Analysis and Management of Tripod Fractures: Our Experience

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Abstract: ***The present prospective study seeks to evaluate the incidence of tripod fracture, etiology and treatment options. All patients with faciomaxillary fractures following road traffic accidents admitted in the Deptt. Of otorhinolayngology, silchar medical college & hospital, Assam during the period of one year from Aug 2011 to Aug 2012, were scrutinized for tripod fracture, both clinically and radiologically & were managed according to the severity of fracture. Patients presenting with simple zygomaticomaxillary complex fractures were managed conservatively. While comminuted/malaligned fractures had monofragments fixed using open & closed reduction methods. Out of which most had early intubation, before edema occurred, to make airway control and provide anaesthesia.in few patients in whom intubation by oral route was impossible, tracheostomy was performed to secure airway.The adequacy of fracture reduction & its stability was confirmed by subsequent CT scan measurements, statistical analysis, and clinical follow-up during the postoperative period, in which patients showed no significant associated complications, facial asymmetry, enophthalmos, or diplopia. Road traffic accidents came out to be most common cause of facio-maxillary fracture, incidence of zygomaticomaxillary fractures is second to nasal bone fracture, which in itself most common facial fracture.***

Keywords: tripod fracture, zygomaticomaxillary complex fractures, fracture reduction.

1. Introduction

The body & process of the zygomatic bone make up the lateral middle third of the facial skeleton. Blows to this part 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 [1] may cause either a depressed fracture of the entire zygomatic bone or a fracture of the zygomatic arch. Assaults, road traffic accidents and falls are the principal etiologic factors that may cause fractures of zygomatic bone.

The term tripod fracture is because of the disruption of the three commonly recognized articulations:

1. Fronto-zygomatic;
2. Infraorbital rim;
3. Zygomaticomaxilary buttress [2]

The lateral middle third of the face provides support & protection for the eye. Anatomical reduction of such fractures is impotant for facial appearance, optimum function of the eye, & because of its proximity to the coronoid process, for opening and closing of the mandible

Trauma of the zygomatic complex constitutes about 45% of the fractures of middle third of the face [3]. Etiology cites the physical aggressions, falls and road traffic accidents [3, 4]. The prevalence age for the fractures of the zygomatic bone varies from 21 to 40 years [4].

Study conducted by Hang et al in 1983, showed the ratio of 6: 2:1 of mandibular, zygomatic, maxillary fractures incidence respectively. The different fracture reduction methods are applied to treat the zygomatic bone fractures. The type of the fracture, its severity and associated facial fractures usually interferes with the treatment modality. Surgical methods include different approaches – anterior approache (involving incisions for zygoomaticofrontal suture exposure, incisions for infraorbital rim exposure and incisions for zygomaticomaxillary exposure) standard transcutaneous subciliary or subtarsal incisions, transconjunctival incision, and intraoral incisions.[5- 10]

2. Objective

- Institutional prevalance of tripod fracture in patients with faciomaxillary injuries.
- To find out the types of zygomatic fracture.
- To assess the clinical features in different types of zygomatic fracture.
- To assess the type of treatment for different types of zygomatic fractures & its complications.

3. Materials and Methods

This is a one year prospective study conducted in the Deptt. Of Otorhinolaryngology, Silchar Medical College & Hospital from Aug 2011 to Aug 2012.

Patients attending both ENT OPD and Emergency were included in the study. Besides patients' profile, full clinical history with emphasis on the mode of injury and clinical presentation along with careful palpation of orbital rim, zygomatic arch, and lateral maxillary buttress were recorded. Eye assessment for visual acuity, extra-ocular muscle function, gaze and diplopia were done. Further assessment was done radiologically (X-rays facio- maxillary region - waters & Caldwell AP view; CT scan Facio-maxillary).

3.1 Exclusion criteria

Isolated nasoethmoidal complex fracture.

3.2 Inclusion criteria

Zygomaticomaxillary complex fractures.

Radiologically confirmed cases of zygomatico-maxillary complex fractures were classified into three types: A, B, and C as proposed by Zingg M et al [11]

- **Type A fracture**. This refers to a zygomaticomaxillary injury that only happens to one of the tetrapod components, such as: the zygomatic arch (A1), lateral orbital wall (A2), Inferior orbital rim (A3). This is not really common among patients with ZMC bone fracture.
- **Type B fracture**. This refers to fractures that happen to all the four buttresses (Tetrapod)
- **Type C fracture**. This refers to the complex fractures wherein the fractured zygomatic bone has comminution.

Other fractures associated with zygomatico complex fractures were also documented. In all patients suspected of ocular injury ophthalmological consultation was obtained. Patients were managed according to the Type of fracture. Type A undisplaced zygomaticomaxillary complex fractures & no functional & cosmetic deformity were managed conservatively and followed up till fully healed. While Type B & C (i.e comminuted /malaligned/ moderate to severely displaced fractures with functional and aesthetic problems) were treated with ORIF & closed reduction methods. During surgery airway was secured by oral, nasal, retrograde intubation to provide anaesthesia. In whom the above was not possible, tracheostomy was performed. Criteria for surgical intervention— All ZMC fractures where there is:

- Radiographic evidence of displacement.
- A palpable step or discrepancy in the orbital rim or zygomatic arch.
- Enophthalmos and extra ocular muscle dysfunction.
- Trismus.
- Cosmetic.

The choice of different incisions was based on site, type of fracture and exposure to fix the fracture fragments. Post operatively, all patients were put on prophylactic antibiotics for at least 5 days, nil orally for 2 days followed by straw feeding for 2 weeks. Sutures were removed after 7 days post operatively.

The adequacy of fracture reduction & its stability was confirmed by clinical outcome measures and radiological study. The satisfactory outcome of the procedure was judged by the fulfillment of the aim of the procedure decided preoperatively. Any post-operative complication was noted. Patients were followed up for 1 month. Aesthetic features were assessed based on facial width, malar projection, occlusal, orbital position and width of nasal pyramid base, from both pre- and post-operative photographs assessed by the surgeon & patient.

4. Results & Discussion

4.1 Gender Distribution

Men were found to be maximum in number (95%) compared to females (5%).Similar higher incidence in males is also reported by Majed Hani [13],Szontagh E et al(1993)[14], Freidl S et al (1996)[15] and V.I. Ugboko et al (1998),Hogg NJ et al, Klenk G et al,. This can be due to females are most often confined to housework, drive vehicles less, occasional participation in trading or farming & less exposed to accidents, fights and work.

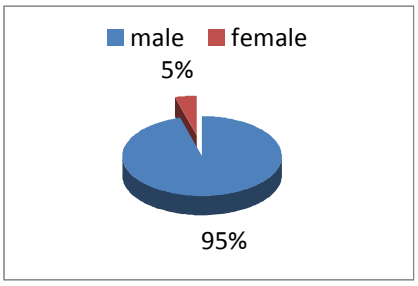

Figure 1: Gender distribution of ZMC fractures

4.2 Age wise distribution

Injuries were most common in (23-27) age group accounting approx 33%. Similar results were found by Br Chandra Shekar et al (2008) [12] and Gruss JS et al who all stated that the prevalence age for the fractures of the zygomatic bone varies from 21 to 40 years [4]Its due to that subjects in this age group are more prone to violence and exposed to road traffic.

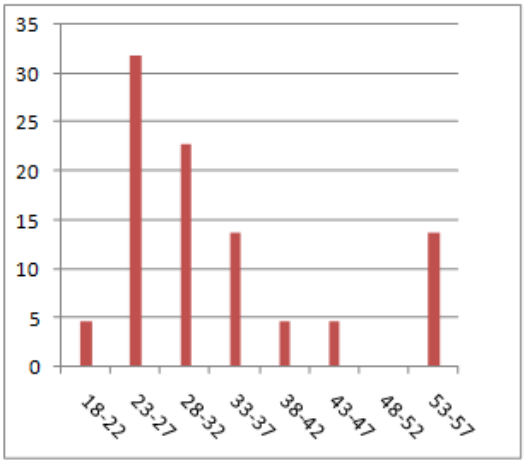

Figure 2: Age wise distribution of cases with ZMC fractures

4.3 Mode of Injury

The main etiology of ZMC was found to be RTA accounting 60% of cases followed by physical assault approx 22%. Sirirak in their study also stated that RTA to be the commonest cause of all faciomaxillary fractures [19]. Szontagh E et al[14} and V.I.Ugboko et al, Hogg NJ et al

and Klenk G et al[16-18] in their studies found that RTA are the major cause of ZMC fractures.

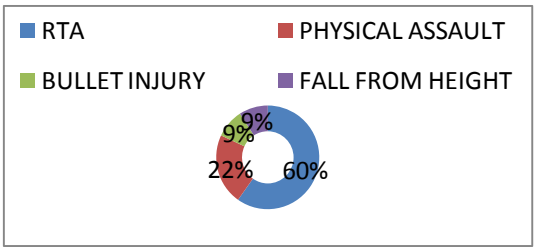

Figure 3: Mode of injury

The results were consistent with the findings of the present study. ZMC fractures are usually cause 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

4.4 Types of faciomaxillary fractures

In our study the total no.of patients presenting with facio-maxillary fractures were 101 .Nasal bone fracture was the most common fracture of faciomaxillary region (41%) followed by zygomatic complex fracture (23%). Nasal bone fractures are commonest as relatively little force is required to fracture the nasal bone as 25-75 lb/in sq and the nasal pyramid is the most prominent structure of face [20]. Other studies also revealed that the zygoma is the second most commonly fractured facial bone [6, 7]. This finding is similar to Erlanger et al [21].

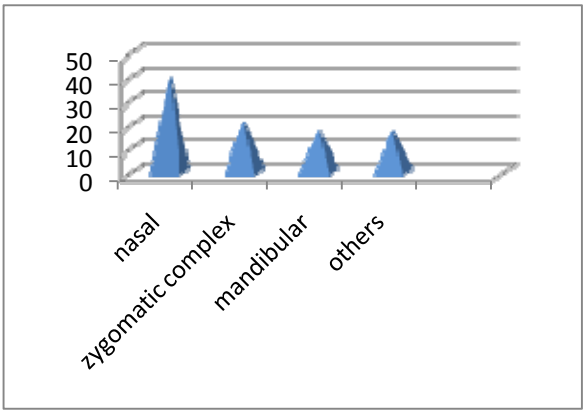

Figure 4: Distribution of faciomaxillary fractures.

4.5 Symptoms and signs of ZMC fractures

Most of the patients with ZMC presented with subconjunctival haemorrhage (90%), followed by depression of inferior orbital rim, swelling along with deformity of malar region (80%) each.

In agreement with Holmes, Gleeson et al, subconjunctival haemorrhage is almost invariably present in fractures of the zygomatic body in our study [22].

Paresthesia along infra-orbital nerve is seen in 32% cases and is caused by fracture through canal and foramen in orbital floor and rim.. This result compare well with other studies reporting a range from 30% to 80%[23-24]. Depression of the infra-orbital rim was present in 80% of patients, which is similar to results reported by[25]. Trismus was seen in 40% cases. It's due to impingement of depressed zygomatic arch on temporalis muscle and coronoid process of the mandible.

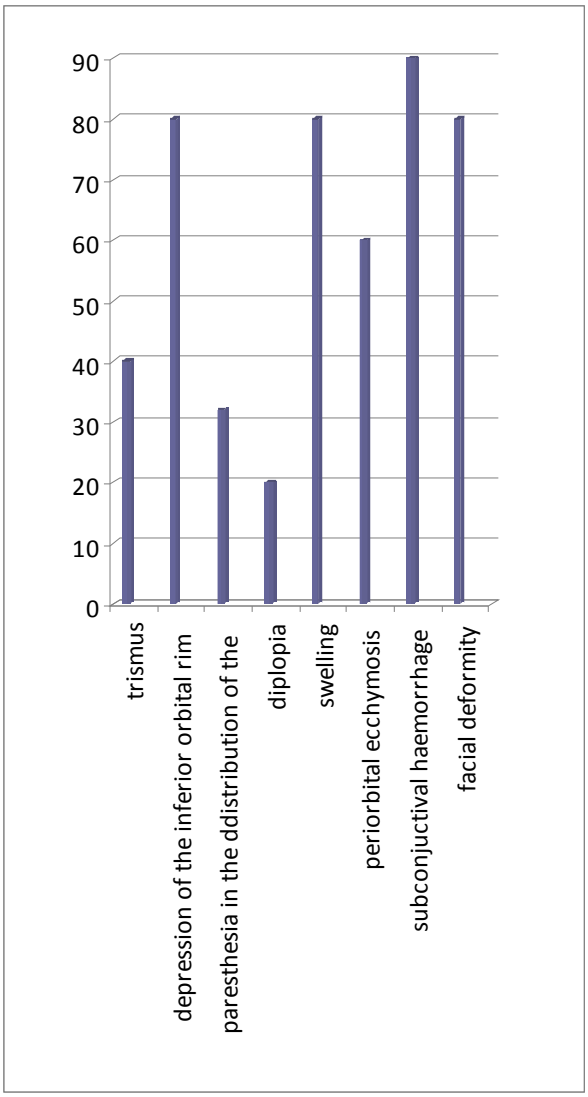

Figure 5: Symptoms and signs of ZMC fractures

Today fractures of ZMC are receiving increased attention because of increase in incidence and recognition of direct involvement with the contents of orbital cavity, particularly the extra ocular muscles.

20% patients presented with diplopia[26]. It is seen due to generalised oedema of orbit and entrapment of extra-ocular muscles. Studies in the literature report similar figures [27-28]. Some studies reported a lower incidence [29] and peri-orbital oedma in about 60% of the cases similar to Albright RC et al study [30].

4.6 Associated mandibular fractures

There are about 18 % of mandibular fractures associated with ZMC in our study. The higher involvement of mandible may be attributed to its prominence and also its exposed

anatomical position on the face. Most of the victims of RTAs try to avoid their head , may receive impact to the mandible.

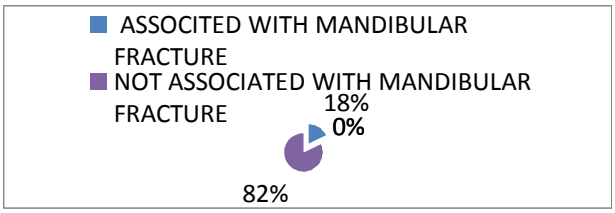

Figure 6: Associated mandibular fracture with ZMC fracture

4.7 Role of CT scan in ZMC fractures

This can be a factor responsible for the higher involvement of mandible compared to other facial bones in faciomaxillary injuries, which in itself is the third most common facio-maxillary fracture.

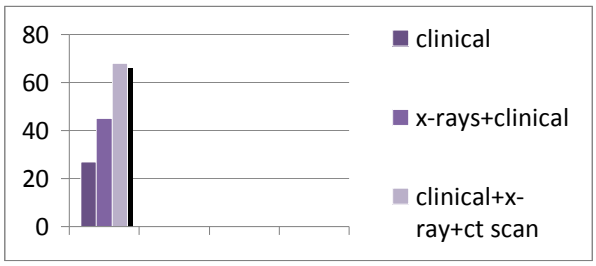

Figure 7: CT scan in diagnosing ZMC fractures.

In the present study, it had been seen that 27% of the cases could be diagnosed with ZMC fracture on the sole basis of clinical examination, 47% when x-ray was added to clinical evaluation and 68% of cases when CT faciomaxillary was used along with clinical examination & x-ray. Therefore, 20% cases are missed with x-ray alone which shows that 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. This study is vital for planning the operative approach. Therefore, the diagnosis is well established (68%) by applying clinical & radiological assessment, both ski gram & CT facio-maxillary. As stated by Erlanger et al, CT scan is considered as the “gold standard” in both evaluation and treatment planning.

4.8 Injury Vs type of fracture

Our analysis revealed that type B fractures are more common with low velocity force of physical assault (7 out of 22). Type C comminuted fractures of the body with separation at the suture lines are commonly associated with high velocity road traffic accidents (9 out of 22).

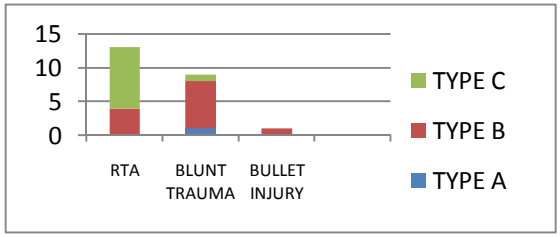

Figure 8: Injury Vs Type Of Fracture

As is stated in one of the publications of 1997 Erlanger Health System Tennessee Craniofacial Center. 4.5 % cases are Type A fracture which was isolated fractures of zygomatic pillar (zygomatic arch, lateral orbital rim, inferior orbital rim). These fractures were related to low energy injuries and required only conservative treatment in most cases.

4.9 Type of surgery and airway

Patients’ undergoing surgery the airway was secured during general anaesthesia through orotracheal route. Patients presenting with gross trismus were given nasotracheal intubation by

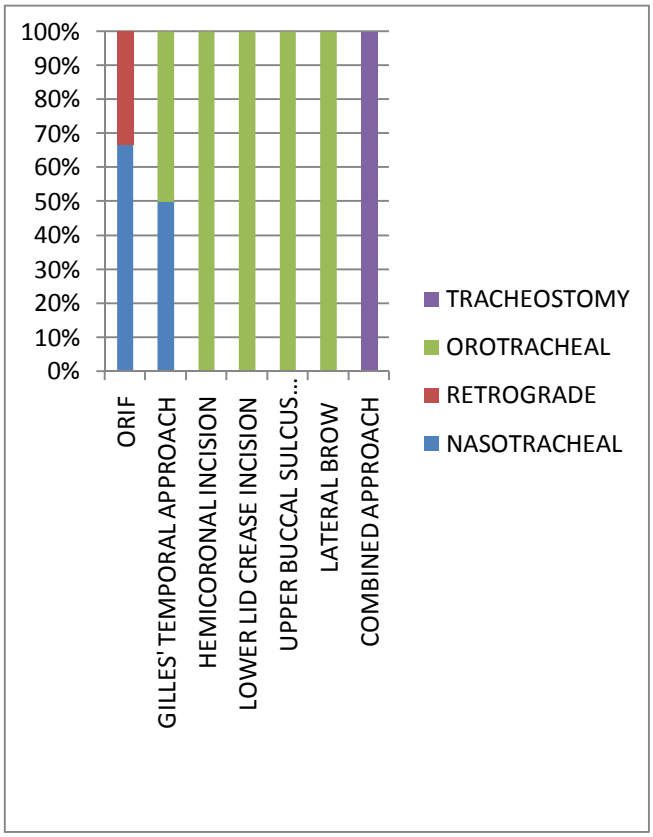

Figure 9: Type of surgery and airway secure

either prograde or retrograde route. Tracheostomy was required in that patient who had combined fractures involving nasal bones and coronoid process of mandible so an internal maxillary fixation and mandibular plating was done in such cases.

Figure 10: A & B Showing basic steps in Retrograde airway

4.10 Type of operation

Type A fracture was treated surgically as he had significant trismus and aesthetic deformity. Lateral orbital rim fractures don't require reduction as they are stable whereas infra-orbital rim fractures with orbital floor fracture require ORIF.

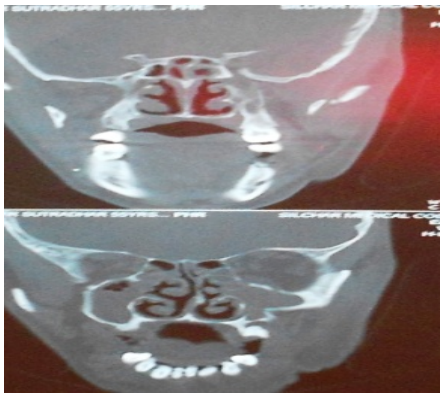

Figure 11: CT Scan Type A fracture

Figure 12: Gilles temporal approach for Type A fracture reduction

Type B fractures: The undisplaced and stable fractures were treated conservatively (27.2%) cases [31] and rest of the Type B fracture required repositioning using Gillies approach similar to as reported by Yaremchuk M et al (1990) and also required miniplate fixation where zygomatic arch & body were exposed & anatomical correction was done.

Type C fractures: ORIF was done using 0.5 mm 4 hole 6 hole mini titanium plates.

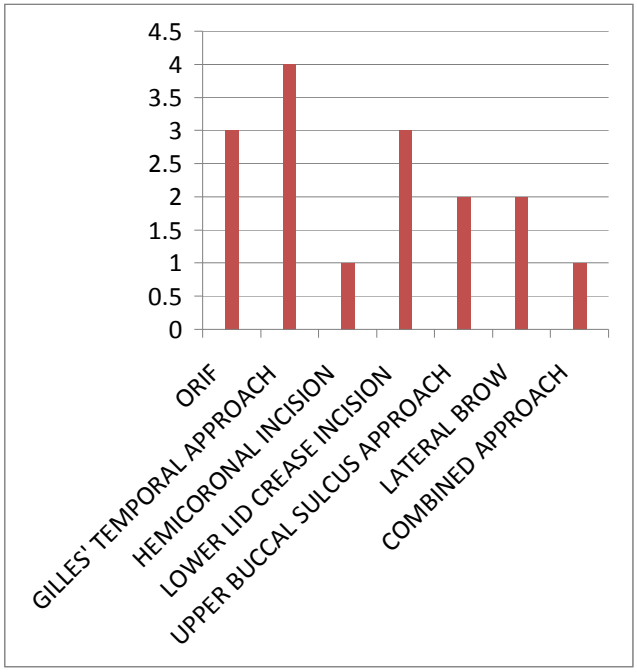

Figure 13: Type of Operation

As any mobility of fracture fragments impedes healing, fixation is often necessary to achieve healing of fractured bone according to Zingmunt W.Pozatek [11].

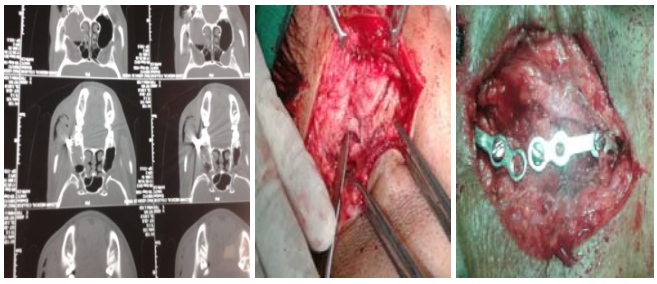

Figure 14: A B C

A- CT Scan of Type C fracture
B- Incision over superior border of zygoma
C- ORIF (double miniplate)

Different surgical approaches employed in our study:

For zygomatic arch fracture Gilles' temporal approach was found to be most suitable. In our study in Gilles' temporal approach incision was modified from horizontal to vertical incision made at temporal hairline superior to arch. Blunt dissection done up to temporalis fascia to prevent injury to superficial temporal artery. Temporalis fascia is cut & tunnel is made inferior to zygoma by Freer's elevator then Gilles' elevator is placed, lateral pressure applied lifting the arch. No plating is required.

Advantages of this procedure being:

- No risk of injury to superficial temporal artery.
- Small incision with good aesthetic results
- Satisfactory improvement of trismus post-operatively.

For infra-orbital rim / orbital floor fractures lid crease incision, subcilliary incision, transconjunctival incisions are preferred. In our

experience lower lid incision was preferred for infra-orbital rim fractures. In this incision periosteum was incised 3mm parallel & below infra-orbital. Periosteum & peri-orbita elevated, bony fragments are removed and defect is closed by gel-foam & mesh.

In Type B fractures minimally comminuted & displaced fracture of tripod are approached by lateral brow incision, lower eye lid and unilateral sub labial route.

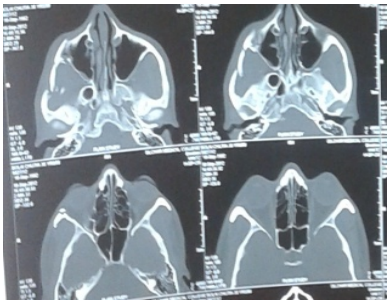

Figure 15: CT Scan Type B fracture

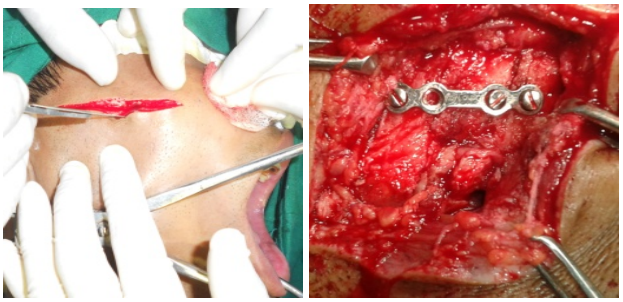

Figure 16 A & B : Incision over superior border of zygoma with miniplate fixation.

In about 75% of patients the whole complex was exposed using various incisions viz;

i. Lateral brow incision (12%)
ii. Lower eyelid crease incision (19%)
iii. Incision over upper border of zygoma (19%)
iv. Upper buccal sulcus incision. (13%)
v. Hemicoronal incision. (6%)
vi. Combined Gilles temporal approach & other incision (6%)

The criteria of approach were based on the location & type of fractures. In lateral brow incision our findings agree with Zingmunt W.Pozatek [11] regards to scar which confines within eyebrow. In this approach incision is made on the lateral eye brow to expose fronto-zygomatic suture tunnel deep to temporal fascia is developed to appoint inferior to malar eminence. Repositioning is done with Gilles' elevator by giving lateral & inferior force. Proper reduction is achieved & bone is stable so internal fixation was not required in our patients. Hemicoronal incision was added to make three dimensions reconstruction to expose the zygomatic body and arch for accurate assessment of the position of the zygomatic arch in relation to cranial base and midface [19].

Figure 17 A&B Skiagram showing bullet injury & upper buccal sulcus approach during reduction.

But this technique had some disadvantages including:

- an increased risk of blood loss,
- scarring
- aloplecia
- loss of sensation posterior to incision
- traction palsy of facial nerve
- post-operative oedema.

In this approach incision starts inferiorly at the level of inferior margin of tragus. Periosteum is then elevated to expose fracture sites and plating carried out. The factors of optimal reduction of zygomatic fractures are aesthetic and functional restoration of both face and orbit. It has been seen that alignment & fixation of facial buttresses which are areas of thick bones transmitting force are key to achieve optimum, functional & aesthetic results. Among numerous methods of treatment of zygomatico-maxillary complex fractures, it is miniplate osteosynthesis that is considered to be the method yielding best results and stabilisation of bone fragments [35-37]. So whatever the incision we gave rigid fixation with screw & 4 hole titanium miniplate was used

4.11 Post-operative complications

In our study, trismus is the commonest complication. Persistence of trismus was seen in cases with concomitant coronoid process fractures.

Infection, severe pain and palpable plates were seen in 12.5% cases ach.

Post-operatively hypoesthesia was elicited in 1 patient who had infraorbital rim fracture and was reduced by upper buccal sulcus approach.

In our present study no displacement of zygoma occurred after fixation. But in one case little asymmetry existed due to soft tissue loss that resulted in esthetic compromise which correlates with findings of Jackson, Kunio Ikemura and Keith et al. Holemes Keith D, Mathews Brain L

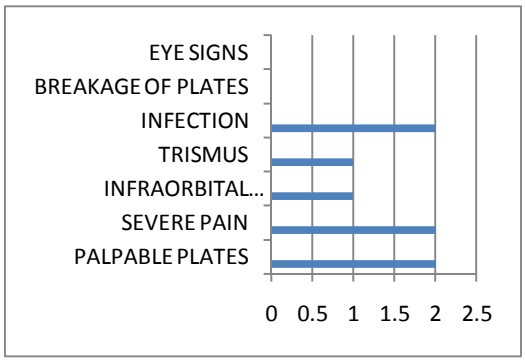

Figure 18: Post-operative complications

The post operative malalignment of zygomatic fracture miniplate osteosynthesis may be due to:

- Secondary dislocation of bone fragments consequent upon the fact that the long arm of the zygomatic arch starts performing the function of a lever after miniplate bonding.
- It is very difficult to reach an appropriate angle and positioning of the fragments via titanium miniplates owing to the anatomic changeability of the zygomatic arch.

Postoperative infection was observed only in patients after miniplate osteosynthesis and occurred in 2 of all surgically reduced fractures. This can be explained by the fact that early infections are due to retained nonviable tissue, vommiting, or hematoma. Late infections are generaly due to miniplates as they intensify the loss of vascularisation that leads to complete or partial resorption and inflammation. In the literature, complications connected with miniplate osteosynthesis appear in around 13% of patients. [38-39]. In the present study, enophthalmos and diplopia was not observed in any of the patients after surgery [40, 41]. It is obvious that concomitant orbital floor fractures with visual disturbances necessitate open reduction and orbital floor reconstruction and even minor inaccuracies may lead to less than adequate results. The most common sequelae of these fractures are enophthalmos and diplopia. The rate of this complication described in recent studies varies from 3.9% to 5%. In our study no breakage of plate was seen. In post operative period in clinical examination, the proper position of the relocated bone segment is confirmed by correction of external facial asymmetry and by palpation (lack of bone slide on lower orbital rim, lack of displacement of the malar prominence and depression of the zygomatic arch). Although cosmetic and functional results of ZMC fractures treatment are frequently less than satisfactory, unacceptably poor outcomes are very rare in the literature. [40, 42-44]

Figure 19(A) Pre-Operative with trismus **(B)** post-operative without trismus after Gilles approach reduction.

5. Conclusion

This prospective study presents information that can be valuable in describing the pattern and spectrum of zygomaticomaxillary complex fractures in local population. As, the high velocity vehicular accidents are the leading cause of facial trauma, theses usually associated with greater severity of injuries, managment of such fractures needs to be comparatively aggressive e.g. exposure of fracture sites and internal fixations, for better aesthetic and functional outcome. Our study reveals that males in the age group (23-27) years are the most common to suffer ZMC fracture and present with subconjunctival haemorrhage along with malar deformity. Clinical evaluation along with CT scan of facio-maxillary region plays an important role in the assessment & type of fracture and planning of appropriate surgical intervention

The most important considerations in treating zygomatic complex fractures should be: proper reduction and stabilization keeping in accordance with the facial buttresses, adequate orbital floor reconstruction (when associated with infr- orbital rim fractures), and sufficient positioning of periorbital soft tissue which will provide precise and satisfactory postoperative results. Although, different modalities of treatment exist, the type of ZMC fracture, time since injury and associated complications are the deciding factors. The effectiveness of bone fragment reposition relies on the adequate reconstruction of three-dimensional anatomical configuration of the zygomatico-maxillary complex. The use of miniplates and screws has provided good postoperative results both in aesthetic terms and functional effectiveness. Ideally management of zygomatic complex injuries should be undertaken after residual oedema has subsided and the decision of surgical modality should be based on detailed CT scan fracture site evaluation, patient symptoms and choice of fixation. If properly assessed, surgical treatment gives encouraging results both functionally and cosmetically.

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