Effectiveness of multislice computed tomography in the detection of hidden thoracic injuries

Alaa M.A. Eldeen Ahmed, Moustafa H. Othman, Shimaa F. Gad

Department of Radiodiagnosis, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Alaa M.A. Eldeen Ahmed, BSc,
Department of Radiodiagnosis, Faculty of Medicine, Assiut University, Assiut, Egypt
postal Code 71526;
Tel: 01000406571
e-mail: alaamohamed2850@gmail.com.

Received 01 March 2020
Revised 06 March 2020
Accepted 15 March 2020
Published 30 December 2021

Journal of Current Medical Research and Practice
2021, 6:411–414

Background
Blunt chest trauma is a serious problem affecting mainly men and it is usually caused by motor car accidents. A chest radiograph is the initial screening modality of trauma patients; however, multislice computed tomography (MSCT) is the modality of choice for rapid assessment of blunt chest trauma patients.

Aim
The aim was to determine the effectiveness of MSCT over chest radiography in the detection of hidden thoracic injuries in blunt chest trauma patients.

Patients and methods
The study included 50 patients who presented with blunt chest trauma either as a sole presentation or as a part of polytraumatic insults. All patients underwent chest radiography followed by noncontrast MSCT after a detailed history and complete examination by a cardiothoracic surgeon.

Results
Pulmonary contusion was the most frequent thoracic injury caused by blunt chest trauma as it occurred in 43 (86%) patients, followed by rib fracture (82%), pleural effusion (72%), pneumothorax (60%), surgical emphysema (50%), and scapular fracture (14%). MSCT was more effective than chest radiography in the detection of thoracic injuries, especially in the pneumothorax and pleural effusion with a percentage of difference was 133 and 120%, respectively, which was highly statistically significant (as P=0.01, 0.03, respectively). Also, it was more effective in the detection of pulmonary contusion, rib fractures, scapular fractures, and surgical emphysema with the percentage of difference being 96.5, 44.7, 14, and 8.3%, respectively.

Conclusion
MSCT is the imaging modality of choice in evaluating hemodynamically stable blunt chest trauma patients.

Keywords:
blunt trauma, chest radiography, multislice computed tomography, thoracic injury

J Curr Med Res Pract 6:411–414

2357-0121

Introduction

Thoracic trauma has an overall mortality rate of 10.1%, which is higher in patients with cardiac or tracheobronchial–esophageal injuries. It is considered one of the most common injuries of trauma patients, after brain and extremity injuries [1].

Blunt chest trauma is considered one of the significant causes of morbidity and mortality, especially in young patients. It can vary in severity from minor hematoma or isolated rib fracture to severe crush injuries compromising the thoracic structure and leading to potentially fatal respiratory failure [2].

After an initial clinical evaluation and stabilization of traumatized patients, radiological methods play an important role in the evaluation of injuries [3]. Chest radiography is considered the first initial assessment-screening method for blunt chest trauma patients who are stable enough to receive diagnostic studies [4]. However, information provided by standard chest radiography may be insufficient for diagnosing vascular and nonvascular thoracic injuries [5].

In recent years, multislice computed tomography (MSCT) is being used with increased frequency in the evaluation of patients with blunt or penetrating thoracic injuries due to its ability for direct detection of some injuries that are sometimes occult on chest radiography such as pericardial hemorrhage, vascular injury, small pneumothorax, rib and scapular fracture, and diaphragmatic tears, as well as its ability for better detection of the extent of other injuries such as lung contusion and pulmonary laceration [6]. Also,

it has been proved to be superior to chest radiography in the detection of pulmonary and tracheal laceration, pneumothorax, and allows accurate detection of bronchial tears [6].

However, due to the lack of time and in order to avoid unnecessary radiation, computed tomography (CT) chest is often performed when a CT examination of the abdomen or head has been indicated because of the frequent association between thoracic and extrathoracic injuries [5]. Finally, regardless of the importance and the growing application of MSCT examination in the Emergency Department, it should be borne in mind that MSCT examination should not delay necessary surgeries [5].

Aim

The aim was to determine the effectiveness of MSCT over chest radiography as a quick diagnostic modality in the detection of hidden thoracic injuries in a blunt chest trauma patient.

Patients and methods

This prospective study was conducted in the Diagnostic Radiology Department of Assiut University Hospital. The study was carried out after obtaining the permission of the Ethics Committee of Scientific Research, Faculty of Medicine, Assiut University, with the informed consent of the patients with IRB number 17101021.

All patients who presented with blunt chest trauma either as a sole presentation or as a part of polytraumatic insults were included in the study in the period from the June 1 to December 31, 2017. Patients who discharged from the hospital without having MDCT examination or surgical intervention and also hemodynamically unstable patients that required immediate surgical intervention were excluded from the study. All patients underwent chest radiography, followed by MSCT for the diagnosis of hidden intrathoracic injuries.

The MSCT was carried out using 16-row General Electric (New York, New York, USA) Bright Speed or 64 row Toshiba (Tokyo, Japan) Aquilion MDCT scanners. Scanning was performed from the lung apices to the diaphragm using the following parameters: 140 kV and 380 mA at GE 16 MSCT with rotation time 0.6. Axial cuts were sent to the workstation for processing and reconstruction. Contiguous transverse 1.25-mm-thick images with a slice interval of 0.8 and 0.5 mm thickness were routinely reconstructed in sagittal and coronal views at mediastinal, lung and bone windows. Maximum intensity projection (MIP) and virtual reality (VR) techniques were done providing three-dimensional (3-D) images that are helpful in providing more anatomical and pathological details.

Statistical analysis

Data were collected and analyzed using SPSS (the Statistical Package for Social Sciences, version 20; IBM, Armonk, New York, USA). Continuous data were expressed in the form of mean ± SD or median (range), while nominal data were expressed in the form of frequency (percentage). The percentage of difference between the findings on chest radiography and MSCT was calculated by the difference between two values divided by the average of the two values, calculated using the AJ Design Software (Company is AJ Design Software Math Science Engineering, Finance Physics Health Calculators Apps, Country is united states of America, Town is wilmingnton, DE).

Results

The study included 50 patients (40 men and 10 women) with age range from 20 to 65 years and the mean age was 42.56 ± 10.06 years. The etiology of chest trauma was the motor car accident (70%), followed by fall from height (30%).

Pulmonary contusion was the most frequent injury as it occurred in 43 (86%) patients, followed by rib fracture (82%), pleural effusion (72%), pneumothorax (60%), surgical emphysema (50%), and scapular fracture (14%) (Fig. 1).

Regarding the efficacy of MSCT in the detection of thoracic injuries compared with radiography revealed that MSCT is more effective than chest radiography

MSCT is more effective than chest radiography in the detection of thoracic injuries such as the pneumothorax (Figs. 2 and 3), pleural effusion (Fig. 3), pulmonary contusion (Figs. 2 and 3), rib fracture (Fig. 3), and scapular fracture with the percentage of difference being 13, 120, 96.5, 44.7, 8.3%, respectively, which was statistically significant as P = 0.01, 0.03, 0.001, 0.01, and 0.00, respectively (as shown in Table 1).

Discussion

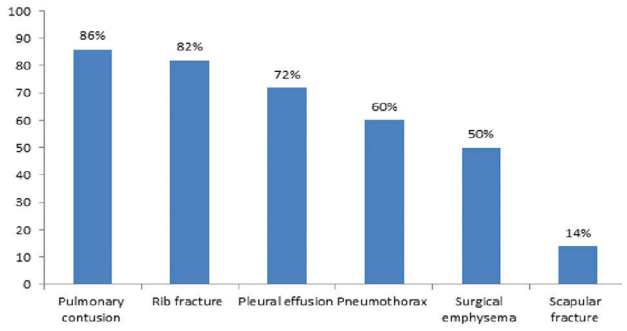
This clinical study was performed as a collaborative work between the Radiodiagnosis Department and Trauma Unit at Assiut University Hospital in patients presented with blunt chest trauma using MSCT for

Table 1 Efficacy of MSCT in the detection of thoracic injuries compared with radiography showed that MSCT is more effective than chest radiography

	Chest radiography [*n* (%)]	Chest MSCT [*n* (%)]	Percentage of difference
Pneumothorax	6 (12)	30 (60)	133% (*P*=0.01)
Pleural effusion	9 (18)	36 (72)	120% (*P*=0.03)
Pulmonary contusion	15 (30)	43 (86)	96.5% (*P*=0.001)
Rib fracture	26 (52)	41 (82)	44.7% (*P*=0.01)
Surgical emphysema	23 (46)	25 (50)	8.3% (*P*=0.76)
Scapular fracture	0	7 (14)	*P*=0.00

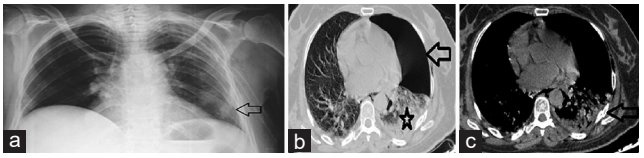
MSCT, multislice computed tomography.

Figure 1



Frequency of the type of injury in the studied patients based on MSCT. MSCT, multislice computed tomography.

Figure 2



(a) AP chest radiography (expiratory film) shows a small area of left lower lung opacity (arrow) suggesting a small area of pulmonary contusion with no other detected abnormalities. (b) The corresponding axial noncontrast MSCT image (lung window) confirms the presence of lung contusion (asterisk) and shows also the area of left side pneumothorax (arrow). (c) Axial noncontrast MSCT image (pulmonary window) shows fracture rib (arrow) which is missed on chest radiography. AP, anterioposterior; MSCT, multislice computed tomography.

the evaluation of the role of MSCT in the assessment of blunt chest trauma patients. This study included 50 patients with abnormal chest radiography and pathological findings on physical examination of the chest.

Seventy percent of the patients with blunt chest trauma was caused by motor car accidents followed by falling from height by 30%, and this is close to that reported by Turkalj *et al.* [7], who found that 63.9% of blunt chest trauma cases were due to motor car accidents.

The age of the studied patients in this study ranged from 20 to 65 years with a mean age of 42 years and this agrees with Traub *et al.*[8] and Turkalj *et al.* [7], who reported that the mean age was 47.2 and 43.9 years, respectively.

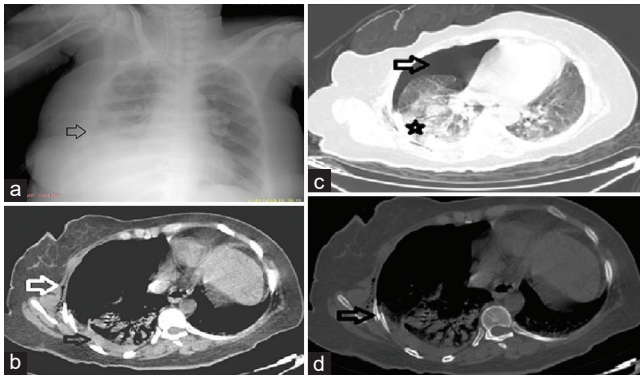
Male predominance was reported in our study as 80% were men while 20% were women which agree with that reported in Dabees *et al.*[2] and Traub *et al.*[8] who found a male percentage of 79.3% and 75%, respectively. In our study, the most frequent injury based on MSCT was pulmonary contusion by 86% and this agrees with Turkalj *et al.* [7], who reported that pulmonary contusion was the most frequent injury in blunt chest trauma by 77.1% based also on MSCT chest.

Although only 15 (30%) cases were diagnosed in this study as pulmonary contusion based on chest radiography, the frequency increased up to 43 (86%) cases based on MSCT with the percentage of difference being 96.5% and the *P* value was 0.001, which is highly statistically significant. This coincided with Dabees *et al.*[2] who reported that the diagnosis of pulmonary contusion was increased after the use of MSCT chest to 50% instead of only 30% by chest radiography.

Rib fracture was the second most frequent finding following pulmonary contusion by 82% based on MSCT chest instead of 52% by chest radiography with the percentage of difference being 44.7% and the *P* value was 0.01, which is statistically significant and this agrees with the results of Dabees *et al.* [2], who reported that patients with rib fractures which were diagnosed by MSCT were 56.7%, although on chest radiography it was 36.7% with a *P* value of 0.0099. So MSCT is the most sensitive technique for imaging rib fractures, since it can help in determining the site and number of fractures and, more importantly, provides information regarding any associated injuries.

Prevalence of pleural effusion among the studied population in our study by chest radiography was only nine (18%) cases; however, the diagnosis increased up to 36 (72%) cases by MSCT chest with the percentage of difference being 120% and *P* value was 0.03, which agree with the Turkalj *et al.*[7] study, which reported that 40 (65.6%) cases can be diagnosed as pleural effusion based on MSCT.

Figure 3



(a) AP supine chest radiography (expiratory film) shows blunted right costophrenic angle which suggests right pleural effusion and inserted right intercostal tube (arrow). (b) The corresponding noncontrast axial MSCT image (mediastinal window) confirms the presence of minimal right-sided pleural effusion (black arrow) and shows also surgical emphysema (white arrow which is missed on chest radiography). (c) Noncontrast axial MSCT image (lung window) shows right pneumothorax (black arrow) and pulmonary contusion (asterisk) which also are missed on chest radiography. (d) Noncontrast axial MSCT image (bone window) shows a fractured rib which is also not seen on chest radiography. MSCT, multislice computed tomography.

Thirty (60%) cases of pneumothorax were diagnosed in this study by MSCT, although on chest radiography only six (12%) cases can be diagnosed with the percentage of difference being 133% and the *P* value was 0.01 which is statistically significant, and this is in agreement with the results of the Turkalj *et al.*[7] study as it was reported that the number of patients with pneumothorax increased up to 50% by MSCT instead of only 23.3% of the cases which were diagnosed by chest radiography with *P* value less than 0.001.

Although our results showed that chest CT is more effective than routine chest radiography in the detection of thoracic injuries, some limitations of MSCT were reported in our study such as high cost, shocked patients with difficulty of transferring them to radiology department, unstable patients with increased motion artifacts, as well as hazards of radiation exposure as in pregnant cases. Other reported limitations in this study are the bad quality of supine radiographs due to poor positioning, poor inspiration, or artifacts from an underlying backboard or overlying monitoring equipment.

Conclusion

MSCT is the gold standard in routine imaging modality for detecting hidden thoracic injuries in blunt chest trauma patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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