



## THE DIAGNOSTIC VALUE OF ULTRASONOGRAPHY IN THE DETECTION OF ZYGOMATICO-ORBITAL COMPLEX FRACTURES

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### ABSTRACT

**Context:** The maxillofacial skeleton is very vulnerable to injury because of the convex shape and protrusion of the zygoma which gives the contour of the cheek. The zygomatico-orbital fracture can lead to significant cosmetic and functional disorders. Ultrasound has been traditionally used to image irregularities of soft tissues of head and neck region, but ultrasound in maxillofacial trauma diagnosis has only been recently studied.

**Aims:** The present study was conducted to assess the usefulness of ultrasonic imaging in the diagnosis of zygomatico-orbital complex fractures as a result of acute trauma.

**Settings and Design:** This study designed as cross-sectional study consisted of twenty individuals who had presented with the signs and symptoms of zygomatico-orbital complex fracture with no age and sex bar. Subjects were sourced from the Department of Oral Medicine and Radiology and Hospital for Orthopaedics, Sports Medicine, Arthritis & Trauma, Bangalore.

**Methods and Material:** The study consisted of 20 patients of suspected zygomatico-orbital complex fracture. Ultrasound examination with high frequency probe of 11 MHz was used to assess zygomatico-orbital complex fracture.

**Results:** In our study, 40 fractures of the zygomatico-orbital complex in all 20 cases were detected by ultrasound. The sensitivity and positive predictive value of fracture diagnosis by ultrasound were both 100%.

**Conclusions:** It is concluded that ultrasound is a reliable and accurate imaging modality in diagnosing zygomatico-orbital complex fractures. Therefore we recommend the use of ultrasound as a preliminary visualizing tool for zygomatico-orbital complex fractures.

**KEYWORDS :** ultrasound; zygomatico-orbital complex fracture; imaging modality; computed tomography; conventional radiography.

### INTRODUCTION:

Accelerated urbanization and industrialization have lead to an alarming increase in the rate of accidental injuries, crime and violence. There has been a rising incidence of facial injury over the past decade as a result of an increasing number of assaults and motor vehicle accidents.<sup>1</sup> Maxillofacial injuries in isolation or in combination with other injuries account for a significant percentage of emergency room and hospital admissions.<sup>2</sup> It is important to perform an early diagnostic test to plan appropriate management of facial fractures.

Zygomaticomaxillary complex fractures present challenging diagnostic and reconstructive problems for the surgeon.<sup>3</sup> The zygomatic complex injury, by definition, includes orbital involvement and the possibility of associated ocular or extraocular soft tissue damage.<sup>4</sup> The complexity of the facial skeleton has led to the development of many specialized views to visualize the entire facial skeleton adequately such as conventional radiography, CT and MRI.<sup>4,5</sup> As expertise in the facial area improves it is obvious that the oral diagnostician may find the use of ultrasound as an excellent screening tool, especially in the evaluation of multiple trauma patients.<sup>6,7</sup>

With this background this study was undertaken to assess the usefulness and validity of the ultrasonic imaging in diagnosis of zygomatico-orbital complex fractures as a result of acute trauma.

### SUBJECTS AND METHODS:

This study designed as cross-sectional study consisted of twenty individuals who had presented with the signs and symptoms of zygomatico-orbital complex fracture with no age and sex bar. Subjects were sourced from the Department of Oral Medicine and Radiology and Hospital for Orthopaedics, Sports Medicine, Arthritis & Trauma, Bangalore.

The study was approved by the ethical committee of the review board. The participants were enrolled after an informed consent. Case history of all the patients was recorded and

their clinical examination was carried out. In order to determine the exact location of the fracture, a paranasal sinus view or a C.T. scan was done as a preliminary mode of investigation. All the twenty patients were subjected to ultrasonographic examinations using LOGIC 400 ultrasonic equipment and linear transducer (frequency 11 MHz). (Figure 1) In most cases ultrasound was performed within 24 hours of the patient's arrival. The areas included in the ultrasonographic examination were infraorbital rim, orbital floor, lateral and medial orbital walls, frontozygomatic process and body of maxilla.

The areas of interest were scanned under both transverse and longitudinal sections. (Figure 2, 3)

### RESULTS:

The present study was undertaken to assess the diagnostic value of ultrasonography in zygomatico-orbital complex fractures which was designed as a cross-sectional study over duration of 1 year. A total of 20 subjects with clinically diagnosed zygomatico-orbital complex fractures were selected. They had sustained a total of 40 fractures.

Age groups involved in the present study were between the ages of 10 to 60 years. The mean interval of 32.72 years was present. Among the 20 fracture subjects 14(70%) were males and 6(30%) were females. Majority of patients were between age groups of 20-40 years in males and 10-30 years in females. In the present study, the major cause of fractures were road traffic accident (n=12, 60%) followed by injuries due to alleged assault (n=6, 40%). Alleged assault was more common in males than females, with 75% of fractures in males and 25% of fractures in females having been caused in altercations. 14 patients showed unilateral fractures and remaining 6 patients showed bilateral fractures. Patient with alleged assault showed most common involvement of left side (75%) than right side and bilateral fractures. However, patients injured in road traffic also showed predominantly left side involvement (41.66%), but not of much statistical value. In the present study, 20 patients had sustained a total of 40

fractures. The majority of fractures involved zygomatico-orbital complex either in isolation or in combination with other midface fractures. Among 20 cases of zygomatico-orbital complex fractures 7 cases (35%) were diagnosed with displaced orbital rim fractures (Type III) followed by fractures with no displacement (30%) (Type I), (15%) with tripod fracture and no displacement (Type V) and orbito-antral wall fracture (Type VI), based on classification by Rowe and Killey (1968).

In present study, five sites of midfacial structures were assessed which are as follows; infraorbital margin, orbital floor, fronto-zygomatic fracture, medial and lateral wall of orbit and body of zygoma. US diagnosed 40 fractures in 20 patients. Most commonly involved sites includes infraorbital margin (n=17, 42.5%), body of zygoma (n=11, 27.5%), anterior orbital floor (n=5, 12.5%), fronto-zygomatic suture (n=3, 7.5%) and lateral or medial wall of orbit (n=3, 7.5% and n=1, 2.5% each) in descending order.

## DISCUSSION:

Zygomatico-orbital trauma is common and although orbital fractures are rarely life threatening, they may be associated with serious intracranial and ocular injuries that require emergent management.<sup>8</sup> The zygomatico-orbital complex fractures can lead to significant cosmetic and functional disorders such as enophthalmos, depression of malar eminence and parasthesia due to injury of infraorbital nerve. Fractures of the facial bones account for fewer than 15% of all maxillofacial injuries with a ratio of mandibular to zygomatic to maxillary fractures of 6:2:1.<sup>9,10</sup>

The complexity of the facial skeleton has led to the development of many specialized views to visualize the entire facial skeleton adequately which includes conventional radiographs, CT and MRI. The use of ultrasound in diagnosis and management of maxillofacial trauma has been reported previously.<sup>5</sup>

Majority of age groups involved in the present study were between the ages of 20 to 40 years (n=11, 55%). The mean interval of 32.72 years was present. Study by S.Jank et al which showed mean average age was 43.1 years. In present study, out of 20 patients, 14 males (70%) and 6 females (30%) were present. This finding is consistent with the study by S.Jank et al which showed number of males was commonly involved than females.<sup>11</sup>

Alleged assault was more common in males than females, with 75% of fractures in males and 25% of fractures in females having been caused in altercations. This may account for the fact that the majority of injured patients were young adult males who sustained their injuries in alleged assaults.<sup>12,13</sup>

In present study, out of 20 patients 14 patients showed unilateral fractures and remaining 6 patients showed bilateral fractures. Patient with alleged assault showed most common involvement of left side (75%) than right side and bilateral fractures. Alleged assaults were responsible for fracture most commonly of left side. The only cause that yielded a greater percentage of right-sided and bilateral fractures than left-sided fractures was road traffic accidents.

The predominance of left sided fractures in patients who sustained their fractures in altercations correlates with the fact that the majority of people are right handed. This finding is in agreement with the investigations of Hitchin and Shuker, Altonen et al., and Muller and Schoeman, who found that assault victims displayed a predominance of left-sided fractures.<sup>12,13</sup>

The areas included in the ultrasonographic examination were infraorbital rim, orbital floor, lateral and medial orbital walls, frontozygomatic process and body of maxilla.

All the 40 fractures in 20 patients were successfully assessed by ultrasound. The sensitivity and positive predictive value of fracture diagnosis were both 100%.

This is consistent with earlier study conducted by Gulicher which showed that ultrasonography detected all the fractures of zygomatic arch and zygomatic complex.<sup>14</sup>

McCann correlated radiographs and ultrasound of zygomatico-orbital complex fractures in his study and found an overall agreement of 85% accuracy in diagnosis.<sup>15</sup> Study by J. Siegfried et al concluded the reliability of ultrasound evaluation of orbital floor unsatisfactory, but the sensitivity, specificity and accuracy remains acceptable.<sup>11</sup>

In the present study, US diagnosed 40 fractures in 20 patients. We found that infraorbital margin was the most commonly involved fracture site. This is in agreement with a study conducted by Siegfried, who also noted that orbital floor fractures and combinations of orbital floor fractures are the most common fractures in the orbital region.<sup>11</sup>

It has been shown that using high-frequency probes enhances the details of smaller structures and the use of a high-resolution scanner allows identification of fracture and assesses 0.1 mm disruption in the bony surface.<sup>15</sup>

In the present study, ultrasound with a frequency of 11 Mhz was able to demonstrate the cortex of normal bone as smooth, echogenic reflective surface and fractured bone fragments as highly echogenic foci with an angulation. The gap between the fractured segments was clearly appreciated. It also evaluated the displacement of the fractured fragment and size of the fractured fragment.

Study by McCann et al showed that 10-MHz probe frequency was adequate in recording the fractures but a frequency in excess of 15-MHz enhanced the details of smaller structures.<sup>6,15</sup> S Nezafati et al and earlier studies by Akizuki et al used frequency as low as 5 Mhz, which resulted in inadequate visualization of superficial regions.<sup>16,17</sup>

In the present study, out of 20 patients, 13 patients had conventional radiographic PNS views, 9 patients had CT and 2 patients had both conventional radiograph and CT.

In the present study, out of the 13 patients who had conventional radiographs, the PNS view failed to diagnose 5 fracture sites in 4 patients. Conventional radiographs may fail to demonstrate the zygomatico-orbital complex fractures adequately due to overlap of anatomical structures. Other disadvantage of exposure to radiation cannot be neglected in conventional radiographs. Also the possibility of the suture lines at the infraorbital region appearing as "pseudofracture lines" cannot be ruled out.<sup>5,18</sup>

But in the present study, ultrasound was also able to assess the increased separation of fronto-zygomatic sutures which are difficult to detect on conventional radiographs.

In our study, out of the 9 patients who had CT, all the zygomatico-orbital complex fractures were detected by CT. Even though CT is a gold standard in evaluating craniofacial trauma, there are certain limitations of this imaging modality. Computed tomography (C.T), both coronal and axial sections, is required in complex cases. The disadvantages of the C.T. are patient's exposure to high radiation and it is an expensive method. Not all fractures of the orbital rim could be visualized in an axial CT. The quality of coronal reconstructions is often not acceptable because the axial CT is normally carried out with 2- to 3-mm slices, which are insufficient for a satisfying coronal reconstruction.<sup>19</sup> A coronal C.T. is not possible in all cases particularly in severely injured patients and patients

with neck fractures.<sup>4</sup> Delay in extricating the patient from the machine is an emergency widely recognized and may prove fatal. Limitations in patient positioning and radiation exposure of the lens are other disadvantages.<sup>20</sup>

Ultrasound is useful in assessing the facial fractures; high-resolution scanner can allow the identification of 0.1 mm disruptions in the bony surface, which were often missed on plain film radiographs.<sup>15</sup> The ultrasound scan in this study took less time than the usual CT scanning and plain films. Ultrasonography represents a well-tolerated, safe, noninvasive, cost-effective, portable diagnostic modality which has an application in the diagnosis of zygomatico-orbital complex fractures. Improved technology of ultrasound machines has made it easy to handle and is no longer an obstruction in the ever crowded emergency room. Ultrasound provides the possibility to view a region in the desired number of planes.<sup>20,21</sup>

A small curved array transducer is preferable as it is a better fit for midface anatomical structures resulting in improved diagnostic value. Study by Jank et al showed the acceptable results for the detection of orbital floor and infraorbital rim fracture with the use of curved-array transducer.<sup>22,23,24</sup>

Intraoperative ultrasound has also been found to be helpful in the reduction of zygomatic arch fractures in a study conducted by Akizuki et al and others.<sup>14</sup>

But certain limitations of this imaging modality persist. In our study, we found that posterior floor of orbit was difficult to visualize. Sonographically, the fracture line course from the zygomatic bone into the orbital floor can be identified only up to a length of about 1-2 cm. A nondislocated fracture is difficult to identify on ultrasound. The procedure is highly operator dependent. Ultrasound imaging has also been found difficult in cases of massive emphysema. Sometimes, ultrasound of bony structures may reveal artifacts which were either repetitive echoes, ring down, curved, acoustic shadow or dispersion artifacts or pseudo-lesions. To overcome this, Grechenig et al carried out a study using degassed water bath which minimized artifacts caused by air bubbles. Pressureless application of transducer may be difficult to achieve in acute trauma patients. However, in the maxillofacial region, due to the limited survey of the region of interest and the system of hollow spaces separated by craniofacial bones, ultrasound is not uncomplicated.<sup>21</sup>

We found the application of ultrasound in zygomatico-orbital complex fractures of immense value as it was able to diagnose 100% of all the 40 fracture sites and was easily used in emergency.



Figure 1: Ultrasonic Equipment LOGIC 400

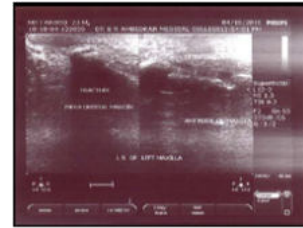


Figure 2: Fracture of Left Infraorbital Margin and Anterior Wall of Maxilla

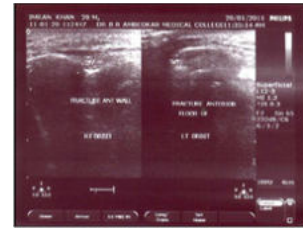


Figure 3: Fracture of Anterior Wall of Right and Left Orbit

### CONCLUSION:

We found ultrasound to be reliable and accurate in diagnosing zygomatico-orbital complex fractures. Ultrasound has many advantages over other imaging modalities. Therefore we recommend the use of ultrasound as a first line diagnostic modality for zygomatico-orbital complex fractures. Since the data obtained in this study is quite promising, we suggest further studies on a larger number of trauma cases involving the zygomatico-orbital complex fractures. We also suggest further studies on ultrasound application in intraoperative zygomatico-orbital complex fracture reduction and assessment of post operative healing.

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