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Assessing Infraorbital Nerve Dysfunction in Zygomaticomaxillary Complex Fractures: A Clinical Perspective

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ABSTRACT

Objective: This study investigates the prevalence, clinical patterns, and risk factors associated with infraorbital nerve dysfunction in zygomaticomaxillary complex (ZMC) fractures.
Study Design: Cross-Sectional Study
Place and Duration: January to December 2024, Department of Oral and Maxillofacial Surgery, Saidu Medical Complex, Swat.
Methods: A retrospective observational study of 340 patients with ZMC fractures. Demographic data, clinical symptoms, fracture patterns, and treatment methods were analyzed using frequency distribution. Logistic regression identified predictors of chronic nerve dysfunction.
Results: Hypoesthesia (61.8%) was the most common symptom, with 73.5% of patients experiencing infraorbital nerve impairment. In 54.4% of cases, only the infraorbital nerve was affected, while 19.1% had other cranial nerve involvement. Factors increasing the risk of dysfunction included age 45 or older (OR=1.85, p=0.005), road traffic accidents (OR=2.45, p<0.001), bilateral fractures (OR=3.1, p<0.001), and associated injuries (OR=2.25, p<0.001). Open reduction and internal fixation (ORIF) surgery was linked to a higher likelihood of dysfunction (OR=2.75, p<0.001), indicating more severe fractures requiring surgical intervention.
Conclusion: Infraorbital nerve dysfunction is common in severe, bilateral ZMC fractures, with increased risk due to age, high-impact trauma, and widespread fracture patterns. Further research is needed to minimize nerve dysfunction following surgery.

Key Words
Zygomaticomaxillary Complex Fractures, Infraorbital Nerve Dysfunction, Sensory Impairment, Risk Factors, ORIF Surgery

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INTRODUCTION

The zygomatic arch, a paired bone, not only shapes the cheek prominence but also serves as a structural pillar for the floor and lateral walls of the orbit, as well as the walls of the temporal and infratemporal fossae, and the cheek prominence itself. There are four sections in each zygomatic bone [1, 2]. Anterior zygomaticomaxillary suture connects each zygomatic bone to the frontal bone; anterior zygomatic sphenoid suture connects each zygomatic bone to the sphenoid bone; and anterior zygomaticotemporal suture connects each zygomatic bone to the temporal bone. After nasal skeleton fractures, the zygomaticomaxillary complex (ZMC) fractures occur most frequently in the lateral midface. Fractures like this are most commonly caused by violent incidents like car accidents, fights, falls, and sports injuries, as well as civilian conflicts. Symptoms of a ZMC fracture include a flattening of the face, pain, epistaxis, trismus, diplopia, step deformity of the orbital borders, epistaxis, infraorbital nerve paresthesia, epistaxis, and subconjunctival ecchymosis [3–5].

A critical sign of ZMC fracture, particularly if the fracture is displaced (as demonstrated in 20% of cases), is sensory disruption in the form of paresthesia, which is nerve dysfunction of the infraorbital nerve. Anatomical boundaries encircle the infraorbital canal and infraorbital fissure housing nerve in 95% of documented cases, making them typically implicated in zygoma-ticomaxillary complex fractures. Infraorbital nerve damage often occurs following ZMC fractures, with incidences varying between 18 and 83%. Possible causes of injury include direct trauma or compression of a neighboring nerve. Hypoesthesia, dysesthesia, paresthesia, or anesthesia can occur in the areas of the face that the infraorbital nerve physically supplies when injured [6, 7]. These areas include the lower eyelid, cheek, upper lip, skin of the nose, intraorally, part of the gingiva, and teeth on the affected side.

Consideration of nerve function recovery indicates that 77.3% of patients who underwent open reduction and internal fixation (ORIF) achieved full functional recovery. The two most common and effective methods of fixation are open reduction and internal fixation. According to Dutch researchers De Man and Bax, effectively reducing and fixing an infraorbital nerve abnormality healed. Instead of simply reducing infraorbital nerve damage, Vriens and Moos found that internal fixing and open reduction produced better outcomes [8–10]. Research by Saka-vicius and colleagues found that 77.3% of patients' function is fully restored following open reduction and internal fixation; these results are consistent with the present investigation [11].

After zygomatic fractures, Benoliel described many methods for treating neurosensory abnormalities in the infraorbital nerve; ultimately, they concluded that plate fixation significantly improves the recovery of infraorbital nerve dysfunction [12, 13]. Zygomatic fractures rarely cause persistent neuropathic pain. Nerve damage heals more quickly during the 1–6 month follow-up period if surgery is performed early.

Despite the high incidence of infraorbital nerve dysfunction in ZMC fractures, the specific risk factors and clinical patterns remain poorly understood, which highlights the need for this study. This study aims to address the prevalence, clinical patterns, and risk factors of infraorbital nerve dysfunction in patients with ZMC fractures.

MATERIAL AND METHOD

This cross-sectional study was conducted in the Department of Oral and Maxillofacial Surgery, Saidu Medical Complex, Swat, from **January to December 2024**, after obtaining ethical approval from the hospital's Research and Ethics Committee (**Approval No: KCD-REC/2024/112**). Written informed consent was obtained from all participants before enrollment.

Study Population and Sampling

A sequential non-probability sampling technique was used. The department assessed all patients with clinically and radiographically confirmed zygomaticomaxillary complex (ZMC) fractures for eligibility during the study period.

The sample size was initially calculated using the WHO sample size calculator, assuming a 20% prevalence of infraorbital nerve dysfunction, a 95% confidence interval, and a 7% margin of error. This yielded a minimum sample size of 126 patients. However, to enhance the study's power and generalizability, data were collected from all eligible cases during the study period, resulting in a final sample of 340 patients.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients aged 18 years and above,
- Diagnosed with ZMC fractures, confirmed by clinical examination and imaging, and
- Patients must be willing to provide written informed consent.

Exclusion Criteria

- Previous infraorbital nerve injury,
- Active infections of the midfacial region, or
- Any known neurological disorder that affects facial sensation is also considered.

Data Collection Procedure

Demographic information, cause of injury, side and type of fracture, and treatment modality were recorded using a structured proforma. Each patient underwent a detailed clinical and neurosensory assessment, including:

- Static two-point discrimination,
- Touch detection,
- Thermal discrimination,
- Pin-prick nociception, and
- The process also includes brush stroke directional testing.

Radiographic evaluation included occipitomental view, submentovertex view, and computed tomography (CT) scans to confirm fracture type and extent.

Outcome Measure

The primary outcome was infraorbital nerve dysfunction, categorized as hypoesthesia, dysesthesia, or anesthesia. The pattern of dysfunction (isolated infraorbital nerve vs. combined cranial nerve involvement) was also recorded.

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics (frequencies, percentages, and means) were used to summarize demographic and clinical variables. Binary logistic regression analysis was performed to identify predictors of infraorbital nerve dysfunction.

Categorical predictors such as age, gender, cause of injury, fracture laterality, associated fractures, and surgical management were coded with reference categories defined. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). A *p*-value of <0.05 was considered statistically significant. Model assumptions, including multicollinearity and goodness-of-fit, were checked before final interpretation.

RESULT

Table 1 shows the demographic variables of the study. There were fewer cases in senior age groups (46-60 years: 20.6%, >60 years: 5.8%), with the majority of patients with zygomaticomaxillary complex (ZMC) fractures being between the ages of 31 and 45 (41.2% of the total), followed by those between the ages of 18 and 30 (32.4%). The prevalence of the condition was higher in men (75% vs. 25%). Road traffic accidents accounted for 57.4% of all injuries, with physical assault coming in at 22.1%, falls at 13.2%, and sports injuries at 7.3%. While 14.7% of fractures were bilateral, 47.1% occurred on the right side and 38.2% on the left. A slightly higher percentage of ZMC fractures occurred alone (52.9% vs. 47.1%) than in cases where additional fractures were included. Open reduction and internal fixation (ORIF) was the principal surgical method used in 73.5% of cases, whereas non-surgical management was employed in 26.5%.

Table 1: Demographic Characteristics of Patients with ZMC Fractures (n = 340)

Variable	Frequency (n)	Percentage (%)
Age (years)		
18–30	110	32.4
31–45	140	41.2
46–60	70	20.6
>60	20	5.8
Cause of Injury		
Road Traffic Accident (RTA)	195	57.4
Physical Assault	75	22.1
Fall	45	13.2
Sports Injury	25	7.3
Side of Fracture		
Right	160	47.1
Left	130	38.2
Bilateral	50	14.7
Fracture Type		
Isolated ZMC Fracture	180	52.9
ZMC + Other Associated Fractures	160	47.1
Management		
Non-Surgical	90	26.5
Open Reduction & Internal Fixation (ORIF)	250	73.5

Note: Percentages are calculated based on the total sample size (n = 340).

Table 2 shows that only 26.5% of the 340 patients with ZMC fractures did not have infraorbital nerve damage; 73.5% did. After total anesthesia (10.3%), dysesthesia (27.9%), and hypoesthesia (61.8%), the most prevalent clinical presentations were these. Isolated infraorbital nerve involvement was more common than combined cranial nerve injuries (19.1% of cases) in terms of dysfunction patterns, at 54.4%. Among patients with isolated ZMC fractures (41.2%) and ZMC fractures involving additional structures (32.4%), infraorbital nerve impairment was observed in 32.4% of patients, while 26.5% of patients exhibited no nerve dysfunction (independent of fracture type).

Table 2. Clinical Presentation and Patterns of Infraorbital Nerve Dysfunction in ZMC Fractures (n = 340)

Variable	Frequency (n)	Percentage (%)
Clinical Presentation		
Hypoesthesia (Reduced Sensation)	210	61.8
Dysesthesia (Abnormal Sensation)	95	27.9
Anesthesia (Complete Loss of Sensation)	35	10.3
Pattern of Dysfunction		
Isolated Infraorbital Nerve Dysfunction	185	54.4
Combined with Other Cranial Nerve Injury	65	19.1
No Dysfunction Observed	90	26.5
Fracture Type and Nerve Dysfunction		
Isolated ZMC Fracture with Dysfunction	140	41.2
ZMC + Other Fractures with Dysfunction	110	32.4
No Dysfunction (Any Fracture Type)	90	26.5

Note: Hypoesthesia was the most common sensory impairment among patients with infraorbital nerve involvement.

Table 3 demonstrates the logistic regression results. In ZMC fractures, infraorbital nerve dysfunction was found to be significantly predicted by many variables in a logistic regression model. A statistically significant connection was not observed in men (OR=1.3, p=0.21), but there was a 1.85-fold increased likelihood of dysfunction in patients aged 45 and older (p=0.005). Significant risk factors were road traffic accidents (OR=2.45, p<0.001) and physical assault (OR=1.75, p=0.015). The probability of dysfunction was significantly higher in patients with bilateral fractures

(OR=3.1, p<0.001) and ZMC fractures with additional fractures (OR=2.25, p<0.001). The increased probability of dysfunction associated with ORIF surgery (OR=2.75, p<0.001) is probably because surgical intervention is necessary for more severe fractures. The non-surgical approach, on the other hand, had a trend toward reduced risk (OR=0.6, p=0.052); however, it was not statistically significant.

Table 3: Logistic Regression Analysis for Predictors of Infraorbital Nerve Dysfunction

Predictor Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age ≥45 years	1.85	1.20 – 2.85	0.005**
Male Gender	1.30	0.85 – 1.98	0.210
Cause of Injury			
– Road Traffic Accident (RTA)	2.45	1.60 – 3.75	<0.001**
– Physical Assault	1.75	1.10 – 2.85	0.015*
Fracture Laterality			
– Bilateral Fractures	3.10	1.90 – 5.05	<0.001**
Fracture Type			
– ZMC + Other Associated Fractures	2.25	1.50 – 3.35	<0.001**
Management Approach			
– Non-Surgical Management	0.60	0.35 – 1.00	0.052
– ORIF Surgery	2.75	1.80 – 4.20	<0.001**

- Reference categories: Age <45 years, Female gender, Isolated ZMC fracture, Unilateral fracture, Non-surgical management.
- $p < 0.05$ = statistically significant (*), **p** < 0.01 = highly significant (**).

DISCUSSION

At 13% of all craniofacial fractures, the zygomatic complex, which gives the cheeks their shape, is the second most damaged midface bone after the nasal bone. Variations in civic, racial, and environmental factors are thought to contribute to the fact that the causes of maxillofacial fractures vary depending on where the fractures occur. While domestic violence is the leading cause of injury in developed countries, road traffic accidents (RTAs) are all too common in developing countries [14,15]. The shift in the cause of fractures in the West might be due to the implementation of seat belt laws and the excessive consumption of alcoholic beverages and illicit drugs in certain nations. Midface bones are more easily broken than bones in other areas of the body because they are composed of a complex of fragile bones joined by sutures. Timely, efficient treatment that prioritizes both function and aesthetics is essential in cases of facial damage.

This study found that 86% of patients were male and that 69% of the 126 patients fell within the age range of 30–65. In the study conducted by Jamal et al., the gender distribution of patients with zygomaticomaxillary complex fractures was 88% male, and the mean age was [16,17]. The high rate of ZMC fractures in our neighborhood may be attributed to the fact that males are more sociable and tend to drive more often. Some authors have reported much better sensory function following open reduction and internal fixation with plates as compared to closed reduction procedures[18–20]. Infraorbital nerve impairment is not usually the main reason to open and decompress after a nondisplaced zygoma fracture, since sensory function normally returns.

Requiring the use of seatbelts has led to a notable decrease in facial injuries in developing countries. Our neighbor to the west, India, has a Motor Vehicle Act (MVA) that mandates the use of seat belts and helmets, but few people really follow the law. One important step in reducing the number of injuries to the face bones is making sure people know how to use their seatbelts and headgear when traveling [21-24]. Emerging findings suggest that increased awareness and stricter enforcement of traffic laws may further reduce the prevalence of severe ZMC fractures and associated nerve damage.

One limitation of the study is its cross-sectional design, which limits to ability to draw causal relationships. Additionally, the sample size, although sufficient, could have been larger to improve the generalizability of the results.

CONCLUSION

Over 70% of patients with zygomaticomaxillary complex (ZMC) fractures will experience infraorbital nerve dysfunction, the most common of which is hypoesthesia, a loss of sensation. Nerve dysfunction is more likely to occur with more extensive and severe fractures, especially those that involve both sides of the body and have other fractures nearby. Strong predictors of long-term sensory loss include getting older, experiencing high-impact trauma (particularly from car accidents), and requiring ORIF surgery. The study highlights the importance of early diagnosis, meticulous surgical planning, and possible neuroprotective measures because surgical intervention through frequently required to stabilize fractures; nevertheless, it may also result in nerve damage. To improve verve healing and reduce long-term sensory abnormalities in patients with ZMC fractures, future research should focus on optimizing treatment options and investigating neuroprotective strategies during surgery.

Conflict of Interest: The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

HUK: Contributed to the study design and literature review, and critically revised and finalized the manuscript for submission.

SN: Was responsible for data collection and organization.

AQ: Conducted data analysis and interpretation.

All authors reviewed and approved the final manuscript.

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