3D PERSPECTIVE OF MAXILLOFACIAL TRAUMA

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ABSTRACT

AIM
Role of 3 Dimensional Computed Tomography in facial fractures.

METHODS AND MATERIALS
133 patients with history of head trauma were scanned using multi slice CT for a period of 2 yrs. Data acquisition was performed using - 16 Slice GE Bright Speed Elite CT Scanner. The datasets were transferred to workstation and VR post-processing protocols were applied.

RESULTS
22 patients were male and 11 were female. The mean age of patients with fractures was 32.3 years old. Fractures included the mandible, the maxilla, the frontal bone, the zygomatic arch and the nasal bone.

CONCLUSION
Continuing advances in computer software algorithms and improved precision in the acquisition of radiographic data makes 3D reformatted CT imaging a necessary complement to traditional 2D CT imaging in the management of complex facial trauma. CT is the investigation of choice in the evaluation of patients with maxillofacial trauma.

KEYWORDS
3D Computed Tomography, Facial Fractures, Maxillofacial Trauma.

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INTRODUCTION: Maxillofacial trauma presents as isolated injuries or part of polytrauma and are clinically important as the disruption of soft tissues and bones of the face cause facial asymmetry and disfigurement which causes emotional and cosmetic concerns and the region is also associated with several important functions of daily living. Plain radiographs have been the initial modality of imaging in these patients. But they can be inadequate due to superimposition of bony structures. Despite a higher radiation dosage compared to conventional radiography, CT is the imaging modality of choice to display the multiplicity of fragments, the degree of rotation and displacement or any skull base involvement.

METHODS:
Patient Selection: 133 patients with history of facial trauma were scanned using 16 slice CT scanner during the period from Oct 2012-Aug 2014. 122 patients were male and 11 were female. The age range was 3-85 years. The mean age of patients with fractures was 32.3 years old. Fractures included the mandible, the maxilla, the frontal bone, the zygomatic arch and the nasal bone.

Data Acquisition: Data acquisition was performed using - 16 Slice GE Bright Speed Elite CT Scanner. Patients were scanned using the following protocol: 120 kV, 200 mA, 20 mm collimation.

Final retro reconstruction in bone algorithm was achieved by applying a high-resolution algorithm at 1.25 thickness, 20 cm field of view (FOV) and a 512 X 512 matrix.

The datasets were transferred to workstation and VR post-processing protocols were applied.

Inclusion Criteria: Clinical history or physical examination suggestive of facial trauma. Patients of all age groups with facial trauma

Exclusion Criteria: Patients who are unwilling to undergo CT. Operated cases of facial trauma.

RESULTS: In this study 133 patient with history of trauma and suspected to have facial injury underwent CT scan. The Images obtained by axial, coronal & 3D reformulation were studied and evaluated in terms of detection, displacement & extent of fracture.

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. of patient</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Male</td>
<td>122</td>
<td>92</td>
</tr>
</tbody>
</table>

Table 1: Gender distribution of the study population
Graph 1: Bar graph representing the age distribution of the study population

Graph 2: Bar graph showing the distribution of the study population different modes of injury in facial fractures

Graph 3: Bar graph representing the fracture

Graph 4: Bar diagram showing nasal fractures

Graph 5: Bar graph representing different components of orbital fracture

Graph 6: Bar diagram showing non-osseous component of orbital fracture

Graph 7: Bar diagram showing the different components of zygomatic fracture

Graph 8: Bar graph of different components of maxillary fractures
Case 1: Sequence of images [3D-CT (A, B), Axial (C), Coronal (D)], shows linear fracture of the left frontal bone with collection in the frontal sinus. Fracture of the medial, roof, posterolateral wall of the left orbit Fracture of the body and arch of the left zygoma. Loss of right upper incisors

Case 2: Sequence of images [3D- CT (A, B) and Axial (C, D)], shows comminuted depressed fracture involving right frontal bone with involvement of the medial and lateral walls of the right orbit. Fracture of the nasal bone also noted Ethmoid bone, lesser and greater wings of the sphenoid were also involved.

Case 3: Sequence of images [3D-CT (A, B), Axial (C, D)], shows comminuted fracture involving the right maxilla extending to the floor of the right orbit. A bony fragment is seen to impinge on the inferior rectus muscle. The right globe is deformed. Fracture of the right zygoma noted.
Case 4: Sequence of images [3D-CT (A, B), Axial (C, D)], shows Comminuted fracture of the frontal bone involving the left frontal sinus, bilateral orbital roofs. There is fracture of both nasal bones and lacrimal bones with involvement of the nasolacrimal duct. Fracture involving all the walls of the maxillary sinuses. Undisplaced fracture of bilateral zygomatic processes. Extensive pneumocephalus with haemorrhagic contusion were also noted in this patient.

Case 5: Sequence of images [3D-CT (A, B), Axial (C, D)], shows Tripod fracture-Comminuted fracture of the lateral and anterior walls of the left maxillary sinus with hemosinus. Displaced fracture of the lateral wall of the orbit and zygomatic process of the left temporal bone. Fracture of the ramus of the left mandible.

DISCUSSION: Tanrikulu and EROL compared the clinical utility of CT with plain radiography and proved the superiority of CT in the diagnosis and classification of all facial fractures.4

Multislice CT is a significant advance in the technology of x-ray CT, and the latest technological advance in CT imaging, resulting in the opportunity to greatly increase the speed of data acquisition and reconstruction.5 It has been demonstrated that multislice CT can obtain a great anatomic coverage during the scan.6,7

The continuous data acquisition and archiving occurs as the entire volume of interest is scanned. Consequently, it is possible to scan rapidly a large volume of interest with high image quality, thin sections, and a low artefact rating in short time, thereby dramatically reducing respiratory motion problems.8,9

According to KIESER et al, 80% facial fractures (of all injuries) were commonly seen in males.10

A study done by EM Salonen, et al, also showed that violence related fracture were more common in the age group between 20-40 yrs.11

The most common mode of injury in patients presented to the Emergency Department with maxillofacial trauma was road traffic accidents. Many authors reported that traffic accidents were the most frequent cause of facial fractures.12,13,14

Assault and fall from height being the other causes of maxillofacial fractures in this study is also consistent with the other similar studies mentioned. Because of social, cultural, and environmental factors, the causes of maxillofacial fractures vary. More recent studies have shown that motor vehicle accidents remain the most frequent cause in many industrial countries.15,16

Anatomically, face is divided into five regions:17

- Nasal.
- Orbital.
- Zygomatic.
- Maxillary.
- Mandibular.

<table>
<thead>
<tr>
<th>Nasal region</th>
<th>Nasal bones, lacrimal bones, frontal process of the maxilla, nasal septum and ethmoid cells.</th>
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<tbody>
<tr>
<td>Orbital region</td>
<td>Maxillary, zygomatic and frontal bones comprise the external orbital skeleton, while the internal orbit includes the lacrimal, palatine, ethmoid and sphenoid bones.</td>
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<tr>
<td>Zygomatic region</td>
<td>Is comprised of the zygomatic process of the frontal bone, the zygomatic bone and the zygomatic process of the maxilla.</td>
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<tr>
<td>Maxillary region</td>
<td>Includes the alveolar process and the bony components of the hard palate.</td>
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The 3D images were found to be inferior in the assessment of detection, extent and displacement of fractures in the nasoorbitoethmoid region when compared to axial images in most patients. Coronal images were superior to axial images in the detection of fractures in the region especially in the floor and medial wall of orbit.

FOX found that 3D reconstructed CT scans was inferior to axial images for evaluating orbital fractures.  

Three dimensional imaging is not indicated, however, for small fractures of the orbital floor or isolated fractures of the maxillary wall, in which the fracture is limited to one plane. Here, examining 3D scans alone can give false-negative results.

According to TANRIKULLU and EROL, axial and coronal CT images are adequate for diagnosis of medial orbital wall fractures, and they confirmed the superiority of coronal CT in the diagnosis of fractures of the orbital floor and blow-out fractures, especially in those patients who may develop diplopia or exophthalmos.

These finding were consistent with the findings in this study where 3D images were found to be inferior to axial images in detect of fractures, their extent and in assessing displacement. The thin bones in these regions causing partial volume averaging resulting in 'pseudo foramina' and considerable bony overlap could explain this finding.

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, it was found to be superior to axial images in most patients.

FOX found that 3D reconstructed CT scans were interpreted more rapidly and more accurately and that 3D CT was more accurate at assessing zygomatic fractures.

The detection and extent of involvement assessed by 3D and axial images were similar in most patients with mandibular fractures in this study. However, there was a definite advantage in assessment of displacement of fracture fragments with the use of 3D images. Coronal images were similar to axial images in the detection of mandibular fractures.

In the assessment of frontal bone fracture, detection and displacements were seen well 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. This is due to the overlap of the bony anterior wall of the sinus restricting visualization.

CONCLUSION: This article demonstrates the valuable role of 3D CT in the evaluation of maxillofacial fractures. The advantages of 3D images in the assessment of facial trauma could be described especially in mandible and zygomatic bone. The easier detection of fractures in the frontal and maxillary bones as well as their displacement in patients with complex mid facial fractures could be described. 3D images were better in the identification of fracture lines. In the assessment of frontal bone fracture, detection and displacements were seen well 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. This is due to the overlap of the bony anterior wall of the sinus restricting visualization.

REFERENCES: