ORIGINAL ARTICLE

FUNCTIONAL EVALUATION OF THE BEHAVIOR OF MASTICATORY MUSCLES IN ZYGOMATICO MAXILLARY COMPLEX FRACTURE

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ABSTRACT

Background: The purpose of this study is to functionally evaluate the behavior of the masticatory muscles (Masseter and Temporalis) following Zygomaticomaxillary Complex fractures by assessing bite force, electromyography and mandibular movements.

Materials And Methods: Group I consisted of twenty patients with unilateral Zygomatico Maxillary Complex fractures who were treated surgically with one, two or three point fixations at the frontozygomatic, infra orbital or zygomatico maxillary buttress region as per clinical and radiological assessments. Group II control group included twenty normal patients. The muscle activity was functionally evaluated before and after the surgery for a period of six months. The evaluation consisted of bite force measurement, EMG analysis and measurements of mandibular movements.

Results: There was an increase in bite force and EMG activity throughout the evaluated post-operative period but at the end of six months, majority of the patients were still below the control levels. Maximum mouth opening increased considerably after the surgery. The number of fixation points (one, two or three point fixation) did not influence the muscle activity.

Keywords: Zygomatico maxillary complex fracture, Bite force, Masseter, Temporalis, Electromyography.

INTRODUCTION:

The foundation of a beautiful face lies in the design of the facial skeleton. Modern hallmarks of beauty are defined by bold facial contours that are accentuated by a youthful mid-face configuration. An essential component of midface skeleton is the prominent cheekbones which forms a part of Zygomatico Maxillary Complex. The midface itself consists of a bony lattice with a system of relatively strong, vertically oriented struts[1]. They are thought to be a mechanical adaptation to masticatory forces. The midfacial bones in isolation are fragile but gain strength from each other via the buttress which Manson[2] (1980) alluded to when describing the vertical and horizontal struts that support the facial skeleton.

The zygoma is the cornerstone of the buttress system and its prominence, the

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malar eminence, is often the recipient of blunt trauma. Any force applied to the malar eminence or zygoma is transmitted through this series of connections in the bony lattice that comprises the midface. Starkhammer and Olofsson (1982) reported that the zygomatic region is involved in 42% of facial fractures[3]. Concomitant fractures are common, particularly those of the anterior wall of the maxillary sinus as this represents one of the weakest areas in the facial skeleton[4]. The most common etiologic factors involved in these injuries are interpersonal violence, road traffic accidents, falls, and sports injuries. The integrity of zygoma is maintained by the muscles which are attached to it. Muscles that act directly on the zygoma include the masseter, anterior temporalis, and, to a lesser extent, the zygomaticus minor and major as well as part of the orbicularis oculi muscle[5]. The force vectors that act on the ZMC during normal function undergo a change affecting the equilibrium of these muscles during the ZMC fractures which results in displacement of the fracture segments leading to facial asymmetry and functional limitations.[6]The masseter muscle is assumed as the primary cause of postreduction displacement of the fractured ZMC[7] as it is capable of exerting sufficient inferiorly directed force on the fractured zygoma to cause movement, even after surgical insertion of fixation devices. In addition, studies by Oyen et al (1996)[8] showed that the tensile strain exerted by anterior temporalis muscle fibers may either displace the reduced zygomatic complex in a vertically downward direction or cause distraction osteogenesis, resulting in gradual elongation of the lateral orbital rim and inferior rotation of the zygomatic complex. Hence stable reduction and fixation of fractures of the zygomatic complex is essential to avoid long term aesthetic, sensory, and ocular consequences.The purpose of this study is to evaluate behaviour of the masticatory muscles (Masseter and Temporalis) following Zygomaticomaxillary Complex fractures by assessing bite force, electromyography and mandibular movement.

MATERIAL & METHODS:

The study was conducted after getting approval from the Institutional Ethical Committee. This study assessed twenty patients for Bite force measurement who underwent Open Reduction and Internal Fixation for Zygomatico Maxillary Complex Fractures at the Department of Oral and Maxillofacial Surgery, Dental College Azamgarh and Hospital, Azamgarh. Electromyography was done to assess the muscle activity of masseter and temporalis were performed. This retrospective analysis was planned done by collecting the data from Group I: 20 patients with unilateral fracture of Zygomatico maxillary complex.Group II: 20 healthy adults included in the control group. Ethical approval was obtained for the study from the Institutional Ethical Committee and informed consent obtained from each patient in the regional language explaining the nature of the surgical procedure and the study. Patients who were included in this study were having unilateral isolated Zygomaticomaxillary Complex fracture of between 15- 55 yrs of age, of both sexes. Other inclusion criteria were Dentulous patients – Molars/second premolar and incisors in good condition and patient available for follow-up for a period of 6 months. Patient with Bilateral zygomaticomaxillary complex fractures

and Severely Comminuted/ infected fractures and Zygomaticomaxillary complex fractures associated with other facial bonefractures were excluded.Twenty patients were diagnosed with Zygomatico Maxillary Complex Fracture using the following methods.

1. Clinical Examination showing a palpable step in the orbital rim, zygomatic arch or zygomatic buttress
2. Radiological Examination showing evidence of displacement – Digital Paranasal Sinus View, Digital Submentovertex View, CT scan of facial bone in axial and coronal section.

Fractures requiring reduction and fixation were identified using the classification system of Larsen and Thomsen (1968)

1. **Group A fractures**: Showing minimum or no displacement requiring no intervention
2. **Group B fractures**: Unstable fracture - great displacement and disruption of FZ suture and comminuted fracture requiring reduction and fixation
3. **Group C fractures**: Fractures of all other kinds which required reduction but no fixation.

SURGICAL PROCEDURE

All patients were treated one week from the day of injury. After ruling out head and cervical spine injury, selected cases were planned for open reduction and internal fixation under local anesthesia.

PARAMETERS FOR EVALUATION:

1) **BITE FORCE MEASUREMENT: The** bite force transducer is cleaned with alcohol and disposable latex finger cots are positioned on the biting plate for biosafety measurements. The patients are given detailed instructions and bite tests were performed before actual recordings to ensure the reliability of the procedure.

   a) **Maximum Voluntary Clench:** The patient was asked to bite directly on the bite sensor 3 times with maximum force (maximum voluntary clench), with 2-minute intervals between recordings. The highest value is taken as the reading for maximum voluntary clench. Evaluations were performed on the first molar (right and left) and central incisor regions.

   b) **Bite Force at increasing vertical dimension of the bite plane:** Measurement of the bite force was performed by gradually increasing the height of the bite plane by 5 mm. The patient is asked to clench on a four different heights of the bite plane (made of acrylic) at: 15 mm, 20 mm, 25 mm and 30 mm and the

bite force was recorded on the first molar (right and left) and central incisor regions.

c) **Endurance (Fatigue Test) at bite force in 10 mm vertical dimension:** The patient is asked to clench on the bite sensor of 10 mm vertical dimension and the time taken to reach and sustain the force at maximum voluntary clench is recorded. This is measured as the endurance time of the masseter muscle calculated in seconds.

3. **Surface electromyographic activity of masseter and temporalis muscles recorded bilaterally:** The skin region where the surface electrodes are to be placed was cleaned with alcohol and shaved if necessary for adaptation of the electrodes. Intramuscular EMG requires the use of surface electrode to be positioned over the ventral region of both the masseter muscles and in the anterior portion of both the temporal muscles. The muscular activity was measured by using EMG recordings of the masseter and temporalis at rest and during activities under the following clinical conditions: The maximum peak value is recorded from the EMG potentials. 1. Rest for 10 seconds 2. Opening the mouth passively 3. Right lateral movements 4. Left lateral movements 5. Protrusion 6. Closing the mouth passively 7. Clenching (maximum voluntary clench.

4. **Mandibular movements (mouth opening, lateral excursive movement, protrusion)**: Mandible range of motion was based on the methodology proposed by Cattoni et al. and Ferreira, and Felício & Trawitzki. Using the digital caliper the following mandibular movements are measured: A) Mid line - with the teeth in occlusion – Check whether or not the lines between the central upper and lower incisive teeth match. When the lines do not coincide, the amount of deviation is measured on the horizontal plane, using a vernier caliper. B) Maximum mouth opening - Measure the distance between the incisive faces of the upper and lower teeth Mandible protrusion - Horizontal trespass between the occlusal face of the upper central incisor and the distal face of the lower central incisor. Mandible lateralization to the right - The horizontal distance of the line between the lower central incisive teeth to the line between the upper central incisive teeth after right-side mandible shifting E) Mandible lateralization to the left - The

same procedure carried out to measure mandible lateralization to the right is used to obtain the value for mandible lateralization to the left.

5. **Surgical procedure**: A). Preparation: The patient's face was prepared and draped taking sterile aseptic precautions..B).Injection of local anesthetic and vasoconstrictor: 2% Lignocaine with 1:200000 adrenaline is injected into the subcutaneous tissue over the lateral orbital rim, zygomatico-temporal region and infra orbital rim region to aid in hemostasis as well as anesthetize these areas. Intra-oral injection is used to anesthetise the zygomatic buttress and infra orbital nerve block is performed. C). Incision: Incision is made with No. 15 Bard Parker blade. Incision is planned based on the fracture sites to be exposed. Lateral eyebrow or Supra orbital eyebrow incision: This incision is performed to gain access to the lateral orbital rim mostly at the frontozygomatic suture area. A 2 cm incision is made parallel to the hair line of the eyebrow to avoid cutting hair shafts. The incision is made to the depth of the periosteum in one stroke and another incision through the periosteum completes the sharp dissection. . Infraorbital skin crease incision: This incision is performed to gain access to the infraorbital rim and orbital floor. This incision is placed transcutaneously over the infraorbital region in the natural skin crease, 4.5 mm inferior to the gray line. The incision passes through the Orbicularis oris muscle to the periosteum of the infraorbital rim. . Maxillary vestibular approach: This incision is made 3-5 mm superior to the mucogingival junction in the maxillary buccal sulcus in the first molar region. The incision traverses the mucosa, submucosa, facial muscles and periosteum. This incision provides good exposure to the midface particularly to the zygomatic buttress and body of the zygoma. C). Exposure and reduction of the fracture**:** The fracture site is exposed after sharp subperiosteal dissection. Elevation of the depressed zygoma is brought about by two methods. a. Dingman's technique through the supraorbital incision: Once the exposure of the fracture at the frontozygomatic area is accomplished, Rowe's zygoma elevator is inserted posterior to the zygoma along its temporal surface. The instrument is used to lift the zygoma anteriorly, laterally and superiorly while one hand palpates the infraorbital rim and the body of zygoma. b.

Keen's technique via the maxillary vestibular approach: Once exposure of the zygomatic buttress is accomplished, Rowe's zygoma elevator is inserted behind the infratemporal surface of the zygoma, and using superior, lateral and anterior force, the zygoma is reduced. An audible click may sometimes be heard once the reduction is accomplished. Next, under direct vision, the fracture site is inspected for adequate reduction. The index finger of the operator hand is used to palpate over the infraorbital rim and the zygomatic bone to fully appreciate the reduction of the zygoma.

E)Fixation :Internal fixation is carried out using stainless steel mini plates and screws. Fixation along the lateral orbital rim is performed with one miniplate (diameter 2 mm) and two screws (diameter 2 mm, length 6 mm). . Fixation along the infra orbital rim is performed with one orbital miniplate which is 'C' shaped (diameter 1.5 mm) and four screws (diameter 1.5 mm, length 6 mm).. Fixation along the zygomatic buttress is performed with one miniplate which is 'L' shaped (diameter 2 mm) and four screws (diameter 2 mm, length 6 mm). F) Wound closure: the surgical site is irrigated with povidone iodine and saline. Simple interrupted suturing is performed with resorbable 3-0 vicryl material. Sub cuticular skin closure is done with non resorbable synthetic 3-0 polyamide material. Compression bandage is applied over the surgical site. G) Immediate post-operative phase: Patient is kept under observation for an hour and vitals monitored. Patient is noted for post-surgical bleeding. The patient is started on intravenous antibiotic (Cefotaxime 1 g and Metrogyl 500 mg), intravenous glucocorticosteroid (Dexamethasone 8 mg) tapered after 2 days and intramuscular NSAID (Diclofenac 75 mg) administered for a period of five days. The patient is advised to avoid pressure over the cheek on the operated side and to sleep in supine position for a month. A soft diet is recommended for the same duration. Synthetic non resorbable sutures are removed on the seventh post-operative day. The patient was advised to come for follow-up on a regular basis.

Statistical Analysis: All the data was analyzed using SPSS software. Pearson Chi-square test was used to measure the level of significance.

significant.

RESULTS:

The study included 20 patients with Zygomatico maxillary complex fracture (Group I) and 20 healthy adults who were assigned to the control group (Group II). The study was conducted from March 2014 – November 2014. The demographic data of the patients included in the study has been tabulated in Table 1.

Table 1: Demographic data of the patients included in the study

	AGE	MALE	FEMALE
GROUP I	20 – 40 years Avg: 30 years	16 (80%)	4 (20%)
GROUPO II	18-41 years Avg: 28.6 years	15 (75%)	5 (25%)

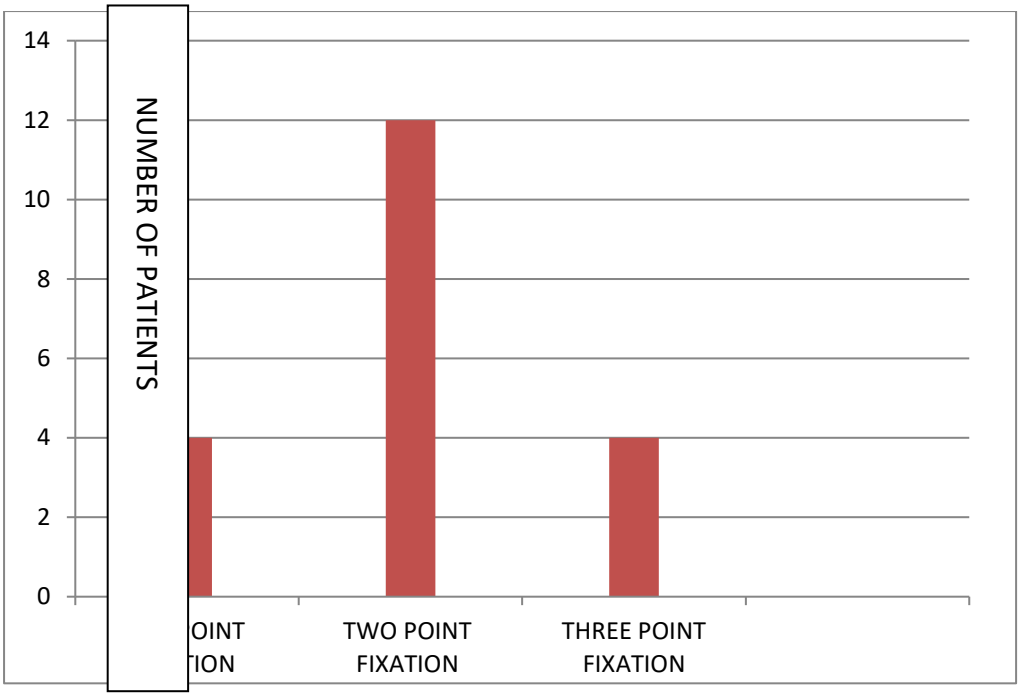
All the patients were evaluated pre-operatively for bite force, electromyography and mandibular movements. Most of the patients found measurement of these parameters acceptable. All the patients had complaints of pain when biting on the bite force transducer and on the bite blocks. Hence the patients were asked to rest between the procedures to minimize fatigue. The average time taken to measure each of the parameter is given in the Table 2

Table 2: Time taken for measurement of the parameters

PARAMETERS	TIME TAKEN (MEAN IN MINUTES)
BITE FORCE	30
EMG	30
MANDIBULAR MOVEMENTS	15

In the present study, 4 patients needed fixation at three points, 12 patients required fixation at two points and 4 patients required fixation at one point (Graph 1). The number of fixation points did not significantly affect the outcome of the parameters addressed in the present study. In other words, there was no statistically significant difference in the bite force levels and EMG activities when comparing patients with one, two or three point fixation.

Graph 1: Distribution of number of points of fracture fixation



The patient was asked to bit on the bite force transducer and the maximum force in kilograms was recorded. The control group used in this study presented, as an average of single measurement, the following biteforce values in the following regions: first molars on the right side, 43.54 kgf; first molars on the left side, 44.84 kgf; and incisors, 42.22 kgf. The measurements have been tabulated in Table 3.

Table 3: Bite Force at Maximum Voluntary Clench in kilogram (10 mm Vertical Dimension)

Serial No.	Group I (n=20)	Right Molar (Mean±SD)	Left molar (Mean±SD)	Incisor (Mean±SD)
1.	**Pre-Op day**	15.79 ± 8.15 *****	15.57 ±7.65 *****	11.22 ± 5.15 *****
2.	**I Post-op day**	8.40 ± 5.14 *****	8.66 ± 2.96 *****	9.19 ± 4.35 *****
3.	**I week Post-op**	19.89 ± 6.22 *****	17.44 ± 6.55 *****	16.66 ± 4.60 *****
4.	**I month Post-op**	29.45 ± 6.66 *****	28.78 ± 9.09*****	26.15 ± 5.25 *****
5.	**3 month Post op**	34.31 ± 5.23	34.66 ± 6.35	31.32 ± 4.08*****
6.	**6 month Post op**	39.00 ± 4.20	39.05 ± 6.06	35.62 ± 4.16*****
7.	**Group II – Control**	43.54 ± 7.52	44.84 ± 6.44	42.22 ± 3.16

*** - Significance at p≤*0.05* between Group I and Group I**

Table 4: Bite Force at 15 mm vertical dimension in kilogram

Serial No.	Group I n=20	Right Molar (Mean±SD)	Left molar (Mean±SD)	Incisor (Mean±SD)
1.	Pre-Op	8.58 ± 4.14 *	8.52 ± 4.04 *	9.35 ± 4.82 *
2.	I Post-op day	4.42 ± 3.31 *	5.04 ± 3.28 *	6.28 ± 3.36 *
3.	I week Post-op	12.09 ± 5.02 *	12.24 ± 4.30 *	12.33 ± 4.01 *
4.	I month Post-op	21.51 ± 8.01 *	20.39 ± 7.11 *	20.95 ± 4.85 *
5.	3 month Post op	26.80 ± 6.23 *	25.80 ± 6.71 *	27.25 ± 4.65 *
6.	6 month Post op	31.34 ± 5.99*	31.36 ± 6.05*	32.27 ± 3.75*
7.	Group II - Control	38.95 ± 4.56	37.56 ± 4.55	38.83 ± 4.36

* - Significance at p≤*0.05* between Group I and Group II

Table 5: Bite Force at 20 mm vertical dimension in kilogram

Serial No.	Group I n=20	Right Molar (Mean±SD)	Left Molar (Mean±SD)	Incisor (Mean±SD)
1.	Pre-Op	7.89 ± 4.54 *	7.64 ±4.44 *	7.98 ± 4.28 *
2.	I Post-op day	3.97 ± 2.57 *	4.30 ± 2.80 *	6.10 ± 3.49 *
3.	I week Post-op	12.26 ± 3.91 *	12.37 ± 4.33 *	12.71 ± 4.47*
4.	I month Post-op	19.77 ± 6.63 *	19.29 ± 5.45 *	21.17 ± 6.04 *
5.	3 month Post op	23.41 ± 5.47*	25.21± 4.98	25.63 ± 4.77
6.	6 month Post op	30.33 ± 4.93	30.06 ± 5.17	30.75 ± 4.30
7.	Group II - Control	31.25 ± 6.66	30.88 ± 4.98	31.25 ± 4.87

Table 6: Bite Force at 25 mm vertical dimension in kilogram

Serial No.	Group I n=20	Right Molar (Mean±SD)	Left molar (Mean±SD)	Incisor (Mean±SD)
1.	Pre-Op	4.18 ± 3.52 *	4.25 ± 3.47 *	5.05 ± 3.93 *
2.	I Post-op day	2.97 ± 1.91 *	2.95 ± 2.11 *	4.15 ± 2.47 *
3.	I week Post-op	8.92 ± 5.53 *	8.40 ± 3.91 *	8.53 ± 3.63 *
4.	I month Post-op	15.75 ±4.63	14.72 ± 3.32	13.77 ± 2.34
5.	3 month Post op	20.31 ± 3.21	18.31 ± 3.09	16.66 ± 2.31
6.	6 month Post op	25.72 ± 3.82	23.27 ± 4.43	23.89 ± 22.55
7.	Group II - Control	25.82 ± 3.06	24.14 ± 3.73	23.35 ± 2.96

* - Significance at p≤*0.05* between Group I and Group II

Table 7: Bite Force at 30 mm vertical dimension in kilogram

Serial No.	Group I n=20	Right Molar (Mean±SD)	Left molar (Mean±SD)	Incisor (Mean±SD)
1.	**Pre-Op**	1.46 ± 2.21 *	1.08 ± 1.77 *	1.38 ± 2.21 *
2.	**I Post-op day**	1.45 ± 1.50 *	1.34 ± 1.37 *	1.23 ± 1.52 *
3.	**I week Post-op**	7.18 ± 3.82 *	2.94 ± 2.40 *	5.05 ± 3.22 *
4.	**I month Post-op**	12.07 ± 5.06	8.04 ± 3.88	8.96 ± 4.50
5.	**3 month Post-op**	13.57 ± 4.24	11.76 ± 3.50	12.61 ± 4.21
6.	**6 month Post-op**	15.68 ± 3.83	12.87± 2.05	13.67 ± 3.08
7.	**Group II - Control**	17.15 ± 3.87	16.28 ± 3.05	15.32 ± 2.68

*** - Significance at p≤*0.05* between Group I and Group II**

Table 8: Endurance level (in seconds) in Group I and Group II patients

Serial No.	Group I – Patients (n=20)	RIGHT MOLAR	LEFT MOLAR
1.	**Pre-Op**	22.40 ± 14.96 *	28.7 ± 17.17*
2.	**I Post-op day**	11.4 ± 7.46 *	12.85 ± 6.17*
3.	**I week Post-op**	26.25± 11.15 *	29.15 ± 11.57*
4.	**I month Post-op**	52.00 ± 15.35 *	52.9 ± 17.24*
5.	**III month Post-op**	85.75 ± 18.26*	83.35 ± 20.95*
6.	**6 month Post-op**	119.75 ± 19.67*	126.05 ± 29.04*
7.	**Group II – Control**	219.65 ± 68.99	221.85 ± 63.14

*** - Significance at p≤*0.05* between Group I and Group II**

Table 9: EMG activity (mean in millivolts) in Right masseter muscle

	Clenching Mean±SD	Closing Mean± SD	Protrusion Mean±SD	Left Lateral Mean± SD	Right Lateral Mean± SD	Open Mean ±SD	Rest Mean ±SD
Pre-Op	158.80± 34.39*	24.45± 8.82*	43.70± 13.96*	34.95± 7.12*	56.10± 26.45	53.70± 27.31*	18.00 ±4.18
I Post-op day	161.90± 17.52*	43.15± 11.21*	48.25± 14.96*	35.70± 7.27*	56.45± 22.58	54.65± 20.17*	15.45 ± 3.85
I week Post-op	184.85± 30.36*	45.95± 10.98*	57.30± 12.32*	54.90± 8.60*	70.85± 17.26	189.80 ± 105.82 *	22.65 ±2.96
I month Post-op	235.00± 37.77*	85.55± 8.63	83.50± 10.00	61.30± 9.05*	82.80± 7.93	496.90 ± 129.35	23.40 ±2.21

3 month Post-op	280.30± 34.82*	88.05± 10.74	86.15± 9.65	85.65± 7.86	89.10± 9.07	561.30 ± 111.65	23.90 ±1.77
6 month Post-op	314.10± 17.03*	98.90± 8.45	121.40 ± 13.16	95.75± 3.38	95.20± 4.66	567.75 ± 135.53	24.45 ±1.43
Group II - Control	580.00± 151.72	101.65 ± 7.36	148.25± 8.03	99.90± 9.89	97.60± 14.48	568.55 ± 115.16	24.65 ±3.99

*** - Significance at p≤*0.05* between Group I and Group II**

Table 10: EMG activity (mean in millivolts) in Left Masseter Muscle

	Clenching Mean±SD	**Closing Mean± SD**	**Protrusion Mean±SD**	**Left Lateral Mean± SD**	**Right Lateral Mean± SD**	**Open Mean ± SD**	**Rest Mean ±SD**
Pre-Op	153.65± 36.00*	25.10± 9.61*	41.95± 11.40*	37.35± 12.53*	53.65± 20.98*	37.35 ± 26.19*	16.30 ± 6.24
I Post- op day	166.95 ± 15.18*	44.35± 9.65*	51.20± 11.46*	40.30± 9.72*	61.10 ± 18.35*	55.85± 10.01*	16.30 ± 3.86
I week Post-op	178.40± 31.37*	50.15 ± 7.16*	59.80± 15.18*	57.35± 14.69*	82.00± 27.62	187.2± 65.50*	23.30 ± 2.57
I month Post-op	228.65± 44.89*	85.40± 8.82	83.30± 9.65	64.35± 10.78*	83.85± 7.37	444.75 ± 127.5*	24.10 ± 2.73
3 month Post-op	282.90± 34.30*	88.25± 10.17	86.10± 9.64	85.45± 7.12	88.15± 8.52	552.9± 98.37	24.05 ± 2.56
6 month Post-op	316.05± 23.77*	95.60± 6.06	107.50± 6.01	96.55± 5.79	95.85 ± 3.2	571.25 ± 65.11	24.95 ± 2.50
Group II – Control	802.10± 121.74	98.1± 9.21	109.55± 9.04	93.35± 8.34	93.80± 7.66	625.35 ± 123.69	26.15 ± 17.11

*** - Significance at p≤*0.05* between Group I and Group II**

Table 11: EMG Activity (mean in millivolts) of Right Temporalis Muscle

	Clenching Mean± SD	**Closing Mean± SD**	**Protrusion Mean± SD**	**Left Lateral Mean± SD**	**Right Lateral Mean± SD**	**Open Mean± SD**	**Rest Mean± SD**
Pre-Op	155.80± 26.28*	24.70 ± 10.48*	46.35± 18.54*	52.35± 13.17	50.50± 18.65	54.45±16. 42*	22.00 ±3.88
I Post- op day	162.80± 19.43*	43.60± 9.79*	56.45± 12.07*	75.35± 11.84*	51.50± 10.66	59.25± 10.76*	20.85± 3.93

I week Post-op	179.40± 20.78*	50.55± 6.57*	68.80± 17.80*	81.35± 12.26*	60.95± 13.73	90.00± 13.44*	24.00± 2.44*
I month Post-op	194.30 ± 39.10*	84.85± 8.29*	83.95± 7.82*	83.95± 7.89*	86.75± 8.07	128.10± 37.45*	23.45± 2.06*
3 month Post-op	265.70± 28.44*	89.20± 10.37*	85.10± 8.30*	84.75± 10.27*	85.70± 8.78*	173.20± 42.18*	23.65± 2.41*
6 month Post-op	296.30± 20.33*	95.00± 4.25*	99.10± 4.41*	95.00± 4.49*	96.15± 3.57*	218.65± 32.69*	23.55± 2.25*
Group II - Control	521.45± 142.87	263.00 ±99.56	349.60± 118.00	60.20± 8.76	60.20± 9.45	523.80± 79.09	18.05± 4.9

*** - Significance at p≤*0.05* between Group I and Group II**

Table 12: EMG Activity (mean in millivolts) of Left Temporalis Muscle

	Clenching Mean± SD	**Closing Mean± SD**	**Protrusion Mean± SD**	**Left Lateral Mean± SD**	**Right Lateral Mean± SD**	**Open Mean ± SD**	**Rest Mean ± SD**
Pre-Op	145.65± 25.20*	28.11± 9.36 *	41.80± 7.32*	54.95± 11.49*	54.45± 15.23*	55.25± 20.64*	18.55± 5.22
I Post-op day	162.80± 20.71*	45.95± 10.93*	50.60± 4.63*	50.30± 6.66*	53.35± 14.90*	58.35± 12.39*	21.75± 4.05*
I week Post-op	178.05± 25.32*	51.47± 7.12*	55.40± 5.81*	77.65± 12.22	64.60± 15.62	61.10± 15.72*	24.6± 4.5*
I month Post-op	216.40± 43.30*	82.95± 6.67*	91.80± 10.71*	82.95± 11.43	78.95± 10.80	155.55 ± 16.24*	23.5± 1.93*
3 month Post-op	288.70± 20.74*	89.21± 9.61*	89.40± 8.67*	84.80± 7.51	85.50± 7.55	163.15 ± 30.66*	23.85± 2.39*
6 month Post-op	316.20± 20.60*	97.95± 4.98*	100.40± 6.02*	94.55± 2.89	96.30± 6.12	194.90 ± 31.29*	26.05± 3.08*
Group II - Control	733.90± 73.86	697.84 ± 141.46	649.00± 97.92	71.70± 12.70	69.80± 5.58	737.50 ± 37.65	16.25± 3.89

*** - Significance at p≤*0.05* between Group I and Group II**

DISCUSSION:

Zygomatico maxillary complex fractures are one of the most common maxillofacial injuries. A patient with this type of facial injury usually presents with a clinical picture of gross facial edema, periorbital ecchymosis, sub conjunctival hemorrhage, bleeding from the nostril, paraesthesia of infra orbital nerve, flattening of the ipsilateral malar prominence, limitation in mouth opening. Clinical examination augmented with radiological investigation gives an accurate picture of the extent of these injuries. In the present study, the intraoperative assessment of the stability of the repositioned ZMC was determined using digital pressure after reduction to determine the need for applying fixation devices[17]. Hence the need for fixation and the number of fixation was determined clinically during surgery[9, 10, 11]. The present study is in agreement with by Dal Santo et al[7] wherein there was no further worsening of the facial asymmetry in the post operative period i.e., the modicum of symmetry achieved intraoperatively sustained throughout the post operative period of six months. The patients did not report dissatisfaction or worsening of esthetics. EMG data in the present study showed that at one week post operative period, the masseter muscles presented an 8% increase in EMG activity compared with control in the right masseter and 10.8% increase in left masseter activity. In the temporal muscles, there was 32.96% increase in EMG activity in right temporalis and 16.70 % increase in left temporalis muscle activity than the controls. This is in contrast to the study by Ribeiro et al[10] where the EMG data during rest for the group with a fractured ZOC, the masseter muscles presented a 30% increase in EMG activity compared with the control for the right masseter, and a 2.1% increase for the left masseter and the temporal muscles, showed a 31.7% higher activation for the right temporal muscle and 38.3% for the left. In general, in the EMG activity in the Group I throughout the evaluated post operative period. This was consistent with the findings of Dal Santo et al[7] and Ribeiro et al[12]. Nevertheless, bite force measurements and EMG activity predict the functional behaviour of the muscles and gives a picture of when these muscle activities return to normal/ near normal limits. This provides a rationale for the location of the fixation points that will best maintain the position of the reduced fractures during the healing period.However, further studies with larger samples, standardized treatment protocol, utilization of minimum variables and standardized radiological protocol for outcome assessment are recommended to verify and confirm the pattern of recovery of the masticatory muscle evaluated in this study

CONCLUSION:

The present study is in accord with the current clinical concepts which advocate the need for minimized fixation in zygomatic fractures to provide maximum stability and efficient masticatory functions.

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FIGURES:

Figure 1: Armamentarium

Figure 2: Bite force apparatus

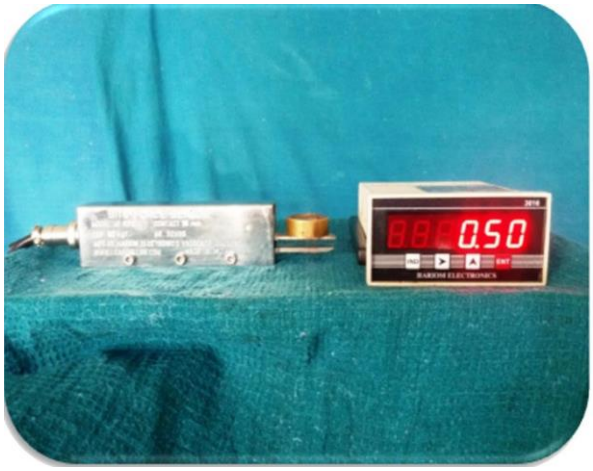

Figure 3: Acrylic blocks – 5 mm, 10 mm, 15 mm, 20 mm

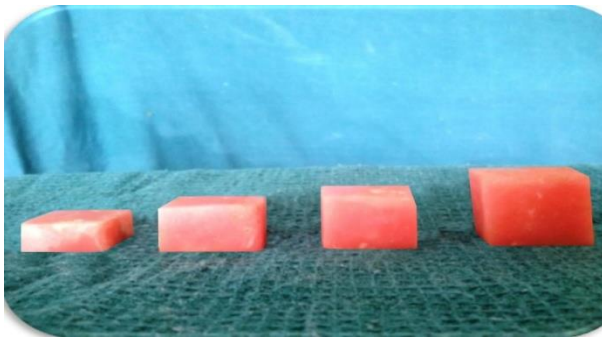

Figure 4: EMG Machine

5.EMG Electrode surfaces

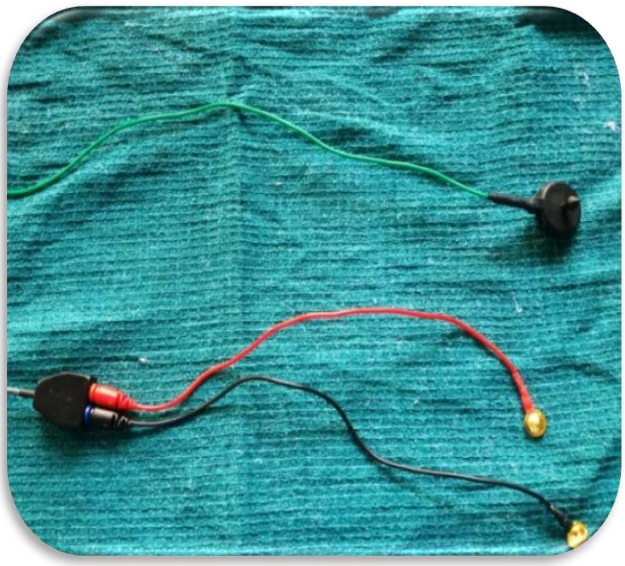

Figure 6: Bite force measurement.

Figure 7: EMG electrode placement.

Figure 8: Reductiom in frontozygomatic region

Figure 9: Fixation in frontozygomatic suture region.