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Comparison of infraorbital nerve recovery after open and closed reduction of zygomaticomaxillary complex fractures

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ABSTRACT

Background: Zygomaticomaxillary complex (ZMC) fracture is quite commonly seen fracture in the road side accidents (RTA). It is the second most common fracture after nasal bone fractures. Infraorbital nerve is almost always involved with ZMC fractures which can be treated with open reduction and internal fixation or closed reduction.

Methods: The aim of this study was to compare the recovery of infraorbital nerve paresthesia following open reduction and internal fixation verses closed reduction in the management of ZMC fractures.

Results: Two groups with n=50 patients each, qualifying our inclusion criteria were selected, examined, reduced by open and closed reduction respectively and followed up.

Conclusions: The functional infraorbital nerve recovery was found among 74% patients those who underwent open reduction and internal fixation. While the patients treated with closed reduction the functional nerve recovery was seen in 52%.

Keywords: Zygomaticomaxillary complex fractures, Infraorbital nerve, Open reduction, Closed reduction

INTRODUCTION

The anatomical prominence of zygomaticomaxillary complex (ZMC) in the facial skeleton is one of the most common reasons for trauma constituting 45% of all midfacial and 25% of all fractures of facial population. Traffic accidents are the most frequent cause of ZMC fractures. Young males with motorcycle accidents are documented as the most repeated etiology (24.8%) followed by car accidents (19.2%). Males involved in interpersonal violence constitutes 15.2% while fall due to old age 12%, bicycle accidents 8.8%, sports mishaps 7.2%, vehicle-pedestrian collisions 4.8%, work related injuries 3.2% and other causes 4.85%.

Periorbital edema and ecchymosis is a common sign of orbitozygomatic complex fractures. Other signs include sub conjunctival hemorrhage with or without lateral limit in all planes, depression of the malar eminence (loss of projection) and neurological fallout in distribution of infraorbital nerves. Dystopia, decreased movement, binocular diplopia, enophthalmos, antimongoloid slant of lateral canthus as well as palpable steps around the orbital rim and buttress are further indication of zygomatic fractures. Limited mouth opening may be present when the arch is fractured impeding on the coronoid process or as a result of muscle injury.³ A distinctive sign and remarkable feature of zygomatic injury is flattening of the normal prominence and limitation of mouth opening.⁴ The patient may present with visible facial asymmetry, significant functional impairment of mandibular movements, disturbance in vision or eye movements, a step at infraorbital rim or frontozygomatic suture and infraorbital dysfunction.5

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Incidence of infraorbital nerve injury following ZMC fractures ranges from 18-83%. Infraorbital nerve is often involved in ZMC fractures because fracture line includes infraorbital fissure, canal or foramen in 95% of cases. Sensory alteration of infraorbital nerve produced by ZMC fractures include hypoesthesia, dysesthesia, paresthesia and anesthesia of upper lip, cheek, lower eyelid, skin of nose, anterior gum and teeth of affected side.^{6,7}

ZMC fractures present with different patterns. Various types can be treated by different surgical' techniques based on type, extent and nature, patient's limitation and surgeon expertise. Each procedure has its own advantages and limitations. Closed reduction techniques like Gillie's, Keen's approach and Champion's technique are relatively short procedures, cost effective and that complications caused by external incisions, manipulations and fixations are reduced but sizeable complications like facial deformity, persistent paresthesia, diplopia and limitation of mandibular movements may indicate the necessity of more aggressive approach in future. Open reduction with miniplate osteosynthesis provides better fixation but is costly, time consuming and often ends up with prominent facial scars.

Neurosensory deficits after such fractures heal over a period of time. Based on time period healing required, paresthesia is classified as mild moderate and severe. Nerve injury is classified based on time period of nerve recovery post operatively. Mild nerve injury recovers within two months and moderate takes as long as one vear. 10 Different documentations support different theories. It is postulated that nerve recovery is faster and better after closed reduction. 11 In a study nerve function was completely recovered in 52% of patients. 12 On the contrary, data supporting open reduction and internal fixation allows for significantly better restoration of infraorbital nerve function is also found. 13 It was found that only 22.1% of patients had persistent nerve dysfunction after open reduction and internal fixation (recovery in 77.9%). ¹⁴ Nerve injury following fracture may involve traction, pressure, ischemia, inflammation and physical damage. Nerve decompression while open reduction hastens recovery.1

Rationale of this study is to evaluate sensory recovery postoperatively treated with open reduction comparing it with closed reduction method to find a better treatment modality for reduction considering functional recovery of infraorbital nerve and to determine the significant difference in nerve recovery in patients treated by closed reduction and open reduction and internal fixation as previously there is no comprehensive study comparing these two treatment modalities.

METHODS

It was a randomized controlled trial conducted in the department of Oral and Maxillofacial Surgery, Mayo Hospital, Lahore. The study was completed in 12 months (November 2014 to October 2015). A total of n=100 adult subjects of both gender were divided into two groups using non probability purposive sampling technique. The inclusion criteria comprised of subjects with unilateral isolated enbloc zygomatic bone fractures with any infraorbital nerve symptoms of both gender and age range of 18 to 60 years, diagnosed clinically and radiographically (Water's view, submento vertex (SMV) radiographs and a true posterior-anterior (PA) view) with no previous infra-orbital nerve sensory disturbances. Patients presenting with fractures to other facial bone and comminuted zygomatic bone fractures were excluded from the study.

All patients presenting with midfacial trauma in the outpatient department of Oral and Maxillofacial surgery, Mayo hospital Lahore and fulfilling inclusion and exclusion criteria were included in the study after the approval of ethical committee. An informed consent was obtained from patient or patient's guardian after explaining study protocol, use of data for research and risk benefit ratio. Patient's demographic data like age and gender were collected on a specially designed proforma. Patients were selected blindly via lottery method and divided into two groups. Group A, who underwent closed reduction method and group B, those treated with open reduction and fixation with mini plate osteosynthesis. All patients underwent surgical management within 1-5 days of presenting in the OPD. Paresthesia of every patient was checked by surgeon. It was determined by relief of initial complaint like tingling or numbness. Recovery was accessed by using a sterile dental needle in a quick prick fashion in sufficient intensity to be perceived by the patient. Appropriate response was perception of sharp pain and not just pressure. Follow up was done after 2 weeks, 4 weeks, 6 weeks, 12 weeks and a final evaluation was be made.

Data collected was entered on SPSS version 15.0 (SPSS, Inc., Chicago, IL, USA) and results were analyzed as followings. The qualitative variables in data that are gender and outcome variables (infraorbital nerve recovery) are presented as frequency and percentages. The quantitative data that is age will be presented as mean with standard deviation. Chi-Square test was used to compare the infraorbital nerve recovery in both groups. $P \le 0.05$ will be considered as significant.

RESULTS

A total of 100 cases fulfilling the inclusion/exclusion criteria were enrolled into two groups as mentioned to determine the frequency of functional nerve recovery in patients with paresthesia treated with open reduction and internal fixation verses closed reduction.

Gender distributions of the patients' show 72% were male and 28% were females. The mean age of the patients were 36.54 ± 11.06 with age range of 18-60 years of age.

Table 1: Frequency of functional nerve recovery.

Age group	No. of patients	%
18-30	34	34
31-40	33	33
41-50	26	26
>50	07	07
Total	100	100

Age distribution showed n=34 patients between 18-30 years of age, n=33 were between 31-40 years, n=26 between 41-50 years and the rest n=7 were >50 years of age, mean and SD was calculated as 37.43 ± 11.06 years (Table 1).

In this study, the functional nerve recovery in the patients treated with closed reduction was seen in n=26 (52%) while the patients treated with open reduction and internal fixation was found among n=37 (74%). This relation was statistically significant (p=0.023) (Table 2).

On stratification of age groups with the functional recovery of the infraorbital nerve damage, it was noted that open reduction and internal fixation yielded a better result in total recovery of the nerve in all the age groups when compared to the closed reduction where it had a low chance of recovery. This relation was statistically significant (p=0.109) (Table 3).

Table 2: Functional nerve recovery in patients with paresthesia treated with closed reduction versus open reduction (n=100).

	Group	Group			
		Closed	Open	Total	
Functional nerve recovery	Yes	26	37	63	
	No	24	13	37	
Total		50	50	100	
P value				0.023	

Table 3: Stratification for functional nerve recovery with regards to age of the patients (n=100).

Recovery of nerve injury in		Age groups	Age groups					
patients (n)		18-30 yr	31-40 yr	41-50 yr	>50 yr	Total		
Open reduction	Yes	09	10	13	05	37		
	No	02	07	04	0	13		
Closed reduction	Yes	12	08	05	01	26		
	No	11	08	04	01	24		
Total		34	33	26	07	100		
P value						0.109		

DISCUSSION

ZMC fractures have a very high incidence because of its prominent anatomical position. The infraorbital foramen is involved mostly with ZMC fractures resulting in infraorbital nerve injury. As soon as patient presents in the emergency room an initial preoperative assessment and documentation of infraorbital nerve function is strongly endorsed. The precise three dimensional relationship of the malar complex to the skull base in displaced fractures require restoration and establishment of fixation sufficient enough to resist the pull of the masseter during bony healing along with functional nerve recovery of infraorbital nerve. ¹⁶

The highest incidence of maxillofacial fractures is commonly seen in young adults mostly in the age group of 20 and 40 years. This can be due to the irresponsible behavior of this age group in following the traffic rules especially in the developing countries. ¹⁷ This finding was consistent with our finding which resulted in 67% of the patients in the same age group.

We planned this study to determine the degree of sensory recovery postoperatively treated with open reduction and internal fixation verses closed reduction to counsel the patient for prolonged recovery of paresthesia postoperatively. There is evidence that rigid fixation of ZMC suture enhances the recovery of infraorbital nerve compared with other means of closed surgical treatments. Previously no local study is conducted on this issue.

Infraorbital nerve sensory disturbances after a ZMC varies widely in the studies. In one study the nerve injury was quite common finding after a ZMC fracture which was diagnosed in 64.4% of the patients. ¹⁸ On the contrary, another study found far fewer (7.4%) infraorbital nerve sensory disturbances to be present in subjects on initial evaluation. ¹⁹ The possible explanation for this difference in results can be difference in the method used. Further, due to subjective nature, it is quite difficult to compare between different studies performed on different methods for assessment of neurosensory deficit. Various techniques are used to evaluate the infraorbital nerve function. These include two point

discrimination, pressure threshold, pin prick test, sharp and blunt instrument. The incidence of residual sensory dysfunction varies with the testing modality. There is a vast difference in the resources and equipment used in evaluation of sensory changes used in objective evaluation of the nerve. This could lead to differences in the definition of sensory changes. This problem can be sorted out by standardization of the instruments used for this purpose.

A paper from UK reported the treatment results of 106 patients with zygomatic fractures treated with conservative method and by open reduction. The patients managed with conservative options, 50% suffered late reduced sensitivity in the infraorbital region at follow-up examination, whereas in the group with miniplate osteosynthesis only 21% had late neurological sequelae. All these findings are in agreement with the results of the current study which also showed complete recovery in 74% (n=37) after open reduction and internal fixation.

A study from Lithuania found that function of infraorbital nerve was completely reversed in 77.3% of patients after open reduction and internal fixation. This trend is well documented by Taicher et al who reported that 30% of patients had sensory dysfunction after miniplate osteosynthesis in ZMC fractures compared to 43-68% treated with other methods. He concluded 70% patients were free of paresthesia after open reduction and internal fixation. The sensor of t

Westermark et al reported an impaired infraorbital nerve function up to 80% of cases presenting with ZMC fractures. He also suggested that the frequency of hypoaesthesia of the infraorbital nerve following ZMC fracture can be reduced if fixation is rigid on the infraorbital rim. Similar finding was also reported by Maria et al. showing recovery of infraorbital nerve functions in 67% cases fixed with open reduction and intermal fixation.

The results of our study are in agreement with Benoliel R who recorded incidence of infraorbital nerve injury following ZMC fractures ranging from 18-83%. Benoliel documented the neurosensory changes managed in various ways and concluded that plate fixation allows for significantly better restoration of infraorbital nerve function. Chronic neuropathic pain following zygomatic fractures was rare. ¹³

Ahmed with other coworkers concluded the superiority of using miniplate osteosynthesis for the better healing of infraorbital nerve in 2010 and majority of the patients (32.4%) in their study recovered in 4 months duration after surgery.⁶ Prachur and coworkers in 2012 proposed a highly significant beneficial effect on nerve function when plates were used to stabilize fractures. They reinforced the advantage of reduction and the practice of miniplate use for the fixation of zygomatic fractures in avoiding sensory deficit of the infraorbital nerve.²³ Our

study was consistent with recovery of infraorbital nerve dysfunction following zygomatic fractures were recovery in 74% patients treated with open reduction within 12 weeks.

CONCLUSION

The incidence of infraorbital nerve paresthesia is quite high and duration of recovery depends not only on extent of injury but also on treatment modality used. On the basis of this study, the authors recommend open reduction and internal fixation as preferred mode of treatment which results in better functional nerve recovery among patients with paresthesia when compared to closed reduction methods.

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