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Management of Zygomaticomaxillary Complex Fractures Using 2-point Fixation technique

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Abstract: Purpose: The aim of this study is to evaluate clinically, radiographically the validity of using Two-point fixation in the management of Zygomaticomaxillary Complex fractures.

Methods: The clinical study was conducted on twenty patients had unilateral zygomaticomaxillary complex fracture. Preoperative and Postoperative clinical follow up after 1-week and 1-month was done to all patients for these parameters: vertical orbital dystopia, limitation in mouth opening, diplopia, enophthalmos, limitation of eye movement, sensory disturbance, fracture instability and infection at surgical site. Also, preoperative, and postoperative radiological assessment was done to all patients for these parameters: malar width, malar projection, malar height and, malar asymmetry.
Result: improvement in all clinical parameters and decreased the asymmetry index significantly postoperatively by 1 week and 1 month by using the 2-point fixation technique.
Conclusion: Stable fixation result and adequate esthetic outcome can be obtained by using 2-point fixation technique in ZMC fractures.

Keywords: *Maxillofacial trauma, Zygomaticomaxillary complex, Malar height, Malar width, Malar projection, Facial asymmetry, Enophthalmos, Diplopia*

Introduction

The objectives of surgical management of ZMC fractures include restoration of facial esthetics, restoration of ocular function, restoration antral function, and restoration of normal mandibular range of motion.(1) Indications for surgery include (1) presence of cosmetic defects in the form of facial deformity, loss of lower eyelid support, or ocular dystopia; (2) functional deficits such as limitation of mouth opening, sensory nerve

deficit, and impaired ocular movements; and (3) ZMC fracture associated with oculo-cardiac reflex in children. (2)

The purpose of internal fixation is to stabilize bony segments to allow normal bone healing. The number of fixation points is directly proportional to the requirements of stability.(3). Single point fixation may fails to address three-dimensional stability as it does not counteract with the rotational forces of the zygomaticomaxillary complex.(4) Two-point fixation is used when anatomic reduction cannot be confirmed using one point. It allows the visualization of an additional fracture site and a better stabilization to the ZMC. The zygomatic buttress can be used as the main point and the second point cab be either the infra orbital rim or the fronto zygomatic suture.(5) (6). Three-point fixation include ZM buttress, FZ suture and infra orbital rim. mainly indicated when the fracture is displaced and/or comminuted requires more than 2-point exposure to verify reduction and need for orbital reconstruction. Four-point fixation is indicated for complex zygomatic fractures where exposure of the ZA is necessary to ensure proper reduction of the ZMC. However, complications such as a longer scar on the scalp, extended hair loss of the incised site, injury of the temporal branch of the facial nerve, numbing or tingling of the supraorbital and supratrochlear nerves, and atrophy of the temporal fat pad may occur. Furthermore, a longer operation time and hospitalization period may be required.(7)

The aim of our study is to evaluate the accuracy of the 2-point fixation technique using the zygomatic buttress as a key point of fixation in achieving high quality anatomical reduction and adequate and stable fixation and restoring proper aesthetic and function of the fractured zygomaticomaxillary complex. After reviewing the advantages and limitations of various fixation techniques, a sincere effort was made in the form of a prospective clinical study to manage zygomaticomaxillary complex fractures using the zygomatic buttress as the main key point of fixation and using either the infraorbital rim or the frontozygomatic suture area as the second point of fixation in the larger interest of the patients.

Patients and Methods:

The study was conducted on twenty patients with unilateral zygomaticomaxillary complex fractures. All patients were admitted to Suez Canal University hospital suffered from zygomaticomaxillary complex fractures. The patients were instructed about the procedure that was performed and an informed consent was signed by each participant.

The sample was selected to fulfil the required inclusion and exclusion criteria.

Inclusion criteria: All patients enrolled in this study were had the following characteristics:

1- Unilateral ZMC fracture.

2- Recent ZMC fracture, operated within 20 days.

3- Non comminuted ZMC Fracture.

Exclusion criteria: All patients with the following characteristic were excluded from this study:

1-Severely comminuted and dislocated ZMC fractures.

2- When anatomic reduction could not be confirmed using two-point fixation.

3- When general anaesthesia was contraindicated as in patients with severe underlying systemic disease (American Society of Anaesthesiologists III and IV).

The sample size was estimated using G*power version 3.1.9.6 for Mac OS. A total sample size of 20 was sufficient to detect an effect size of 0.35 at a power of 0.9 (90%) at a partial eta squared of 0.11. (8)

Data were collected, handled, and analyzed using IBM-SPSS version 28.0 for Mac OS. The normality of data was evaluated using the Shapiro-Wilk test to check whether the data was parametric or nonparametric. Differences

between scores were assessed using the Chi-square test, and differences between time points were evaluated using Friedman's test at 0.05 level. Overall differences were assessed by repeated measures ANOVA.

Surgical procedures

The surgical procedure was carried out under general anesthesia, and the reduction of the fractured ZMC was done by Gillie's temporal approach or Keen's approach.

Three anatomical points of fixation were used for internal fixation of the zygomaticomaxillary complex fractures: zygomaticomaxillary buttress, frontozygomatic suture, and infraorbital margin.

The zygomaticomaxillary buttress was used as a key point of fixation in all cases and either frontozygomatic suture or infraorbital margin was used as the second point of fixation using mini plates.

Clinical parameters:

Preoperative and Postoperative clinical follow up after 1-week and 1-month was done to all patients for these parameters: vertical orbital dystopia, limitation in mouth opening, diplopia, enophthalmos, limitation of eye movement, sensory disturbance, fracture instability and infection at surgical site.

Radiographic assessment:

Also, preoperative, and postoperative radiological assessment was done to all patients from CT scan for these parameters: malar width, malar projection, malar height. (Figure 1,2)

Malar asymmetry index:

After measuring the malar width, malar projection, and malar height on both sides, the pre operative and Postoperative asymmetry index was calculated (9),(10).

$$\text{Asymmetry index} = \sqrt{(\text{Wr} - \text{Wl})2 + (\text{Pr} - \text{Pl})2 \ + \ (\text{Hr} - \text{Hl})2}$$

Where Wr is right malar width, Wl is left malar width, Pr is right malar projection, Pl is left malar projection, Hr is right malar height, and Hl is left malar height.

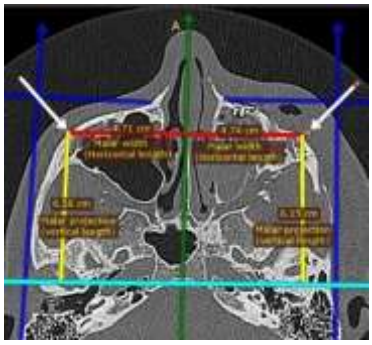

Fig 1. radiographic malar width and malar projection on both sides

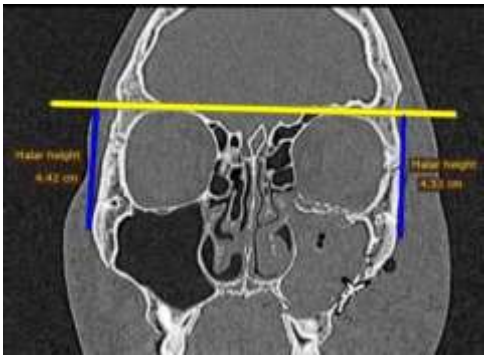

Fig 2. radiographic malar height on both sides.

RESULTS

1. Epidemiological data: The age of studied patients ranged between 18 years to 65 years with an average age of 41.5±14.4 years. Our study included 14 males (70%) and 6 females (30%). The most usual circumstances of the occurrence of the trauma were road traffic accidents: 15 cases from 20 (75%), aggressions: 4 cases from 20 (20%), Sport accidents: 1 case from 20 (5%). The left side was the most frequently injured in our study in 65% of the cases (13 patients), the right side in 35% (7 patient). (Figure 3,4)

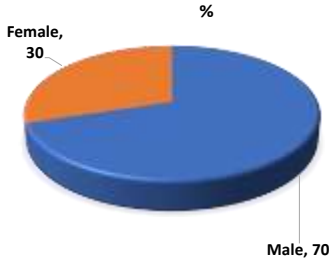

Fig (3) Distribution of patients according to genders.

Fig (4) Pie chart present the most usual circumstances of the occurrence of the trauma.

2. Preoperative clinical parameters:

Tab (1) Preoperative clinical parameters

Clinical Parameter	Frequency				Chi-square
	Yes		No		
	n	%	n	%	
1-Vertical orbital dystopia	10	50	10	50	>0.999ns
2-Mouth opening limitation	17	85	3	15	0.002**
3- Diplopia	8	40	12	60	0.371ns
4- Enophthalmos	10	50	10	50	>0.999ns
5- Limitation of eye movement	5	25	15	75	0.025*
6-Sensory disorders	16	80	4	20	0.007**

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

3-Surgical procedures:

The zygomatic buttress was exposed through intraoral buccal approach and used as the main point of fixation in all cases (fig.5 and fig. 6). The infraorbital rim was used as the second point of fixation in 15 cases and was exposed by Subciliary incision in 9 cases (45%) and subtarsal incision in 6 cases (30%). The frontozygomatic suture was exposed by lateral eyebrow incision and used as the second point of fixation in 5 cases (25%). Reduction was

achieved through Gillie's approach in 4 cases, keen's approach in 13 cases and by manipulating mini screw in 3 cases. Orbital floor was explored in 15 patients (75% of cases); inferior rectus muscle was freed when entrapped and fat hernia was reduced. Infraorbital nerve was gently released when compressed. Orbital floor reconstruction was done for 10 patients (50% of cases) by soft titanium mesh.

The reduced ZMC was fixated with miniplates and screws using 2-point fixation in the previously exposed areas:

-Zygomatic buttress as the main key point for all cases.

-Infra orbital rim as the second point in 15cases.

-Frontozygomatic suture area as the second point in 5 cases.

Fig(5) fixation of zygomatic buttress and post operative 3D CT

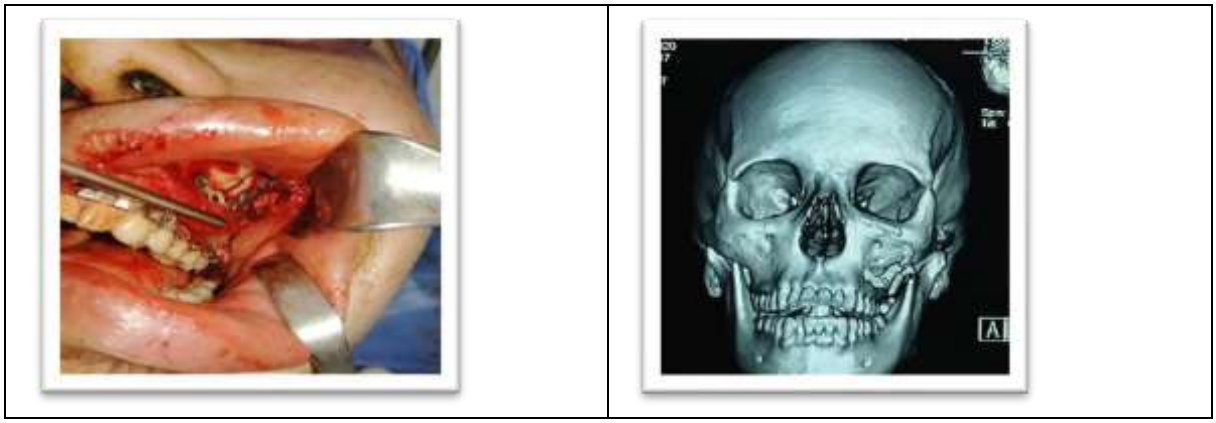

Fig (6) fixation of zygomatic buttress and post operative 3D CT

4.Postoperative clinical assessment after 1-Week &1-Month:

1-Vertical orbital dystopia: Four of our patients were presented with mild post-operative vertical orbital dystopia at 1-week. only one patient had post operative vertical orbital dystopia at 4-week follow up period which disappeared 1 month later (Table 2). The

preoperative, postoperative 1week, 1 months of vertical orbital dystopia recorded in 10 (50%), 4 (20%), and 1 (95.0%); respectively.

Tab(2) Vertical orbital dystopia

Clinical Parameter	**Time of measure**		**Frequency**				**Chi-square**
			Yes		**No**		
			n	**%**	**n**	**%**	
1-Vertical orbital dystopia	**Pre-operative**		10	50	10	50	>0.999ns
	Post	**1 week**	4	20	16	80	0.007**
	Post	**1 month**	1	5	19	95	<0.001***
	Friedman's test		<0.001***				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

2- Mouth opening limitation:

Out of 20 patients 6 patients had limitation of mouth opening at 1-week. None of our patients were presented with trismus at 1-month follow up period (Table 3). The preoperative, postoperative 1week, 1 months of mouth opening limitation recorded in 17 (85%), 6 (30%), and 0 (0.0%); respectively.

Tab(3) Limitation of mouth opening

Clinical Parameter	**Time of measure**		**Frequency**				**Chi-square**
			Yes		**No**		
			n	**%**	**n**	**%**	
2-Mouth opening limitation	**Pre-operative**		17	85	3	15	0.002**
	Post	**1 week**	6	30	14	70	0.074 ns
	Post	**1 month**	0	0	20	100	>0.999ns
	Friedman's test		<0.001***				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

3- Diplopia:

Three patients had diplopia post-operatively at 1-week follow up. Only one patient had diplopia at one month follow up which disappeared 2 months later (Table 4; Figure 7). The preoperative, postoperative 1week, 1 months of diplopia recorded in 8 (40%), 3 (15%), and 1 (5 %); respectively.

Tab (4) Diplopia in preoperative and postoperative

Clinical Parameter	Time of measure		Frequency				Chi-square
			Yes		No		
			n	%	n	%	
3- Diplopia	**Pre-operative**		8	40	12	60	0.371ns
	Post	**1 week**	3	15	17	85	0.002**
	Post	**1 month**	1	5	19	95	<0.001***
	Friedman's test		0.004**				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

4- Enophthalmos:

From 10 Cases that had preoperative enophthalmos (50%). None of our patients presented with post-operative enophthalmos at 1week or 1month follow-up. The preoperative, postoperative 1week, 1 months of Enophthalmos recorded in 10 (50%), 0 (0.0%), and 0 (0.0 %); respectively (Table 5).

Tab (5) Enophthalmos pre and postoperative.

Clinical Parameter	Time of measure		Frequency				Chi-square
			Yes		No		
			n	%	n	%	
4- Enophthalmos	**Pre-operative**		10	50	10	50	>0.999ns
	Post	**1 week**	0	0	20	100	>0.999ns
	Post	**1 month**	0	0	20	100	>0.999ns
	Friedman's test		<0.001***				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

5- Limitation of eye movement:

3 of our patients presented with mild limitation of eye movements at 1-week follow up and all limitation disappeared at 1-month follow up (Table 6). The preoperative, postoperative 1week, 1 months of Limitation of eye movement recorded in 5 (25%), 3 (15 %), and 0 (0.0 %); respectively.

Tab (6) Limitation of eye movement evaluation between pre and postoperative.

Clinical Parameter	Time of measure		Frequency				Chi-square
			Yes		No		
			n	%	n	%	
5- Limitation of eye movement	Pre-operative		5	25	15	75	0.025*
	Post	1 week	3	15	17	85	0.002**
	Post	1 month	0	0	20	100	>0.999ns
	Friedman's test		0.022*				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

6-Sensory disorders: Six patients had postoperative hypoesthesia at infraorbital area at 1-week follow up. 1 patient did not fully recover at 1 month follow-up period. He had complete recovery after 3 months. (Table 7). The preoperative, postoperative 1week, 1 months of Sensory disorders recorded in 16 (80%), 6 (30 %), and 1 (5 %); respectively.

Table 7. Sensory disorders evaluation between pre and postoperative.

Clinical Parameter	Time of measure		Frequency				Chi-square
			Yes		No		
			n	%	n	%	
6-Sensory disorders	Pre-operative		16	80	4	20	0.007**
	Post	1 week	6	30	14	70	0.074 ns
	Post	1 month	1	5	19	95	<0.001***
	Friedman's test		<0.001***				

*, **, ***, significant at p<0.05, <0.01, <0.001, NS non-significant at p>0.05

7-Fracture instability:

All our patient presented with stable fixation and proper bone healing as shown in CT scans after 1 month.

8-Infection at surgical site:

Two patients from 20 (10%) have post operative intra oral infection duo to poor oral hygiene, after oral hygiene improvement and treatment the infection was cured.

4. Postoperative Radiographic assessment after 1-Week &1-Month:

asymmetry index

The postoperative asymmetry index was calculated to show the degree of ZMC reduction and alignment using the 2-point fixation technique and presented in Figure (5,6).

There was a highly significant difference ($p<0.001$) in the asymmetry index between preoperative, and postoperative timepoints (1 week, 1 month). The average asymmetry index in preoperative, and
postoperative time points was 8.3±3.1, 2.6±1.3, and 2.6±1.2; respectively. The asymmetry index decreased
significantly postoperatively by 1 week ($p<0.001$***) and 1 month ($p<0.001$***).

Disccusion:

The zygomaticomaxillary complex is an important part of the facial skeleton, and because of its lateral prominence it is commonly injured, particularly in road traffic accidents and interpersonal violence. Despite the high frequency of the zygomaticomaxillary complex fractures, there is no consensus among surgeons regarding the best surgical management. Thus, the surgical treatment of these fractures remains challenging. However basically, four principles must be considered when undertaking the repair of a facial fracture: namely, adequate exposure, proper reduction, stable fixation, and minimal complications**.(11)** One of the most controversial topics in treating zygomatic fractures is the number of fixation sites necessary to achieve sufficient stability of the zygoma in the correct location during the bone healing process. The need for one-point, two-point, three-point, or four-point fixation should be based on fracture stability and applying the minimum amount of hardware to maintain fracture reduction throughout the process of healing.**(12)**

Fixation point at the zygomatic buttress intraorally is favoured by many authors due to many reasons: (1) absence of external scarring; (2) ease of surgical access; (3) unlike the FZ region, adequate soft tissue cover is present; and there are no issues of plate palpability; (4) easier to remove the plate, when needed; and most importantly; (5) ZM buttress is a better indicator of zygoma alignment than the FZ region due to the wider area of articulation; (6) plating ZM buttress will counteract the masseter muscle action and proved better stability.(4)

Kühnel and Reichert, 2015 managed simple displaced, non-comminuted ZMC fractures by one-point fixation in the maxillary buttress with accepted results. **(13)** Kim et al.,2011 used one-point fixation at zygomatic buttress without addressing frontozygomatic or infraorbital region. They claimed that the method is aesthetically satisfactory.(**14)** Chen et al.,2015 reported that high surgical stability can be obtained with a 1-point fixation at zygomatic buttress using a single vestibular approach**.(15)** The current study agree with the above-mentioned studies in the importance of fixation of the zygomatic buttress as a key point for stabilizing the reduced ZMC, In the present study the zygomatic buttress was used as the key point of fixation in all cases and there was significant improvement in clinical and radiographic results after 1-week and 1-month which indicate stable fixation of the ZMC. However, one point fixation failed to address three-dimensional stability of the ZMC in many studies and can lead to facial asymmetry and permanent deformity.

Nasr et al.,2018 compared two- and three-point fixation in two groups and evaluated surgical outcomes with CT scans. They found no significant difference in stability and concluded that two-point fixation is as good as three-point fixation with respect to stability of fractures.(16) Also, in the retrospective study by Kim et al.,2020 forty patients with ZMC fracture were divided into two groups (group 1, two-point fixation and group 2, three-point fixation). Patient's demographics and follow-up were evaluated, protruding difference of zygoma, and malar difference using asymmetry index were measured through preoperative and postoperative CT scans. They found that protruding difference of zygoma, and facial asymmetry index between the groups were not statistically different and they concluded that two-point fixation in ZMC fracture excluding incision approaching the ZF provides surgical efficacy and similar surgical outcomes to three-point fixation but offers reduced operation time and fewer complications**.(17)** Our study results agree with the conducted results by Nasr et al., 2018 and Kim et al., 2020.

If similar stability can be obtained by less fixation points, it has clinical value to performing a smaller number of fixations which can reduce the operation time, the post operative edema, and makes less postoperative complications.

Conclusion:

ZMC is a key component to facial form and function, as it contributes to orbital volume, facial width, and malar prominence. Adequate diagnosis and treatment can readily restore facial and orbital harmony, but at the same time, inadequate treatment can leave the patient with severe deformities that are difficult to correct secondarily. Stable fixation result and adequate esthetic outcome can be obtained by using 2-point fixation technique in non-comminuted ZMC fractures. The zygomatic buttress as a key point of fixation through intra oral access have the best esthetic and functional outcome. When the orbital floor needs reconstruction, Infraorbital rim used as the second point of fixation, otherwise the frontozygomatic suture area can be used as a second point of fixation.

List of Abbreviations:

Abbreviation	**Definition**
ZMC	zygomaticomaxillary complex;
ZM	Zygomaticomaxillary
IOR	Infraorbital rim.
ZF	Zygomaticofrontal

Source(s) of support: No funding was received.

Ethical policy and Institutional Review board statement: The study was authorized by the Research Ethics Committee, Faculty of Dentistry Suez Canal University, established according to WHO-2011 Standards, Approved in 3\5\2020 with (serial no. 277\2020).

Patient Consent: Written informed consent was obtained from the patient for publication of this case report and accompanying image.

Patient declaration of consent statement: an informed consent was signed by each participant.

Data Availability statement: The data set used in the current study is available (tick the appropriate option and fill the information)

- ❑ repository name

Mohamed Abo Shabana Mostafa

- ❑ available on request from (contact name/email id) drshabana33@gmail.com

Declaration of competing interest: The authors declare that they have no conflict of interest

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