

**Radiographic Evaluation of Adequacy after Reduction  
& Fixation for Unilateral Zygomatic Complex  
Fractures - A Retrospective Study of 12 Cases**

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## CERTIFICATE

This is to certify that this dissertation titled “ **RADIOGRAPHIC EVALUATION OF ADEQUACY AFTER REDUCTION & FIXATION FOR UNILATERAL ZYGOMATIC COMPLEX FRACTURES - A RETROSPECTIVE STUDY OF 12 CASES** ” is a bonafide work done under my guidance by **DR. SULPHI .A** during his postgraduate study period between 2002-2005.

This dissertation is submitted in partial fulfillment for the award of the degree of Master of Dental Surgery in Branch I - Oral and Maxillofacial Surgery of The Tamil Nadu Dr. M.G.R. Medical University.

It has not been submitted (partially or fully) for the award of any other degree or diploma.

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## INTRODUCTION

The zygoma articulates with the frontal, sphenoid, temporal, maxillary bones and contribute significantly to the strength and stability of the midface. The zygomatic bone forms the cheek prominence, part of the lateral, inferior orbital rim and the orbital floor. The zygomatic complex is important in the function of the globe, facial symmetry and gives passage to the infra-orbital nerve that innervates the mid-facial region.<sup>5,7,18</sup>

The architectural pattern of zygomatic bone allows it to withstand blows of great forces without fracturing. Because of its forward projection, the zygoma is frequently injured. In response to such heavy forces zygomatic bone gets separated from adjacent bone at or near the suture lines. It may be separated from its four articulations, resulting in a zygomatico-maxillary complex, zygomatic-complex or orbito-zygomatic fracture. Fractures of this complex are one of the more common types of maxillofacial injuries to treat. They are seen as isolated or in association with other facial fractures due to the complex midface anatomy. The fracture of the zygomatic arch can result in restricted mouth opening due to impingement on the coronoid process.<sup>31,45,75</sup>

The diagnosis is made on clinical features and confirmed on the basis of the findings in the maxillary sinus radiograph. The assessment of the treatment of zygomatic complex fractures is done by three main visualization methods such as; Computed

Tomography, Photographs, Radiographs. The gold standard for the assessment of the adequacy of reduction and postoperative healing of the zygomatic complex is the use of CT. The visualization of the zygomatic complex by axial and coronal views are to be done pre and post operatively if proper reduction is to be planned and achieved. Photographic comparison of the face by profile, frontal, three-quarter, bird's and worm's eye views are to be done. They are good for assessing facial symmetry and for medico-legal records.<sup>18, 19,29,52</sup>

Even though, the principles of management of the zygomatic complex fractures are similar to those of fractures elsewhere in the skeletal system, the complexity of the midface and zygomatic bone being the most prominent part of the face, its precise reduction becomes even more crucial. Various procedures for the repair of zygomatic complex have been advocated with emphasis on types of incision, open / closed reduction, choice of fixation methods, single or multiple fixation sites, indications for exploration and reconstruction of orbital floor. Studies have shown that secondary repair of zygomatic complex fractures is less successful in restoring the function and esthetics than surgical repair soon after injury.<sup>3, 5,7,13,</sup>

The single best radiograph for assessment of zygomatic complex fractures is the Water's view. Submento-vertex ( Jug Handle ) view is used to evaluate arch and malar projections. Even though, Computed Tomography now tends to gain more importance in the visualization of zygomatic complex fractures, conventional

radiographs still are very valuable for screening and post-operative assessment.<sup>29</sup>

This retrospective study evaluates the treatment outcome of unilateral zygomatic complex fractures, which were treated by reduction and internal fixation, by the use of radiographs.<sup>18</sup>

## **REVIEW OF LITERATURE**

**Melvin J. Sherman in 1952**<sup>46</sup> suggested an intraoral reduction of maxillary fractures by malar suspension. To follow this procedure, one or both of the malar bones or zygomatic process of maxilla must be intact. The advantage of this technique is that it is a simple procedure and no important structures will be encountered. It helps to control prosthetic appliance in an edentulous maxilla.

**Walter W. Crowe in 1952**<sup>75</sup> reported treatment of depressed fractures of zygomatic bone using steel hook for reduction. The diagnosis of fracture was done based on the history, local appearance, palpation and roentgenographic features. The signs and symptoms were; facial swelling, depression or flatness of the face, limitation of the mandibular movement resulting from muscular spasm or mechanical obstruction, ecchymosis, unilateral nasal haemorrhage, infraorbital anaesthesia, diplopia and emphysema.

**G. Kenneth Lewis in 1953**<sup>39</sup> discussed a method of restoring the facial contour with rib cartilage or cancellous bone, combined with

excision of the involved coronoid process for the treatment of old depressed fractures of zygoma with impingement on the coronoid process of the mandible. The diplopia resulting from the downward displacement of the level of the eyeball is corrected by implantation of the rib cartilage or bone graft along the floor of the orbit. Coronoidectomy was done to attain normal mandibular function.

**E.W.B. Varley et al in 1955** <sup>73</sup> presented a case of traumatic orbital apex syndrome following delayed reduction of zygomatic fracture. The severe infraorbital haemorrhage leads to complete loss of vision. The immediate decompression of the orbit via the maxillary antrum and intra-arterial injection of papavarine to the central retinal artery was achieved by cannulating the supraorbital artery.

**Vernard R. Jackson et al in 1956** <sup>74</sup> recommended balloon technique in the reduction of the depressed orbital and comminuted fractures of the zygomatic bone and the anterior surface of the maxilla. The air pressure in the balloon can be controlled and regulated easily and further alignment can easily be accomplished. They stated that cosmetic results are excellent since no external incisions are necessary, and the intranasal opening into the antrum heals readily.

**Raymond E. Boudreaux in 1957** <sup>60</sup> developed a modified urethral sound for reduction of isolated zygomatic complex fractures to prevent lateral movement of the urethral sound in the region of operators wrist to assure a maximum direct pull force.

**Richard.W. Branca in 1970** <sup>63</sup> explained the healing of the zygomaticomaxillary complex fractures by a hypothesis concerning the induction mechanism in facial fractures. He made a conclusion that the final repair in zygomaticomaxillary fracture is a combination of fibrous and bony union where as the palatal and zygomatic section showed bony healing but with increased amount of connective tissue.

**Kai Lund in 1971** <sup>38</sup> evaluates the long-term result after closed reduction of fractures of the zygoma by Gillies temporal approach. He achieved a 92% satisfactory results, including repositioning carried out one week or more after accident.

**A.D.Hitchin and S.T.Shuker in 1973** <sup>30</sup> analyzed case histories of patients with zygomatic bone fractures treated at the Eastern Regional Board (Scotland) hospital during 10 years. They found that the zygomatic fractures due to fights, falls and sports shows a high incidence affecting the left side than the right and road traffic accidents were slightly more on the right than the left.

**Podoshin and M.Fradis in 1974** <sup>57</sup> suggested a method for the reduction of fractures of the zygomatic arch by the use of Foleys catheter. He concluded that the method is a simple one without complications and superior to the wiring in comminuted fractures which cause delayed reduction and removal at later date and cause scar on face.

**David Poswillo in 1976** <sup>15</sup> described the reduction of the malar complex fractures by direct extra-oral applications of a specially designed traction hook. He describes the intersection of two imaginary lines, one dropped vertically from the outer canthus and the other drawn horizontally from the ala of the nose. The skin hook is to be inserted at this point to engage the infratemporal surface of the zygoma. The advantage includes the speed and effectiveness of reduction of the fracture following a line of withdrawal almost identical to that occurring during inward impaction. The stroymeyer bone hook is used most widely for this procedure although a large number of zygomatic hooks have been described. He reported that no evidence of wound on skin of the cheek after thirty days and short operating time (less than 5minutes) and simple anesthetic methods.

**Altonen M, Kohonen A, Dickhoff K. in 1976** <sup>3</sup> Fifty-two patients with zygomatic fractures were examined clinically and roentgenologically 1 to 4 years after treatment. Of these patients, 15 were treated with wiring fixation, 26 with antral packing using plastic tubing, and 11 with reduction only without fixation. At clinical examination, internal wiring fixation proved to be better than antral packing when hospital stay, restoration of function of the infra-orbital nerve, position of the eye, symmetry of the palpebral fissure and the final cosmetic results are considered. In the antral packing group, the result was better when jaw movements and occurrence of permanent diplopia were compared. The roentgenological examination revealed that the reduction results were more exact with internal fixation than with antral packing.

**Gerlock AJ, Sinn DP. in 1977** <sup>24</sup> enforces a better understanding of the mechanisms by which clinical signs and symptoms are produced is a prerequisite to the correct appreciation of radiographic features. Radiographs of facial trauma are no different in this respect. This paper describes the specific clinical findings associated with each displaced bony fragment of the zygomatic complex fracture. Limitation of jaw movement and flattening of the cheek are produced by depressed fractures of the temporal process or zygomatic arch; unilateral epistaxis is a result of fractures of the zygomatic process of the maxilla. The clinical and radiographic findings are correlated with surgical management.

**J.M. Gorman in 1979** <sup>26</sup> described the stabilization of malar fracture by means of silicone elastomer wedges placed at the malar buttress fracture site. He proposed that indications of the silicone wedge stabilization are;

1. Unstable simple malar fracture as a result of delayed reduction with inward displacement with a hinge movement at the fronto-malar suture without overlap.
2. Simple fracture with a transverse fracture line, across the body of the malar bone that separates it into upper and lower components.

**D. Gutman and D. Laufer et al in 1980** <sup>28</sup> found that the use of Foleys catheter inserted by an oroantral approach described by Jarabak (1959) was very encouraging for displaced zygomatic bone fracture. The constant elastic pressure exerted by the balloon in

displaced fracture make it an ideal fixation appliance. It allows correction of the pressure by removal or addition of fluid post-operatively.

**Winstanley RP. in 1981** <sup>78</sup> describes a series of cases of zygomatic fractures, studied to see if a change to a more extensive surgical intervention was justified. The surgical anatomy of the cheekbone complex was studied and certain protective features which determine the pattern of fracture were noted; treatment which takes account of these facts were suggested. Some observations are made on diplopia and enophthalmos and a plea is made for caution in accepting the concept of the "blowout" fracture.

**Fain J, Peri G, Verge P, Thevonen D. in 1981** <sup>21</sup> In certain orbito-zygomatic fractures, a fronto-zygomatic plate and a sinus balloon permit at the expense of a single eyebrow incision, the repositioning of the cheekbone and the alignment of the other fracture sites; the other fractures sites consolidate and remodel themselves spontaneously due to the action of the adjacent soft tissues. Success depends on the experience of the surgeon - does not apply in the case with a comminution of the orbital rim; closed fracture site reduction and distant osteosynthesis offer an alternative to the classical repair which requires a wide cutaneous incision and significant periosteal stripping with the subsequent risk of eyelid distortion.

**Balle V, Christensen PH. in 1982** <sup>7</sup> One hundred and five patients with zygomatic fractures are presented. The main cause of the fracture was violence, followed by road traffic accidents, fall and sports injuries. They did not find the X-ray subdivision by Knight & North, useful in the evaluation of the stability of the fractures. As a method of choice in cases of dislocated zygomatic fractures, they used reposition by the method of Gillies and in cases of instability this reposition was combined with internal wiring, reconstruction of the orbital floor and antral packing. An active attitude towards reconstruction of the orbital floor is recommended.

**J. Cornah in 1983** <sup>11</sup> described treatment of malar bone fracture complicated by the development of a lower eyelid abscess, dehiscence and discharge from the temporal wound and prolapsed necrotic temporal fascia following Gillies temporal approach. He found that the spread of antral infection through the comminuted roof into orbit, lower eyelid and the temporal fossa would be facilitated by the potential subperiosteal space. Early incision and drainage with appropriate antibiotic was given for management.

**P.M.Finly, K.P.Wardbooth, K.F. Moos in 1984** <sup>22</sup> discussed the complication encountered during the treatment of unstable zygomatic complex fracture with antral packs and external pins. They followed the **Henderson classification** system.

- Type 1 – undisplaced fracture
- Type 2 – zygomatic arch fracture only
- Type 3 – Tripod fracture with frontozygomatic suture intact.
- Type 4 – Tripod fractures with separation of frontozygomatic suture
- Type 5 – Pure blowout fracture
- Type 6 –Orbital rim fracture
- Type 7 – Comminuted fracture.

There is no displacement of the main body of zygoma in Type1, 2, 5 and 6. In type 3, 4 and 7 displacements occurs and once reduced fixation is required to stabilize the fragments. They proved the complications with the antral packs was, high incidence of infraorbital dysesthesia, due to excess pigmentum iodoform composition on the pack and with pins, residual scarring. They showed that antral packing was less satisfactory and had an increased morbidity that was statistically significant.

**K.W. Butow and J.H.Eggert in 1984** <sup>10</sup> discussed the modern trend in the therapy of maxillofacial trauma, which include miniplates, wire osteosynthesis and suspension wiring, bone transplantation for orbital floor reconstruction and the use of lyophilized dura placed over bony defects. They treated the fracture of frontozygomatic suture by a single four-hole miniplates to stabilize the quadri-malar fracture. They preferred wire oseosynthesis in displaced fractures of the inferior orbital margin.

**Bienfait A, Monballiu G, Depoorter M. in 1984**<sup>9</sup> In this article, the authors relate their experience in the management of zygomatic fractures, based on 168 cases treated in the Plastic Surgery Unit of Bruges between January 1971 and August 1980. The symptomatology and treatment of those fractures are discussed according to the type of fracture. The importance of the early treatment and the necessity of osteosynthesis when the fronto-zygomatic suture is distracted are stressed. Multifragmented fractures are treated in the same way by means of osteosynthesis. The use of a silastic sheet for blow-out floor fractures is advocated.

**M.Jones and B.Speculand in 1986**<sup>37</sup> recommended reduction of depressed unstable zygomatic arch fractures by Gillies temporal reduction and fixation with circumferential wires placed around the zygomatic arch. It is tied over a plastic endotracheal tubing on the face. They suggested that it is a simple effective and inexpensive method.

**Andrew Bernard and Donald Sadowsky in 1986**<sup>4</sup> reported a case of mono-ocular blindness secondary to a non-displaced malar fracture. They concluded that the blindness was sequelae of orbital apex syndrome, which is an extension of superior orbital fissure syndrome involving the optic foramen and optic nerve and resulting retrobulbar neuritis, papilloedema and blindness.

**J.D. Price and S.Kalamchi in 1986**<sup>58</sup> discussed an unusual presentation of a fracture of zygomatic complex and its initial

misdiagnosis as the dislocation of TMJ. An occipito-mental view confirmed the clinical impression of a fracture of the left zygomatic complex with coronoid process wedged beneath the fracture. They obtained a normal occlusion following a Gillies reduction.

**Kristensen S, Tvetenas K. in 1986** <sup>41</sup>A retrospective study of zygomatic fractures is presented in order to analyse late complications and to evaluate the different radiographic classifications. The study comprises 109 patients with 111 zygomatic fractures. The aetiology was violence in 39% and road traffic accidents in 28%. Associated fractures of the craniofacial skeleton occurred in 42% of the patients. Seventy-two patients were available for the follow-up study. Malar flattening was found in 16% of the patients operated on. Thirty-four per cent of the patients had sensory disturbances, 6% had enophthalmos, and 1% had diplopia. Classifications of zygomatic fractures are reviewed. The fractures in the current study were grouped in accordance with the classifications of Knight & North and Larsen & Thomsen. Neither of these classifications was found to be useful in the preoperative evaluation of the postreduction fracture stability. The most reliable method of evaluating this stability is the preoperative evaluation, but CT classification systems may in the future demonstrate their value.

**T.R. Flood in 1987** <sup>23</sup> reported a case of mediastinal emphysema complicating a zygomatic fracture. He made the diagnosis by chest radiographs. He treated it by analgesics, bed rest and antibiotics prophylaxis for 1 week.

**G.R.Ogden and J.G.Cope in 1988** <sup>52</sup> did a survey of the fractures involving the zygomatic complex to provide information on whether postoperative radiograph is necessary in their management. They proposed that preoperative radiographs are absolutely essential for the proper assessment of the extent of the injury of the facial skeleton. The limitation of the mandibular opening following Gillies reduction in the absence of post-operative radiograph is suggestive of inadequate reduction. They concluded their study by saying it, in respect of avoiding unnecessary patient exposure to ionizing radiation, the clinical judgment alone is sufficient for postoperative evaluation.

**L.F.A.Stassen and K.F.Moos et al in 1988** <sup>70</sup> did a prospective study to compare external pin and transnasal Kirschner's wire fixation of the unstable non-comminuted tripod fracture. It was apparent from their study that the transnasal K-wire technique is quicker, and has few complications and is better tolerated by the patients.

**Desloovere C, Meyer-Breiting E., in 1988** <sup>17</sup> states that at the University ENT Clinic Frankfurt, 105 patients with zygomatic fractures were treated from 1980 to 1986. 45 patients were treated with a maxillary sinus stent, part of them in combination with wire osteosynthesis. Miniplate osteosynthesis was performed in 30 patients, some fractures seemed stable after repositioning without fixation. The zygomatic fractures are classified into 3 types requiring different surgical treatments. Comparing the long term results of

these methods with the pre and postoperative radiological and functional data, patients with type 2 and 3 fractures do better with miniplate osteosynthesis than with the other treatments. In combination with an orbital floor fracture, the degree of enophthalmus is more severe in those patients where fractures were only repositioned without fixation.

**Holmes KD, Matthews BL. in 1989** <sup>32</sup> described the use of a sublabial incision for direct visualization and alignment of the fracture lines at the infraorbital rim and lateral maxillary buttress. When coupled with single miniplate fixation of the zygoma across the frontozygomatic suture, the sublabial approach resulted in improved reduction of the fractures with rigid stabilization. Their experience with this approach, as well as with two-point wire fixation and with miniplate fixation without sublabial exposure, were reviewed.

**Souyris F, Klersy F, Payrot C. in 1989** <sup>69</sup> The authors analysed the results of 1,393 cases of malar fractures treated in the maxillo-facial Departments of Montpellier and Perpignan. A clinical and therapeutic classification is given. Study of the sequelae demonstrated that the most frequent were infra-orbital nerve lesions, residual displacement of the malar bone, diplopia, and enophthalmos. A point is made about the use of Franchebois's inflatable balloon as a means of retention. Its indications as well as its contra-indications are clearly defined. The reduction in the number of bone sequelae, when compared to cases treated without the balloon, demonstrated the efficacy and simplicity of this method.

**Rinehart GC, Marsh JL, Bresina S. in 1989** <sup>64</sup> emphasizes that Open reduction and internal fixation of displaced zygoma fractures are necessary to avoid immediate and delayed facial disfigurement. Each zygoma was sequentially fixed with three miniplates, two miniplates, one miniplate, and three interosseous wires across the orbital rim and arch "fractures". Static and oscillating loads simulating maximal physiologic masticatory stresses were applied to the fixed zygoma along the lines of action of the masseter muscle by means of a tensometer. The stability and adequacy of each pattern of fixation were recorded. Neither single miniplate fixation nor triple wire fixation are sufficient to stabilize the zygoma against similar forces.

**N.Ravindanathan and J.F.Yeo in 1989** <sup>59</sup> described the causes of traumatic blindness following malar fractures.

**Michel.F.Zide and Jeffrey WU in 1990** <sup>48</sup> did an anatomical study to assess the safe position to place the screw holes for the stabilization of zygomatic fractures in the frontozygomatic region. They found that when drilling perpendicular to the bone above the frontozygomatic suture the cranial cavity should be entered as low as 12cm above it. So the drill should be placed at an acute angle to the forehead to prevent cranial encroachment. It was also found that 6mm screws could be safely placed above the lateral frontal sutures.

**Davidson J, Nickerson D, Nickerson B. in 1990** <sup>16</sup> have analyzed different methods of internal fixation of simple displaced fractures of

the zygoma in an attempt to define the simplest method(s) of achieving postreduction stability. Twenty-five combinations of interfragmentary wiring and miniplate and screw fixation of fractured zygomas on human skulls were compared for postreduction rotational stability against stresses simulating the muscular forces that act to displace the zygoma once it has been reduced. Analysis of the data suggests that while three-point fixation using either miniplates or interosseous wires allows for virtually no displacement, two-point fixation and in some cases one-point fixation provides acceptable stability.

**Nakano Y, Nakamura T. in 1990** <sup>50</sup> states that the occurrence of maxillofacial bone fractures has gradually increased. These were two-hundred-fifty-nine cases of maxillofacial bone fractures from 1981 to 1988, in which fourteen cases were fractures of zygomatic bone and zygomatic arch. Pathognomonic symptoms were infra-orbital neuroparalysis, trismus and recess of the buccal region. The incisions for open reduction were applied for the lateral brow, the lower eyelid, or intra-oral approach. U-shaped elevator was used for the reduction and miniplate and stainless steel wire were used for fixation.

**G.R.Ogden in 1991** <sup>53</sup> in his analysis of 105 cases of zygomatic complex fractures treated by Gillies temporal method stated that occurrence of infraorbital paresthesia is frequently reported followed by restricted mandibular movement. He reviewed the Gillies temporal approach for reduction of zygomatic complex fractures. The advantages described include:

1. Ability to supply great amount of controlled force for reduction
2. Quick, simple and does not require more than 15 to 20minutes
3. Scar produced is negligible and hidden
4. Incision is far away from the broken and swollen parts
5. The field is free of any important nerves.

**Wilfried.G.Schilli in 1991** <sup>77</sup> reported that in simple tripod fractures without great comminution, the use of one dynamic compression plate in the frontozygomatic area is sufficient.

**V.IIankovan and D.G.Starr in 1991** <sup>35</sup> carried out a randomized prospective study using 50 consecutive patients requiring elevation of fractures of the malar complex. The results were analyzed with the preoperative and postoperative patient attitude and postoperative sequelae. In conclusion they proposed that hair removal prior to the Gillies temporal approach was unnecessary.

**A-AI-Qurainy and L.F.A.Stassen et al in 1991** <sup>1</sup> carried out a study on the type of injury sustained by the incidence and severity of subsequent eye movement and to identify the risk factors involved to determine the prognosis for the restoration of the binocular vision. They classify the duration of diplopia from the time of injury as;

1. less than 1 day
2. 1day to 1 week
3. 3 weeks to 1 month

4. 1 month to 6 months
5. 6 months to 1 year
6. more than 1 year

They classified diplopia as;

1. Close to midline
2. Which developed following surgery
3. Diplopia of either category
4. In eccentric space.

The risk factors for diplopia comprise road traffic accidents, blowout fractures and comminuted malar fractures. They concluded in their study that early surgical reconstruction of midfacial fractures with conservative management of concomitant mobility disorders resulted in very few patients having diplopia in long-term.

**Peter.D.Waite and Dennis.D.Carr in 1991** <sup>56</sup> presented a study on the transconjunctival approach to the infraorbital rim, orbital floor and lateral orbital rim for treating orbital trauma to evaluate the enophthalmos, scarring, ectropion, diplopia and limited ocular function. They compared the results with those of previous techniques to reconstruct the orbital rim through bicoronal flaps, lateral eyebrow and transoral incisions. They concluded that the access with transconjunctival incision is same as that of the other surgical techniques and the complications of the facial scars, ectropion and alterations in tarsal plates are diminished.

**Zingg M, Laedrach K, Chen J. in 1992** <sup>81</sup> A treatment guideline based on a simple classification of zygomatic fractures was presented. The emphasis is placed on the indications for closed and open reduction, consistent methods of three-dimensional alignment and fixation, and the management of concomitant infraorbital rim and orbital floor fractures. Postoperative results with regard to infraorbital nerve and maxillary sinus dysfunction, malar asymmetry, and orbital complications in the treatment of 1,025 consecutive zygomatic fractures are presented.

**Westermarck A, Jensen J, Sindet-Pedersen S. in 1992** <sup>76</sup> reviewed the results obtained with different modalities of treatment employed in isolated fractures of the zygomatic complex. Seventy-three patients were re-examined with respect to infraorbital nerve function. The results obtained suggested that the incidence of hypoaesthesia of the infraorbital nerve following fracture of the zygomatic complex can be reduced if rigid fixation is applied on the infraorbital rim. The present report is a retrospective study and aimed to evaluate the recovery of infraorbital nerve function obtained with different modalities of treatment of isolated fractures of the zygomatic complex.

**Medvedev IuA, Sivolapov KA. in 1993** <sup>45</sup> The authors analyzed the results of surgical treatment of 78 patients with zygomatico-orbital injuries. Mini-plates of titanium nickellide with thermomechanical memory were employed for fracture fixation. Surgical strategy based on osteosynthesis with the use of such devices provides a reliable fixation of bone fragments and makes the operation less traumatic.

**P.McCloughlin, M.Gilhooly, G.Wood in 1994**<sup>44</sup> did a study to investigate the differing practices in the management of isolated fractures of the zygomatic complex. The method of elevation was Gillies in 69% of moderately displaced fractures and 74% in severely displaced fractures. They concluded that the Gillies temporal approach is the most widely practiced method of elevation and shaving of temporal hair practiced by 80% of the surgeons.

**M.Adamson and P.S.Douglas in 1994**<sup>2</sup> constructed a Kirschner's wire guide in the laboratory. This device is helpful in learning the technique of transnasal K-wire insertion for unstable fractures of the zygomatic complex. K-wire fixation is a quick and efficient means of support with low morbidity.

**V.Ho in 1994**<sup>31</sup> reported an isolated fracture of zygomatic arch and its treatment. His search for the literature failed to find any previous report of this fracture pattern from 1960 to 1992. He managed the case under general anaesthesia by bilateral elevation of the zygomatic arch fractures via the Gillies temporal approach, with open reduction and A/O miniplates fixation.

**V.Uglesic, M.Virag in 1994**<sup>72</sup> described a new method for zygomatic arch stabilization with silicone tube placed under the zygomatic arch. They repositioned the fractured zygomatic arch with an elevator via Gillie's temporal approach. This method is safe and easy to perform without complications.

**Tarabichi M. in 1994** <sup>71</sup> described and evaluated transsinus reduction and one-point miniplate fixation of the zygomaticomaxillary buttress for the treatment of tripod malar fractures. A consecutive sample of 17 patients presenting with isolated tripod malar fractures over a 42-month period. Miniplate fixation of the zygomaticomaxillary buttress area was then performed, bridging over an area of bone loss and comminution. Clinical assessment of facial symmetry by patients, physician, and roentgenographic methods were done. This technique is simple, limited, and successful in treating most malar fractures. The lack of comminution of the orbital rim is crucial for the stability of the reduced zygoma.

**Covington DS, Parks DH. in 1994** <sup>13</sup> presented a ten year retrospective review of 259 zygoma fractures to highlight changes in epidemiology and treatment. Motor vehicle-related trauma resulted in a majority of the injuries (80.6%), with a high incidence of multiple facial fractures (43.2%). The proportion of fractures receiving open reduction and internal fixation (ORIF) remained relatively constant (46.3%). There was a trend toward the use of multiple fixation sites and more frequent use of the lateral maxillary buttress. The need for orbital floor exploration decreased by almost half, possibly reflecting improved preoperative radiologic evaluation. Although overall surgical complications were few (1.5%) there was a high incidence of associated ocular injuries (36.3%).

**Reher P, Duarte GC. in 1994** <sup>61</sup> A study of the frontozygomatic region (FZ) to determine an anatomic basis for the use of miniplates in this area was done. Plaster models were obtained from 35 adult skulls and were sectioned at six defined points. Osseous thickness measurements were made perpendicularly to the bone surface. Measurements to determine the risk of penetrating the cranial cavity were also done. The results showed that above the FZ suture 5-mm screws should be used. At the two points below the suture, 7-mm screws can be used. The risk of penetrating to the cranial cavity occurs 10 mm above the suture. The diploe thickness at the level of the anterior cranial fossa floor indicates the use of a 7-mm screw at a distance 13.5-18.5 mm from the suture and 5-mm screws above 18.5 mm.

**Rod.J.Rohrich and Denton Watumull in 1994** <sup>66</sup> evaluate retrospectively the long-term results of the plate and wire fixation with a high volume of craniomaxillofacial fracture. The long-term experimental studies demonstrated that miniplates maintain the osseous volume of bone grafts and prevent the nonunion at bone graft contact points better than wires. They confirm that rigid internal fixation is superior in minimizing or preventing long-term sequelae of facial fractures.

**A.G.Smyth in 1995** <sup>68</sup> described a modification of a titanium miniplate for the reduction of unstable fracture of malar complex.

**M.G. Gilhooly and D.T.Falconer et al in 1995** <sup>25</sup> reported a case of orbital subperiosteal abscess complicating a minimally displaced zygomatic complex fracture. They made the earlier diagnosis by the interpretation of the lateral skull radiograph with the patient's brow up. They treated the subperiosteal abscess by drainage via infraorbital and medial canthal incisions and antibiotic therapy.

**D.A.Mitchell and S.P.R. Macleod et al in 1995** <sup>49</sup> recommended the use of side-by side microplate multipoint fixation to increase the total screw to bone contact in addition to improving geometric stability and an impalpable method of long-term fixation. They achieved fracture reduction by Gillies temporal approach and local manipulation. The reduced fracture line is then stabilized by two side by side four hole 0.5mm vitalium microplates one lying posterior to the lateral orbital rim. Fixation was done with 4 x 0.8mm vitalium screws. The wound is closed in two layers.

**Makowski GJ, Van Sickels JE. in 1995** <sup>43</sup> retrospectively evaluated the results of three-point visualization and liberal rigid fixation for the treatment of unilateral zygomaticomaxillary fractures by assessing the incidence and severity of complications. Fourteen patients were examined at an average of 19 months after 3-point visualization with multiple points of rigid fixation for their unilateral zygomaticomaxillary fractures. Three-point visualization and liberal rigid fixation for zygomaticomaxillary fracture treatment results in a low incidence of complications that are proportional in severity to the trauma sustained.

**Yong Oock Kim in 1995** <sup>79</sup> did a study to evaluate the effectiveness of the treatment of non-comminuted monofragment zygomatic fractures with closed reduction using transcutaneous threaded pins and an external fixation device. Moving the pin to counteract the initial vector force of injury reduced the fractured zygoma segments. After reduction the external fixation device immobilized the fractured segment for 9 to 14 days. He found that the advantages of this method are minimal scar formation, less operative time and less oedema.

**Edward Ellis and Winai Kittidumkerng in 1996** <sup>18</sup> made an analysis of the treatment for isolated zygomatic complex fractures. They classified the isolated zygomatic complex fractures with CT as severely displaced, segmented or having comminuted articulations are placed into high energy category.

**Dae-Hyun Lew et al in 1997** <sup>14</sup> described a simple fixation method for unstable zygomatic arch fracture using double Kirschner's wires. They repositioned the fractured zygomatic arch segment by the conventional Gillies temporal approach or Dingmans approach. They proposed that the advantages of this method are;

1. The procedure is simple and easy
2. The reduction and maintenance are satisfactory
3. There is no need for any complex device or special instruments.

**Greg Chotkowski and Todd.I.Eggleston et al 1997** <sup>27</sup> described the use of Lag-screw fixation of frontozygomatic suture for zygomatic complex fractures in which fixation is necessary. They suggested the advantages are;

1. Low profile of rigid fixation device
2. Compression of the fracture segments adding stability
3. Ease of placement
4. Reduced surgical time compared with plate fixation
5. Reduced hardware cost.

**Richard.M.Carr and Robert.M.Mathog in 1997** <sup>62</sup> did a study to review the experience with early and delayed repair of the orbitozygomatic complex fractures and developed guidelines for repair based on the timing and extent of injury. They concluded that orbitozygomatic fracture can be repaired up to 21 days post-injury using primary reduction and fixation technique. Osteotomies are required after 21days and can be used successfully upto 4 months post injury. After 4 months, successful repair requires onlay bone grafting.

**Luiz Carlos Manganello-Souza in 1997** <sup>42</sup> proposed that transconjunctival approach gives good access to the orbital floor, infraorbital rim and zygomatic, frontal and zygomaticotemporal sutures. Despite the complication rate of 12.5% they recommended retroseptal technique, as it is easy to perform and its excellent access.

**Bel'chenko VA, Kuznetsov IA. in 1997** <sup>8</sup> presents a new method for fixing bone fragments and the entire zygomatic bone in patients with comminuted fractures of the zygomatico-orbital complex. They demonstrated the possibility of repair of the zygomatic bone and the contours of the zygomatico-orbital area, discussed the probability of venous inclusion in the treatment of patients with posttraumatic deformations of the upper and median zones of the face. Stable cosmetic and functional results were attained in 12 patients treated by this method.

**Azarchenko Kl. in 1998** <sup>5</sup> presented an analysis of surgical treatment of 113 patients with fractures of zygomatico-orbital complex. Operations were fulfilled on 77 patients by using miniplates from titanium, on 25 men with application of the osteosuture, in 7 cases with a combination of the osteosuture and the miniplate, intrasinus fixation was done on 4 patients. The problem of using computed tomography in a pilot survey of the patients is considered.

**Shumrick KA, Campbell AC. in 1998** <sup>67</sup> emphasizes the importance of reducing and fixing the facial buttresses involved in zygomatic complex fractures, and recommends orbital exploration on a selective basis. Criteria are given to decide which patients require orbital rim and floor exploration. If a patient's fracture does not meet these criteria, the fracture is managed by exposing, reducing, and stabilizing the major facial buttresses involved without performing an orbital exploration. Ninety-seven patients with zygomatic complex fractures were examined and treated with selective orbital rim and

floor explorations. Most patients could be managed without the need for orbital exploration, and all were felt to have good fracture reduction and stability.

**Zachariades N, Mezitis M. in 1998** <sup>80</sup> evaluated the efficacy of the current methods for the treatment of fractures of the zygomaticomaxillary complex. One thousand two hundred seventy-seven patients with fracture of the zygomaticomaxillary complex and 196 patients with fractures of the zygomatic arch that were admitted between 1984 and 1995 were evaluated. The Gillie's approach was used in 514 cases, intraosseous wiring in 89 cases, bone plate osteosynthesis in 322 cases, Roger-Anderson pins in 180 cases, antral packing in 17 cases, and elevation with a hook in 28 cases. The best results were achieved with the use of semirigid fixation with miniplates applied at one or more sites of the fractured complex, occasionally used in combination with other methods such as Roger-Anderson pins. They concluded that semirigid fixation with miniplates offers the most reliable method available today for the treatment of zygomatico-orbital complex fractures and has practically replaced every other method in our institution.

**Enslidis G, Pichorner S, Lambert F. 1998** <sup>20</sup> · Did a prospective study, a new biodegradable osteosynthesis material for the facial skeleton have been used in 27 patients with zygomatic fractures. In the six-month follow-up period, the first ten patients showed clinically and radiologically uneventful healing of bone. There were no implant-related complications. The main advantages of the new material are

its malleability when heated, enabling fast adaptation to the bone surface, and the avoidance of a second operation for implant removal.

**Jan.P.M.Virens and H.W.Vander Glas et al in 1998**<sup>36</sup> did a study on the sensory disturbance following orbitozygomatic complex fractures in relation to the type of the fracture and the method of treatment. They concluded the study by saying that the degree of sensory disturbance of patients who underwent orbital floor reconstruction was intermediate compared to patient with closed and open reduction respectively.

**Merten HA, Honig JF. in 1999**<sup>47</sup> defined the most simple and inexpensive method of achieving post-reduction stability in zygomatic fractures, the authors compared two different methods of internal rigid fixation of the frontozygomatic suture line in one group with miniplates and in another group with Panfix lag screws. Lag screw fixation in malar type B fractures could lower hardware treatment costs and is an alternative method that provides sufficient stability in indicated patients.

**D.J.Courtney in 1999**<sup>12</sup> conducted a retrospective study of 50 cases of fractures of the zygomatic complex reduced by upper buccal sulcus approach. The technique has proved successful at reducing zygomatic complex fractures with a safe, rapid and effective technique. The advantages are;

No scar

Closer and more precise application of force by the operator  
Placement of bone plates at the buttress possible through the  
same incision

Minimal bleeding

Simplified antral bone harvest if required

Simple mucosal closure.

**F.Kovacs and M.Ghahremani in 2001** <sup>40</sup> did a non-randomized study to establish and justify the minimized therapy for classification and terminology of zygomatic complex fractures.

They propose the following;

1. Fracture where the reconstruction of the orbital bone obtained by the reduction of the zygomatic bone alone.
2. Orbitozygomatic fracture with primary diplopia in which orbital floor reconstruction is mandatory.
3. Comminuted zygomatic bone fracture in which reconstruction of the orbital floor is necessary whether or not primary diplopia is present.

**Holmes SB, Hardee PS, Mani RR. in 2001** <sup>33</sup> described a technique of percutaneous miniplate osteosynthesis of the zygoma, using the transbuccal approach. Also says that it can be used in conjunction with an extraoral approach, or in isolation. Excellent access was achieved to the posterior zygomatic buttress and arch of zygoma, and the infraorbital rim. No complications developed in the two cases

presented. This technique is a useful addition to the armamentarium of maxillofacial surgeons.

**Nardi P, Acocella A, Acocella G. in 2003** <sup>51</sup> presents that fractures of the zygomatico-orbito-maxillary complex (ZOM) are among the most frequent in maxillo-facial surgery. The study evaluates treatment for this type of fracture in the long-term and the sequelae linked to it. Particular attention was paid for evaluating tooth sensitivity on the side involved by the trauma, for any damage of the dental plexus. The most frequent sequelae found in the studied group were lesion of the infra-orbital nerves, and a lower percentage of other sequelae such as residual deformities, enophthalmos or diplopia. Interestingly, in all cases in their series there was a significant reduction in tooth sensitivity on the side of the lesion, above all in the anterior sectors.

**Bali N, Lopes V. in 2004** <sup>6</sup> examined the impact of postoperative radiographs after repair of facial fractures on immediate postoperative management. All patients who had a general anaesthetic for the treatment of a facial fracture were included. The intervention was postoperative radiographs before discharge. The outcome measured was whether the patient had to return to theatre within a month. No patient was returned to theatre solely on the evidence of an immediate postoperative radiograph. In line with official guidelines, they suggest that postoperative radiographs must not be used routinely, but only when they are required clinically.

**Heiland M, Schulze D. in 2004** <sup>29</sup> Three-dimensional imaging using digital volume tomography after reduction of zygomaticomaxillary complex fractures was performed and evaluated. Ten patients admitted for surgical treatment of zygomaticomaxillary complex fractures were included in the study. A digital volume tomography data set was generated using the NewTom 9000. The results stated that one data set was sufficient to visualize all fracture sites of the midface in all patients. Osseous structures of older patients with decreased bone density proved difficult to visualize. In Conclusion they state that, Digital volume tomography using the NewTom 9000 is suitable for assessment of postoperative results after zygomaticomaxillary complex reduction.

Hirsch JM, Ohnell LO. in 2004 <sup>34</sup> evaluated treatment outcome with Zygoma fixtures with regard to fixture survival, patient satisfaction, and function of prosthesis replacement. The overall survival rate for the Zygoma fixtures was 97.9% after 1-year of follow-up. Eighty percent of the patients were fully satisfied with both aesthetic and functional outcome at the time of prosthetic insertion and at the 1-year follow-up. This 1-year follow-up of Zygoma fixtures has shown good results for them with an acceptable number of minor complications and a majority of satisfied patients.

**Ellis E 3rd, Reddy L. in 2004** <sup>19</sup> sought to determine the status of the internal orbit before and after reduction of zygomaticomaxillary complex (ZMC) fractures when treated without internal orbital reconstruction and conducted a retrospective study of preoperative and postoperative computed tomography (CT) scans in 65 patients with unilateral ZMC fractures who were treated by reduction of the ZMC complex without internal orbital reconstruction. The size and location of the internal orbital defects, orbital soft tissue displacement, and orbital volume were assessed in the preoperative and postoperative CT scans. They found out that Reduction in the ZMC fractures was considered ideal in 58 of the 65 patients. Only minor malpositions occurred in the remaining 7 patients. The size of the internal orbital defects increased slightly with ZMC reduction but the internal orbital fractures were realigned, and few had increase in orbital volume or soft tissue sagging into the sinuses. Examination of follow-up CT scans in several patients taken weeks to months later showed that the residual defects became smaller and that none of these patients had an increase in orbital volume or soft tissue sagging. In conclusion, the preoperative CT scan can be used to assess the amount of internal orbital disruption for purposes of developing a treatment plan in patients with ZMC fractures. When there is minimal or no soft tissue herniation and minimal disruption of the internal orbit, ZMC reduction is adequate treatment.

## **SUMMARY & CONCLUSION**

A retrospective study that included 12 patients treated for unilateral zygomatic complex fracture by open reduction and internal fixation in the department of Oral and Maxillofacial surgery, Ragas Dental College & Hospital from the year 2001-2004.

The following observations were highlighted in this study;

1. Only 3 cases (25%) out of 12 had been considered radiographically malaligned according to the radiographic parameters used in the study,
2. The method of elevation, either intra-oral or extra-oral played a role in the quantity and quality of the reduction,
3. In our study all the three cases which were radiologically malaligned had reduction via an extra-oral Gillie's temporal approach,
4. All the three cases which had 2 point fixation showed a good symmetry, whereas 3 of the 9 cases with a single point fixation showed radiographically evident malalignment.

Limitations of the study:

1. No standardization of plain radiographs,
2. Multiple operators were involved and this could influence the treatment outcome.

In conclusion, our study demonstrated a satisfactory radiographic outcome in 75 % of the cases with a satisfactory clinical outcome in 83 %. The parameters used in this study to analyze the adequacy of reduction was found to be ideal and reproducible so that, it could serve as a model for future investigators.

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