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EVALUATION OF MAXILLOFACIAL AND ORBITAL INJURIES BY MULTI DETECTOR COMPUTED TOMOGRAPHY

Kancherlapalli Divya Rani[1*], Nagateja Bonala[2,] Padala Mohan Kumar[3]

[1*]Assistant Professor, Department of Radiodiagnosis, Government Medical College. Mahabubnagar, Telangana
[2]Associate Professor, Department of Radiodiagnosis, IQ City Medical College, Durgapur Westbengal
[3]Assistant Professor, Department of Orthopaedics, Government Medical College, Sangareddy,Telangana.

***Corresponding Author:-**Dr Kancherlapalli Divya Rani,
*Assistant Professor, Department of Radiodiagnosis, Government medical College Mahabubnagar, Telangana

ABSTRACT

Background: The rapid pace of twenty first century, living with high speed travel, our increasingly violent and less tolerant society has made facial trauma an ever increasing problem. Facial trauma can be regarded as a form of social disease from which no one is immune..

Objective: To study the role of computed tomography in the evaluation of maxillofacial trauma thus helping the surgeon in proper management of the cases.

Methods: The main source of data for the study is patients referred to department of Radiology, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda. All patients with trauma to the maxillofacial region, usually acquired in motor vehicle accidents or personal altercations referred to the Department of Radiodiagnosis in a period of 2 years from December 2014 to June 2016 were subjected to study

Results: In our study majority of the patients were males (80%) and in the age group of 25-35 years (40%).We found that anterior maxillary sinus wall (12.6%) was the most commonly fractured site, followed by zygomatic arch (11.8%). Cribriform plate was the least commonly fractured site (0.4%). In our study, zygomatico-maxillary fractures (26.4%) were the most common type of fractures, followed by mandibular fractures (21.5%). In the mandible, body (43%) was the most frequently fractured site, followed by condyle (22%)

Maxillary wall, orbital wall, and pterygoid plate fractures were detected on CT which were least suspected on clinical assessment. Axial CT sections were superior in detecting the fractures of anterior maxillary sinus wall and zygomatic arch. Coronal CT was better for detecting fractures of orbital floor, orbital roof, pterygoid plates and mandible. Both axial and coronal were equally efficient in detecting fractures of the nasal bones, medial orbital wall and posterolateral maxillary sinus wall.

Conclusions: CT is the most accurate diagnostic method in the evaluation of maxillofacial injuries when compared to clinical assessment. CT sections taken in a plane perpendicular to a strut provides the best information about the fractures and displacements of that strut,

Keywords: Maxillofacial, Orbital Injuries, Multi Detector Computed Tomography

Introduction

The etiology of facial fractures varies from one geographical area to another. According to the development and type of the prevalent transportation system, automobile accidents probably cause more facial injuries than any other modality in most modern countries[1, 2]. In developing countries, altercations, home accidents and other sources of trauma may account for most.

Recognition of true extent of fractures, displacements and soft tissue injuries of the facial skeleton is very much necessary for the optimum reconstruction of the face. Appropriate clinical radiographic investigation, together with an understanding of the normal radiographic anatomy of the facial skeleton, allows for precise delineation of facial fractures and associated soft tissue injuries encountered in clinical practice. A combination of multiple plain radiographic views and coronal and axial computed tomographic images allow for optimal delineation of fracture patterns.

This information is beneficial in the clinical and surgical management of patients withfacial injuries[3].

Accurate diagnosis and complete evaluation of maxillofacial trauma requires a comprehensive knowledge of maxillofacial anatomy. Facial skeletal anatomy represents some of the most complex anatomy in the body. The complexities arecompounded when the anatomy is shown in two dimensions as seen on radiographs.

Cerebral and pulmonary injuries are often associated withmaxillofacial fractures in severely injured trauma patients. Knowledge of these associated injuries provides useful strategies for patient care and prevention of further complications. A multidisciplinary and coordinated approach is important for optimum stabilization and ongoing treatment of patients with facial fractures[4].

There is a need for prompt identification and proper management of theassociated life-threatening injuries in facial fracture patients. Clinical assessmentshould begin with evaluation of cerebral trauma, followed by haemorrhagic shock,airway compromise, and hemopneumothorax. Proper management may require amultidisciplinary and coordinated team approach[5].

In recent years computed tomography has taken quantum leaps in its utility and acceptance by the clinical community as it is quick, accurate, non-invasive and easy to perform. The present study outlines the role of computed tomography in the evaluation of maxillofacial trauma thus helping the surgeon in proper management of the cases.

Materials and Methods: The main source of data for the study is patients referred to department of Radiology, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda

All patients with trauma to the maxillofacial region, usually acquired in motor vehicle accidents or personal altercations referred to the department of Radiodiagnosis in a period of 2 years from December 2014 to June 2016 were subjected to study.

Institutional Ethical Committee clearance was taken before the start of study.

The study was conducted on sixty patients with trauma to the maxillofacial region

In all cases a thorough clinical examination was carried out and details were documented with attention to facial bones and soft tissues.

All patients were evaluated with CT to look for fractures suspected or to investigate further complex fractures identified on plain films.

Inclusion criteria

All patients with maxillofacial and orbital trauma.

Patients of all age group & both sexes are included.

Exclusion criteria

Pregnant women with maxillofacial trauma.

Postoperative patients in need of repeat CT.

Equipment and protocol

Somatom® Emotion 6 (Siemens Medical Systems, Germany) CT – 6 Slice

Alexion™ Multislice CT System (Toshiba Medical Systems Corporation, Japan) – 16 Slice
Topogram : Craniocaudal
Scan type : Helical
Respiratory phase : Any
Start : 1cm inferior to mandible
End : 1cm superior to frontal sinuses
KV/ mA/ Rotation time : 120kv/ 130 mA / 0.75 sec
Raw slice thickness : 5mm
Reconstructions :1mm
The Images obtained by axial, coronal & 3D multiplanar reformation are studied and evaluated in ter
ms of detection, displacement & extent of fracture.
All the data of patient is collected in form of age, sex & type of fracture to know the prevalence of maxillofacial and orbital injuries.

Results:
Patients included in this study were 60 in number. Majority of the cases were males constituting 80%. Most of the patients were in the age group of 25-35 years.
Table 6 gives a breakdown of the number of fractures identified in different locations on CT. Fractures of the walls of the maxillary sinus, zygomatic arch and nasal bones are the most common.

Table 1: Number of fractures identified on CT

Site of Fracture	No.	Percentage
Anterior Maxillary Wall	64	12.6
Posterolateral Maxillary Wall	56	11
Medial Maxillary Wall	40	7.9
Orbital Floor	36	7.1
Orbital Roof	12	2.4
Inferior Orbital Rim	08	1.6
Superior Orbital Rim	04	0.8
Lateral Orbital Wall	24	4.7
Medial Orbital Wall	32	6.3
Anterior Frontal Wall	20	3.9
Posterior Frontal Wall	14	2.7
Pterygoid Plates	32	6.3
Nasal Bones	44	8.7
Nasal Septum	12	2.9
Zygomatic Arch	60	11.8
Zygoma	20	3.9

Cribriform Plate	02	0.4
Mandible	28	5.5
Total	**408**	**100**

Table 2 shows the comparison of the fractures clinically suspected and those identified on CT in different locations. Fractures of the anterior maxillary sinus wall, inferior and superior orbital rims, nasal bones, zygomatic arch and mandible showed best clinical correlation.

Table 2: Comparison between clinical suspicion and CT identification of fractures

Site of Fracture	Clinically Suspected	Identified on CT
Anterior Maxillary Wall	48	64
Posterolateral Maxillary Wall	16	56
Medial Maxillary Wall	12	40
Orbital Floor	12	36
Orbital roof	02	12
Inferior Orbital Rim	06	08
Superior Orbital Rim	04	04
Lateral Orbital Wall	06	24
Medial Orbital Wall	04	32
Anterior frontal Wall	14	20
Posterior Frontal Wall	00	14
Pterygoid Plates	00	32
Nasal Bones	36	44
Nasal Septum	02	12
Zygomatic Arch	52	60
Zygoma	12	20
Cribriform Plate	2	2
Mandible	20	28
Total	**248**	**508**

Table 3 gives a breakdown of different fracture types identified on CT. Zygomatico-maxillary complex and mandibular fractures were the most common types.

Table 3: Types of fractures identified on CT

Type of Fracture	No. identified	Percentage
Tripod (Zygomatico-Maxillary Complex)	32	24.6
Naso – Ethmoido – Orbital Complex	20	15.4
Medial Orbital Blow Out	04	3.2
Inferior Orbital Blow Out	10	7.7
Superior Orbital Blow Out	00	0
Lateral Orbital Blow Out	00	0
Medial Orbital Blow – In	02	1.5
Inferior Orbital Blow – In	00	0
Superior Orbital Blow – In	00	0
Lateral Orbital Blow – In	00	0
Le-Fort I	12	9.2
Le-Fort II	20	15.4
Le-Fort III	02	1.5
Mandibular Fractures	28	21.5
Total	**130**	**100**

Table 4 provides a breakdown of different sites of mandibular fractures encountered in our study. Fracture of mandible most commonly occurred in the region of body of mandible.

Table 4: Distribution of Mandibular fractures

Site of Mandibular Fracture	No. of Fractures	Percentage
Body	12	42.9
Angle	04	14.3
Condyle	06	21.4
Symphysis	02	7.1
Ramus	04	14.3
Alveolar	00	0

Coronoid Process	00	0
Total	**28**	**100**

Table 5 shows the different fracture sites identified by Axial and Coronal CT images. Maxillary fractures were delineated more effectively on axial images. Coronal images were better for diagnosing Orbital fractures. No significant difference was noted between axial and coronal images for fractures of zygoma.

Table 5: Comparison of fracture sites identified by axial and coronal CT

Site of Fracture	Axial	Coronal
Anterior Maxillary	64	48
Posterolateral Maxillary	56	44
Medial Maxillary	40	30
Orbital Floor	00	36
Orbital Roof	00	06
Inferior Orbital Rim	00	08
Superior Orbital Rim	00	04
Lateral Orbital Wall	18	24
Medial Orbital Wall	22	32
Anterior Frontal	20	14
Posterior Frontal	14	09
Pterygoid Plates	28	32
Nasal Bones	42	39
Nasal Septum	08	12
Zygomatic Arch	60	54
Zygoma	18	16
Cribriform Plate	02	00
Mandible	28	22

Coronal scans were marginally better in identifying fractures of the maxillofacial region compared to axial scans.

Table 6 provides the types of fractures identified on axial and coronal scans. The table shows that the coronal scans have a better efficacy than axial scans in classifying the facial fractures, especially the transfacial LeFort type fractures and the inferior orbital blow-out fractures.

Table 6: Types of fractures identified on axial and coronal CT

Type of Fracture	Identified on Axial	Identified on Coronal
Tripod (Zygomatico-Maxillary Complex)	16	24
Naso – Ethmoido – Orbital Complex	08	08
Medial Orbital Blow Out	04	04
Inferior Orbital Blow Out	00	04
Superior Orbital Blow Out	00	00
Lateral Orbital Blow Out	00	00
Medial Orbital Blow – In	00	04
Inferior Orbital Blow – In	00	02
Superior Orbital Blow – In	00	02
Lateral Orbital Blow – In	00	00
Le-Fort I	02	10
Le-Fort II	04	16

The coronal scans are clearly more efficient in classifying the facial fractures from the identified fractures. Surgical management is clearly the treatment of choice in the facial fractures than the conservative management.

Table 7: Treatment of facial fractures

Treatment	No. of Patients	Percentage
Surgical	44	73.4
Conservative	16	26.6
Total	**60**	**100**

Discussion:

The criterion of success in the management of maxillofacial injuries in the past has varied considerably. Both the diagnostic modalities as well as the methods available for the management were limited.

As a result, the diagnosis tended to be less precise and the final outcome of management acceptable even when anatomically imperfect.

The advent of CT scanning has now laid bare the intricacies of fractures involving the maxillofacial skeleton. So, we no longer have a simple Le Fort fracture line, but many complex array of fractures appreciated only by the sectional anatomy provided by the computerised tomographic scanning.

It would, therefore seem that computerised tomography by exposing greater details of anatomy would eliminate the role of explorative surgery thus making management more definitive thereby improving the outcome.

On the other hand, restoration of the anatomical harmony in midfacial fractures particularly the ethmoid complex may not be always possible and not always necessary. In our study male to female ratio was 4:1 and 40% of the patients were between 25 to 35 years.

Lee KH, Chou HJ in Christchurch hospital, New Zealand conducted a study named Facial fractures in road cyclists. They retrospectively reviewed the database of the patients presenting to the Oral and Maxillofacial Surgery unit in the hospital during a 11-year period.

The study results had a male to female ratio of 3:1 and 76% of patients were between first and third decade[6]. This is in similarity to our study which concluded that young male adults are predominantly affected.

Both studies had more of male patients which may be due to increased use of vehicles by group.

NajmehAnbiaee et. al. had their study on Maxillofacial fractures conducted on 553 maxillofacial trauma patients from March 2010 to Feb 2011[7]. There were 230 patients with fractures.

The fractures occurred in 85% of the adults, 7% of the adolescents (14-17 years), and 8% of the children (0-14 years) suffered maxillofacial fractures. Female and male patients of the study comprised 10% and 90%, respectively among adults.

Our study also had a similar significant male predilection to traumatic fractures.

The use of CT offers several advantages. Earlier diagnosis is possible when facial edema, lacerations and altered sensorium limit the clinical and radiological examination. Comminuted fractures, rotational deformities and multiple fractures were all better seen on CT.

In craniofacial trauma, a cranial CT being ordered by the neurologist, additional scans of the midface require only little extra time and render more detailed information to the maxillofacial surgeon than clinical and radiological examination. Stress to the patients due to risky manoeuvres of positioning in radiography can be avoided.

Several authors have also shown the advantages of CT scanning in the delineation of facial fractures. Cadaver studies done by Gentry andothers have confirmed the accuracy of CT in delineating fractures in the facial region in the presence of soft tissue edema and other soft tissue injuries[8].

A study by Kreipke DL and others concluded that imaging in two planes, including the coronal plane is desirable for greatest accuracy in fracture detection. CT was also better for the display of soft tissue abnormalities[9].

Another study done by Tanrikulu R and Erol B concluded that coronal CT (CCT) proved superior in the diagnosis of orbital fractures. There was no significant difference betweenaxial CT (ACT) and coronal CT for fractures of the zygoma. Axial CT was the most effective method in imaging of the maxillary fractures. Coronal CTwas the most useful in classification of the orbital and maxillary fractures[10].

Our study also concluded that axial CT was more effective in delineating the maxillary fractures and coronal CT was better for diagnosing the orbital fractures and no significant difference between axial CT (ACT) and coronal CT for fractures of the zygoma, which correlated with the study.

The study done by Tanrikulu R and Erol B also showed that the classification of blow-out fractures and Le Fort fractures were better with coronal CT. Both axial and coronal CT showed no major difference in the classification of tripod ftactures[10].

Our study also correlated with the above mentioned study for the classification of blow-out and Le Fort fractures but coronal CT proved to be better for the classification of tripod fractures possibly because of thicker axial slices obtained because of which fractures of the frontozygomatic suture were not identified.

A study done by Hamad Ebrahim AI Ahmed and others showed that condyle (25%) of the mandible was the most commonly fractured site, followed by angle (23%) of the mandible and body (20%) of the mandible[11].

Our study concluded that body (43%) is the most common site of fracture in the mandible, followed by condyle (22%) and angle and ramus (14%).

The difference in the most commonly fractured site can be explained due to difference in the mechanism of injury.

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[12] which is in agreement with our study.

A study 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[13].

In our study, only 60% of the mandibular fractures were detected on the axial CT while coronal CT detected 100% of those, thus correlating with the above mentioned study.

The study done by Hamad Ebrahim AI Ahmed and others also showed that most common type of fracture in the maxillofacial injuries was the mandible fracture, followed by Zygomaticomaxillary fractures and the least common type was the Le Fort II fracture[11].

In contrast our study showed that Zygomaticomaxillary fractures are the most common type, followed by mandible fractures. The least common type was the Le Fort III fracture. Another study by Col. Gk. Thapliyal and others also showed that mandible fracture is the most common type of fracture and Le Fort II is the least common type[14], which is again in contrast to our study. The difference may be due to a different mechanism of injury.

The study by Balwant Rai and others showed that most common facial fractures were in maxilla and zygoma (73%), followed by mandible (61%) and the nasal bone (19.5%)[15], which is in agreement with our study.

Another study by Amir Dibaie and others concluded that most common type of fractures were the nasal fractures, followed by the mandible fractures and the least common type of fractures were the orbital fractures[16], which were in contrast to our study, because majority of patients in the above mentioned study were victims of assaults as opposed to road traffic accident patients in our study.

A study by Huey-jen Lee and others concluded that the orbit floor was the most common and the orbital roof the least common site of fracture of the bony coverings of the eye[15], which is in agreement with our study.

A study by Behcet Erol and others showed that 77.9% of cases were treated with conservative methods and 22.1% with one or more internal fixation techniques[17].

Another study by Giovanni and others concluded that in 89 patients (40.1%), no treatment was considered necessary, whereas 133 patients (59.9%) were treated by surgery. In 115 patients (86.5%), the fractures were treated by open reduction and internal fixation, whereas closed reduction was used in 18 patients (13.5%) [18].

In our study 22 (73%) patients were treated surgically which included both closed reduction and open reduction and internal fixation and 8 (27%) patients were treated conservatively, that is, they required no active interventions.

Therefore, an analysis of the results of our study shows that the main indications for the use of CT in maxillofacial trauma would be:

- Analysis of complex or transfacial injuries suspected clinically and not identified on plain radiographs.
- Analysis of the fractures of the orbit.
- Suspected concomitant fractures at the base of the skull.
- Analyses of the midfacial injuries in the course of a cranial CT check up in the multiply injured patients.
- To explore a possibility of effective treatment in the form of surgical or conservative management.

Conclusion: It was concluded that CT is the most accurate diagnostic method in the evaluation of maxillofacial injuries when compared to clinical assessment. CT sections taken in a plane perpendicular to a strut provides the best information about the fractures and displacements of that strut, so both axial and coronal sections must be taken for the complete evaluation of injuries. Even in the presence of soft tissue edema, laceration, hematoma which hinders the clinical assessment, CT makes precise assessment of fractures.

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