Original Article – Comparative Study

Two-Point versus Three-Point Fixation in the Management of Zygomaticomaxillary Complex Fractures: A Comparative Study

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Abstract

Introduction: The zygoma plays an important role in the facial contour for both cosmetic and functional reasons; therefore, zygomatic bone injuries should be properly diagnosed and adequately treated. Comparison of various surgical approaches and their complications can only be done objectively using outcome measurements that require a protocol for management and long-term follow-up. The objectives of this study were to compare the efficacy of zygomatic bone after treatment with open reduction internal fixation (ORIF) using two-point fixation and ORIF using three-point fixation and compare the outcome of two procedures. **Materials and Methods:** Twenty patients were randomly divided equally into two groups. In Group A, ten patients were treated by ORIF using two-point fixation by miniplates and in Group B, ten patients were treated by ORIF using three-point fixation by miniplates. They were evaluated with their advantages and disadvantages and the difference between the two groups was observed. **Results:** We found that postoperative facial and neurological complications are minimum in two-point fixation group. Based on this study, open reduction and internal fixation using two-point fixation by miniplates is sufficient and the best available treatment of choice for the management of zygomaticomaxillary complex fractures. **Discussion:** Alignment of the fracture at three points and fixation at two stable points provide the most accurate and satisfactory postoperative results. Two-point interosseous fixation at the "buttress" fracture and the frontozygomatic (FZ) fracture is suitable for routine surgery. The results of these studies confirm with the present study that two-point fixation provided better stability in patients with clinical and radiological evidence of fracture in FZ and zygomaticomaxillary buttress area.

Keywords: Internal fixation, open reduction, three-point fixation, two-point fixation, zygomatic fracture

Introduction

The face occupies the most prominent position in the human body rendering it vulnerable to injuries. Zygoma plays an important role in the facial contour for both cosmetic and functional reasons; therefore, zygomatic bone injuries should be properly diagnosed and adequately treated. Due to its position, it is the second most common mid-facial bone fractured after the nasal bones and overall represents 13% of all craniofacial fractures.[1]

Zygomatic bone contributes significantly to the strength and stability of the mid-face and it articulates with the frontal, temporal, sphenoid, and maxillary bones.[2] The zygomatic bone forms the cheek prominence, part of lateral and inferior orbital rim, and the orbital floor. The zygomatic complex is important in the function of globe, facial symmetry and also gives passage to infraorbital nerves and vessels that innervates the mid-facial region.[3]

The first description of this type of fracture comes from the *Papyrus of Edwin Smith*, but Duverney[4] was the first

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to describe the zygomaticomaxillary complex (ZMC). The main objectives of this study were to compare the efficacy of zygomatic bone after treatment with open reduction internal fixation (ORIF) using two-point fixation and ORIF using three-point fixation and compare the outcome of two procedures. The rationale of the study on reduction and internal fixation using two-point fixation by miniplates is sufficient and the best available method for the treatment ZMC fractures in terms of intraoperative stability and postop complications.[5-14]

Materials and Methods

Source of data

The prospective study was done on patients reporting to the Department of Oral and Maxillofacial Surgery, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur, for the management of zygomaticomaxillary complex fractures during the period of August 2015 to August 2020.

Sample of data

The clinical study was conducted on 20 patients who had sustained fractures in zygomaticomaxillary complex fractures selected under the following criteria. Informed consent was obtained from all the patients before inclusion in the study. Ethical approval number was obtained OS/194/2015 and date of approval August 10, 2015 as a standard protocol. Student's pair t-test and Student's unpaired t-test was used for statistical analysis of the data.

Inclusion criteria

1. Patients having zygomatic complex fracture
2. Patients who are ready for follow-up.

Exclusion criteria

1. Patients who are medically compromised and are not fit to undergo the surgery.

Sample size

- A total of 20 patients who had sustained fractures of zygomaticomaxillary complex were included in the study
- A standard proforma was used to collect necessary information regarding each case after inclusion
- The patients were informed about the study, explained to them in their own language, and necessary consent was obtained from the concerned personnel
- All necessary preoperative, intraoperative, and postoperative photographic records were maintained for these patients. All the required hematological investigations were done
- The patients after inclusion were divided into Group 1 and Group 2 based on the clinical and radiological evidence of the fractured frontozygomatic area, infraorbital rim. In Group 1 (ten patients), fixation was done near zygomaticomaxillary buttress, frontozygomatic (FZ) area, and in Group 2 patients, fixation was done near zygomaticomaxillary buttress, frontozygomatic area, and infraorbital rim.

Surgical technique

Under general anesthesia, nasoendotracheal intubation was done. All patients were scrubbed and draped in a standard fashion. Two percentage lignocaine with 1 in 80,000 adrenaline was injected at the local site for hemostasis. Incision was given in the upper buccal sulcus and reduction of the fractured zygoma was done via Keen's approach using Howarth's periosteal elevator or Bristow's elevator. After achieving adequate reduction, in case of two-point fixations, the fractured FZ region was exposed by lateral eyebrow incision. After visualization of fractured areas, fixation of reduced fractured segments was done with 4–6 holed, 1.5 mm to 2 mm miniplate at ZMB, and 1.5 mm to 2 mm FZ area (for two-point fixation) and additional infraorbital margins were exposed by infraorbital/subciliary incision and fixation was done (three-point fixation group). After achieving adequate hemostasis, muscle layer was closed with 3-0 vicryl and mucosa was closed with 3-0 black braided silk and skin sutures were placed with 5-0 prolene.

Intraoperative stability

- Intraoperative assessment of stability of the repositioned zygomaticomaxillary fracture, as performed with the help of digital manual palpation method to determine the need for applying fixation devices [Figures 1 and 2].

Duration of surgery

- Duration was calculated from the adaptation of miniplate till the fixation of the last screw at the fracture site.

Facial assessment

- Frontal and bird's eye views were taken for assessment of malar asymmetry
- Grading of malar asymmetry was done according to the classification system proposed by Holmes and Mathews
- Grade 1: Excellent cosmetic result, no malar asymmetry with any visible scar formation
- Grade 2: Good cosmetic result, malar asymmetry on careful inspection with very minimal scar formation
- Grade 3**:** Poor cosmetic result, noticeable malar asymmetry with minimal scar formation
- Grade 4: Gross malar asymmetry with noticeable scar formation [Figures 3 and 4].

Radiological assessment

- Horizontal line which touches the supraorbital margins was drawn on the PNS. Vertical median line was drawn by touching the glabella and passed between two upper central incisors. McGregor and Campbell's second line was from the zygomatic arch on one side throgh the infraorbital margins and to the zygomatic arch on the opposite side. One more vertical line was drawn on either side perpendicular to horizontal reference line touching the medial aspect of lateral orbital margin and extended downward to touch the McGregor and Campbell's second

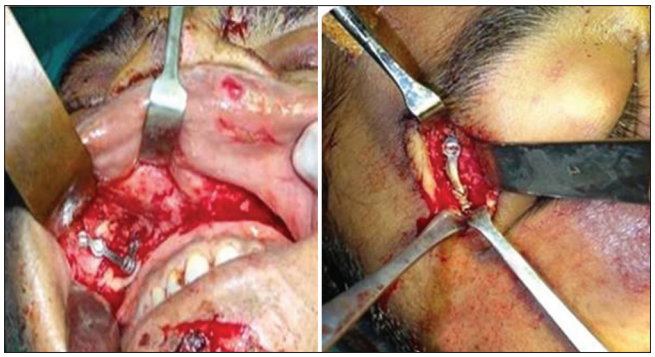

Figure 1: Group A – Intraoperative stability and fixation at fracture site

Figure 3: Group A – Facial assessment preoperative and postoperative

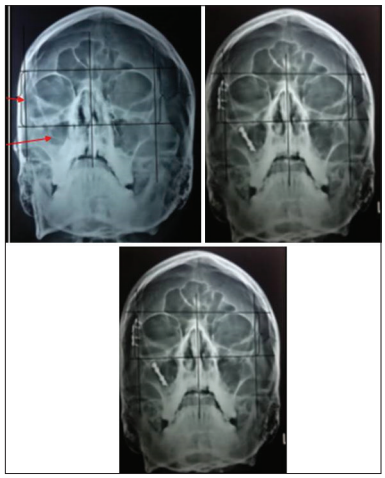

Figure 5: Group A – Radiological assessment preoperative, 1 and 6 months

line. These intersecting point of the two lines was chosen as a reference point and vertical measurement has been taken from horizontal reference line to intersecting point and horizontal measurement has been taken from vertical median line to intersecting point. These two measurements were taken on both right and left sides, difference between these measurements on the fracture side with the normal side was evaluated [Figures 5 and 6].

Neurological assessment

This was performed with pinprick test. The evaluation was done preoperatively, after 1 month, and after 6 months of surgery.

- Score – 0: No paraesthesia

Figure 2: Group B – Intraoperative stability and fixation at fracture site

Figure 4: Group B – Facial assessment preoperative and postoperative

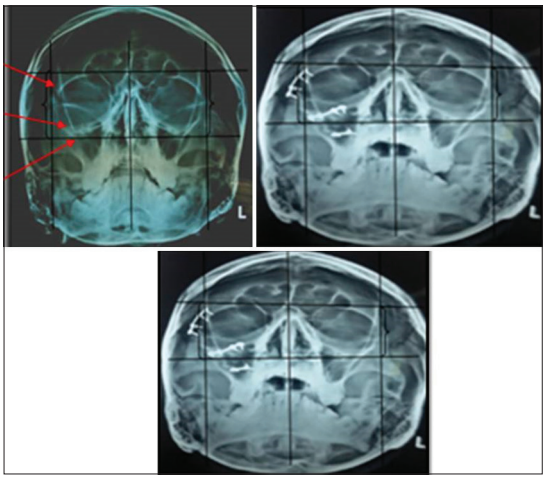

Figure 6: Group B – Radiological assessment preoperative, 1 and 6 months

- Score – 1: Paraesthesia present.

Mouth opening

This was performed with Vernier caliper. The evaluation was done preoperatively, after 1 month, and after 6 months of surgery [Figures 7 and 8].

Figure 7: Group A – Interincisal mouth opening preoperative, 1 and 6 months

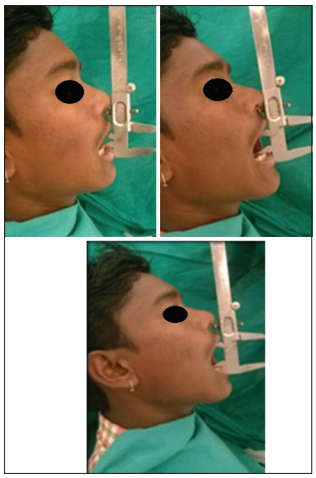

Figure 8: Group B – Interincisal mouth opening preoperative, 1 and 6 months

Results

Following the completion of clinical study on the patient, the measurement and the data taken from all patients were tabulated for statistical studies and observational data was made after the analysis of two Groups (Group A& B). All the results are summarized in master Tables 1 and 2.

The treatment outcomes of two techniques were evaluated and compared with regard to the following variables:

1. Intraoperative stability
2. Duration of surgery
3. Facial assessment
4. Radiographic assessment
5. Neurological assessment
6. Interincisal mouth opening
7. Associated complications.

The mean duration of surgery in Group A was 68.80 ± 13.89 and in Group B, it was 103.10 ± 6.80. By using Student's unpaired *t*-test, a statistically significant difference was found in the mean duration of surgery in patients of both the groups ($t = 7.01$, $P = 0.0001$).

The mean facial aesthetic in Group A at 1 month was 2.50 ± 0.52 and at 6 months, it was 1.70 ± 0.48. By using Student's paired *t*-test, statistically significant difference was found in mean facial aesthetic at 1 month and 6 months ($t = 2.75$, $P = 0.022$).

The mean facial aesthetic in Group B at 1 month was 2.70 ± 0.82 and at 6 months, it was 2.40 ± 0.69. By using Student's paired *t*-test, no statistically significant difference was found in mean facial aesthetic at 1 month and 6 months (t = 1.40, $P = 0.019$).

Mean radiological assessment at 1 month in Group A was 2.21 ± 0.69 and at 6 months, it was 1.46 ± 0.20. By using Student's paired *t*-test, statistically significant difference was found in mean radiological assessment in Group A at 1 month and 6 months ($t = 1.58$, $P = 0.019$).

Mean radiological assessment at 1 month in Group B was 2.36 ± 0.29 and at 6 months, it was 1.76 ± 0.36. By using Student's paired *t*-test, statistically significant difference was found in mean radiological assessment in Group A at 1 month and 6 months ($t = 5.69$, $P = 0.0001$).

Mean neurological assessment at 1 month in Group A was 0.10 ± 0.31 and at 6 months, it was 0.50 ± 0.52. By using Student's paired *t*-test, statistically significant difference was found in mean neurological assessment in Group A at 1 month and 6 months ($t = 2.44$, $P = 0.037$).

Mean neurological assessment at 1 month in Group B was 0.20 ± 0.42 and at 6 months, it was 0.90 ± 0.31. By using Student's paired *t*-test, statistically significant difference was found in mean neurological assessment in Group A at 1 month and 6 months ($t = 4.58$, $P = 0.001$).

Discussion

Intraoperative assessment of stability of the repositioned ZMC was performed with the help of digital manual palpation method. This study has also been advocated by Barry CP *et al*.[15] using digital pressure after reduction to determine the need for applying fixation devices. In our study, both two-point and three-point fixation groups showed adequate intra- and postoperative stability and fracture site.[16]

In Group A, fixation is done at ZMB and FZ suture. As the soft tissue overlying the FZ area is very thin, to prevent visibility, sensibility, and palpability, it is considered as second point. In this group, the mean duration of surgery was 68.80 ± 13.89 min which was minimum as compared to Group B. Barry *et al*.[17] suggested that primary location for fixation should be in vertical plane to resist the vertical displacing force either at the frontozygomatic suture or the zygomatic buttress.[18-20]

Abhay[21] concluded that alignment of the fracture at three points and fixation at two stable points provides the most accurate and satisfactory postoperative results. Two-point

Table 1: Group A

Age/sex	Etiology	Diagnosis	Treatment done	Duration of surgery (min)	Stability		Facial aesthetic (months)		Radiological assesment (cm) (months)		Neurological assesment (months)		Complications (months)	
					Intra operative	Postoperative	1	6	1	6	1	6	1	6
25/male	RTA	Left ZMC fracture	Two-point fixation	94	Adequate	Adequate	3	2	2.1	1.2	0	0	No	No
22/male	RTA	Right ZMC fracture	Two-point fixation	59	Adequate	Adequate	2	2	2.3	1.8	0	0	No	No
34/male	RTA	Right ZMC fracture	Two-point fixation	64	Adequate	Adequate	3	1	2.3	2	1	0	No	No
45/male	ASSULT	Left ZMC fracture	Two-point fixation	86	Adequate	Adequate	2	2	2.4	1.2	0	0	No	No
26/male	RTA	Right ZMC fracture	Two-point fixation	75	Adequate	Adequate	3	1	1.8	1.1	1	0	Yes	No
20/male	RTA	Left ZMC fracture	Two-point fixation	74	Adequate	Adequate	2	2	2.6	1.1	0	0	No	No
32/female	RTA	Left ZMC fracture	Two-point fixation	54	Adequate	Adequate	3	1	2.5	2	0	0	No	No
27/male	RTA	Right ZMC fracture	Two-point fixation	49	Adequate	Adequate	2	2	2.3	2.1	0	1	No	No
29/male	RTA	Left ZMC fracture	Two-point fixation	66	Adequate	Adequate	2	2	2.4	1.9	1	1	No	No
34/male	RTA	Right ZMC fracture	Two-point fixation	67	Adequate	Adequate	3	2	2.9	2.1	1	0	Yes	No

RTA=Renal tubular acidosis; ZMC=Zygomaticomaxillary complex

Table 2: Group B

Age/ sex	Etiology	Diagnosis	Treatment done	Duration of surgery (min)	Stability		Facial aesthetic (months)		Radiological assesment (cm) (months)		Neurological assesment (months)		Complication (s) (months)	
					Intra operative	Postoperative	1	6	1	6	1	6	1	6
25/male	RTA	Left ZMC fracture	Three-point fixation	94	Adequate	Adequate	2	2	3.1	2.1	1	1	Yes	No
22/male	RTA	Right ZMC fracture	Three-point fixation	112	Adequate	Adequate	2	2	3.2	2	1	1	No	Yes
34/male	RTA	Right ZMC fracture	Three-point fixation	99	Adequate	Adequate	2	1	2.9	1.8	1	0	Yes	No
45/male	RTA	Left ZMC fracture	Three-point fixation	102	Adequate	Adequate	3	3	2.2	1.6	1	0	Yes	Yes
26/male	RTA	Right ZMC fracture	Three-point fixation	105	Adequate	Adequate	2	1	1.8	1.5	1	0	Yes	Yes
35/male	RTA	Right ZMC fracture	Three-point fixation	112	Adequate	Adequate	3	1	1.9	1.6	1	0	Yes	Yes
45/male	RTA	Left ZMC fracture	Three-point fixation	105	Adequate	Adequate	2	2	1.2	1.2	0	0	Yes	Yes
34/male	RTA	Right ZMC fracture	Three-point fixation	97	Adequate	Adequate	4	3	1.3	1.2	1	0	No	No
44/male	RTA	Left ZMC fracture	Three-point fixation	95	Adequate	Adequate	3	3	2.2	2	1	1	Yes	Yes
29/male	RTA	Left ZMC fracture	Three-point fixation	110	Adequate	Adequate	4	3	2.3	2	1	0	Yes	Yes

RTA=Renal tubular acidosis; ZMC=Zygomaticomaxillary complex

interosseous fixation at the "buttress" fracture and the FZ fracture is suitable for routine surgery. The results of these studies confirm with the present study that two-point fixation provided better stability in patients with clinical and radiological evidence of fracture in FZ and ZMB area.[22] Patient satisfaction was good without unsightly scars in this group and the mean facial aesthetics at 1 month was 2.50 ± 0.52 and at 6 months, it was 1.70 ± 0.48.(t = 2.75, P = 0.022). The mean radiological assessment at 1 month was 2.21 ± 0.69 and at 6 months, it was 1.46 ± 0.20 (t = 1.58, P = 0.019). The mean neurological assessment at 1 month was 0.10 ± 0.31 and at 6 months, it was 0.50 ± 0.52 (t = 2.44, P = 0.037).[23,24]

In Group B, fixation was done at ZMB, FZ suture, and inferior orbital rim. In this group, the mean duration of surgery was 103.10 ± 6.80 min which was maximum as it requires additional incision and additional adaptation of miniplate as compared to Group A.

In a study conducted by Vatsa R (1995),[25] seven (51%) patients appeared to have symmetric malar prominence and another five (35%) patients were mildly asymmetric. They emphasized that three-point visualization and liberal rigid fixation for ZMC complex fracture treatment results in a low incidence of complications that are proportional to the severity of injury.[26-28] The present study reveals that mean facial cosmetic result 2.70 ± 0.82 at 1 month and at 6 months, it was 2.40 ± 0.69 (t = 1.40, P = 0.019) and mean radiological assessment at 1 month was 2.36 ± 0.29 and at 6 months, it was 1.76 ± 0.36 (t = 5.69, P = 0.0001). However, the study conducted by Gadkari *et al*.[16] strongly recommended that three-point fixation provides excellent results and maintains the three-dimensional stability at the fracture site. In the present study, three-point visualization and fixation resulted in untoward complications such as postoperative visible scars. These results confirm with the study conducted by Kim JH *et al*.[29] where scores for annoyance were significantly higher for paraesthesia than for deformity pain or trismus with increasing annoyance resulting from all types of symptoms. Finally, ratings for total satisfaction tended to decrease.[30,31]

In the present study, infraorbital paraesthesia was maximum in three-point fixation group compared to two-point fixation group. Degree of paraesthesia has been mentioned by score 0 – no paraesthesia and score 1 – paraesthesia present. The mean neurological assessment at 1 month was 0.20 ± 0.42 and at 6 months, it was 0.90 ± 0.31 (t = 4.58, P = 0.001). However, the study conducted by Gawande *et al*.[32] showed that infraorbital sensations were diminished in three-point fixation group. This may attribute to the risk of additional trauma to infraorbital nerve, even if great care is taken leading to its compression. This is in contrast to the study conducted by Gawande *et al*.[33] where infraorbital nerve function following treatment of orbitozygomatic complex fractures were more pronounced and severe in patients who underwent closed reduction without miniplate fixation.[34-36] Postoperative complications in three groups were very minimal. Minimal infection which developed after fixation of plates was resolved by routine antibiotic therapy. In recent Luck JD's study[18] in January 2020, two-point fixation yields promising result in terms of stability, aesthetic as well as functional outcome as compared to three-point technique. According to Sato *et al*.[19] Five out of eight studies showed that the use of three-point fixation in the treatment of ZMC fractures was superior than two-point fixation for the same. Hence, it can be concluded that three-point fixation is superior than two-point fixation in reducing malar asymmetry in ZMC fractures.[37,38] The authors' results suggest that two-point fixation is an effective management strategy for repair of displaced ZMC fractures in children. In addition, rigid plate-and-screw fixation at the zygomaticomaxillary buttress in children with deciduous dentition appears to be safe and effective when performed.[20] Widodo *et al*. suggest that ultrasound-guided one-point fixation on the zygomaticomaxillary buttress provides accurate reduction on ZMC fractures without the separation of the frontal process of the zygomatic bone fracture. Sufficient stability was obtained, even with the use of biodegradable plates.[22,39,40]

In the present study, only one patient showed postoperative infection in three-point fixation group. Although postoperative infection rates are theoretically higher for a number of reasons, it has been experienced that postoperative systemic antibiotics coupled with adequate hygiene and antibacterial mouth rinses result in low incidence of infection.[20]

Conclusion

Zygoma and maxilla forms a critical portion of the orbit and therefore contributes to the deformities that may remain even after fracture treatment. Proper planning for ZMC fracture treatment is necessary to minimize the occurrence of deformities such as enophthalmos, dystopia, and loss of zygomatic prominence. Stainless steel plates used in this study were very economical and provide better stability in Group A (two-point fixation). Postoperative aesthetic appearance of all patients was acceptable, except in Group B (three-point fixation) who had noticeable malar asymmetry (Grade 2) as compared to Group A (two-point fixation). Group A (two-point fixation) is better in terms of paraesthesia as compared to three-point fixation group because of more handling and more instrumentation in Group B (three-point fixation). Group A (two-point fixation) yields promising results in terms of malar symmetry, interincisal mouth opening, and providing adequate postoperative stability as well as resolution of infraorbital paraesthesia as compared to Group B (three-point fixation). Group A (two-point fixation) provides better advantages as compared to Group B (three-point fixation) because of minimized incision, duration of surgery, and postoperative complications.

Informed consent

Informed consent was obtained from the patients as a standard protocol.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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