

## An analysis on the reduction of deeper fracture lines in two and three points fixation on zygoma fracture

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**Abstract:** The study entitled “An analysis on the reduction of deeper fracture lines in two and three points fixation on zygoma fracture” was taken up with an aim to compare the treatment and to look which one gives a better surgical outcome in terms of stability and osteosynthesis after rigid titanium mini plate fixation. A total of 67 cases of fracture zygomawho had undergone Open reduction and internal fixation (ORIF) using titanium mini plate in two point and three point fixation was studied during the period from November 2016 to November 2018. The study was conducted in the Department of Plastic and Reconstructive Surgery, Regional Institute of Medical Sciences, Imphal. Manipur. The deeper fracture line (Inner table or cortex gap) was reassessed after one month of ORIF by CT Scan on follow up. After the nasal bone, the zygoma is the second most common bone of the face to be fractured. The group at highest risk are young males at the age of 18-28 (40.3%) years of age followed by 29-38 (28.4%) years of age. Zygomatic bone fractures are due to various causes, Road traffic accidents (RTA) account 53 (79.1%) cases, followed by accidental mishap 11 (16.4%) cases and assault account 3 (4.5%) cases respectively. The incidence vary widely in different regions of the world due to social, economical and cultural consequences. The highest incidence occurred in the people residing in urban areas accounting for 51 (76.1%) cases and people residing in the hilly areas accounting for 16 (23.9%) cases in Manipur. The surgical outcomes of ORIF with rigid titanium mini plate fixation at two points and three points were analysed and found that both two point and three point fixation show a significant reduction of deeper fracture line. However, independent “T” test shows three point fixation was more effective compared to two point fixation. The three point fixation produced a better aesthetic outcome as compared to two point fixation in malar projection and facial symmetry.

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### I. Introduction

The zygoma is the second most commonly fractured facial bone, eclipsed in number only by nasal fractures. The body and process of the zygomatic bone make up the lateral middle third of the facial skeleton. Blows to this region of the face are common as the convexity on the outer surface of the zygomatic body forms the point of greatest prominence of the cheek. This may cause either a depressed fracture of the entire zygomatic bone or a fracture of the zygomatic arch.<sup>1</sup> The term tripod fracture is because of the disruption of the three commonly recognized articulations:

1. Fronto-zygomatic
2. Infra-orbital rim
3. Zygomatico-maxillary buttress.<sup>2</sup>

Fracture zygoma is usually displaced in a downward, medial and posterior direction. Road traffic accidents, sports and falls are the principal etiologic factors that cause fractures of zygomatic bone.<sup>3</sup> The prevalent age for the fractures of the zygomatic bone varies greatly and commonly are at the range of 20 to 40 years. The type of the fracture, its severity and associated facial fractures usually determine the degree of impact and the treatment modality.<sup>4</sup> Arch fractures may result in trismus, flattening of the midface, asymmetry of the malar regions, or a reduction in oral aperture. Orbito-zygomatic complex fractures may be associated with diplopia, enophthalmos, subconjunctival echymosis, extra ocular muscle entrapment due to herniation of orbital content to the maxillary sinus.<sup>5</sup>

The Zygomatico-maxillary complex (ZMC) fractures present a challenging diagnostic and reconstructive task to the surgeon. However, surgical intervention is not always usually taken up unless a functional or aesthetic impairment in the form of reduced mouth opening, sensory disturbance and depression of the cheek prominence are encountered.<sup>6</sup> Although many surgical treatment modalities have been mentioned so far, every technique may have its own limitations. Fracture zygoma is conventionally plated at two or three sites i.e. Fronto-zygomatic, Infra-orbital rim and Zygomatico-maxillary buttress which are superficial sites. No plates are applied in the deep fracture line.

Diagnosis of zygomatic complex fractures is usually clinical, with radiographic confirmation. Although isolated zygomatic complex fractures occur, several studies have shown that fractures of the zygomatic complex are often associated with other maxillofacial injuries. Anatomical reduction of such fractures is important for facial appearance, optimum function of the eye and because of its proximity to the coronoid process for opening and closing of the mandible.

Open reduction and internal fixation (ORIF) is one of the modalities of treatment giving good results. There are several clinical and experimental studies which shows that use of rigid plating is much more superior and give a better long term stability.<sup>7</sup> However the stability of the fracture zygoma with reference to the number of fixation point and the site of rigid fixation still remain a topic.<sup>8</sup> There are a few studies which compares the two point and three point rigid fixation in patients with zygoma fractures. This study was conducted to compare the difference in reduction of the deeper (inner) fracture line in two point and three point rigid internal fixation in zygoma fracture which will give long lasting stable fixation and thus minimizing the morbidity.

### **Aims And Objects**

1. To evaluate the etiology and incidence of fracture zygomaticomaxillary complex.
2. To analyse the outcomes on the reduction of deeper fracture lines in two and three points fixation in zygoma fracture.

## **II. Materials And Method**

**Study Design:** Non-randomized interventional study.

**Study Setting:** The study was conducted in the Department of Plastic and Reconstructive Surgery, Regional Institute of Medical Sciences (RIMS), Imphal, Manipur.

**Study Duration:** The study was carried out for 2-years starting from November 2016 to November 2018.

**Study Population:** All cases of Zygomatic bone fractures who had undergone open reduction and internal fixation (ORIF) using mini titanium screw and plate in the Department of Plastic and Reconstructive Surgery, RIMS, Imphal were included in the study provided they satisfied the inclusion and exclusion criteria.

### **Inclusion Criteria:**

1. Adult patients with fracture zygoma and orbital wall seen in CT Scan.
2. Presenting within 7days of injury.
3. Both male and female who give consent.

### **Exclusion Criteria:**

1. Refusal to participate in the study.
2. Patients under 18years.
3. Associated with multiple facial bone fractures.

### **Study Variables:**

1. Age (years), sex, address and etiology.
2. Radiological features: Distance of the displacement at the fracture site over the orbito-zygomatic complex (Orbital floor) before and after surgery.

### **Outcome Measures:**

1. Deeper fracture line (gap) analysis preoperative and postoperative.
2. Symmetry of face on comparing both malar eminence by subjective appearance.

**Sample Size:** From the study conducted by RanaM et al<sup>9</sup>, surgical treatment of zygomatic bone fracture using two point and three point fixation was 80%. Taking confidence level of 95% and absolute allowable error of 10% sample size was calculated using the following formula

$$N = P_1 \frac{100 - P_1 + P_2 (100 - P_2)}{e^2}$$

Where P<sub>1</sub> = proportion of unstable fracture in two point

P<sub>2</sub> = proportion of unstable fracture in three point

e = 10 (standard error)

Sample size of 61 has been calculated based on the above formula.

**Working Definitions:**

Zygomatic bone is a mid facial bone which is also called cheek bone or malar bone. They form the most prominent part of the cheek.

Deeper fracture line is defined as a gap in the inner side of the bone cortex (inner table) and is measured in millimetre.

Two point fracture fixation is defined as fixation of fracture over the fronto-zygomatic and infraorbital rim whereas three point fracture fixation is define as fixation over the fronto-zygomatic, infra-orbital rim and zygomatico-maxillary buttress.

**Study Tools:**

Computed Tomography (CT) Scan: A computed tomography scan, makes use of computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional images of specific areas of a scanned object, allowing the user to see inside the object without cutting.

Deeper fracture line: A gap in the inner side (inner table) of the fractured zygomatic bone seen in CT Scan. Pre operative and post operative gap measured in millimetre.

Aesthetic: Symmetry of the face and scar by visual analysis comparing the normal side.

**Procedure:**

After thorough investigation for fitness for general anaesthesia, the patient was subjected to operation. After induction of general anaesthesia, the face was painted with 10% povidone iodine solution and draped. Injection Lignocaine with adrenaline 1:200000 of 5ml was injected over the area where surgical incision is to be made. Incision were made over the at the zygomatico-frontal suture, zygomatico-maxillary suture and infra-orbital rim. Fracture sites were identified and reduced. Stryker power drill was used in drilling the bone for internal fixation. Titanium mini plate of 1.5mm and screw 6mm long were used for internal fixation. After stabilisation of fractures, the surgical wound was closed in two layer.

Postoperatively, dressing was opened after 48hours and checked for any sign of hematoma or infection. Stitches were removed on postoperative day seven.

The patient were called back after three month for follow-up and radiological assessment was done by CT Scan. The preoperative and postoperative CT Scan were compared and the difference in the fracture gaps were studied. The fracture line gap was measured in millimetre.

**Statistics Analysis:** The data collected was entered in a data based programme namely IBM SPSS Statistics 21 developer. Descriptive statistics like mean were tabulated and analysed statistically. Paired ‘T’ test and independent ‘T’ test was used for quantitative data.

**Ethical Issues:** The study was carried out after obtaining approval from the Research Ethics Board (REB), Regional Institute of Medical Sciences, Imphal, Manipur. All the participants were informed about the nature of the project and those agrees to participate were asked to sign the informed consent form. Participants were assured that they can withdraw from the project at any time.

**Conflict of Interest:** None.

**III. Results And Observation**

The study data obtained from all the 67 cases of zygomatic bone fracture who had undergone Open reduction and internal fixation (ORIF) using titanium miniplate (ie. two point and three point fixation) in displaced or tripod fracture in the Department of Plastic and Reconstructive Surgery Regional Institute of Medical Sciences (RIMS), Imphal during the period from 2016 November to 2018 November.

**1. Age and Sex incidence.**

Age ranging from 18-68 years are divided into five categories as shown in Table I and Figure 1. The highest incidence were seen at the age group of 18-28 years, accounting for 40.3% of the patients followed by 29-38 years of age accounting 28.4% of cases. Majority of the patients were in the most active and productive period of life.

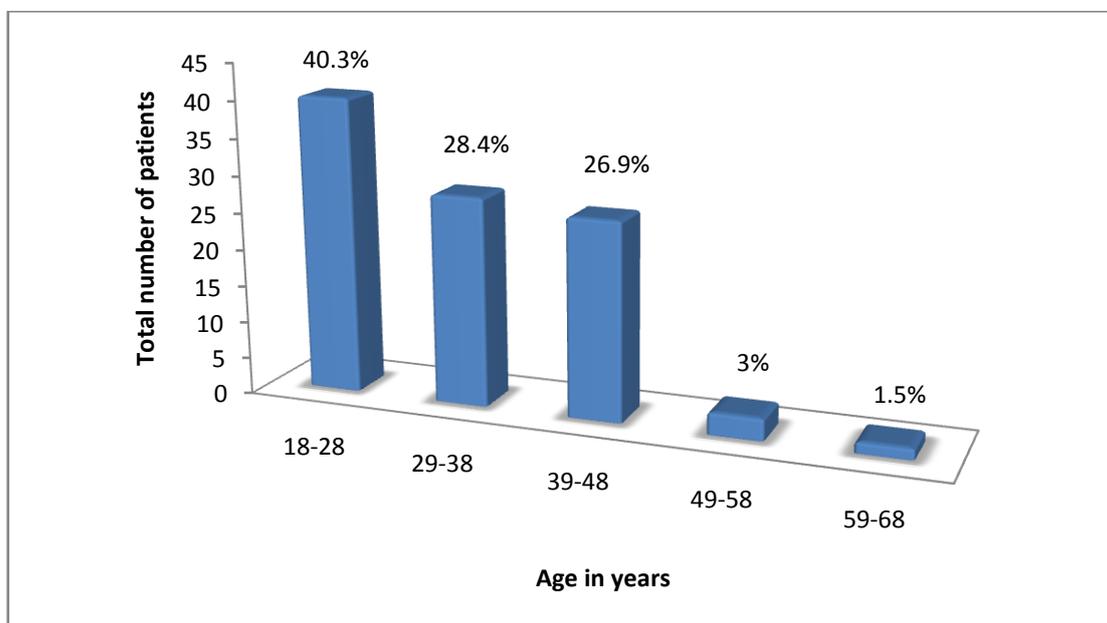
Males outnumbered females as shown in Table II and Figure 2. Out of 67 cases, 61 (91%) patients were male and 6 (9%) cases were female respectively.

**Table I:** Age in years of the patients.

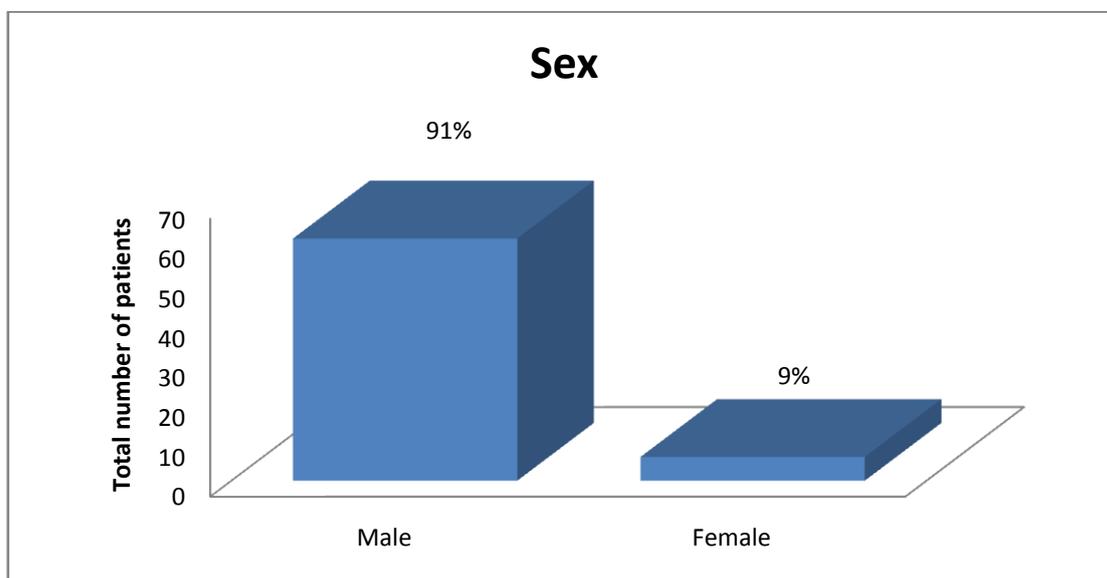
Age in years	Frequency	Percentage (%)
18-28	27	40.3
29-38	19	28.4
39-48	18	26.9
49-58	2	3
59-68	1	1.5
Total	67	100

**Table II: Sex.**

Sex	Frequency	Percentage (%)
Male	61	91%
Female	6	9%
Total	67	100%



**Figure 1.**



**Figure 2.**

**2. Address or Geographical region.**

Majority of the cases of zygomatic bone fractures were from urban area where it is thickly populated and a commercial hub of the state with 51 cases accounting 76.1% and people residing in rural areas accounting 23.9% (16 cases) respectively as also shown in Table III and Figure 3.

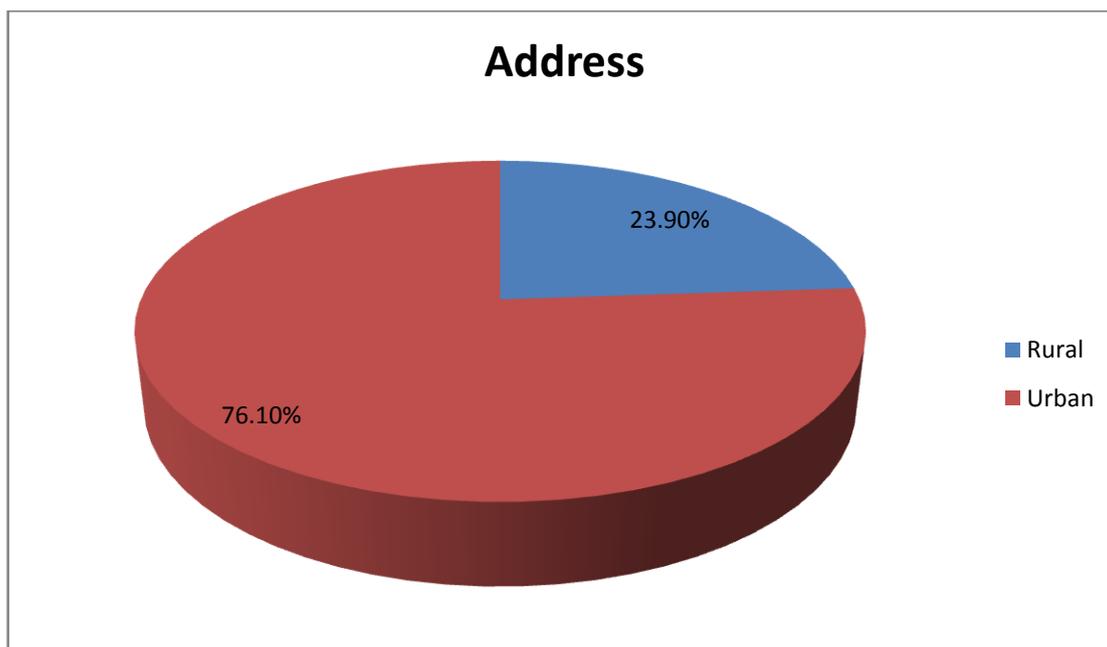
**Table III: Address.**

Address	Frequency	Percentage (%)
Urban	51	76.1%
Rural	16	23.9%
Total	67	100%

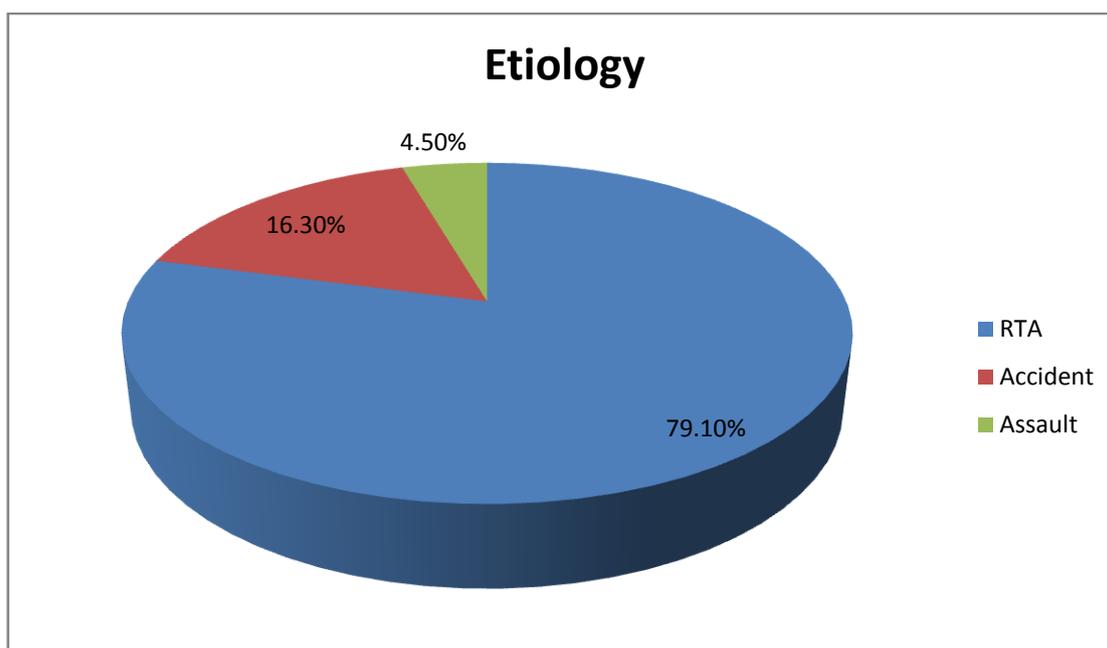
3. **Etiology:** Out of the 67 cases of zygomatic bone fracture who had undergone ORIF with two point and three point fixation using titanium mini plate and screw were due to road traffic accident (RTA) with 53 cases accounting 79.1% followed by accidental mishap with 11 cases accounting 16.4% and assault with 3 cases accounting 4.5% respectively as also shown in Table IV and Figure 4. Most of the patients with RTA are under the influence of alcohol without helmet.

**Table IV: Etiology.**

Etiology	Frequency	Percentage (%)
RTA	53	79.1
Accident	11	16.4
Assault	3	4.5
Total	67	100



**Figure 3.**



**Figure 4.**

**4. Two point and three point fixation using Titanium mini plate and screw:**

Out of the 67 cases of ORIF for fracture zygoma with rigid titanium mini plate at two point and three point were shown in Table V and Figure 5. The patients were randomly categorized into two group. 34 patients had undergone two point fixation and 33 patients had undergone three point fixation respectively. Table VI shows both two point and three point internal fixation using titanium mini plate showed significant reduction postoperatively when compared with preoperative fracture gap as both the paired “T” test of P\*value showed significant. However, independent “T” test of P\*\*value shows three point fixation is more effective with regard to two point fixation.

**Table V: Titanium Miniplate and Screw.**

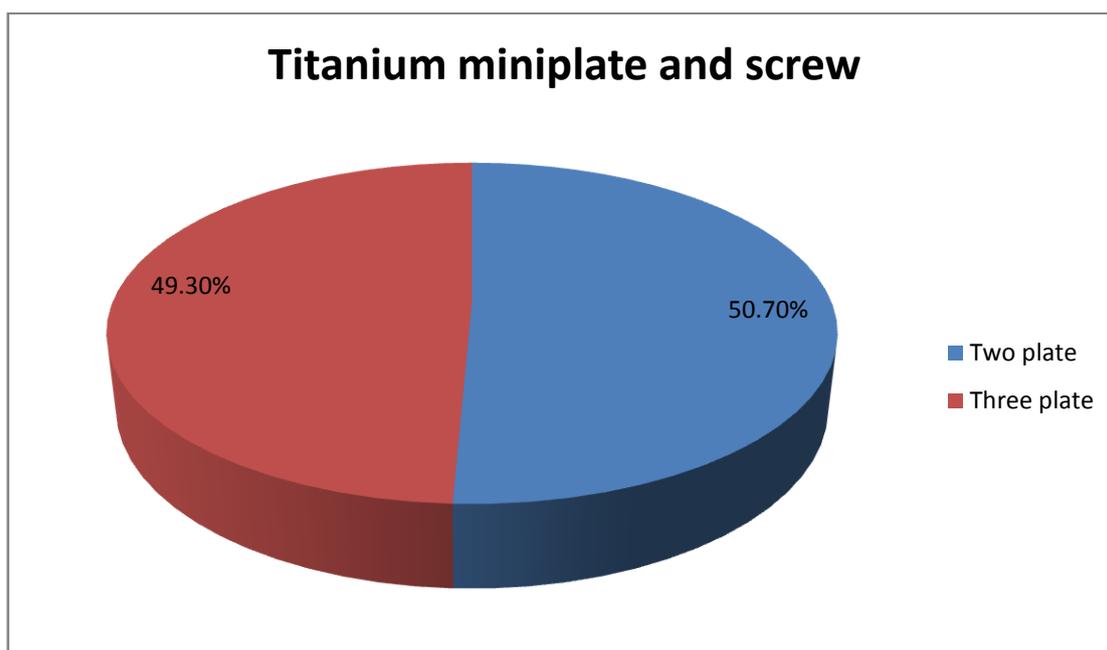
Miniplates fixation	Frequency	Percentage (%)
Two plate fixation	34	50.7
Three plate fixation	33	49.3
Total	67	100

**Table VI: Comparison of two point and three point fixation.**

Fracture gap	Two point fixation	Three point fixation	P**value
Preoperative	2.097 +/- 79	2.152+/-92	.018
Postoperative	.262+/-30	.103+/-22	
Difference	1.835	2.049	
P*value	.00	.000	

P\* value= Paired ‘T’ test

P\*\* value= Independent ‘T’ test.



**Figure 5.**

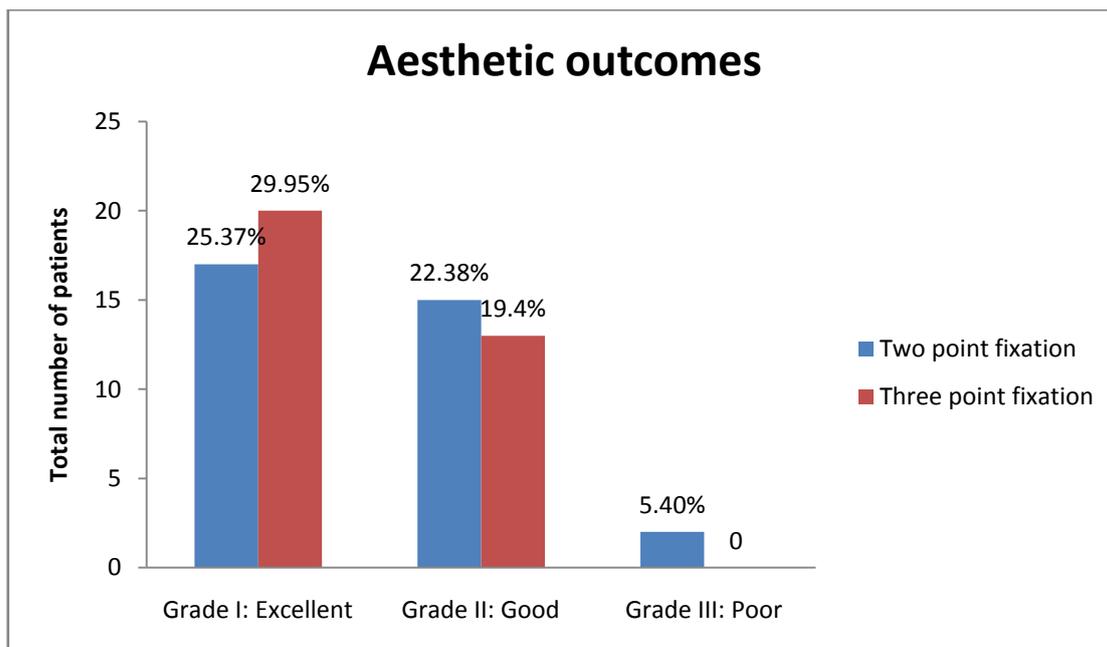


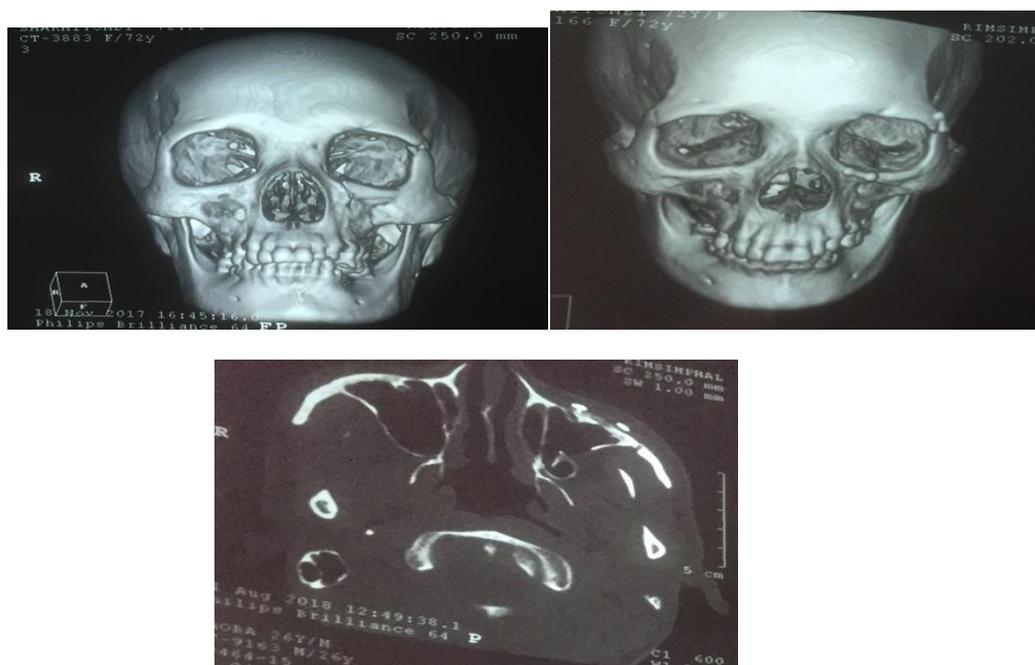
Figure 6.

5. Aesthetic outcomes by visualisation and photography:

Subjective assessment of aesthetic outcomes were compared in two point and three point fixation. It was divided into three grade to interpret the result as Grade I: Excellent symmetry. Grade II: Good symmetry. Grade III: Poor symmetry. Table VII shows both achieved significant aesthetic outcomes but in three point fixation the aesthetic outcome was slightly better in terms of facial symmetry and malar prominence but statistically not significant.

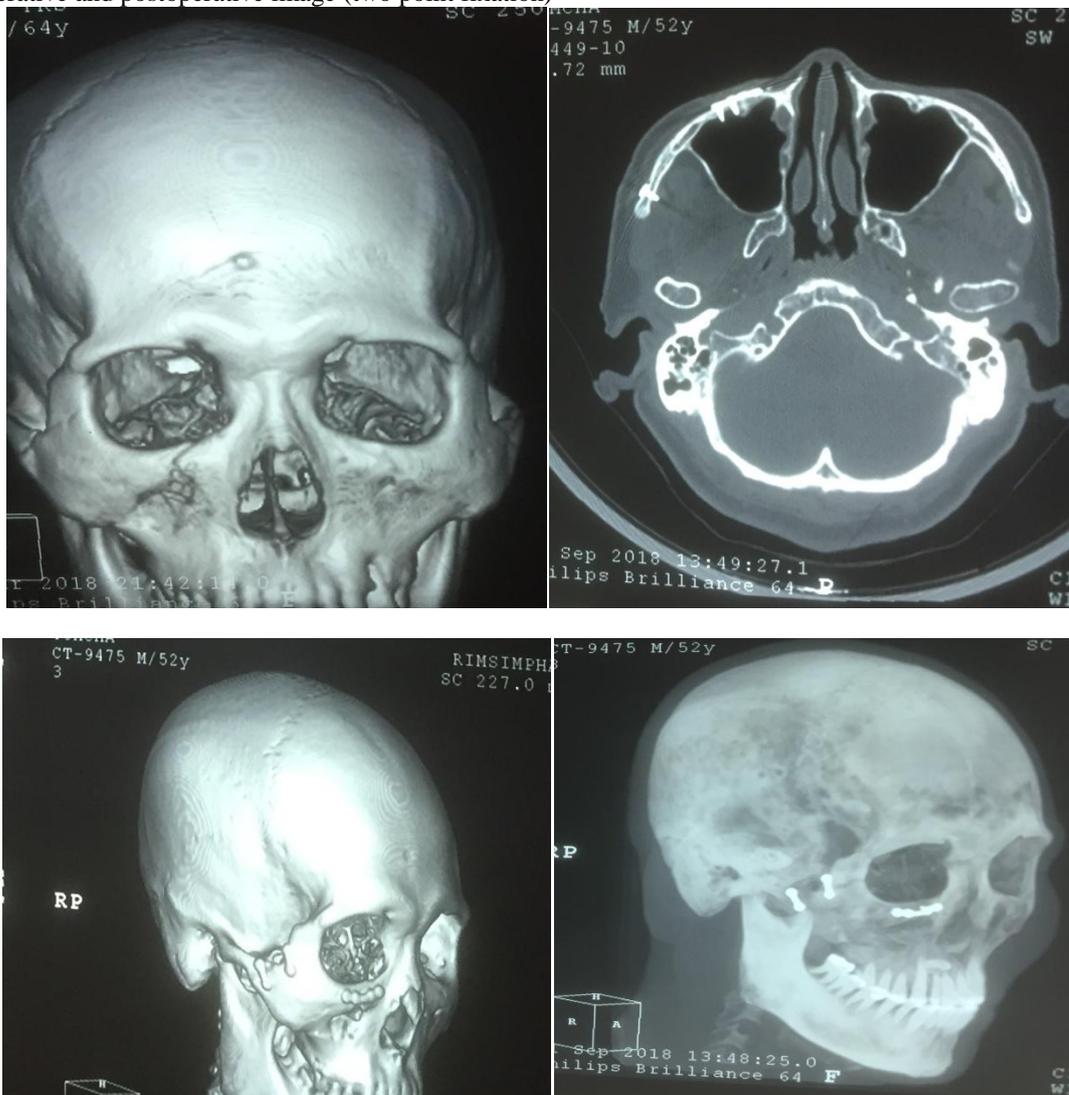
Table VII: Aesthetic outcomes.

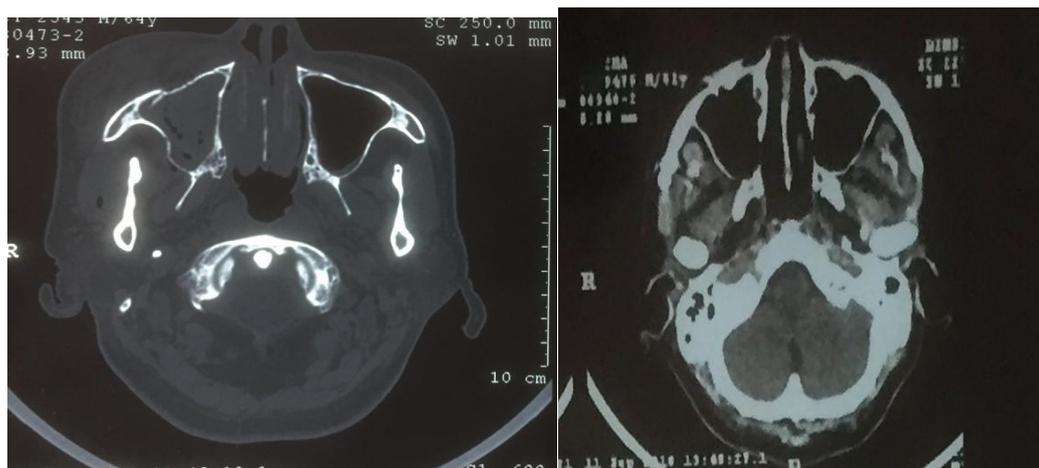
Grade	Two point fixation	Three point fixation
I: Excellent	17 (25.37%)	20 (29.85%)
II: Good	15 (22.38%)	13 (19.4%)
III: Poor	2 (5.40%)	0





Preoperative and postoperative image (two point fixation)





Preoperative and postoperative image (three point fixation).

#### IV. Discussion

The zygomatic bone (cheekbone or malar bone) is a paired irregular bone which articulates with the maxilla, the temporal bone, the sphenoid bone and the frontal bone. They form a functional and aesthetic unit of the mid-facial skeleton. The zygomatico-maxillary complex (ZMC) plays a key role in the structure, function, and esthetic appearance of the facial skeleton. They are the second most common facial bone fracture after nasal bone injuries. The fracture results from a direct blow to the malar eminence and results in three distinct fracture components that disrupt the anchoring of the zygoma.<sup>53</sup> Epidemiological analysis of maxillofacial fractures is crucial to identify the trauma burden and to help in developing a more efficient system to plan resource allocation and to deliver care and preventive measures establishing clinical and research priorities for effective treatment and prevention of these injuries.<sup>17</sup>

Men were found to be maximum in number (91%) as compared to females (9%). Similar higher incidence in males is also reported by Esses DF et al<sup>20</sup>, Agarwal P et al<sup>31</sup>, Neovious E et al<sup>35</sup>, Singaram M et al<sup>36</sup>, Manana W et al<sup>28</sup> and Ji SY et al.<sup>24</sup> This can be due to the fact that females are most often confined to housework, drive vehicles less, occasionally participate in trading or farming so they are less exposed to accidents, fights and work.

Injuries were most common in (18-28) age group accounting for 40.3% in our study. Similar results were also found by Ozoemene O et al<sup>44</sup>, Gruss JS et al<sup>48</sup>, Manana W et al<sup>28</sup>, Klenk G and Kovacs<sup>45</sup> who also stated that the prevalence age for the fractures of the zygomatic bone varies from 21 to 40 years.

The main etiology of ZMC was found to be RTA accounting for 79.1%. Agarwal P et al<sup>23</sup>, Ramneesh G et al<sup>14</sup>, Cavalcante JR et al<sup>37</sup>, Ozoemene O et al<sup>44</sup>, Klenk G and Kovacs A<sup>45</sup> and Manana W et al<sup>28</sup> in their study also stated that RTA to be the commonest cause of all faciomaxillary fractures. The results were consistent with the findings of the present study. ZMC fractures are usually caused by forces applied from antero-lateral direction which includes fracture of lateral and inferior orbital rim, orbital floor, zygomatic arch and lateral maxillary buttress. Isolated depressed zygomatic arch fracture was seen in localized force over the structure.

In the present study, most of the cases could be diagnosed as ZMC fracture on the basis of clinical examination but was confirmed by CT scan. CT scan plays an important role in diagnosis of ZMC fractures along with revealing accurately the extent of orbital involvement, as well as degree of displacement of the fractures. CT scan is considered as the "gold standard" in both evaluation and treatment planning.

Pearl<sup>54</sup> noted that the key to adequately reduce the fracture is to fix at three points in three dimensions to improve and achieve stability. He also opined that reduction in fronto-zygomatic suture and inferior orbital rim can still leave persistent lateral rotation in the region of the anterior maxillary buttress. Many experimental biophysical studies have been conducted to find out post reduction rotational stability of zygoma fracture after miniplate fixation. O'Hara et al<sup>55</sup> also found out that three point fixation over the fronto-zygomatic suture, inferior orbital rim and zygomaticomaxillary buttress give a maximum stability against forces matching physiological stresses. Any mobility of fracture fragments impedes healing, accurate reduction and fixation is necessary.

In our study, both the groups (two point and three point titanium miniplate fixation) show statistically significant fracture line reduction on the inner cortex as compared to preoperative fracture gap. Three point fixation provides a better postoperative result in fracture reduction and reduces postoperative displacement as shown by the independent T-test. The findings of the photographic assessment also reveal better malar eminence and facial symmetry in three point fixation. Our study is in agreement with Rana et al who recommended three-

point fixation to obtain stable fixation but against Lee et al, Naser et al and Chakranarayan et al. Despite the advantages of better result in terms of fracture reduction and facial symmetry in three point fixation, it has also got its demerit of more extensive surgery, periosteal stripping, more implant/foreign body in the body, more costly and longer operative time with more chances of complication.

## **V. Conclusion**

A total of 67 cases of fracture zygoma who had undergone Open reduction and internal fixation (ORIF) using titanium mini plate in two point and three point fixation was studied during the period from November 2016 to November 2018 in the Department of Plastic and Reconstructive Surgery, Regional Institute of Medical Sciences, Imphal, Manipur.

In our study zygomatic bone fractures are due to road traffic accidents (RTA) account 53 (79.1%) cases, followed by accidental mishap 11 (16.4%) cases and assault account 3 (4.5%) cases.

The incidence vary widely in different regions of the world due to social, economical and cultural consequences. In our study the highest incidence occurred in the people residing in urban areas accounting for 51 (76.1%) cases and people residing in the hilly areas accounting for 16 (23.9%) cases in Manipur

Osteosynthesis by using rigid titanium mini plate in fracture zygoma is simple and gives effective treatment as compared to other treatment modalities. Assessment of fracture site after one month of ORIF, between two point and three point show statistically significant reduction of the deeper fracture line by the paired "T" test. However, independent "T" test showed three point fixation is more effective than two point fixation.

Subjective assessment on aesthetic appearance showed better outcomes in three point fixation over two point fixation in malar prominence and facial symmetry. We recommend three point internal fixation for management of displaced or tripod fracture for better osteosynthesis and stability.

## **VI. Summary**

The study entitled "An analysis on the reduction of deeper fracture lines in two and three points fixation on zygoma fracture" was taken up with an aim to compare the treatment and to look which one gives a better surgical outcome in terms of stability and osteosynthesis after rigid titanium mini plate fixation. A total of 67 cases of fracture zygoma who had undergone Open reduction and internal fixation (ORIF) using titanium mini plate in two point and three point fixation was studied during the period from November 2016 to November 2018. The study was conducted in the Department of Plastic and Reconstructive Surgery, Regional Institute of Medical Sciences, Imphal, Manipur. The deeper fracture line (Inner table or cortex gap) was reassessed after one month of ORIF by CT Scan on follow up.

After the nasal bone, the zygoma is the second most common bone of the face to be fractured. The group at highest risk are young males at the age of 18-28 (40.3%) years of age followed by 29-38 (28.4%) years of age.

Zygomatic bone fractures are due to various causes, Road traffic accidents (RTA) account 53 (79.1%) cases, followed by accidental mishap 11 (16.4%) cases and assault account 3 (4.5%) cases respectively.

The incidence vary widely in different regions of the world due to social, economical and cultural consequences. The highest incidence occurred in the people residing in urban areas accounting for 51 (76.1%) cases and people residing in the hilly areas accounting for 16 (23.9%) cases in Manipur

The surgical outcomes of ORIF with rigid titanium mini plate fixation at two points and three points were analysed and found that both two point and three point fixation show a significant reduction of deeper fracture line. However, independent "T" test shows three point fixation was more effective compared to two point fixation.

The three point fixation produced a better aesthetic outcome as compared to two point fixation in malar projection and facial symmetry.

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