The Role of Multi Detector Computed Tomography in the Assessment of Chest Trauma

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Abstract: Objective: This study aims to assess the role of multi detector computed tomography in the evaluation of trauma to the chest including both bony and soft tissue injuries and comparing them with the radiographs. **Methods**: It was a prospective study carried out at Alzahraa university hospital. A total number of25 patients coming to the emergency department with history of chest trauma from January 2019 to June 2019 were selected and examined clinically. Those who had findings that suspect chest trauma on clinical examination underwent CXR and 160 slice MDCT examination. Finally, we compared between CXR and MDCT in detection of complications of blunt chest trauma. **Results**: MDCT has been shown to be better than chest X-ray in assessment of complications of chest trauma especially as concerns the vertebral fractures, hemothorax, hemopneumothorax, pulmonary contusions and mediastinal injuries. **Conclusion:** Whereas chest radiographs are broadly used as the first imaging modality in suspected chest trauma in the emergency settings, a subsequent computed tomographic evaluation has proven to be more effective, especially with the advance in its multiplanar capability, since it's more sensitive than chest radiographs in detecting chest injuries, especially pulmonary and mediastinal ones. The early use of MDCT in chest trauma cases allows early detection of possible serious injuries and better evaluation of the underlying pathology which in turn allows for better and proper management of the case that subsequently decreases the risk of complications and decreases trauma related morbidity and mortality rates.
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1. Introduction

Chest trauma is classified as blunt or penetrating, with blunttrauma being the cause of most thoracic injuries (90%). The main difference lies in the presence of an opening to the inner thorax in penetrating trauma, created by stabbing or gunshot wounds, which is absent in blunt chest trauma (1). Chest trauma is the third most common in trauma patients, next to trauma to the head and extremities. It has an overall fatality rate of 15–25%, which is the highest in patients with cardiac or tracheo bronchial-esophageal injuries. The most common cause, road traffic accidents that account for 70–80 % of all significant blunt chest trauma cases. Falls, acts of violence are also relevant causes (2). Multi-detector computed tomography is the preferred imaging modality for the evaluation of poly-trauma patients. It's widely available, quick and offers multi-planer and three-dimensional reconstructions and is generally more sensitive and specific than chest radiography. It has been shown to change patient management in up to 20% of patients with abnormal initial chest radiography (3). CT is far more effective than chest radiography in detecting pulmonary contusion, thoracic aortic injury and osseous trauma, especially at the cervicothoracic spine. MDCT has dramatically decreased imaging times and offers readily available multiplaner reformatted images or more sophisticated volume-rendered and MIP images. Therefore, it has been established as the gold standard for the imaging evaluation of chest trauma and trauma in general (4). MDCT can be used to evaluate a wide variety of thoracic injuries, including chest wall bony injuries such as rib fractures, which are the most common injuries in the chest trauma; clavicle fractures with or without sternoclavicular dislocation; fractures resulting from high-energy deceleration, such as sternal and scapular fractures; and dorsal spine fractures, in which MDCT plays a major role in guiding clinical management (5). Chest wall soft tissue injuries include surgical emphysema and soft tissue contusion, which may result in arterial or venous hematoma, with the latter often being self-limiting and slow-growing (6). Pleural space injuries include hemothorax with arterial bleeding causing more significant progressive increase in volume and mass than venous hemorrhage, pnemothorax which is the second most common finding in cases of blunt chest trauma and hydro-pneumothorax (7). Injuries of the lung parenchyma appear as pulmonary contusions, which are the most common lung injury; pulmonary lacerations, which are obvious tears in the lung parenchyma, and rare complications such as lung torsion and lung herniation can also be detected (8).

2. Patients and Methods

It was a prospective study carried out at the radiology department of Alzahraa university hospital, from January 2019 to June 2019. After obtaining local medical ethics committee approval and written informed consent from all patients in the study, 25numbers of patients with chest trauma were eligible in the study. The patients were subjected to brief history taking including age, sex, the mechanism of injury and their current symptoms, vital signs were noted and chest examination then followed. Patients then underwent chest X-ray and MDCT examinations using 160 slice MDCT with 3D reconstruction whenever bony injuries were detected. A comparison was then done between the spectrum of findings detected by both imaging methods.

2.1. Imaging and Imaging Analysis

All CT scans were performed using MDCT (Toshiba Aquilion Prime 160 Slice). All patients were examined in the supine position in which a volumetric acquisition with wide field of view was done in a cranio-caudal direction starting from the root of the neck till the level of the renal arteries with slice thickness 1mm and exposure factors adjusted according to body mass.

2.3. Data Collection and Analysis

A standardized form was used to collect data. Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Chi-square (x^2) test of significance was used in order to compare proportions between qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

3. Results.

The results of the present study are demonstrated in the following tables and figures.

Table (1): Demographic data distribution of the study group.

Demographic data	Total (n=25)
Sex	
Female	4 (16.0%)
Male	21 (84.0%)
Age (years)	
≤35 years	17 (68.0%)
>35 years	8 (32.0%)
Range [Mean±SD]	20-85 [35.92±18.14]

This table shows that the **Sex** Female 4 (16.0%), Male 21 (84.0%); also **Age (years)** ≤35 years 17 (68.0%) and >35 years 8 (32.0%) of demographic data.

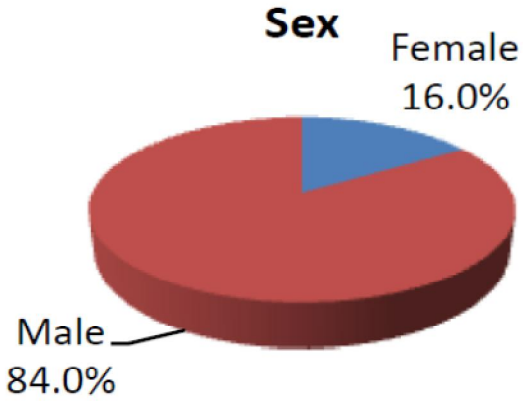

Fig. (1): Pie chart sex distribution of the study group.

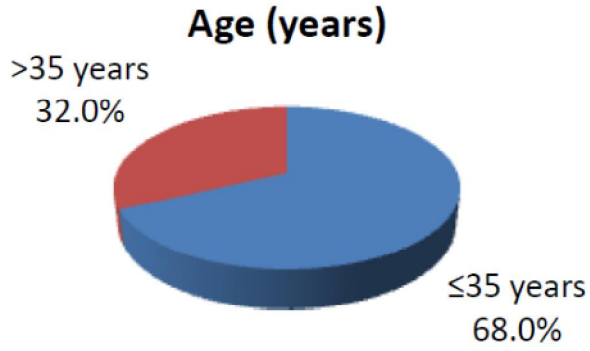

Fig. (2): Pie chart Age distribution of the study group.

Table (2): Type of trauma distribution of the study group.

Type of trauma	Total (n=25)
Blunt	**22 (88.0%)**
Fall from height	8 (32.0%)
Motor vehicle accident	10 (40.0%)
Trauma by blunt object	4 (16.0%)
Penetrating	**3 (12.0%)**
Stab wound	3 (12.0%)

This table shows that the blunt (88%) and penetrating (12%) of type of trauma.

Table (3): Symptoms distribution of the study group.

Symptoms	Total (n=25)
Dyspnea	19 (76.0%)
Chest pain	17 (68.0%)
Back pain	6 (24.0%)

This table shows that the dyspnea (76%), chest pain (68%) and back pain (245) of symptoms.

Table (4): Signs distribution of the study group.

Signs	Total (n=25)
DCL	2 (8.0%)
Crepitation's	7 (28.0%)
Tenderness	19 (76.0%)
Diminished air entry	15 (60.0%)
Peripheral weakness	2 (8.0%)

This table shows that the DCL 2 (8.0%), Crepitation's 7 (28.0%), Tenderness 19 (76.0%), Diminished air entry 15 (60.0%) and Peripheral weakness 2 (8.0%) of signs.

Table (5): CT findings distribution of the study group.

CT Findings	Total (n=25)
Bony chest wall injuries	
Clavicle Fracture	6 (24.0%)
Rib Fracture	9 (36.0%)
Vertebral Fracture	4 (16.0%)
Soft chest wall injuries	
Surgical Emphysema	7 (28.0%)
Hematoma	5 (20.0%)
Pleural injuries	
Hemopneumothorax	3 (12.0%)
Hemothorax	7 (28.0%)
Pneumothorax	12 (48.0%)
Parenchymal injuries	
Contusion	15 (60.0%)
Collapse	2 (8.0%)
Laceration	1 (4.0%)
Mediastinal injuries	
Pneumomediastinum	5 (20.0%)
Other systems	
Abdominal injuries	2 (8.0%)
Fracture pelvis	1 (4.0%)
Fracture shoulder	2 (8.0%)

This table shows that the **Bony chest wall injuries** Clavicle Fracture 6 (24.0%), Rib Fracture 9 (36.0%), Vertebral Fracture 4 (16.0%); **Soft chest wall injuries** Surgical Emphysema 7 (28.0%), Hematoma 5 (20.0%); **Pleural injuries** Hemopneumothorax 3 (12.0%), Hemothorax 7 (28.0%) and Pneumothorax 12 (48.0%); **Parenchymal injuries** Contusion 15 (60.0%), Collapse 2 (8.0%), Laceration 1 (4.0%); **Mediastinal injuries** Pneumomediastinum 5 (20.0%) and **Other systems** Abdominal injuries 2 (8.0%), Fracture pelvis 1 (4.0%) and Fracture shoulder 2 (8.0%) of CT finding.

Table (6): AP x-ray findings distribution of the study group.

PA X-ray findings	Total (n=25)
Clavicle Fracture	3 (12.0%)
Collapse	2 (8.0%)
Contusion	7 (28.0%)
Hemothorax	1 (4.0%)
Pneumothorax	10 (40.0%)
Rib Fracture	6 (24.0%)
Surgical Emphysema	4 (16.0%)

This table shows that the Clavicle Fracture 3 (12.0%), Collapse 2 (8.0%), Contusion 7 (28.0%), Hemothorax 1 (4.0%), Pneumothorax 10 (40.0%), Rib Fracture 6 (24.0%) and Surgical Emphysema 4 (16.0%) of AP x-ray findings.

Table (7): Comparison between CT Findings and AP X-ray findings according to bony chest wall injuries of the study group.

Bony chest wall injuries	CT Findings *(n=25)*	AP X-ray findings *(n=25)*	x2	p-value
Clavicle Fracture	6 (24.0%)	3 (12.0%)	4.099	0.043*
Rib Fracture	9 (36.0%)	6 (24.0%)	5.091	0.035*
Vertebral Fracture	4 (16.0%)	0 (0%)	6.658	0.009*

*x^2: Chi-square test; *p-value <0.05 S*

This table shows statistically significant difference between CT Findings and AP X-ray findings according to bony chest wall injuries in favor of CT scan.

Table (8): Comparison between CT Findings and AP X-ray findings according to soft chest wall injuries of the study group.

Soft chest wall injuries	**CT Findings** ***(n=25)***	**AP X-ray findings** ***(n=25)***	**x2**	**p-value**
Surgical Emphysema	7 (28.0%)	4 (16.0%)	5.526	0.037*
Hematoma	5 (20.0%)	0 (0%)	9.481	0.003*

*x^2: Chi-square test; *p-value <0.05 S*

This table shows statistically significant difference between CT Findings and AP X-ray findings according to soft chest wall injuries in favor of CT scan.

Table (9): Comparison between CT Findings and AP X-ray findings according to pleural injuries of the study group.

Pleural injuries	**CT Findings** ***(n=25)***	**AP X-ray findings** ***(n=25)***	**x2**	**p-value**
Hemopneumothorax	3 (12.0%)	0 (0%)	4.099	0.043*
Hemothorax	7 (28.0%)	1 (4.0%)	9.003	0.003**
Pneumothorax	12 (48.0%)	10 (40.0%)	0.081	0.776

x^2: Chi-square test;
**p-value <0.05 S; **p-value <0.001 HS*

This table shows statistically significant difference between CT Findings and AP X-ray findings according to hemopneumothorax and hemothorax in favor of CT scan.

Table (10): Comparison between CT Findings and AP X-ray findings according to parenchymal injuries of the study group.

Parenchymal injuries	**CT Findings** ***(n=25)***	**AP X-ray findings** ***(n=25)***	**x2**	**p-value**
Contusion	15 (60.0%)	7 (28.0%)	9.131	0.003*
Collapse	2 (8.0%)	2 (8.0%)	0.000	1.000
Laceration	1 (4.0%)	0 (0%)	0.510	0.475

*x^2: Chi-square test; *p-value <0.05 S*

This table shows statistically significant difference between CT Findings and AP X-ray findings according to contusion.

Table (11): Comparison between CT Findings and AP X-ray findings according to mediastina injuries of the study group.

	CT Findings ***(n=25)***	**AP X-ray findings** ***(n=25)***	**x2**	**p-value**
Mediastina injuries				
Pneumomediastinum	5 (20.0%)	0 (0%)	9.000	0.002*
Other systems				
Abdominal injuries	2 (8.0%)	0 (0%)	2.344	0.126
Fracture pelvis	1 (4.0%)	0 (0%)	0.510	0.475
Fracture shoulder	2 (8.0%)	0 (0%)	2.344	0.126

*x^2: Chi-square test; *p-value <0.05 S*

This table shows statistically significant difference between CT Findings and AP X-ray findings according to mediastina injuries.

4. Discussion

The current study is designed to assess the role of MDCT in the assessment of chest trauma patients and to compare between radiological findings based on MDCT with those on radiographs as regards to the presence of bony fractures, soft tissue, pleural, pulmonary and mediastinal injuries. Our study was conducted on 25 patients, of which there were (16.0%, n=4) females, (84.0%, n=21) males; also Age (years) ≤35 years (68.0%, n=17) and >35 years (32.0%, n=8) with blunt trauma accounting for (88%) of cases, while penetrating (12%). The most common mechanism of injury is motor vehicle accident accounting for (40%, n=10) followed by fall from height (30%, n=8).

These results are in agreement with study made by **Naglaa L. et al (9)** in which out of the thirty patients, 70% (n = 21) were males with age ranging from 6 to 62 years (mean =32.7 years) and most of the patients were in the age group 20–40 years (60%). The most common mechanism of trauma was as a result of motor vehicle accidents (56.7%, n= 17) followed by fall from height (23.3%, n=7). Concerning the bony chest wall injuries, the results of the current study showed statistically significant difference between CT Findings and AP X-ray findings according to bony chest wall injuries including ribs, clavicles and vertebral fractures in favor of CT scan. Our study stated that the incidence of clavicle fracture (24.0%, n=6), rib fracture (36.0%, n=9), vertebral fracture (16.0%, n=4) with rib fracture being the most common and MDCT was more sensitive than radiographs in its detection where 9 cases where detected by MDCT as compared to 6 cases only on radiograph, this results coincide with the previous mentioned study by **Naglaa L. et al (9)** carried on 30 patients in which rib fractures were the most common of chest wall injuries (56.7%). MDCT was the most sensitive (100%) technique for imaging rib fractures, and chest radiography had limited sensitivity (65.4%). There were also 3 patients (10%) with clavicular fractures. Also our results were in agreement with **Kerns and Gay (10)** who stated that many of rib fractures are missed on chest radiographs possibly due to difficulties in obtaining good radiographic posterior views. Our study included 4 patients (16 %) with thoracic spine fractures with MDCT scan compared to 0% by chest radiography.

This finding was similar to that described by **Denis F. (11)** who reported that thoracic spine fractures account for 13–30% of all spine fractures and the thoracic region of the spine has a relatively high stability because of the stabilizing effects of the ribs and the rib cage so injuries that result in fracture are usually caused by high energy.

Also our results coincided with **Meyer S. (12)** who reported that spine fractures are usually difficult to detect on routine chest radiographs, especially those located in the upper portion and MDCT is much more sensitive for diagnosing thoracic spine fractures and is the imaging modality of choice. However, in contrary to the present study is the study by **Primak and Collins (13)** who reported that rib fractures were the most common findings of all types of injuries after chest trauma with an incidence reported up to 40%, while our study stated that the most common finding is pneumothorax (48%) while rib fracture accounts for (36%). As regards to soft chest wall injuries our study shows statistically significant difference between CT Findings and AP X-ray findings according to soft chest wall injuries in favor of CT scan in which there were (28%, n=7) cases with surgical emphysema detected on MDCT, while only (16%, n=4) were detected on radiographs. And (20%, n=5) with hematoma on MDCT, none of them were detected on radiographs. In agreement with the results of the current study the study done by **Youssriah Yahia Sabri et al (14)** on 125 patients, in which surgical emphysema was detected by MDCT in (27.2%, n=34) and chest wall haematoma was detected in 13 patients (10.4%, n=13). As regards to pleural injuries our study stated that there was statistically significant difference between X-ray and CT scanning regarding pleural positive findings including Hemopneumothorax (12.0%, n=3), Hemothorax (28.0%, n=7) and Pneumothorax (48.0%, n=12) detected by MDCT whereas only 1 case of hemothorax and none of hemopneumothorax was detected on x-ray, but 10 of the pneumothorax was detected by radiographs. In agreement with the current study is the study performed by **Mohammed A. El Wakeel et al (15)** on 100 patients, in which 86 cases (86%) demonstrated by CT to have pleural diseases in the form of pneumothorax and hemothorax, whereas 56 cases (56%) demonstrated by X-ray to have pleural diseases in the form of pneumothorax and hemothorax. Our findings are also in agreement with the results of the study performed by **De Moya MA. et al (16)** which reported that 10–50% of pneumothoraces from blunt trauma are not visualized on chest radiography performed in supine patients as the air in the pleural space accumulates anteriorly and medially but can be seen on MDCT. This type of pneumothorax is called occult pneumothorax. As regards to parenchymal injuries, in our study we found that there was statistically significant difference

as regards to pulmonary contusions that accounted for (60.0%, n=15) on MDCT whereas on radiographs (28%, n=7), as for Collapse there was no significant difference as the same number detected by both means (8.0%, n=2) and in case of laceration (4.0%, n=1) by MDCT not detected on X-ray. In agreement with the results of the current study, the study by **Traub M. et al (17)** who documented that chest CT is more sensitive than CXR in the detection of lung contusions; CT detected lung contusion in 31% of patients, whereas X-ray detected lung contusion in 16% of cases. It also runs parallel to the study by **Mohammed A. El Wakeel et al (15)** in which X-ray demonstrated lung contusions in 31 cases (31%), whereas CT demonstrated lung contusions in 45 cases (45%). And agreeing with the study by **Naglaa L. et al (9)** in which parenchymal lacerations were found in 2 patients (6.7%) and MDCT scan was highly sensitive in detecting lung lacerations compared to poor sensitivity by chest radiography. As for mediastinal injuries, our study stated that there is statistically significant difference between CT Findings and AP X-ray findings according to mediastinal injuries especially pneumomediastinum that accounts for (20%, n=5) on MDCT compared with none on X-ray. Our study is in agreement with the study conducted by **Oikonomou Anastasia and Prassopoulos Panos (18)** which stated that pneumomediastinum occurs in 10% of patients with chest trauma. Also agreeing to study by **Naglaa L. et al (9)** in which (13.3%, n=4) of cases showed pneumomediastinum on MDCT as compared to (6.7%, n=2) on radiographs.

Conclusion.

Whereas chest radiographs are broadly used as the first imaging modality in suspected chest trauma in the emergency settings, a subsequent computed tomographic evaluation is highly recommended, especially with the advance in its multiplanar capability, since it's way more sensitive than chest radiographs in detecting chest injuries, especially pulmonary and mediastinal ones. The early use of MDCT in chest trauma cases allows early detection of possible serious injuries and better evaluation of the underlying pathology which in turn allows for better and proper management of the case that subsequently decreases the risk of complications and decreases trauma related morbidity and mortality rates.

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