and 2 (5.55%) received conservative treatment. Only 1 (2.77%) patient did not improve, and for the other 10 (27.77%), it was not possible to obtain information (Table 2).

**Discussion**

If not adequately treated, maxillofacial fractures can lead to functional and aesthetic sequelae, decreasing patients' quality of life.14,15 Results from a previous study 16 found that, of 1662 facial fractures, 27% were ZMC fractures, followed by 22% mandibular fractures and 18% nasal fractures. The present study yielded similar results with the following respective percentages: 31%, 29%, and 20%. These results can be justified by the fact that patients tend to seek more care when they present with fractures that cause functional limitations, such as difficulties in mastication and loss of nerve sensation, which can be seen in mandibular and ZMC fractures, respectively. On the other hand, there are reports that nasal fractures are more prevalent among facial fractures due to their facial prominence.1,2

Regarding gender, the present study's results corroborate the literature findings. The male/female ratio varies from 3:1 to 9:1 in scientific reports. In the present study, the variation was 8:1. As for age, the literature suggests that most fractures occur in patients under 50 years old.17 The results of the present study regarding oral and maxillofacial fractures corroborate this statement, with an average age of 42.5 years. However, in a study by Wusiman et al. (2020), there is a wide variation in the age of patients who suffered these fractures, ranging from 0 to 90 years.17

The leading cause of oral and maxillofacial fractures in developed countries is interpersonal violence, followed by motorcycle accidents.1,3,15,16 However, in developing countries, these causes are reversed.18,19 In this study, the etiology of facial fractures is the same as in the previous study, in which traffic accidents are the leading cause of ZMC fractures.20 Both studies were conducted in the same developing country, where most roads are in poor condition, which can expose users to traffic accidents. In addition, recklessness, high alcohol consumption, and disregard for safety regulations (lack of helmet or use of seat belt) can increase the occurrence of orofacial fractures, especially ZMC fractures.

The most prevalent signs and symptoms of ZMC fractures include sensory loss of the ION, hematomas, bone crepitus, subconjunctival hemorrhage, zygomatic depression, and lacerations. Less prevalent signs and symptoms include trismus, malocclusion, ophthalmoplegia, diplopia, and amaurosis. When any of these last three clinical signs are present, an orbital fracture can be associated after the acute phase, making a surgical evaluation mandatory.4,19 In addition to these signs, a study showed that ZMC fractures lead to decreased muscle activity, with improvement occurring postoperatively.21 However, this study did not address this variable due to logistical problems.

In this study, 78% of patients reported a sensory deficit of the ION loss of sensation in the region of the nose, lower eyelid, lips, and ipsilateral teeth.4 The leading cause of sensory loss in these regions is compression or rupture of the ION due to a fracture in the infraorbital region.4 This sensory loss is diagnosed through subjective analysis based on patient reports or tactile and electrical sensory tests.7 In the present study, ION neurosensory loss was diagnosed through subjective analysis, as reported in the methods section, similar to that of Kumar and Shubhalaksmi.7 However, that study gave the patient’s report through mechanical, thermal, and painful stimulation.

In our medical records, the ORIF approach was the most prevalent (65.21%). Conservative treatment is generally less used than ORIF.3,8 Surgical treatment with ORIF is more commonly used than conservative treatment because most ZMC fractures present with bone displacement, mainly in the frontozygomatic process and the infraorbital margin, and therefore require reconstruction of the orbital floor.22 Thus, to understand how the treatment method can improve the resolution of neurosensory loss, some studies have compared conservative treatment to surgical treatment with ORIF. 12,13,15 The results of these studies suggested that ORIF decreases the sensation of ION numbness compared to non-surgical treatment. A previous study reported that ION disturbances were present in 70.67% of ZMC fractures, and after ORIF, 62.26% of patients recovered sensitivity in the region innervated by the ION in 3 months.2 Furthermore, when ORIF is compared to closed reduction or conservative treatment six months after the trauma, ORIF showed better results for the recovery of nerve sensitivity than closed reduction. On the other hand, when conservative treatment was performed without reduction, numbness persisted after six months or worsened.7

Thus, edema may still contribute to ION compression in the immediate postoperative period. However, after six months of surgical treatment, it is possible to verify whether ORIF ensured fracture stabilization, allowing for ION decompression.3 A multicenter study evaluating ZMC fractures showed that neurosensory loss was the main complication observed in the follow-up, and the primary treatment method was reduction without fixation.1 Therefore, there was an association between the ZMC fracture treatment method and the persistence of ION anesthesia in the follow-up.

The present study showed that 66.7% of patients with complete resolution of neurosensory loss were treated with ORIF. However, only 26.1% of patients with ORIF presented a partial resolution of ION numbness. Although the conservative method had a lower prevalence among the total resolutions of ION numbness, this treatment method showed similar results to ORIF (25%) for partial resolutions. Of 8 patients treated with ORIF with complete resolution of the nerve disorder, 5 (62.5%) were treated with fixation at the infraorbital margin and frontozygomatic process. On the other hand, of a total of 11 patients who were treated with ORIF and had partial resolution of ION anesthesia, 5 (45.4%) had fixation of the fracture only at the frontozygomatic process. Thus, based on these results, it is observed that fixation at the infraorbital margin and frontozygomatic process presented better results for the resolution of numbness sensation than fixation only at the frontozygomatic process. This result can be explained because when the surgeon opens and fixes the infraorbital margin and the frontozygomatic process, the orbital contour can be better recovered, favoring ION decompression with consequent resolution of ION anesthesia. Thus, if surgical treatment is indicated, and there is a preoperative complaint of neurosensory disorder, the surgeon should fix both locations whenever possible.

A study compared the fixation of ZMC fractures in two and three fixation points, and the result did not show a significant difference between the techniques. However, this study did not evaluate the resolution of ION anesthesia.23 The present study has some limitations that should be disclosed. First, this is a cross-sectional study with a review of medical records, and the best study design to better answer this question is a randomized clinical trial. The second limitation is that it was impossible to classify the type and location of ZMC fractures, the approach used, and how well the surgically treated fractures were reduced24 because most pre and postoperative exams (X-rays and computed tomography) could not be found. Another possible source of bias is the subjective analysis of the sensation of ION anesthesia and, therefore, the difficulty in categorizing its severity. For logistical reasons, performing electrical tests to assess sensory deficits was impossible. However, the patients were informed of the importance of providing accurate answers about the sensation of numbness in the region innervated by the ION to establish the correct diagnosis and treatment. Therefore, we suggest more studies to answer this question with more robust methodologies, such as randomized clinical trials, and more reliable sensory diagnostic methods like electrical tests.

**Conclusion**

According to the findings of this study, in ZMC fractures, the approach with ORIF at the infraorbital rim and the frontozygomatic process leads to better reduction and orbital contouring, and this situation seems to provide better results for bone stabilization and better neurosensory recovery of the ION. The external validity of this finding is to guide oral and maxillofacial surgeons in planning and treating ZMC fractures with a better prognosis regarding sensory changes of the ION.

**Ethics statement**

Not required.

**Disclaimer (Artificial intelligence)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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| **Table 1** - Signs and symptoms of zygomatic fractures |
| **Clinical signs and complaints** | n (%) |
| Anesthesia of ION | 36 (78,26) |
| Unevenness of infraorbital edge | 25 (54,34) |
| Ecchymosis | 24 (52,17) |
| Blepharohematoma | 13 (28,26) |
| Bleeding under sclera | 13 (28,26) |
| Laceration | 13 (28,26) |
| Trismus | 13 (28,26) |
| Excoriation | 12 (26,08) |
| Edema | 11 (23,91) |
| Bruise | 07 (15,21) |
| Ocular Dystopia | 06 (13,04) |
| Crepitation | 05 (10,86) |
| Dysphagia | 04 (08,69) |
| Pain | 04 (08,69) |
| Facial asymmetry | 03 (06,52) |
| Dislalia | 03 (06,52) |
| Occlusal dystopia | 02 (04,34) |
| Epiphora | 02 (04,34) |
| Anisocoria | 01 (02,17) |
| Diplopia | 01 (02,17) |
| Eyelid eversion | 01 (02,17) |
| Hemorrhage | 01 (02,17) |
| Inadequate nasal perfusion | 01 (02,17) |
| Pupil without light reaction | 01 (02,17) |
| Battle signal | 01 (02,17) |
| Others | 07 (15,21) |
| Legend: ION - Infraorbital nerve |

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| **Table 2** - Comparison of the status of infraorbital nerve disorder according to the treatment method realized |
| **Type of treatment** | **Total resolution (n)** | **Partial resolution (n)** | **Without anesthesia ION (n)** | **No information (n)** | **Without resolution (n)** |
| Conservative or non-surgical | 04 | 02 | 04 | 06 | 0 |
| Total surgical treatment | 08 | 11 | 06 | 04 | 01 |
| ORIF only on the frontozygomatic process | 02 | 05 | 0 | 02 | 0 |
| ORIF only on the infraorbital edge | 01 | 02 | 02 | 0 | 0 |
| ORIF on the frontozygomatic process and infraorbital edge | 05 | 04 | 04 | 02 | 01 |
| Total | 12 | 13 | 10 | 10 | 01 |
| Legend: ORIF - Open reduction and internal fixation / ION - Infraorbital nerve |

