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MAXILLOFACIAL AND ORBITAL INJURIES EVALUATION BY THREE DIMENSIONAL MDCT

Shrishail Patil[1], Shivanand S. Melkundi[2], Santosh[3]

ABSTRACT: There has been considerable increase in maxillofacial and orbital injuries due to road traffic accidents, falls and assaults. There is need for accurate detection of these maxillofacial bony fractures. MDCT is the method of choice in the evaluation of maxillofacial traumas, as it allows accurate determination of the presence, location and extent of fractures especially in cases of communited fractures, rotational deformities and multiple bone fractures also having advantage to diagnose even in patients with facial edema, lacerations and altered sensorium. **PURPOSE:** The objective of the study is to compare axial, coronal and 3D reformatted CT images for the study of maxillofacial and orbital fractures. **MATERIALS AND METHODS:** Multislice CT scan was done for 131 patients attending BTGH Gulbarga with history of maxillofacial and orbital trauma during the period of December 2012 to September 2014 using Philips Brilliance 6 slice CT scanner. **RESULTS:** Majority of the patients were males (85.5%) belonged to age group of 21-30 years (42%). Most common cause of maxillofacial trauma was road traffic accident (78.6%). Fractures of nasal bones were most common followed by walls of maxillary sinuses and least common fractured bone was cribriform plate. Most common type of complex fracture was naso-ethmoido-orbital complex fracture followed by zygomaticomaxillary complex. Lateral wall of the orbit was most commonly fractured followed by medial wall and floor. **DISCUSSION:** Axial CT was better in diagnosing anterior maxillary wall, zygomatic arch fractures. Coronal CT was better in detecting orbital floor, Orbital roof, Pterygoid plate fractures, Classification of Le Fort fractures and orbital floor blow out fractures. 3D CT was slightly better to 2D CT in evaluating anterior maxillary wall fractures and frontal bone fractures. 2D and 3D CT were almost similar in evaluating fractures of nasal bone, zygomatic bone and zygomatic arch fractures. 3D CT was inferior to 2D in medial wall of maxillary sinus, medial wall of orbit, pterygoid plate fractures. **CONCLUSION:** MDCT offers excellent spatial resolution, which in turn enables exquisite multiplanar reformations and 3-D reconstructions allowing enhanced diagnostic accuracy and surgical planning.

KEYWORDS: Maxillofacial Trauma; Computed tomography; Naso-ethmoido-orbital complex fracture.

INTRODUCTION: The sheer pace of modern life with high-speed travel as well as an increasingly violent and intolerant society have made facial trauma a form of social disease from which no one is immune.[1] The combination of traffic accidents and blows sustained during fights and assaults accounts for more than 80% of all injuries to the facial skeleton.[2] Facial injuries are clinically significant because they are often complex in nature and may have serious functional and cosmetic sequelae. This makes accurate diagnostic evaluation essential.

Radiological evaluation of facial injuries may be difficult due to the complex anatomy of the region and to the difficulties in obtaining high-quality imaging studies in severely traumatized patients.[3,4]

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Its goal is to establish the number and exact location of the fractures, determine the dislocation of the bony fragments and assess concomitant soft tissue complications.[5] The complex anatomy of the midface renders CT the ideal imaging modality to display midface trauma without the disadvantage of super imposition.[6] In modern imaging modalities, especially 3D CT have been shown to be of value in the assessment and management of acute facial trauma.

Surgeons frequently need to make their own evaluation of the degree of skeletal disruption revealed by imaging studies when planning initial treatment of facial fractures. 3D reconstructions may not depict more fractures than those seen on axial and MPR images in all cases, interpretation of 3D-CT images provides useful information in almost 75% of cases and can facilitate surgical planning in more than half.[7,8]

In a patient with acute orbital trauma the periorbital soft tissue edema, inadequate cooperation in alert patients and a reduced level of consciousness in obtunded individuals the computed tomography (CT) has come to play a major role in the orbital examination of acute trauma patients.

OBJECTIVES:
1. To study the efficacy of axial, coronal & 3D CT reformatted images in detection of fracture in maxillofacial and orbital injuries.
2. To study the number, extent and displacement of fractures with axial, coronal & 3D reformatted images.
3. To study the prevalence of maxillofacial and orbital injuries.

METHODOLOGY: Source of Data The study population included 131 patients who underwent CT evaluation of face when they presented with facial trauma at BTGH GULBARGA. The CT was done on the advice of the referring doctor and no patient was made to undergo CT for the sole purpose of this study. The dissertation evaluates various fractures involving the facial bone that were detected in these patients.

Inclusion Criteria:
- All patients with clinical evidence of maxillofacial injuries who undergo multislice CT examination and are shown to be positive for fractures.

Exclusion Criteria:
- Patients with maxillofacial injuries in whom a CT examination is contraindicated e.g. Pregnancy.
- Patients with maxillofacial trauma without any fractures after CT examination.

Data Acquisition:
- Once a patient satisfied the inclusion criteria for this study, he or she would undergo the CT evaluation after giving consent.
- All the CT scans in this study were performed using Philips Brilliance 6 slice CT scanner.

CT Protocol consisted of the following:
- Non-contrast axial 6 slice helical series.
- Beam collimation 10mm.

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- Detector configuration 16x0.625.
- Pitch 1.375:1.
- Tube current 200mAs.
- Voltage 120 kV.
- Total exposure time 6.5s.
- Total Radiation - 81.3mGy.

Along with the axial images, Coronal-plane Multiplanar Reformation (MPR) images were reconstructed with 0.5mm increment. Three Dimensional volume-rendering images were also obtained. The fracture detected on CT examination were classified according to the region involved. Coronal images were compared with axial images for detection of fractures. 3D images were compared with axial images and assessed under headings - fracture detection, extent of fracture and displacement.

RESULTS: The study constituted 131 patients attending maxillofacial injuries having minimum one fracture of facial bones. Axial, coronal and 3D reformatted images were taken for all type of fractures Imaging method for different type of fractures was studied both axial and coronal scans were found equally capable in identifying fractures of nasal bone, nasal septum, lateral & medial maxillary sinus walls, lateral & medial walls of orbit, zygoma, anterior & posterior wall of frontal sinus fractures.

Axial scans were superior than coronal in detecting anterior maxillary wall and zygomatic arch fractures. Coronal scans were superior to axial in orbital floor, orbital roof pterygoid plate, cribriform plate superior and inferior orbital rim fractures. 3D images were found to be similar or better for the detection and description of extent in most patients with zygomatic bone fractures. In the assessment of displacement 3D was found to be superior to axial images in most patients.

Coronal CT was similar to axial in detection of Tripod fractures and Naso- ethmoido-orbital complex fractures and medial orbital blow out fractures. Coronal CT was superior to axial in detection of inferior orbital blowout, and classification of Le-Fort fractures. 3D images were superior in the detection of fractures in the maxilla especially with involvement of anterior wall & similar to axial in posterolateral wall and inferior in case of medial wall of maxillary sinus fractures.

The extent of involvement and its displacement were better seen on axial images. The detection and extent of involvement assessed by 3D and axial images were similar in most patients with mandibular fractures. However there was a definite advantage in assessment of displacement of fracture fragments with the use of 3D images. The 3D images were found to be inferior in the assessment of detection, extent and displacement of fractures in the naso-ethmoido-orbital region when compared with axial images in most patients.

Axial images were almost similar to coronal images in the detection of naso-ethmoido-orbital complex fractures. Frontal bone fracture detection and displacements were seen better on 3D images in more percentage of patients. However its extension, especially into posterior wall of sinus or roof of orbit were not adequately visualized on the 3D images.

DISCUSSION: Mid-facial fractures can be very difficult to assess by conventional radiography because of the complex facial anatomy,[9] At present, computed tomography (CT) is the most widely accepted method in the evaluation of patients with maxillofacial trauma, as it makes it possible to identify and quantify fractures, recognize their true extent and if there are bone displacements or not, as well as to assess soft tissue injuries.[10,11]

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MDCT provides high-quality imaging in the three planes and excellent 3D reconstructions.[11] The latter are particularly useful to assess bony architecture in large comminuted, displaced, and complex fractures involving multiple planes.[12] Furthermore, they are an excellent communication tool with the surgeons, as in the case of complex fractures, they allow an adequate visualization and easy interpretation of the fracture segments and their relationship to one another. This is very helpful when deciding on the most suitable preoperative planning for each patient.[11] essentially, they recreate the surgeon's complex mental process of visualizing fractures in preoperative planning.[12]

The study included 131 patients who had a history of maxillofacial injury and were found to have fractures involving the facial bones. The evaluation of these patients done with Philips Brilliance 6 slice MDCT scanner. The axial images generated were supplemented by the coronal multiplanar reformatted images as well as reconstruction of 3D volume rendered images. The study population consisted of patients in the age group of 11 to 70years. Most patients belonged to the 21-30yrs and 31-40 yrs age groups with 42 and 25% of patients respectively. Our study also showed male preponderance accounting for 85.5% of the total cases with ratio of male: female as 5.8:1.

As these age groups 21-40 are the most common users of motor vehicles, so the more incidence in them is obvious, also the high rates in males explained the highest number of motor vehicle users. The most common mode of injury in patients presented to the Emergency department with maxillofacial trauma was road traffic accidents, comprising 78.6% of cases fallowed by fall from height and assault comprising 14.5% and 6.9% respectively.

A study done by K. Subhashraj for maxillofacial injuries showed most patients were in the 21-30 year-old age group, and the male: female ratio was 3.7:1. Road crashes, particularly involving motorcycles, accounted for 62%.[13] Another study done by BR Chandra Shekar found Road traffic accident (RTA) as the common cause for maxillofacial injuries. Men sustained more injuries compared to women. The injuries were mostly sustained in the age group of 11-40 years, constituting about 78% of all the injuries.[14]

In this study the most common fractured site was of nasal bone found in 78 occasions (17%) followed by anterior and posterolateral maxillary wall fractures on 50 occasions (11%) out of total 467 fractures. The most common complex fracture type in this study was the Naso-Orbito-Ethmoidal (NOE) fracture found on 15(32%) occasions followed by zygomatico-maxillary complex fracture in 09(19%) occasions out of total 47 complex fractures. Hwang and You.[15] stated that the most common isolated fracture site was the nasal bone (37.7%) and largest group with complex fractures included the zygomatico-maxilla (14%).

In patients with Zygomatic bone fractures coronal images were similar to axial images in the detection. In patients with zygomtic arch fractures axial CT was superior to coronal in detecting fractures. In our study of zygomatic bone fractures 3D images were found to be similar or better for the detection and description of extent in most patients. In the assessment of displacement, 3D was found to be superior to axial images in most patients.

A study done by Tanrikulu R and Erol B also showed axial CT was best for zygomatic arch fractures and no significant difference between axial and coronal CT for zygomatic bone fractures.[16]

Our study results correlated with study done by FOX who found that 3D reconstructed CT scans were interpreted more rapidly and more accurately and that 3D CT was more accurate at assessing zygomatic bone fractures.[17] in case of maxillary fractures, anterior maxillary sinus wall fractures were better detected on axial CT, while both Axial and coronal CT were similar for medial maxillary and lateral maxillary sinus wall fractures.

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However 3D images were superior to axial CT in the detection of fractures in the maxilla with involvement of anterior wall. 3D images were similar to 2D images in posterolateral wall fractures and inferior to 2D images in medial maxillary wall fractures. The extent of involvement and displacement of fractures were better seen on axial images. Even Tanrikulu R and Erol B concluded that axial CT was the most effective method in imaging of the maxillary fractures, coronal CT was the most useful in classification of maxillary fractures.[16]

Among orbital fractures seen in our study, the lateral wall of the orbit was the most commonly involved in 39(32%) followed by medial wall 35(29%), floor 25(20%) and roof 23(19%). Coronal CT was better than axial CT in detection of orbital floor, orbital roof, superior orbital rim and inferior orbital rim fractures. Both coronal and axial CT were almost equal in detecting medial and lateral orbital wall fractures.

Overall, coronal images were superior to axial images in detection of orbital fractures. 3D images found to be inferior to 2D CT in Orbital fractures especially for medial orbital wall fractures. The medial wall of orbit could not be correctly evaluated on 3D reformation images owing to the partial volume effect. Study done by Tanrikulu R and Erol B concluded that coronal CT was most effective method for imaging orbital fractures.[16]

FOX also found that 3D reconstructed CT scans were inferior to axial images for evaluating orbital fractures.[17] Coronal images found similar to axial images in naso-orbito-ethmoidal complex fractures. The 3D images were found to be inferior in the assessment of detection, extent and displacement of fractures in the naso-orbito-ethmoid region when compared with coronal and axial images in most patients. The thin bones in these regions causing partial volume averaging resulting in 'pseudoforamina' and considerable bony overlap could explain this finding. In case of zygomatico maxillary complex fractures axial and coronal CT were similar in detection and classification of tripod fractures.

Coronal images were slightly better because of thicker axial slices obtained because of which fractures of the frontozygomatic suture were not identified. 3D reconstruction images were found to be similar or better for the detection and description of extent in most patients with zygomatic bone fractures. In the assessment of displacement, it was found to be superior to axial images in most patients. The study done by Tanrikulu R and Erol B showed that both axial and coronal CT showed no major difference in the classification of tripod fracture Le Fort fracture lines were identified in 17 times. The most common Le Fort line identified was the Le Fort II which was seen 7 times (41%). Le Fort III and Le Fort I fracture lines were identified in 5(29%) occasions each.

This is consistent with the studies done by Duval AJ et al who showed the Le Fort II fractures to be the most common and the Le Fort III fractures to be the most severe of all three.[18] CT studies showed type I Le Fort fractures were better appreciated on coronal CT. Although Le Fort II and III fractures were better classified on coronal CT combined axial and coronal CT were better than individual. 2D images were more sensitive than 3D images. However, both 2D and 3D were required in optimal treatment plan. The study done by Tanrikulu R and Erol B also showed that the classification of Le Fort fractures were better with coronal CT.[16]

Our study also correlated with the above mentioned study for the classification of Le Fort fractures. A combination of Le Fort II and Le Fort III was found in two patients and one patient had a combination of Le Fort II and Le Fort III fracture lines. A combination of Le Fort I and Le Fort II lines were not seen in any of the patients Mandiblar factures were detected in 15 patients with total 25

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number of fractures Most common fractured sites of mandible were body followed by ramus,alveolar ridge, angle and coronoid process.

Kruger Go states that the body fractures occur in 16-36% of mandibular fractures, highest incidence occurring in patients involved in motor vehicle accidents.[19] Another study by Balwant Rai and others showed that most frequently fractured site in the mandible is the body in the canine region and least common site of fracture is the coronoid process.[20] Mandibular fractures were better identified on coronal CT compared to axial CT. Coronal CT was best in identifying fractures of angle of mandible.

There was no difference in 3D and 2D images in detection of mandibular fractures but displacements were better seen on 3D. Study done by Markowitz, Bernard L and others showed that coronal CT was the most accurate method as compared to axial CT in the diagnosis of mandibular

Fractures especially fractures of the angle of the mandible.[21] Ohkawa, et al. (1997) reported that both 2DCT and 3DCT techniques presented a similar sensitivity for the diagnosis of fractures in the mandibular region, though 3D-CT imaging allowed a better visualization.[22]

Although not technically part of the facial skeleton, the frontal bone is particularly prominent and often injured in patients with maxillofacial trauma. These fractures are the result of either direct trauma or an extension of a skull fracture. Both Coronal and axial images were found to be similar in the detection of fractures in frontal bones and frontal sinuses. 3D images were better compared to axial images in detection and displacements of frontal bone fractures but extension of fractures especially into posterior wall of sinus or roof of orbit were not adequately visualized on the 3D images. This is due to the overlap of the bony anterior wall of the sinus restricting visualization.

CONCLUSION: In our study which included 131 patients with history of maxillary facial trauma showed male preponderance with common incidence in 21-30 years age group caused mainly due to road traffic accidents. Most common fractured site was nasal bones and most common complex type was naso-ethmoido-orbital complex fractures Axial CT was better in diagnosing anterior maxillary wall, zygomatic arch fractures. Coronal CT was better in detecting orbital floor orbital roof & pterygoid plate fractures. Axial and coronal CT were similar in fractures of zygoma, lateral & medial maxillary sinus walls, and lateral and medial orbital walls, nasal bone, anterior and posterior frontal sinus wall fractures.

Coronal CT was better for classification of Le Fort fractures and orbital floor blow out fractures. 3D CT was slightly better to 2D CT in detecting anterior maxillary wall fractures and frontal bone fractures. 2D and 3D CT were almost similar in fractures of nasal bone, zygomatic bone and zygomatic arch fractures though displacement of zygomatic bone and zygomatic arch fractures were better seen on 3D images.

3D CT was inferior to 2D in medial wall of maxillary sinus, medial wall of orbit and pterygoid plate fractures. However 3D images provided an easy detection of specific characteristics of facial asymmetries, midface defects and skull vault defects, and a clear localization of fractures associated with bone displacement 2D-CT was good for diagnosing facial fractures, while 3D-reconstruction was a useful complementary tool.

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AUTHORS:
1. Shrishail Patil
2. Shivanand S. Melkundi
3. Santosh

PARTICULARS OF CONTRIBUTORS:
1. Professor, Department of Radiology, Mahadevappa Rampure Medical College, Gulbarga.
2. Professor, Department of Radiology, Mahadevappa Rampure Medical College, Gulbarga.
3. Post Graduate, Department of Radiology, Mahadevappa Rampure Medical College, Gulbarga.

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NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shrishail Patil,
Professor,
Department of Radiology,
Mahadevappa Rampure Medical College,
Gulbarga.
E-mail: mailtopatilss@rediffmail.com

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