Print ISSN 1110-208X.

Online ISSN 2357-0016

Original article

Role of MDCT in Detection, Classification and Follow up of Acetabular Fractures

Ahmed F. Yousef [a], Yasser M. Attia [a], Mohamed A. Elhariry [b], Mostafa A. Eissa [a]

[a] Radiology Department, Faculty of Medicine Benha University, Egypt.

[b] Orthopedics Department, Naser Institute Hospital.

Corresponding to: Mostafa A. Eissa. Radiology Department, Faculty of Medicine Benha University, Egypt.

Email: dr.eissa_radiology@gmail.com

Received:18 August 2019

Accepted:8 April 2023

Abstract:

Background: Correct recognition, description, and classification of acetabular fractures are essential for efficient patient triage and treatment. The most widely used is the system of Judet and Letournel, which includes five elementary and five associated fractures. **The aim of the work** is to elucidate the role of MDCT in detection, classification and follow up of acetabular fractures. **Patients and methods:** 30 patients having acetabular fractures. Ages ranged between 20 and 75 years (mean age 45); there were 25 males and 5 females. Observational retrospective study of the previous CT scans done for the acetabular fractures. **Results**: In our study, 16 of patients (53.3%), were with left sided acetabular fracture. Eight of them were with right sided acetabular fracture (26.7%) and Six of them with bilateral acetabular fractures (20%). The common cause of acetabular fracture was Road traffic accidents (80%), then falling from height (20%). The most common types of fracture were posterior wall and both column (20%) according to C.T. According to AP conventional radiography; six cases of acetabular fracture were diagnosed, the other twenty four cases were accurately diagnosed by C.T. **Conclusion:** Radiography Technically easy, quick, portable, not degraded by streak artifact, may be technically suboptimal because of patient condition and body habitus, not as sensitive as CT for depicting fractures. SO, all cases with Acetabular fractures should be evaluated by means of trans-axial CT and additional MPR. The use of appropriate standard MPR views shortens the time required to produce the reformats and thereby maximizes the benefit gained.

Keywords: MDCT, acetabulum, fractures.

Introduction

The introduction of multi-detector computed tomography (MDCT) has been nothing less than a revolution in the way patients with major trauma are evaluated, imaged, and treated. In nearly every large emergency department, a MDCT is the workhorse, where all such patients are rapidly imaged, after primary resuscitation and stabilization. In the last several years, developments in workstation computer software and hardware have resulted in nearly immediate access- not only to axial images- but also to two-dimensional (2-D) multiplanar reformatted (MPR) images in any arbitrary plane as well as three-dimensional (3-D) volume rendered images. Parallel advances in picture archiving and communications (PACS) technology have taken place, allowing for real-time viewing and manipulation of large stacks of images. The rapid high-resolution imaging has led to improved fracture delineation and classification, which in turn has resulted in more rapid surgical interventions. These advances have made radiography unnecessary in acute spine, pelvic, and acetabular imaging (1).

Acetabular fractures are serious injuries-often occurring in polytrauma patients and are associated with head, visceral, spine, and extremity injuries. In younger patients they usually are the result of high-energy trauma, such as motor vehicle or motorcycle accidents, falls from a height, or pedestrian being hit by a car, where a force applied to the femur is transmitted to the acetabulum. Acetabular fractures are less commonly seen in the elderly, where a lesser trauma can result in such fractures (2).

Correct recognition, description and classification of acetabular fractures are essential for efficient patient triage and treatment. The exact type of acetabular fracture depends on the position of the hip during the trauma, the direction and magnitude of the impact force and the bone quality. The importance of understanding acetabular fractures cannot be minimized. The lower extremity supports the axial skeleton by way of the acetabulum. Failure to diagnose, classify or properly repair these fractures results in hip instability and post-traumatic osteoarthritis (3).

MDCT is an indispensable tool in preoperative imaging of acetabular fractures and also in postoperative imaging in complicated cases. Not only is MDCT excellent for a general overview but also for detailed imaging of fracture extent, joint congruency, step-offs or gaps in the joint surface and entrapped osteochondral fragments (1).

Aim of work

To elucidate the role of MDCT in detection, classification and follow up of acetabular fractures.

Patients and methods

Patients :

Observational retrospective study, the patients were imaged at El-Agouza Police Hospital and Nasser Institute Hospital, in the period from April 2018 to January 2019.The study is established on 30 patients with age range from 20 to 75 years diagnosed as acetabular fractures. Procedures are approved by the ethical committee.

Inclusion Criteria: traumatic acetabular fractures.

Exclusion Criteria**:** Patients with pathological fractures due to malignancies.

Methods:

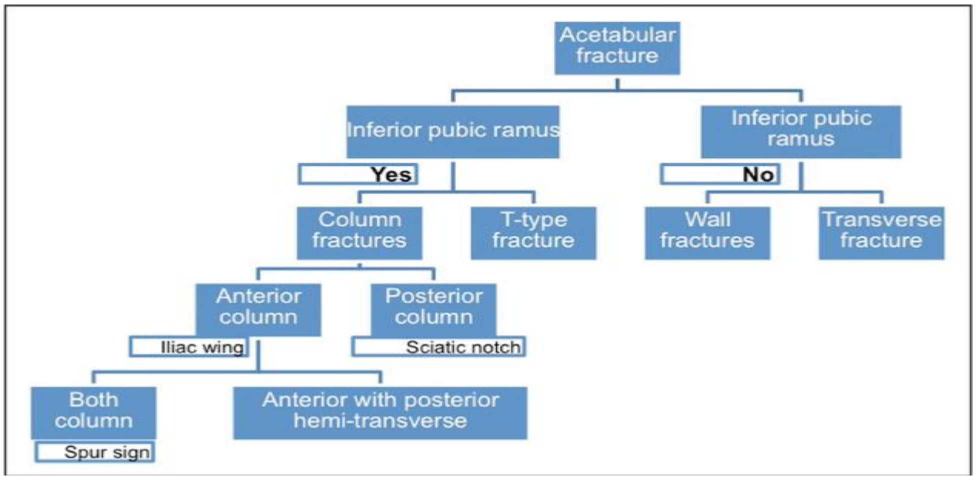
All patients were subjected to the following: History including recording of age, sex and presentation. Clinical examination, type of trauma (car accident, falling from height). All patients subjected to pelvic x-ray AP view. Patients were subjected to examine by 16 MDCT (TOSHIBA ALLEXION).

Medical ethics were considered. The patient was aware of the examination, approval obtained, economic status of the patient has been considered and the patient has to get benefit from the examination.

MDCT scanning Protocol:

The CT examinations were performed on a helical CT scanner. Tube voltage was 120 kV in 14 cases and 140 kV in one case. Tube current was 190-300 mA (mean 250 mA), gantry tilt 0°, and FOV 13- 35 cm. the imaged area extended from the iliac wing to the rami. The CT scanner was connected to a workstation that was used to make the MPR and SSD reformats with 3D software.

In 3D reformate the femur, the unaffected hemi-pelvis (to the sacro-iliac joint on the fracture side), and the table underneath the patient were removed from the images to produce a good medio- cranial view A "filter floater" command was used to remove the tiny noise particles that were considered- on the basis of the original trans- axial slices- to be of no significance. The following SSD views were printed: starting from the AP. view, a full 360° lateral rotation (around the Z-axis) with 45° increments; and starting from the caudal view, a full 360° caudo-cranial rotation (around the X-axis) with 45° increments (here the dorsal views were rotated so that the cranial parts of the reformat remained superior). Although the window setting does not affect the shaded parts of the reformat, a window setting of length- 350/ width-2000 was used to give a clearer visualization of the bone structure at the most cranial and caudal parts of the reformat. Post- processed 3D maximum intensity projection (MIP) views were also filmed.



Flow chart shows step-wise approach for decision making to reach correct identification of acetabular fracture type (13).

Findings that were reported by the examination:

- Presence of fracture
- Patients were grouped according to the type of fracture; Anterior column, posterior column, or combined facture.
- Unilateral or bilateral.
- Other associated fractures.
- Other associated internal organ injury.

Statistical Analysis

- The data collected were tabulated & analyzed by SPSS (statistical package for the social science software) statistical package version 11 on IBM compatible computer.
- **Qualitative data** were expressed as number and percentage (No & %) and analyzed by applying chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables less than 5, fisher exact test was used instead.
- **Chi square test** was done for qualitative variable analysis and p- value < 0.05- was considered significant.

- **Sensitivity:** true positive cases divided by all positive cases.
- **Specificity:** True negative cases divided by all negative cases.
- **Accuracy:** all true positive plus true negative cases divided by all cases (either true positive or true negative or false positive or false negative).
- Receiver operating characteristic curve (ROC cthe best sensitivity and specificity isany tested variable where at this level there is the best sensitivity and specificity cut off values of the variables for the presence of the disease. Moreover, they were used to identify the cut off the prevalence adjusted negative and positive values for the presence of the disease. The validity of the model was measured by means of the concordance statistic (equivalent to the area under the Roc curve). A model with a c value above 0.7 is considered useful while a c value between 0.8 and 0.9 indicated excellent diagnostic accuracy.
- All these tests were used as tests of significance at P<0.05.

Results

Thirty patients were included in this study. They were referred to the Radiology Department, Al-Agouza Police Hospital and Nasser Institute, in the period from April 2018 to January 2019. These patients were referred for radiological assessment of diagnosed acetabular fracture.

The ages ranged between 20 and 75 years (mean age 34years); there were 25 male patients and 5 females, Table 1, 2.

Table (1) shows that more than half of study group age was below 40 years (73.3%).

Table (3) shows that the most affected side in acetabular fracture was the left side (53.3%), then the right (26.7) at lasts the bilateral (20%).

Table (4) shows that the common causes of acetabular fracture were road traffic accidents (80%), then falling from height (20%).

Table (5) shows that the associated pelvic fracture with acetabular fracture was (53.3%) and the isolated acetabular fracture (46.7%).

Table (1) The age incidence of acetabular fracture in studied cases.

	Number	**percent**
Below 40 years	22	73.3 %
40 years and more	8	26.7 %
Total	30	100 %

Table (2) The sex incidence of acetabular fracture in studied cases.

Sex	**Number**	**Percent**
Male	25	83.3 %
Female	5	16.7 %
Total	30	100 %

Table (3) The side incidence in studied cases.

Affected side	Number	Percent
Left	16	53.3 %
Right	8	26.7 %
Bilateral	6	20%
Total	30	100 %

Table (4) The mechanism of acetabular fracture injury in studied cases.

Mechanism of injury	Number	Percent
Road traffic accident	24	80%
Falling from height	6	20%
Total	30	100%

Table (5) Isolated and associated types of fractures.

Type of fracture	Number	Percent
Isolated acetabular fracture	14	46.7 %
Associated pelvic fracture	16	53.3 %
Total	30	100 %

Table (6) shows that the most types of fracture were posterior wall and both column (20%) according to C.T.

Table (7) shows that the most type of fracture was posterior wall (13.3%) according to X ray diagnosis.

Table (8) shows that there were no significance differences between side incidence, mechanism of injury, associated injuries and type of fractures regarding age group (P >0.05).

Table (6) The types of fractures in C.T according to Letournel classification.

Type of fracture	Number	Percent
Posterior wall	6	20 %
Anterior column	3	10 %
Transverse	5	16.7 %
Both column	6	20 %
T-type	5	16. 7%
Transverse with posterior wall	2	6.6 %
T-type with posterior Wall	3	10%
Total	30	100 %

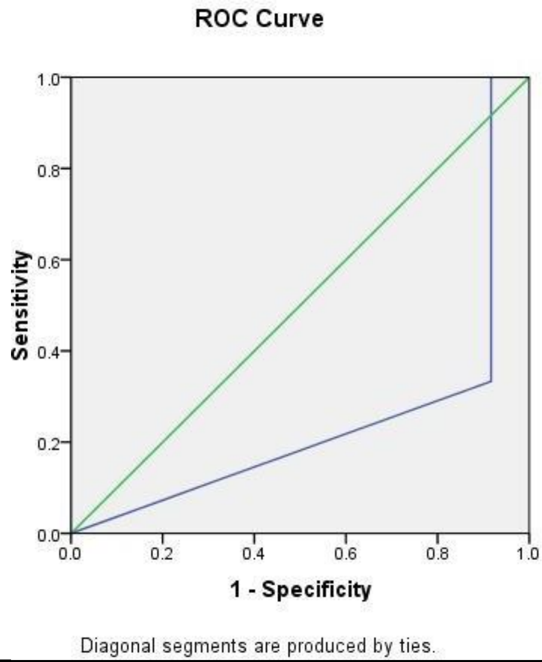
Table (7) The types of fractures according to X ray diagnosis.

Type of fracture	Number	Percent
Posterior wall	4	13.3%
Anterior column	0	0
Transverse	2	6.7%
Both column	0	0
T-type	0	0
Transverse with posterior wall	0	0
T-type with posterior Wall	0	0
Total	6	20%

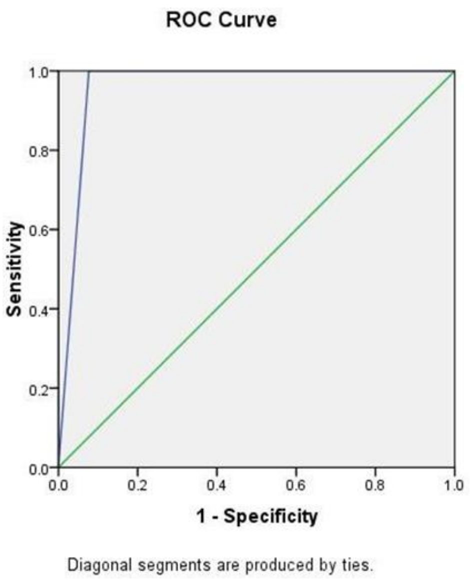
Table (8) Comparison between the group study age regarding Side incidence, Mechanism of injury, associated, type of fractures.

		Age				X2	P.value
		Below 40 years		Forty years and more			
		No	%	No	%		
Side incidence	**Left**	12	54.5	5	62.5	0.05	**>0.05**
	Right	10	45.5	3	37.5		
Mechanism of injury	**RTA**	17	77.3%	6	75%	0.19	**>0.05**
	Falling from height	5	22.7%	2	25%		
Associated	**Cases with associated injuries**	12	54.5%	5	62.5%	0.49	**>0.05**
	Cases without associated Injuries	10	45.5%	3	37.5%		
Type of fractures	**Isolated acetabular fracture**	10	45.5%	5	62.5%	0.41	**>0.05**
	Associated pelvic fracture	12	54.5%	3	37.5%		
Total		**22**	**100.0%**	**8**	**100.0%**		

Table (9) Shows Roc curve:



	Area	Std. Error[a]	Sig.	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
C.T	0.962	0.034	0.003	0.894	1.029
X-ray	0.236	0.121	0.049	0.000	0.473



Roc curve showed that:

CT:

- Sensitivity: was96%.
- Specificity: was89%.
- AUC:0.96

X ray:

- Sensitivity: was67%.
- Specificity: was71%.
- AUC:0.24

CASES

Case 1:

39 years old male was involved in a Road traffic accident.

MDCT pelvis, bone window with 3D reformate, Fig (1&2): Left acetabular fracture involving posterior wall with posteriorly displaced bone fragments. Avulsion fracture of the inferior aspect of the left femoral head with inferiorly displaced fracture segment. 3D reformate shows displaced bone fragments.

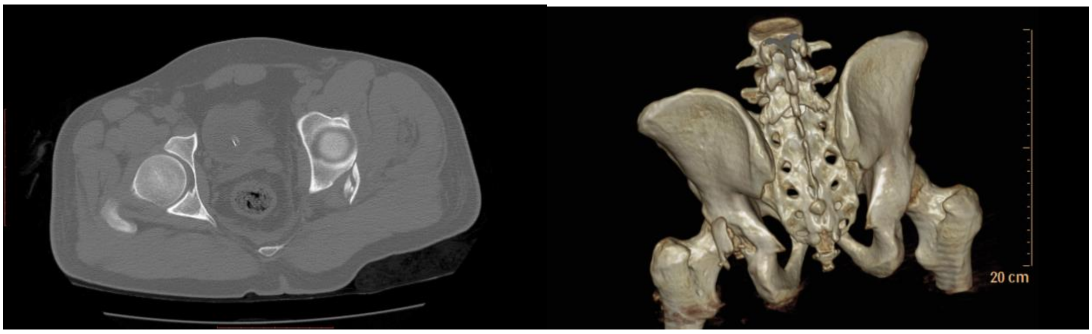


Fig (1,2) Diagnosis: left acetabular posterior wall fracture associated with fracture femoral head.

Case 2:

35 years old male was involved in falling from height.

MDCT pelvis, bone window with 3D reformate, Fig (3,4,5): Comminuted fracture of the right acetabular anterior column reaching the proximal portion of superior pubic ramus.Another comminuted fracture is seen involving the right inferior pubic ramus with multiple tiny bony fragments displaced infero-medially.

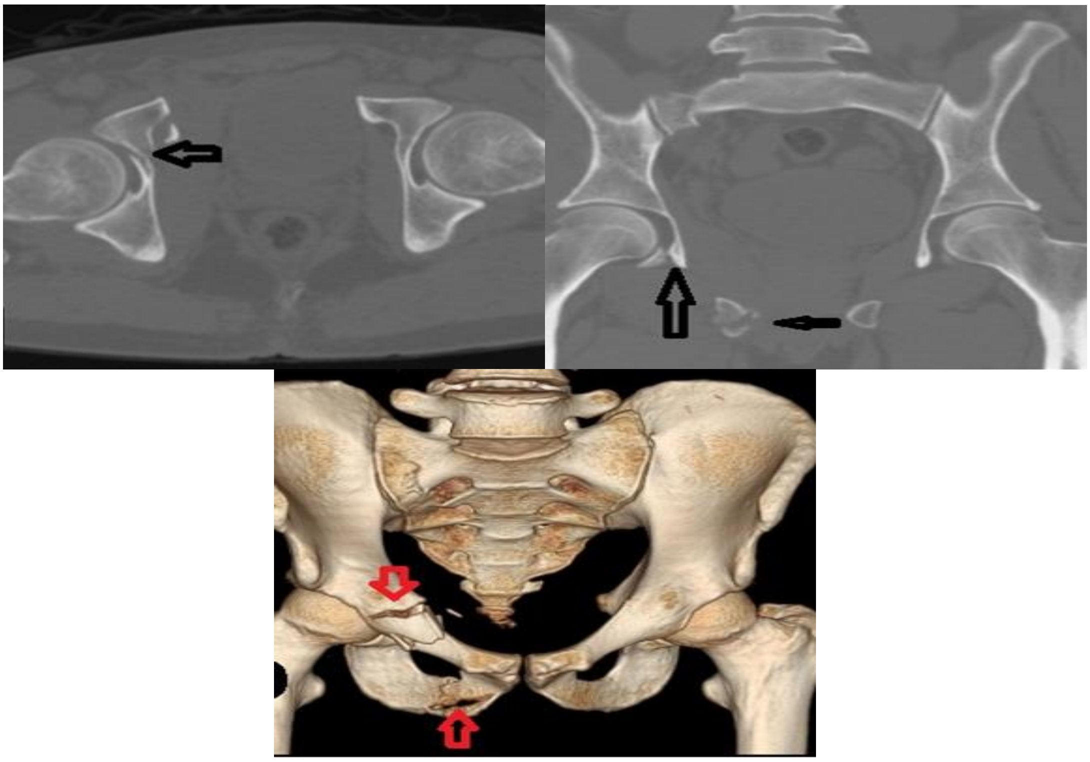


Fig (3, 4,5) Diagnosis: Right anterior column acetabular fracture with inferior pubic ramus fracture.

Discussion

For a patient with a traumatized acetabulum, accurate radiographic diagnosis and classification are the cornerstones of effective clinical care. The types of acetabular fracture and fracture combinations are described in terms of the involvement of the anterior or posterior columns. Correct classification precedes the choice of the surgical approach and serves as the basis for pre-operative planning (4).

Complex acetabular fractures should be evaluated by means of trans-axial CT and additional MPR. The use of appropriate standard MPR views shortens the time required to produce the reformats and thereby maximizes the benefit gained. Also, 2D and 3D reconstructions of CT data have been used as an aid to be understanding complex fracture patterns. The 2D multiplanar (MPR) reformats have already proved useful (5).

The purpose of our study was to establish viable of MDCT, MPR, and 3D projections for evaluating acetabular fractures, and to estimate the benefit thus gained.

The mean age of the patients in our series was 32 years (range15-55). This was agreeing with Mears (6) who reported that mean age of the patients was 13-89 years (range13-89 years). Also, Rev. Bras reported that patients' mean age was 38.4 years (range 17-76 years) (7).

In our series, there were males (86.7%) and females (13.3%). The incidence of acetabular fractures was found to be more in male than female. This was agreed with Rev. Bras, who reported that were 64 male (84.2%) and 12 were female (15.8%) (7).

In our series, Road traffic accident was the causative mechanism in (80%) cases while falling from height was in only (20%) cases. This agrees with many studies like, who reported that Road traffic accident was the causative mechanism in 80.5% of patients,10.7% had falls and in 8.8%, other causes were stated (8).

There were 51 cases of car and motorcycle accidents (67.1%), nine cases of being run over (11.8%), and eleven cases of falls from a height (14.5%) and another five indeterminate cases (6.6%) (7).

In our series, the 2nd most common fracture types were posterior wall and both columns. This was agreed with who reported that the commonest type of acetabular fracture was Posterior wall (23.6 %) and Both column (21.7%) (9). Also reported that commonly occurring acetabular fractures (90%) included both column and posterior wall (10).

In our study, the third commonest types of acetabular fracture are transverse column and anterior column fractures of acetabulum. These agree with Name of the auther, who reported that the Transverse column is coming after posterior wall and both column fracture (10). Also, reported that transverse and posterior wall were uncommon like posterior wall and both column fracture (9).

That reported three most common fracture types are posterior wall, transverse with posterior wall, and associated both columns- which together account for approximately two-thirds of all fractures. Fractures that contain a posterior wall component are most common, with nearly one-half of all acetabular fractures containing a posterior wall component. (1)

That reported the five most common acetabular fractures are reviewed: both-column, T-shaped, transverse, transverse with posterior wall, and isolated posterior wall. Fracture patterns on radiography are correlated with CT, including multiplanar reconstruction and 3D surface rendering (4).

In our series, we depend on The Judet and Letournel classification system for diagnosis of acetabular fracture. This was agreed with who considered that most useful by surgeons (11).

In our study, according to ROC curve the sensitivity and specificity of x-ray- were 67% & 71% respectively. On the other hand, C.T sensitivity and specificity were 96% and 89% respectively.

We note that x-ray sensitivity and specificity was lower than C.T as we depended only on AP view, which was limited, and could not do other positions for patients. These agree with (12), who reported that quality of some plain radiographs in the fracture case was not ideal. Obtaining appropriate Judet views can be a challenge and is often associated with significant patient discomfort. Thus, at the authors’ institution, multiple attempts to correct inadequate images in the emergency department are usually avoided.

Conclusion

- Radiography Technically easy, quick, portable, not degraded by streak artifact. However, radiography Findings may be obscured by overlying material, may be technically suboptimal -because of patient condition and body habitus- not as sensitive as CT for depicting fractures.

- Standard planar C.T depicts intra-articular fragments, articular impaction, soft-tissue injuries, subtle or nondisplaced fractures, and sacral and quadrilateral surface fractures.
- 3D surface rendered MDCT display is easy to understand, depicts fractures well, and has an interactive display (meaning that fractures can be viewed from multiple angles).
- SO, all cases with Acetabular fractures should be evaluated by means of trans-axial CT and additional MPR. The use of appropriate standard MPR views shortens the time required to produce the reformats and thereby maximizes the benefit gained.

Conflict of interest

The authors declare that they have no conflict of interest.

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To cite this article: Ahmed F. Yousef, Yasser M. Attia, Mohamed A. Elhariry , Mostafa A. Eissa . Role of MDCT in Detection, Classification and Follow up of Acetabular Fractures. BMFJ 2023;40 (Radiology):206-216.