ORIGINAL ARTICLE

Assessment of recovery time for the functional status of infraorbital nerve in open versus closed reduction of zygomatico-maxillary complex fractures: a comparative study

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Biomedica - Official Journal of University of Health Sciences, Lahore, Pakistan
Volume 40(2):90-94
https://doi.org/10.24911/BioMedica/5-1047

ABSTRACT

Background and Objective: Zygomatico-maxillary complex (ZMC) fractures and associated infraorbital nerve paresthesia are the most prevalent features of facial trauma associated with road traffic accidents, accidental falls, and violent assaults. The objective of this study was to assess the recovery time of the infraorbital nerve functional status in individuals with paresthesia after open and closed reduction of ZMC fractures.

Method: A comparative cohort study was conducted in the Oral and Maxillofacial Surgery Department of Mayo Hospital in Lahore. The study comprised 100 patients with unilateral isolated en bloc ZMC fractures and post-traumatic paresthesia. Patients were equally divided into two groups: Group A comprised of patients who underwent closed reduction while patients of Group B had open reduction with micro plate osteosynthesis. Demographic information, infraorbital nerve healing, post-op complications, and patients' satisfaction were documented. To compare the outcomes of the two groups, statistical analyses were done and *p*-value <0.05 was taken as statistically significant.

Results: The age distribution revealed a mean age of 37.43 ± 11.06 years, with 72% of the participants being males. In 63% of patients, there was overall functional nerve recovery. After 6 weeks, 74% of those in Group A (closed reduction) had functional nerve recovery, as compared to 52% of those in Group B (open reduction) ($p = 0.023$). Age subgroup analysis revealed no significant differences in the recovery rates. When compared to Group-A, patients in Group-B showed faster sensory improvement and better satisfaction levels. Complication rates were equal for both approaches.

Conclusion: In ZMC fractures with paresthesia, both open and closed reduction procedures yielded good results in recovering infraorbital nerve function; however, the open reduction technique demonstrated quicker sensory recovery and more patient satisfaction.

Keywords: Infra orbital nerve, open reduction, closed reduction, zygomaticomaxillary complex fractures, functional status.

Received: 28 November 2023 **Revised date:** 11 April 2024 **Accepted:** 19 May 2024
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Introduction

Fractures of the zygomaticomaxillary complex (ZMC) are one of the most common face injuries that most frequently result from road traffic accidents, interpersonal violence, dangerous falls, and injuries related to sports[1]. These ZMC fractures are associated in post-traumatic infraorbital neurosensory damage in up to 94% of the cases. The infra-orbital nerve (ION) is a branch of the maxillary nerve that provides sensation to the lower eyelid, cheek, and upper lip. Edema, ischemia, bone compression, cutting edges of the fracture line, hemorrhage, or neurotic inflammation are the etiological disturbances that eventuate injury to the infraorbital nerve[2]. Isolated hypoesthesia, neuralgic pain, tingling, and discomfort in the afflicted region might result from an ION damage[3]. For ZMC fractures, there are two basic treatment options: open reduction with internal fixation (ORIF) and closed reduction. Closed reduction is a non-surgical treatment in which the shattered bones are physically aligned. ORIF is a surgical treatment that includes creating an incision in the face and securing the

shattered bones with plates and screws[4]. Several studies have examined the efficacy of open reduction vs closed reduction to improve ION recovery in patients with ZMC fractures. The findings of these investigations, however, have been varied. ORIF has been shown in certain investigations to be more successful than closed reduction in facilitating ION recovery. For example, Hassan et al.[5] discovered that 65.8% of ORIF patients had full ION recovery, compared to 52% of closed reduction patients[5]. Another study included a comprehensive assessment of light touch, blunt and sharp pricks, and thermal sensations and compared the results of open and closed reductions pre-operatively and post-operatively. It concluded that open reduction showed a higher rate of recovery of functional nerve reactivation in contrast to closed reduction[6]. Other studies have observed no statistically significant difference in ION recovery between open and closed reduction. In patients with ZMC complex fractures, conservative management resulted in better infra orbital nerve prognosis than open reduction and internal fixation, arguing for avoiding needless surgery[7]. According to a study undertaken to evaluate the pattern of broken zygoma, different treatment techniques, and treatment consequences, there was no significant correlation between cheek paresthesia and surgical reduction procedures[8]. Therefore, the data on the efficacy of open and closed reduction for increasing ION recovery in patients with ZMC fractures is conflicting[9]. The explanation for the disparity in findings between research is still to be explored. However, discrepancies in research design, patient demographics, and outcome measures might have contributed to these inconsistencies. The objective of this study was to assess the recovery time of the functional status of the infraorbital nerve in individuals with paresthesia after open and closed reduction of ZMC fractures and to add to the current body of knowledge on the comparative effectiveness of both surgical modalities for increasing ION recovery in ZMC fracture patients. Ultimately, the goal of this research is to improve patient care, treatment results, and overall quality of life for those who have ZMC fractures in the local population.

Methods

This prospective comparative study was carried out at the Department of Oral and Maxillofacial Surgery, Mayo Hospital, Lahore, Pakistan. With a predicted healing rate of the infraorbital nerve in the open and in the closed reduction group[6], the sample size was calculated using a 95% confidence level and 80% power of the test. The sample size was determined to be 100 participants based on these estimations, with 50 assigned to each group, i.e., Group A for closed reduction and Group B for open reduction. The participants were chosen via a non-probability purposive sampling method keeping them matchable for age, gender, and the disease under consideration. The design of this study was Cohort where all the participants were randomly selected for two different treatment groups which were treated equally in all regards except for the intervention under consideration, i.e., the distinct surgical option of open or closed reduction. A simple randomization technique was used for allotment into groups. Patients with unilateral isolated en bloc zygomatic bone fractures with post-traumatic paresthesia, of both genders, between the ages of 20 and 60 years of age, having no facial skin damage, and with resolved post-traumatic edema were included at least after 2-3 weeks of the trauma. Comminuted zygomatic bone fractures and fractures connected to other facial bones were the grounds for the exclusion of the patients.

After receiving approval from the Institutional Ethics Committee, data collecting procedures entailed enrolling patients who gave written informed consent after being made aware of the design of the study, planned use of research data, and risk-benefit ratio. However, the single blinding technique was used as participants were completely unaware of the group they were allotted. Preoperatively, neurosensory deficiencies of ION were recorded. These symptoms include dysesthesia of the skin of the nose, cheek, lower eyelid, upper lip, gingiva, and teeth of the affected side. The tip of a 0.2-mm diameter blunted acupuncture needle was pushed against the patient's skin until the needle slightly bends (the skin was dimpled but not penetrated). The specific sites included mid-way of the dimensions of the lower eyelid, middle of the lateral part of the nose, the middle portion of upper lip, and middle of zygoma. The patient-graded sensation was recorded in a 100 mm visual analogue scale (VAS).[9] Results were recorded as the difference in the VAS values between the control and injured sides post-operatively as well. On a proforma that was specifically designed, demographic information such as age and gender was recorded. One of the department's three consultants was made the incharge of the surgical management procedure, which took place over the course of 1 to 5 days. The researchers evaluated each patient's postoperative paresthesia. Following surgery, infraorbital nerve recovery was assessed using established operational standards[10]. Furthermore, the follow-up evaluations were completed at 2 weeks, 4 weeks, and 6 weeks, culminating in a final assessment for the recovery of the functional status of ION.

Statistical analysis

For analysis, the obtained data were analyzed using Statistical Package of Social Sciences (SPSS) version 20.0 (SPSS, Inc., Chicago, IL). The chi-square test and independent samples

Table 1. *Functional recovery of Infraorbital nerve and other outcomes in patients with ZMC fractures treated with open and closed reduction (n = 50 each).*

Variables	Categories	Group-1 closed reduction *n* (%)	Group-2 open reduction *n* (%)	Total *n*	*p*-value*
Functional recovery of ION	Yes	26 (52%)	37 (74%)	63	<0.05
	No	24 (48%)	13 (26%)	37	
Average time of functional recovery (confidence interval)	Weeks	3.6 (2.8-4.4)	4.2 (3.1-5.3)	3.9	<0.001
Post-operative complications**	Yes	2 (4%)	5 (10%)	7	>0.05

*Independent samples *t*-test and Chi-square test

**Please see description in results section

t-test were used to assess the infraorbital nerve functional recovery and post-operative complications between the two groups, and a *p*-value of 0.05 or less was regarded as statistically significant.

Results

This study comprised 100 patients who met the inclusion/exclusion criteria to examine the outcome of functional ION recovery in patients with zygomatic-maxillary complex fractures treated with open reduction and internal fixation vs closed reduction.

The study's age distribution revealed that most participants (29%) were aged between 18-30, years followed by 31-40 years (32%), 41-50 years (30%), and >50 years (9%). The mean age of the patients was 37.43 years with a standard deviation of 11.06 years, indicating a relatively wide age range among the participants. In terms of gender distribution, there were 28% female patients and 72% males. There was no attrition observed in the follow up as all the participants had been regularly examined post operatively on the scheduled appointments.

The overall frequency of functional ION recovery was found to be 63%. In particular, 37 (74%) of the 50 patients treated with open reduction and internal fixation recovered functional nerve status, while 13 (26%) of the cases showed no functional recovery of ION. In Gillie's method-treated closed reduction group of 50 patients, 26 (52%) experienced full recovery, whereas 24 (48%) did not exhibit any recovery within 6 weeks of the procedure pointing to a statistical difference (*p*-value of 0.023) in the functional nerve regeneration between open and closed reduction procedures.

We noted a negligible frequency of complications and adverse outcomes in both the open-reduction and closed-reduction groups. Only a few cases - 4% in the open reduction group and 10% in the closed reduction - out of the 50 patients in each group encountered minor issues like a short-term infection or a mild hematoma. In comparison to Group-A, the average recovery time for the functional status of ION was quicker in patients with Group-2 (4.2 ± 1.1 weeks vs 3.6 ± 0.8 weeks) with a statistically significant difference ($p < 0.001$) (Table 1).

Discussion

The current study compared the infraorbital nerve functional recovery after open and closed reduction of ZMC fractures in individuals with post-traumatic paresthesia. Both open and closed reduction techniques were effective in promoting infraorbital nerve recovery. However, the open reduction technique may offer quicker relief from sensory disturbances, which can greatly benefit patients in terms of comfort and quality of life. This was validated by a prospective evaluation study of Infraorbital nerve recovery following open reduction[11]. This study was done on 13 patients with ZMC fractures and concluded that after 3-6 months follow up, most of the patients showed recovery of the tactile stimulation. The benefits of open and closed reduction techniques have been reported to be consistent across various age groups and genders.[8] The total success rate in recovering sensory function in ZMC fractures in the present study was around 63%, with a very low rate of minor complications which is consistent with a meta-analysis conducted on the results of open and closed reduction, demonstrating a reasonable success rate[12]. However, there was a significant difference in recovery time between the two groups, with the open-reduction group demonstrating faster sensory improvement than the closed-reduction group. This result is validated by a randomized controlled trial done in India on patients with ION injury following ZMC fracture, showing a significant speedy improvement in patients receiving open reduction as compared to the closed reduction[13]. According to the literature, open reduction allows for more exact anatomical

restoration and direct visualization of the infraorbital nerve, which may lead to a greater and more precise reduction of the fracture [14]. In terms of complications and adverse events, both open and closed reduction procedures revealed a low frequency of minor issues which is consistent with earlier research. Both techniques have been reported to have comparable safety profiles, with no significant difference in the incidence of complications between the two groups[15]. A study conducted by the researchers at the University of Washington, USA reported that infraorbital nerve healing improves over time on long-term follow-up after surgical intervention in patients with ZMC fractures[16]. However, the potential advantages of open reduction are congruent with the current body of information, such as faster sensory improvement and improved patient satisfaction[17]. These factors play an important role in the management of ZMC fractures and in choosing a preferred method of management. This study had multiple strengths to enhance the validity and reliability of the findings, for example, the investigation used a cohort study design and patients were randomly assigned into two groups and compared. Using purposive sampling, the researchers were able to identify matchable patients who met the inclusion and exclusion criteria.

Conclusion

In conclusion, both open and closed reduction procedures produced positive results on the recovery of the functional status of the infra orbital nerve in patients with ZMC fractures associated with paresthesia. The open reduction technique however demonstrated faster sensory recovery and greater patients' satisfaction.

Limitations of the Study

However, it is important to recognize the limits of our research. Firstly, the study was done at a single institution, limiting the findings' generalizability. The sample size might have influenced statistical power to identify modest differences in outcomes between the two groups. A greater sample size may give more reliable evidence. Finally, a longer follow-up may be required to determine the complete level of infraorbital nerve healing over time. Future studies are recommended to be conducted on multi-setting and multi-city levels to enhance the generalization.

Acknowledgement

The authors would like to acknowledge the staff and doctors of the Department of Oral and Maxillofacial Surgery, Mayo Hospital, Lahore, Pakistan, for their support during the execution of this research work.

List of abbreviations

ION	Inferior Orbital Nerve
ZMC	Zygomaticomaxillary Complex
CI	Confidence Interval

Conflict of interest

None to declare.

Grant support and financial disclosure

None to disclose.

Ethical approval

The study was approved by the Institutional Ethical Review Committee of the College of Physicians and Surgeons Pakistan vide Letter No. CPSP/REU/DSG/066-925 for the dissertation of Dr. Yaser Ishaq.

Authors' contributions

YI: Concept and design of study, acquisition of data.
MN: Drafting of manuscript and acquisition of data.
FAC, FA: Drafting of manuscript and critical intellectual input.
FSM, HS: Analysis of data.
ALL AUTHORS: Approval of the final version of the manuscript to be published.

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