The value of spiral computed tomography in the diagnosis of facial fractures

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Abstract

Trauma to the face is one of the common clinical problems that face the Iraqi peoples nowadays because of the critical security situations. Spiral Computed Tomography (CT) is an accurate diagnostic modality in the evaluation of maxillofacial injury. This study has been done on 25 patients sustaining maxillofacial trauma with 30 facial fractures examined with CT at Tikrit Teaching Hospital. Fracture lines, bony fragments and associated skeletal deformities were clearly identified by CT in all 25 patients, permitting the diagnosis of zygomatic, orbital, midfacial, nasal, orbital, ethmoidal, and mandibular fractures. In addition facial & orbital soft-tissues including the globe, optic nerve & extraocular muscles were easily examined by adjusting the CT level & window setting. CT examination were also assist in planning the best operative approach for correction of residual deformities.

Introduction

The maxillofacial region is one of the most complex area of the human body especially in patients with trauma because of their clinical condition & inability to cooperate. Recent changes & innovation in reconstructive techniques used in the surgical management of maxillofacial injuries with increasing use of direct fixation of fractures with miniplates required as complete a picture & assessment of the injury as possible (1). CT has the unique ability to give clear anatomical picture of hard & soft-tissue in axial /coronal and sagittal planes of section & a 3 dimensional pictorial assessment of all the tissue of the head & face is now feasible (2).

Mandibular fractures: Best evaluated by plain film (lateral, oblique, PA) (3). The most common sites are the condylar neck, ramus, angle and the body. Coronal spiral CT should be used to demonstrate undisplaced fractures of the mandibular condyle, which are almost impossible to visualize on plain films. (2,4) Fig-1.

Maxillary fractures are frequent component of facial trauma, often accompanied by gross edema, which complicates the clinical examination. The simplest example is the maxillary alveolar fractures (Le Fort fractures) as a group includes the midface fractures first described by Rene Le Fort in 1900. (5) These fractures result from high velocity injuries that produce disruption across the midface at different levels, depending on the angle & amount of force applied. (6,7)

Le Fort I fracture; includes separation of the maxillary alveolus & lateral maxillary wall to the pterygoid plates, separation of the medial maxillary wall & the perpendicular plate of the ethmoid from the nasal crest of maxilla, allowing mobility of the upper jaw from the nasal & orbital structures. (7) Fig-2.

Le Fort II fracture; a fracture line across the nasal bridge, extending down to the medial orbits to the inferior orbital rim & usually extend further through the infraorbital foramen, and across the lateral maxillary wall to the pterygoid plates. (7)

Le Fort III fracture; fractures extending from the orbital floor to the lateral maxillary wall & producing separation of the midface from the cranial base (7).

Spiral CT is especially important in establishing the extent of potential orbital, ethmoidal & frontal sinus injuries in these fractures (2,8) Fig-3.

The zygomaticomaxillary complex fractures are commonly referred to as tripod fractures. Isolated zygomatic arch fractures can occur (due to direct blow). (9)

Orbital walls fractures: can be divided into two sections: Anterior section: consist of sturdy orbital rim. Posterior section: consist of the comparatively thinner walls (lateral, medial, roof & floor) these thin walls prone to fracture either inward or outward. Commonly termed blow-in & blow-out fractures. The blow-out form could be
either of two distinct types. Downward into the maxillary antrum (mainly posterior), the commonest form, or medially into the ethmoid sinus, primarily at the region of lamina papyracea of the ethmoid bone (9,10). Nasal-orbital–ethmoidal fractures are typically noted to be either unilateral, bilateral, simple or complex. (11).

The aim of the study is to emphasize the accuracy & importance of CT in assessing the wide spectrum of faciomaxillary injuries.

**Materials and Methods**

A descriptive study has been done from March 2005 to December 2007. 25 patients (23 males&2 females) whom ages ranged from 19-54 years, presented with a variety of facial injuries ,examined by spiral CT scan at Tikrit Teaching hospital. All patients were subjected also to plain X-ray. The CT scan were done using siemens somatom plus-4 spiral CT machine.

The technique, include, series of contiguous slices were performed through the area of injury..3 mm slice thickness were used in region of particular complex anatomical details or severely-injured patients, such as nassoethmoid, orbital ,Le Fort fractures elsewhere 5 mm sections were done for head injuries 8 mm scans were used. A 3 D(dimensional )study was performed in every examination.

The films for each patient were taken using both bony & soft-tissue windows.

The statistical approach in this study includes the following:

Accuracy = number of correct cases in all tests.  
\[ \text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{total}} \]

TP= True positive  
TN= True negative

**Results**

The study include 25 patients (23 males &2 females) whose ages ranged from 19-54 years with a mean age of 32 years. presented with 30 facial fractures. The most common etiology of maxillofacial trauma was war injuries, followed by RTA (road traffic accident), fist/ assault.

**Discussion**

Comminuted ,multiple fractures, ability to show fine details between tissues of slightly different density &demonstration of soft-tissue changes associated with bony injuries, such as orbital contents, can be clearly identified by CT (2,12).

Zygoma fractures (Tab-2,Fig-4,8): In this study, fractures of zygoma were the commonest type of facial fractures. complex zygomatic fracture may be isolated or part of more complex facial injuries, plain radiography will usually show any significant displacement of the zygoma, but usually will not show clearly the displacement or distortion of the lateral orbital walls, maxillary antrum & floor of orbit. (9) CT will easily demonstrate any posterior displacement (at the axial plane)and or rotation of the body/arch of the zygoma the amount of mediolateral displacement of the zygoma, lateral wall of the maxillary sinus, floor/lateral orbital wall, all are best assessed by CT in the coronal section (12).

Le Fort fractures (Table 2, Fig-6): In this study the Le fort fractures are not purely isolated & seen more in combination with different types of fractures (9). The second observation is the general orientation of the Le Fort fractures lines are horizontal & CT at the coronal plane lie perpendicular to these lines, makes it more informative and accurate. axial sections will still be important because of their ability to show posterior displacement that usually accompanies these fractures and or to show the palatal fractures (2,12).

Orbital fractures (Table-2, Fig-6,9): CT can be considered to be the best single investigation of orbital injuries. as it shows the wall displacement, entrapment or loss of orbital contents.. Coronal sections yield the most informative view regarding the orbital walls, roof, floor and their relation to the adjacent structures & should always be obtained in the investigation of orbital trauma,(12).

Blow out fractures of both the orbit floor /medial wall .together with their relation to the soft-tissue escape or entrapment are particularly well shown by coronal sections. Axial sections are also important & show medial & lateral wall
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fractures especially even orbital cavity volume or position of the orbital contents e.g. the globe & optic nerve, can be clearly identified (9,10).

Nasoethmoidal injuries (Tab-2): usually associated with other facial fractures. CT (axial/coronal) sections in midface fractures demonstrate clearly the damage to the orbital structures, nasoethmoid, or foreign bodies. CT provides quick & accurate results (11,12).

The mandibular injuries (Tab-2, Fig-7): The fractures satisfactorily shown by plain XR (3). Spiral CT (both axial/coronal sections) specifically requested for condylar fractures or established deformities. (2) In this study the most common site of mandibular injury was the condylar neck...

In the present study, the usefulness of spiral CT scanning was measured by the mean of accuracy, and 100% accuracy was recorded, and this is similar with the results obtained by studies (2,12).

1. In the evaluation of facial trauma, coronal sections are superior than axial one, because:
   • It evaluate the facial skeleton with fewer sections & less exposure to radiation.
   • The coronal sections are perpendicular to the lines of facial fractures (especially LeFort, blow out & zygomatic fractures, mandibular condylar fractures) make it more informative.

But coronal sections has two major disadvantages: More difficult position & artifacts (especially dental restoration) obscure details but these two does not seen to limit the CT value & the artifacts can be avoided by changing the sectional angle.

2. Five mm slice thickness was found in this study to be adequate (i.e. less radiation exposure to the patient).
3. Multiple window levels are required for best imaging.
4. CT provide an adequate radiological evaluation of the maxillofacial area except for the mandible, where its useful only for condylar fractures.
5. for combined head & maxillofacial injury, CT can be done for both at the same time & its considered as an imaging of choice in unconscious patient.

6. CT scanning considered the best imaging modality for orbital injuries for both the hard & soft-tissue including the optic nerve.

References
4-Brandt MN, Mnagi LE, Federle MP. High resolution CT with image information in maxillofacial pathology. AJR 1982;138:477-483.
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Fig (1): A. coronal CT- LT-mandibular ramus fracture. B. common sites of fracture of mandible.

Fig (2): fracture lines in Le Fort I,II,III fractures

Fig (3): diagram of the usual fractures of the zygoma & zygomatic arch

Table (1): Distribution of the facial injuries according to etiology.

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No. of cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>War injuries</td>
<td>16</td>
<td>64</td>
</tr>
<tr>
<td>RTA</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Fist/ assault</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>sport</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
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Table (2): Distribution of the facial injuries according to type.

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>No.</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygoma Fracture</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>Le Fort fracture</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Mandibular fracture</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Nasoethmoidal F.</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Orbital fracture</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig (4): CT findings of zygomatic fractures.

Fig (5): CT findings of orbital fractures.
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Fig. (6): CT findings of Le Fort fractures.

Fig. (7): CT findings of mandibular fractures.

Fig (8): Comminuted fracture of LT-maxilla. A) axial CT  B) 3D image.

Fig (9): A) coronal CT of LT-orbital floor blow-out fracture B) axial CT of the same case.