Suez Canal University Medical Journal Vol. 25 (4), 2022
Pages 12-18

Role of Multidetector Computed Tomography (MDCT) in the Evaluation of Patients with Pelvic Trauma

Ahmed M. Housseini[1], Khaled A. Yousef[1], Laila M. Al-Kady[1], Mahmoud El Sherif[2*]

[1]*Department of Diagnostic Radiology, Faculty of Medicine, Suez Canal University, Egypt.*
[2]*Department of Orthopedic Surgery, Faculty of Medicine, Suez Canal University, Egypt*

Abstract

Background: **Pelvic traumas are severe and disabling injuries. Although plain radiographic evaluation of the pelvis includes many views such as anteroposterior, inlet, and outlet views; however, plain radiographs are not always accurate in the assessment of displacement's degree. Image quality can be compromised by different factors, like suboptimal positioning, obesity, bowel gas, and bladder contrast, also plain radiographs can't assess the associated soft tissue injuries and hematomas.** ***Aim:*** **To evaluate the role of Multidetector Computed tomography (MDCT) as a useful diagnostic modality in the accurate diagnosis of pelvic trauma patients.** ***Subjects and Methods:*** **This cross-sectional descriptive study was carried out in the Diagnostic Radiology Department at Suez Canal University Hospitals from November 2019 to February 2021. It included 20 patients with pelvic trauma that were treated with internal fixation.** ***Results:*** **Regarding age, 70% of cases were in the age group (20–50) years. Regarding gender, males constitute 55% of cases. This study found that the sensitivity of 3D CT in the detection of bone fracture was 100%, specificity was 100%, PPV was 100%, NPV was 100% and accuracy was 100%. The sensitivity of MDCT in the detection of organ injury was 92.3%, specificity was 100%, PPV was 100%, NPV was 87.5%, accuracy was 95%, and accuracy was 95% with area under ROC curve (AUC) 0.99.** ***Conclusions:*** **MDCT is an excellent imaging modality to evaluate patients with pelvic trauma, being a reliable, safe, and non-invasive procedure. It also decreases unnecessary exploration and improves patient survival.**

Keywords: Multidetector, computed tomography, scan, pelvic, trauma

Introduction

Pelvic fractures are major and disabling injuries. Comprehensive radiographic evaluation of pelvic injuries must include both plain radiographs and computed tomography (CT)[(1)]. CT allows a more detailed assessment of injury patterns and prevents misdiagnosis caused by suboptimal positioning, obesity, bowel gas, associated soft tissue injuries, and hematomas[(2)]. Multidetector Computed Tomography (MDCT) has been used to give a more detailed diagnosis of pelvic fracture and soft tissue injuries[(3)]. Establishing the quality of three-dimensional (3D) pelvic images is considered a definitive step for planning and treatment of pelvic fractures[(4)]. In this study, we assessed the role of MDCT in the evaluation of pelvic injuries as a preoperative diagnostic tool.

Subjects and Methods

A cross-sectional descriptive study was conducted in the Diagnostic Radiology Dep

[*]*Corresponding Author: elsherif_mahmoud@hotmail.com*

artment of Suez Canal University Hospital from November 2019 to February 2021. It included 20 adult patients with pelvic trauma who were referred from the emergency room and afterwards treated surgically with internal fixation. Pregnant patients and those who refused to participate in the study were excluded.

Data collection

MDCT

CT Acquisition Technique
All pelvis CT examinations were performed with patients in the supine position during end inspiration in cephalocaudal position and feet first without contrast medium injection. CT was performed on a 16-slice CT scanner (Toshiba Aquilion, Netherland). The following scan parameters were used: Tube voltage, 120 kV; Tube current modulation, 180–230 mAs; Gantry rotation time, 0.5 sec; Helical pitch, 15; Pitch factor, 0.9375; Collimation width, 0.5; and slice thickness, 1 mm.

CT Image Analysis
Images were transferred from the CT machine to Picture Archiving and Communication System (Vitrea Enterprise Suite, Version 6.7; Vital Images, Minnetonka USA). Three-dimensional volume rendering technique (3D VRT) as well as multiplanar coronal and sagittal reformatted images in soft and bone algorithms were obtained from thin slice images according to the parameters seen in table 1. The images were reviewed by consultant radiologists who were blinded to clinical data. They analyzed data and classified pelvic fractures utilizing Tile classification and Young and burgess classification for adult pelvic fractures; Torode and zieg classification for pediatric pelvic fractures; and Judet and Letournel for acetabular fractures[5,6].

Orthopedic operative analysis
All cases were examined and treated by the same orthopedic surgeon through open reduction and internal fixation. Fixation type was planned for each fracture according to preoperative diagnosis. Intraoperative reassessment of pelvic fractures and associated soft tissue injuries was done and documented. Postoperative radiological assessment and follow up were done as seen in Figures 2 & 3.

Ethical Considerations

An approval from Suez Canal University ethical committee was obtained. As well, informed consent was obtained from each patient to participate in the study

Statistical analysis

Data analysis was done using the Statistical Program for Social Science version 20 (SPSS Inc., Chicago, IL, USA). Quantitative variables were described in the form of mean and standard deviation. Qualitative variables were described as number and percent followed by chi-square (X^2) test. Receiver operating characteristic (ROC) analysis was used to find out the best cut off value with detection of sensitivity, specificity, positive predictive value, negative predictive value, and accuracy. p value < 0.05 is considered significant.

Results

Regarding the age, 30% of cases were in age group (20- 30) years, 30% of cases were in age group (41 – 50) years, 20% of cases were in age group (31-40) years, 10% were less than 20 years, and 10% more than 50 years. Regarding the gender, 55% of cases were males and 45% were females. Regarding mechanism of injury, 55% of injuries were resulted from road traffic accident, 35% were

fall from a height and 10% were assault. Regarding site of pelvic bone injury, pubic rami injuries were involved in 25% of cases, pubic arch injuries in 20% of cases, acetabulum injury in 15% of cases, sacrum injury in 15% of cases, and ilium injury in 10% of cases.

Table 1: Reconstruction parameters				
Parameters	**Soft Tissue**	**Bone**	**Thin Data**	**Thin Data**
Slice Thickness	3 mm	3 mm	0.75 mm	0.75 mm
Reconstruction Spacing	3 mm	3 mm	0.5 mm	0.5 mm
Reconstruction Algorithm	B30f	B70f	B20f	B60f
Window Width and Level	410/10	1776/176	410/10	1776/176
Parameters	**Sagittal**	**Coronal**	**Coronal**	**Sagittal**
Slice Thickness	3 mm	3 mm	3 mm	3 mm
Reconstruction Spacing	3 mm	3 mm	3 mm	3 mm
Reconstruction Algorithm	B30f	B30f	B70f	B70f
Window Width and Level	410/10	410/10	1776/176	1776/176

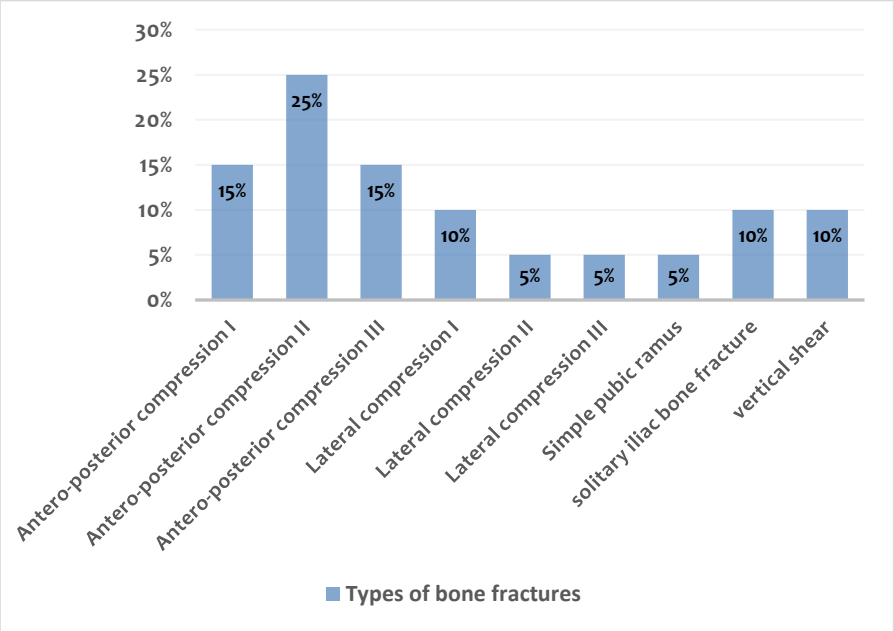

Figure 1: Distribution of pelvic bone injuries among study population

Regarding classification of pelvic injuries according to Young and Burgess, shows that bone injuries was Antero-posterior compression I in 15% of cases, Antero-posterior compression II in 25% of cases, Antero-posterior compression III in 15% of cases, Lateral compression I in 10% of cases, Lateral compression II in 5% of cases, Lateral compression III in 5% of cases, Simple pubic ramus in 5% of cases, solitary iliac bone fracture in 10% of cases and vertical shear in 10% of cases (Figure 2).

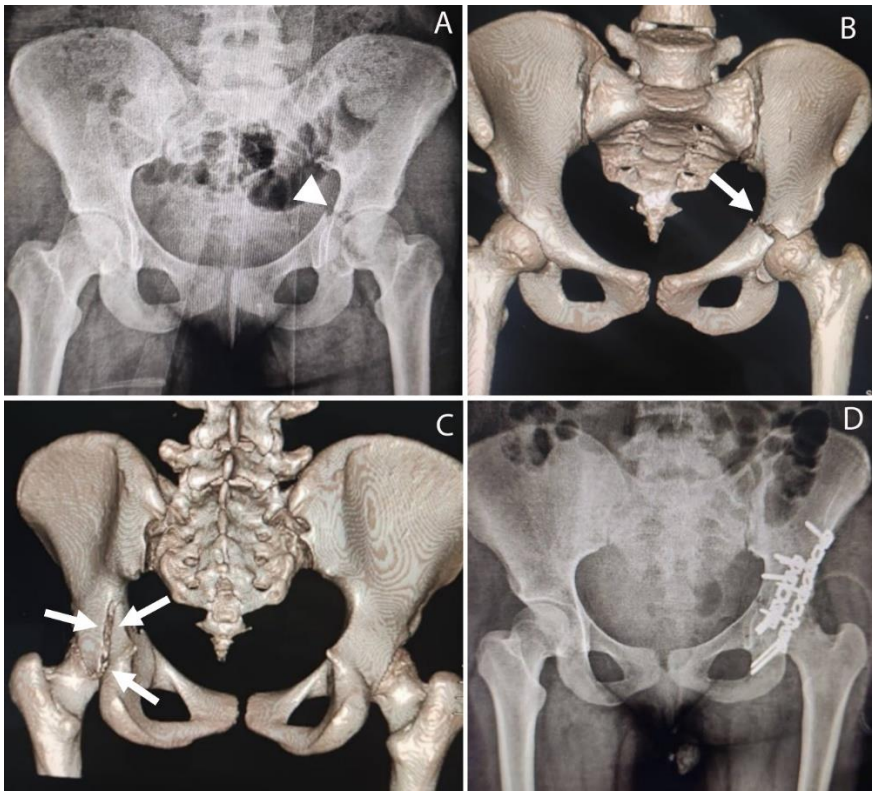

Figure 2: (A) Plain X-ray of the pelvis and both hips (anteroposterior view) show fracture of the left acetabulum (arrowhead). Three-dimensional Volume Rendering Technique (3D VRT) CT image in anteroposterior view **(B)** and posteroanterior view **(C)** show posteroinferior extension of the left acetabular fracture (arrows). **(D)** Post-operative plain X-ray of the pelvis and both hips (Anteroposterior view) show good anatomical reduction with fixation by two plates and screws of the left acetabular fracture.

Table 2: Validity of 3D CT in detection of bone injury in reference to intraoperative diagnosis

	intraoperative diagnosis	
3D CT Validity	Positive	Negative
Positive	20	0
Negative	0	0
Sensitivity	100	
Specificity	100	
PPV	100	
NPV	100	
Accuracy	100	

Table 2 shows that sensitivity of 3D CT in detection of bone fractures was 100%, specificity was 100%, PPV was 100%, NPV was 100% and accuracy was 100%. This table shows that sensitivity of MDCT in detection of organ injury was 92.3%, specificity was 100%, PPV was 100%, NPV was 87.5%, accuracy was 95% (table 3), accuracy was 95% with area under ROC curve (AUC)0.99. This table shows no significant difference between 2D CT and 3D CT as regard detection of fracture, the agreement between the two studied techniques was excellent with value of 0.95 (table 4).

Table 3: Validity of MCT in detection of organ injury in reference to intraoperative diagnosis		
	Intraoperative diagnosis	
MCT Validity	*Positive*	*Negative*
Positive	12	0
Negative	1	7
Sensitivity	92.3	
Specificity	100.0	
PPV	100.0	
NPV	87.5	
Accuracy	95.0	

Discussion

In hemodynamically stable multiple trauma patients, MDCT scanning is currently the gold standard diagnostic method). With the advent of MDCT, scanning times have progressively decreased while image resolution has increased owing to thinner collimation and reduced partial volume and motion artifacts[7]. It was observed that no age group was exempted from traumatic injury of pelvis; However, in the third decade of life, this was more common[8]. These findings are in accordance with those of an Egyptian study, which found that the majority of the study's participants were in their second and third decades. This suggests that young adults are more susceptible to pelvic injuries, maybe because of their increased exposure to everyday dangers. Males were involved in more outdoor activities than females, putting them at greater risk of injury. Male affection was also found to be more widespread in this study (55 percent).

Table 4: Comparison between 2D CT and 3D CT as regard detection of fracture				
	2DCT No. (%)	3DCT No. (%)	X^2	P value
Positive	19 (95.0)	20	Fisher's exact	1.0
Negative	1 (5.0)	0 (0.0)		
Kappa agreement	0.95			

Pelvic-abdominal injuries disproportionately affect young male patients, peaking in the twenty to fifty age groups, according to Awe et al 5-year study, with male patients accounting for 86.9% of the total, while female patients accounted for 13.1 percent[9]. In our study, 20% of the cases had a pubic arch fracture, 15% had a pubic crest fracture, and 25% had a pubic rami fracture. Based on the classification and proper planning, the best surgical strategy is determined. In contrast to Harris et al. study, that showed 23% of the study population had acetabular fractures, our study found that 15% of the study population had acetabular fractures[10]. A "correct" diagnosis was made by 30-76% of the time based on 2D images. The rate of "correct" classifications increased to 65–83% when using 3D images. As a result, the use of MDCT for the precise analysis and categorization of acetabular fractures is critical.

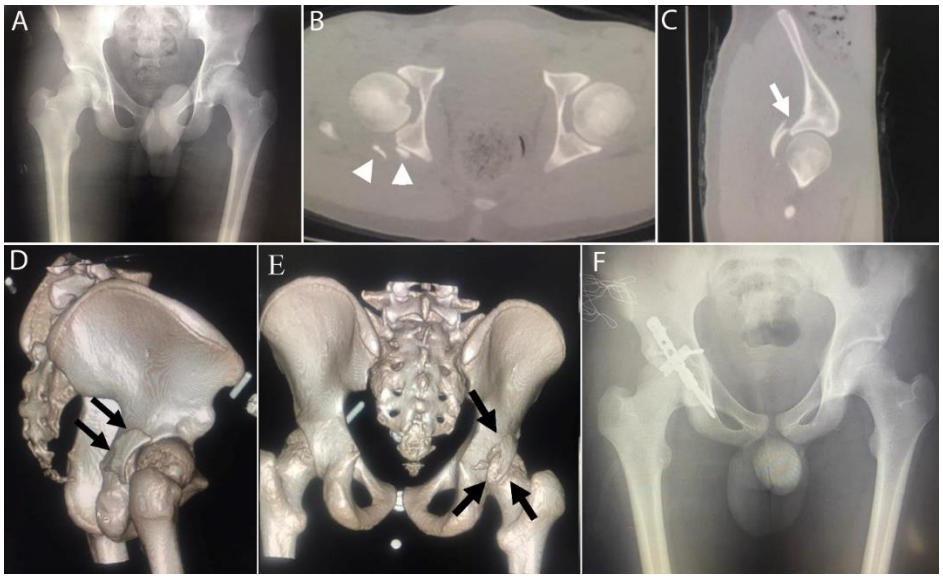

Figure 3: Plain X-ray anteroposterior view of the pelvis and both hips **(A)** with no fractures could be seen. MDCT (bone window) images in axial view (B) and sagittal reformatted view (C) show comminuted posterior wall fracture of the right acetabulum with displaced bone fragments (arrowhead in A and arrow in B). Three-dimensional Volume Rendering Technique (3D VRT) CT images in sagittal oblique view (D) and posteroanterior view (E) nicely demonstrate comminuted posterior wall fracture of the right acetabulum with displaced bone fragments (arrows). **(F)** Post-operative plain X-ray of the pelvis and both hips (Anteroposterior view) show good anatomical reduction after fixation by spring and reconstruction plates.

One third of pelvic fractures were not apparent on the initial radiographs; however, additional views were taken three months later demonstrate a fracture. In this study, the reconstructions added fine details that would be difficult to evaluate using axial reconstructions alone. The MDCT had shown high sensitivity in diagnosis of pelvic injuries involving non-solid organs reaching 95%. In agreement with our findings, the study done by Salimi et al. in 2009 over a period of two years reported MDCT scan had the highest sensitivity for detecting pelvi-abdominal injuries[11]. Also, in agreement with the study done by Van der Vlies et al. in 2011, who reported that MDCT scanning with intravenous contrast has a sensitivity of 90–100%[12]. These findings are consistent with those reported before. The limitations of this study include the small number of patients and the absence of long-term follow-up data. Quantitative correlations were also difficult to develop due to the variability of damage patterns. As a result, we were only able to provide our preliminary findings in this study, and a bigger patient group is needed to further assess this tool for therapeutic use.

Conclusion

MDCT is an excellent imaging tool for evaluating patients who have suffered pelvic injuries. It reduces unnecessary exploration and improves the prognosis of patients.

References

1. Brown JV, Yuan S. Traumatic injuries of the pelvis. Emerg Med Clin North Am, 2020; 38.1: 125-142.
2. Heiken JP, Katz DS, Menu Y. Emergency radiology of the abdomen and pelvis: imaging of the non-traumatic and traumatic acute abdomen. Diseases of the Abdomen and Pelvis 2018-2021: Diagnostic Imaging, 2018; 123-143.
3. Patlas MN, Dreizin D, Menias CO, et al. Abdominal and pelvic trauma misses

and misinterpretations at multidetector CT: trauma/emergency radiology. Radiographics, 2017; 37.2: 703-704.
4. Hallinan JT, Tan CH, Pua U. The role of multidetector computed tomography versus digital subtraction angiography in triaging care and management in abdominopelvic trauma. Singapore Med J, 2016; 57.9: 497.
5. Gray A, Chandler H, Sabri O. Pelvic ring injuries: classification and treatment. Orthop Trauma, 2018; 32.2: 80-90.
6. Butler BA, Lawton CD, Hashmi SZ, et al. The relevance of the Judet and Letournel acetabular fracture classification system in the modern era: a review. J Orthop Trauma, 2019; 33: S3-S7.
7. Raniga SB, Mittal AK, Bernstein M, et al. Multidetector CT in vascular injuries resulting from pelvic fractures: a primer for diagnostic radiologists. Radio Graphics, 2019; 39.7: 2111-2129.
8. DeFrancesco CJ, Sankar WN. Traumatic pelvic fractures in children and adolescents. In: Seminars in Pediatric Surgery. WB Saunders, 2017; 27-35.
9. Awe JA, Soliman AM. Abdominal trauma: a five-year experience in a military hospital. Glob Adv Res J Med Med Sci, 2013; 2: 177-83.
10. Tamburella G, Are A. Acetabular fractures: A new CT-based classification. In: Orthopaedic Proceedings. Bone Joint J, 2009; 22-22.
11. Salimi J, Bakhtavar K, Solimani M, et al. Diagnostic accuracy of CT scan in abdominal blunt trauma. Chin J Traumatol, 2009; 12.02: 67-70.
12. Van der Vlies CH, Olthof DC, Gaakeer M, et al. Changing patterns in diagnostic strategies and the treatment of blunt injury to solid abdominal organs. Int J Emerg Med, 2011; 4.1: 1-9.