



RESEARCH ARTICLE

PRE-OPERATIVE AND POST-OPERATIVE VOLUMETRIC ANALYSIS OF ORBIT IN UNILATERAL ORBITAL FRACTURE.

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Abstract

Background And Objective: Loss of vision, Diplopia and Enophthalmos are major complications of orbital fracture, possibly leading to functional eye impairment and disturbed facial appearance.

Aim: we compared the changes in orbital volume of patients with unilateral orbital fractures treated surgically and conservatively with normal contralateral orbit.

Method: We measured volumes of hard tissue defects of orbit in 54 patients by facial CT scan, and degree of enophthalmos by Hertel's exophthalmometer, post trauma, 7th day and at 3 months interval and compared it with normal contra lateral orbit. Patients having orbital fracture with no deficit were managed conservatively and those with any ophthalmic defect, were surgically treated.

Result: Out of 54 patients, 23 patients were treated surgically and rest were managed conservatively. Among 53 patients, 18 patients showed enophthalmos, four patients showed diplopia and five showed extraocular muscle entrapment and two had complete loss of vision.

Conclusion: Patients who were surgical treated showed significant improvement in ocular activity and restoration of normal orbital volume.

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Introduction:-

The face occupies the most prominent position in the human body and renders it vulnerable to injuries quite commonly. The zygomatic bone or zygoma is a strong buttress on lateral portion of middle third of facial skeleton and is responsible for midface contour and protection of orbital contents. The prominence of zygomatic bone predisposes it to bear the brunt of facial injuries. The etiology of the zygomatic complex fractures include road traffic accidents, assaults, falls, sports and missile injuries.

Zygomatic complex fractures are more prevalent in males. They range in age from 18-70 years, with a mean age of 32 years^[1]. Patients in the 21-30-year age group are most often involved. There is a significant association between road traffic accidents and fractures among the age groups.

Common clinical features of zygomatic complex fractures include diplopia, enophthalmos, subconjunctival ecchymosis, flattening of the cheek, gagging of the occlusion and sensory disturbances. Diagnosis of zygomatic complex fractures is usually clinical, with radiographic confirmation. In this study, the volumetric analysis of hard tissue defects of orbit was measured by facial CT, and degree of enophthalmos and exophthalmos by Hertel's

Exophthalmometer after injury and after healing of zygomatico-orbital fractures and compared with healthy contra lateral eye.

Material and Methods:-

Fifty four patients with unilateral zygomatico-orbital fracture reported to the casualty and interdepartmental referral patients of Sri Aurobindo Institute of Medical Sciences was evaluated with a follow up at three month. Facial CT (Somatom, Definition AS, 64 slices) for axial images (start at the mid-orbit and work upward and downward), for coronal images (work anteriorly and posteriorly from the mid -orbit) & for sagittal images (work from medial to lateral), was taken after injury and after healing of zygomatico orbital complex and the change in orbital volume & soft tissue volume due zygomatico-orbital fracture was evaluated and compared with healthy contra lateral eye. The following parameters was evaluated: (a) Magnitude of displacement (minimal, moderate, severe), (b) direction of displacement of zygomatic complex at frontozygomatic suture, (c) location and extent of internal orbital fractures, (d) anteroposterior and mediolateral dimensions of internal orbital fracture defects, (e) the overall volume of healthy & fractured orbit, (f) Time gap between the occurrence of fracture and surgery, enophthalmos measured by Hertels Exophthalmometre. Patients with unilateral zygomatico-orbital fracture were included in the study. Patients with bilateral zygomatico-orbital complex fracture and who was unable to follow the instructions of the study protocol, or to comprehend information about this study and give voluntary consent were excluded.

Results:-

A total of 54 patients of zygomatico-orbital complex fracture between the year 2012- 2014 were included in this study. The CT examination and the orbital volume measurement in all these patients was made and compared to the non involved side. The mean patient age was 27 years. The time interval after injury to surgical intervention was between five -seven days

Isolated blowout fracture with severity ranging from minimal or undisplaced to severely displaced was present in 54 patients. Among these 32 had right side and 22 on left side. These patients were further divided into two groups based on treatment protocol Group A (n =23) was surgical management and group B (n=31) was conservative management. In Group A, 21 patients were males (91.3%) and two patients were female (8.7%). In Group B, 29 patients were males (93.5 %) and remaining two were females (6.5 %). These data shows that more than 90% of patients with orbitozygomatic complex fracture were males.

CT Measurements:-

CT measurement were done according to the following parameters: Anteroposterior (AP), Mediolateral (ML), and Superoinferior (SI) distance were measured in the normal and involved eye pre operatively and post operatively.

Group A – Surgical Treatment:-

Linear Measurements:-

The mean of ‘anteroposterior measurements’ in the normal eye was 45.647 mm. (SD +/- 3.5) The pre operative measurement of the involved eye was 46.304 mm. (SD of +/- 3.5). Post operative measurements were calculated at seventh day (45.721 mm.) and at three months (45.735 mm.) with SD +/- 2.8.

The mean of ‘mediolateral distance’ of patients of the normal eye was measured at 35.469 mm. The mean pre-operative measurement of involved eye was 37.047 mm. indicating a significant increase in ML distance. Post-operatively the mean measurement on the seventh day (36.528 mm.) and three month post-op (36.273 mm.) shows a mild improvement from pre-operative measurement but not a complete restoration towards normal eye measurements.

The mean of ‘superoinferior measurements’ of the patients were at 38.508 mm. and the mean measurement of involved eye was 45.222 mm. shows significant increase due to trauma. The post-operative mean measurements at seventh day 39.449 mm. and three months post-op 39.270 mm. showing significant improvement post-operatively.

Volume Measurements:-

The mean volume measurement of the uninvolved eye was 27.558 mm³. (SD +/- 3.56) whereas the mean orbital volume of involved eye was around 29.504 mm³. (SD +/-3.3). On the seventh post-operative day the mean orbital

volume was reduced to 28.604 mm³ and it was further reduced to 28.360 mm³ at three months after surgery. (Table 1). Here a significant decrease in the volume post-operatively was recorded. (Fig.3)

Group B – Conservative Management:-

Linear Measurements:-

The mean AP measurements in the normal eye were 45.300 mm. (SD +/- 3.5) and 45.493 mm. in involved eye (SD +/- 3.6). The mean measurement at seventh day and three months follow up was 45.558 mm. (SD +/- 3.5) and 45.461 mm. (SD +/- 3.5). The mean ML measurement in the normal eye 33.754 mm. (SD +/- 3.0) and in involved eye was 34.297 mm. (SD +/- 3.1). The seventh day and three month follow up the measurements were 34.297 mm. (SD +/- 3.1) and 34.242 mm. (SD +/- 3.1). The SI measurement in the normal eye 38.358 mm. (SD +/- 4.6) and in involved eye was 38.822 mm. (SD +/- 4.7). The seventh day and three month follow up the measurements were 38.822 mm. (SD +/- 4.7) and 38.790 mm. (SD +/- 4.7).

Volume measurements:-

The mean volume measurement of the uninvolved eye was 28.418 mm³. (SD +/- 3.7) whereas the mean orbital volume of involved eye was around 28.816 mm³. (SD +/- 3.6). On the seventh follow up day the mean orbital volume was reduced to 28.793 mm³. and by three months follow up it remains unchanged i.e. 28.793 mm³. (Table 2.) This indicates that there is restoration of the orbital volume towards normal but still some discrepancy remains. (fig.4)

Ophthalmologic Evaluation:-

Among 54 patients all the patients had circumorbital ecchymosis, subconjunctival hemorrhage and periorbital oedema associated with involved eye. 18 patients (33.9%) showed enophthalmos as compared to normal contralateral eye and out of which 14 patients (60.9%) were treated surgically. four patients (7.5%) had diplopia and five patients (9.4%) had restricted eye movements. two patients had loss of vision, one reported with corneal laceration and one with blurred vision. (fig. 5)(Table 3.)

Out of 54 patients, 18 (33.9%) had fracture of infraorbital and lateral wall of orbit, 31 (56.6%) had infraorbital wall fracture, two (3.7%) had supraorbital wall fracture, one (1.9%) had medial wall fracture and two (3.7%) had infraorbital and medial wall fracture. (Table 4)

Among the patients treated surgically one patient (4.3%) had minimally displaced fracture, 13 (56.5%) had moderately displaced fracture and nine (39.1%) had severely displaced fracture. Whereas the patients managed conservatively 22 patients (71%) had minimally displaced fracture, eight (25.8%) had moderately displaced fracture and one patient (3.2%) had severely displaced fracture. (Table 5)

Measurement of Enophthalmos:-

In our study 18 patients were found to have enophthalmos among which 12 patients had enophthalmos less than 2 mm. and six patients had enophthalmos greater than 2 mm. Based on the clinical features like severity of fracture, presence of diplopia, restriction of eye movements 14 patients were treated surgically and four patients were managed conservatively.

Based on the treatment protocol Group A was evaluated for enophthalmos using Hertel's exophthalmometer. The maximum enophthalmos in our study group was found to be 4 mm. These patients underwent early surgical intervention with orbital floor exploration, release of muscle entrapment, retrieval of fat tissue and reconstruction of floor with titanium mesh. There was a significant improvement up to 2 mm. in enophthalmos post operatively. one patient had complete resolution of enophthalmos after three months (0 mm.). Pre operatively the mean enophthalmos in affected eye was 1.39 mm. (SD +/- 0.499) and post-operatively after three months it improves to 1.34 mm. (SD +/- 0.507) showing highly significant ($P = 0.00$) according to paired sample test ($P \geq 0.05$). In Group B the mean of pre-operative enophthalmos was 1.87 mm. (SD +/- 0.341) and during the final measurements with conservative treatment protocols also the enophthalmos has improve to 1.45 mm. the improvement is shown to be significant ($P = 0.00$) according to paired sample test ($P \leq 0.05$).

Discussion:-

Orbital fractures in maxillofacial trauma are frequent findings. These fractures are of obvious ophthalmologic importance as the orbit houses the eye and soft tissue structures supporting the globe. Direct or indirect injury to

orbit may lead to ophthalmic functional impairment and aesthetic deformity. The management of the orbital fractures has evolved with the advent of surgical techniques, imaging modalities and use of various alloplastic materials. Accurate diagnosis and treatment can limit the late complications like diplopia, enophthalmos and motility defects. Very few studies were performed to assess the quantitative and qualitative defects of these injuries. Here, in this study we measured the quantitative defect of orbit after trauma through CT scan and qualitative improvement after treatment.

Orbital fractures have been classically classified into blow out and blow in fractures by Smith and Regan. The treatment plan in either type of fractures has been generally based on the severity of the fractures, associated functional impairment and evident aesthetic deformity. When treatment options have been considered according to Edward Ellis III^[2] et al the CT scans were examined for the details like magnitude of ZMC displacement (minimal, moderate, severe), direction of ZMC displacement/ rotation at the fronto-zygomatic suture region, location of internal orbital fracture defect, anteroposterior and mediolateral dimensions of the internal orbit fracture defect and the vertical dimension of orbital soft tissue prolapse into the sinus.

In our study based on the severity of the orbital fracture 23 patients were surgically treated as they fell under the category of moderate to severely displaced fracture and 31 patients which were having minimally displaced or undisplaced fracture were treated conservatively.

The status of the internal orbit after reduction of ZMC was determined by Edward Ellis III^[1] et al and found that volume change of the injured orbit can change either due to comminuted fractures or significantly displaced fractured segments causing change in shape of the orbit.

In our study the linear CT measurements were done according to parameters like anteroposterior, mediolateral and superoinferior dimensions pre-operatively and post-operatively that was compared with normal contralateral eye. A significant improvement in linear measurements was recorded postoperatively which improved from the seventh post op day to three months gradually. A major difference was found in orbital volume in patients with moderate to severely displaced fractures (28.36 mm^3). There was no significant difference in patients with minimally displaced or undisplaced fractures. The complete restoration of the linear measurements was not seen at the end of three months follow up in patients treated either conservatively or surgically.

The patients with minimally displaced or undisplaced fracture were treated conservatively (Group B) as there was not much discrepancy (28.816 mm^3) in the orbital volume pre operatively. After three months follow up mild improvement in the volume was seen (28.793 mm^3) as compared to uninjured eye (28.418 mm^3). The patients with moderate to severely displaced fracture had significant change in volume pre operatively (29.504 mm^3). These patients were treated surgically (Group A) and the orbital walls were anatomically reduced in position. Post operatively there is significant improvement in orbital volume towards normal (27.558 mm^3) at seventh post operative day (28.604 mm^3) and by the end of three months (28.360 mm^3). This data suggests that surgical treatment brings about a significant improvement in the restoration of the orbital volume.

Enophthalmos is the most common complication caused by discrepancy between soft tissue volume and bony volume in the orbit. It may result from failure to anatomically restore the orbital fracture or from loss or atrophy of the orbital soft tissue. According to Edward Ellis^[2] et al approximately 1cu.cm. displaced orbital soft tissue (or increase in orbital volume) produces 1mm. enophthalmos.

In our study 18 patients reported to us with enophthalmos. In all these patients enophthalmos were measured by hertel's exophthalmometer. Further these patients were divided on the basis of extent of enophthalmos ; those that had less than 2 mm enophthalmos (n=12) and rest more than 2 mm (n=6). Along with the six patients who had enophthalmos more than 2 mm another eight patients (enophthalmos less 2 mm) were subjected to surgical treatment taking into consideration all the clinical features, functional and the esthetic disabilities.

The maximum enophthalmos in our study group was found to be 4 mm. Patients with enophthalmos greater than 2mm were those with blow out fractures, entrapment of muscles and herniation of fat in maxillary sinus. These patients underwent early surgical intervention with orbital floor exploration, release of muscle entrapment, retrieval of fat tissue and reconstruction of floor with titanium mesh. There was a significant improvement up to 2 mm. in enophthalmos post operatively. one patient had complete resolution of enophthalmos after three months (0 mm.).

This data proves that surgical treatment is mandatory in patients where enophthalmos is more than 2 mm and the investigatory modalities reveals herniation of fat into maxillary sinus. In the patients who had treated conservatively had enophthalmos less than 2 mm and showed mild improvement (mean).

According to Zhiyong Zhang^[3] et al the overall volume of herniated orbital contents correlated significantly with the amount of enophthalmos. The volume of herniated soft tissues posterior to the eyeball equator showed correlation with the amount of enophthalmos. In our study group 18 patients who had enophthalmos, ten patients had combined infraorbital and frontozygomatic fractures, five patients had isolated infraorbital fracture, two had combined infraorbital and medial wall fracture and one patient had isolated medial wall fracture.

Diplopia is potentially one of the serious complications. Early diplopia indicates involvement of extraocular muscle either through entrapment, edema, hemorrhage or damage to motor nerves. Man^[4] et al recommended that if vertical limitation exists with large herniation of orbital contents into maxillary sinus, a 'wait and see' policy should be employed to allow resolution of the initial hemorrhage and residual edema and if eye movements improve should be delayed. Hiroki Yano^[5] et al suggested that in punched out and burst type of fractures, early diplopia may result from temporal palsy after neurogenic or musculogenic injury, and its frequently diminishes within two-three days, but if it remains, the hung up contents or dislocated muscle position can be properly attended through elective surgery. Diplopia resulting from alteration of orbital form can also be reconstructed electively. In our study we encountered four patients with diplopia. In three patients the diplopia was completely resolved after three months post surgery. And in one patient there is mild improvement in diplopia post operatively as he reported to us 20 days post trauma.

Muscle incarceration is common in punched out and burst type of fractures and it requires immediate surgery. According to Hiroki Yano^[5] et al it presents a more serious condition in floor fractures rather than medial wall fractures because of the structural differences of the paranasal sinuses and herniation caused by forced tension caused by the Bells phenomenon at the time of injury. In our study five patients had restricted eye movements. They all underwent immediate surgical intervention with orbital floor exploration and release of muscle entrapment and reconstruction of the orbital floor. They all presented with complete resolution of diplopia with normal eye movements after three months. This indicates that in cases of diplopia with muscle entrapment early surgical intervention should be performed to save and improve the orbital muscle recovery. The literature suggests that the correction of muscle entrapment in the patients correlates to the degree of damage and time of surgery. Therefore in all our patients immediate surgical intervention were performed with good results.

Conclusion:-

Surgical management of zygomatico-orbital fractures have been the mainstay for restoring the orbital volume and improving the aesthetics of the patient. Evolution of high-tech radiographic modalities provide the clinician with stable platform to work out a holistic treatment plan and compare the results with the normal contralateral eye. Long term follow up of the patients who are managed conservatively is important to assess the healing of tissues as well as to counter and repair delayed complications.

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