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Original Research Article

Role of bedside sonography in the assessment of patients with chest trauma in the emergency department of Suez Canal University Hospital

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ABSTRACT

Background: Chest trauma is responsible for more than 20 to 25% of all traumatic death. Chest trauma is the second leading cause of traumatic death in each year. In order to keep the prognosis of patients with chest trauma relatively good, the patient should be diagnosed rapidly & managed adequately. Chest ultrasound is a safe, rapid and accurate method in diagnosing chest trauma.
Methods: A total of 50 patients were enrolled in this study. Objectives were to assess the accuracy of bedside chest US in detection of either haemothorax, pneumothorax or lung contusion in chest trauma patients. All the patients underwent chest US, CXR, and chest CT. The data from ultrasound and CXR were compared with the gold standard CT. Then the accuracy of which were calculated.
Results: Showed that Motorcar accidents are the most common cause for chest trauma and most patients were presented by chest pain and dyspnea. Chest ultrasound specificity in diagnosing pneumothorax was higher than sensitivity, 100% and 81% respectively, with over all accuracy 88%. Supine CXR showed sensitivity (75%), specificity (88.9%) and accuracy (80%) which are good numbers but still lower than chest US. Chest US Detection of haemothorax by chest had showed 100% sensitivity, 90% specificity and 96% accuracy.
Conclusions: Chest ultrasound is highly accurate tool for detection of pneumothorax, haemothorax and less lung contusion in chest trauma. Chest ultrasound is a useful tool for the emergency physician for bedside rapid and accurate diagnosis without interruption of the resuscitation and without transferring the patient for the radiology unit.

Keywords: Chest ultrasound, Chest trauma, Haemothorax, Lung contusion, Pneumothorax

INTRODUCTION

Road traffic accidents (RTA) remains the most common cause of injuries accounting for 57-70% of chest trauma patient. Between 20-46% of deaths in poly-traumatic patients are due to chest injury.[1,2]

Pneumothorax is a common complication of blunt and stab chest trauma.[3] Rate of occurrence of tension pneumothorax is 10% while traumatic pneumothorax, iatrogenic pneumothorax and late pneumothorax occur in 33.6%, 18.1% and 12% traumatic population, respectively.[3]

Mechanism of chest trauma including blunt trauma (which is the commonest) and penetrating trauma such as stabbing.[4] 90% of thoracic injuries due to blunt trauma and 70% to 85% of penetrating can be managed conservatively without surgery.[5] In order to keep the prognosis of patients with chest trauma relatively good, the patient should be diagnosed rapidly and managed adequately either conservatively or surgically.[6] So that information from different diagnostic tools has a major role in improving the patient prognosis.[7,8]

Chest computed tomography (CT) is the gold standard method for detection of pneumothorax, haemothorax and lung contusion because it has the best sensitivity and specificity. Although this CT is neither practical nor feasible because it usually require transfer of the patient from the emergency room (ER) where its resuscitation equipment's and facilities to the CT place which carry a great risk on patient survival.[9]

Although chest X-ray (CXR) is the first line diagnostic method for chest trauma in ER, CXR can diagnose only a sever pneumothorax or large haemothorax.[10] But lung contusion, small pneumothorax or small to moderate haemothorax may be missed.[11] Although more frequent use of US in chest trauma in the evaluation for traumatic epicardial or pleural effusion, research has shown that US of the thorax is highly accurate for the diagnosis of pneumothorax.[12-14]

Recent researches describe that chest US is more accurate in diagnosis of pneumothorax in comparison with CXR.[15] US is an accurate, rapid and dynamic tool for diagnosis of lung contusion in comparison with supine CXR. The reference standard method for assessment of both techniques is chest CT.[16]

Multiple evidence-based reviews suggest that US is a more sensitive screening test than supine anterior posterior chest radiography for the detection of pneumothorax in adult patients with blunt trauma. The sensitivity and specificity of US ranged from 86% to 98% and 97% to 100%, respectively. The sensitivity of supine AP chest radiographs for the detection of pneumothorax varies from 28% to 75%. The specificity of supine AP chest radiographs was 100% in all included studies.[17]

Our objectives were to compare the sensitivity and specificity of bedside ED US with those for supine AP chest radiography and CT for the detection of a pneumothorax in trauma patients.

METHODS

Type of Study

Descriptive analytic study. A total of 50 patients were enrolled in this study. They were recruited from Suez Canal University Hospital (Ismailia) form September 2014 to September 2016.

Site of Study

Suez Canal university hospital.

Patient's population

Patients with acute chest trauma will be included in this study.

Inclusion criteria

- Age > 18 years old
- Both sexes
- Any patient with blunt or penetrating chest trauma
- Isolated chest trauma or multiple trauma patients.

Exclusion criteria

- Patients treated with open or tube thoracostomy prior to imaging
- Pregnant females at any gestational age
- Patient with sever associated injuries will be excluded.

Data collection: Data was collected from chest trauma patients using interview questionnaire and by the researcher after ultrasound examination.

All patients were evaluated clinically as follow;

Full history (from patient or relative) including: Patient personal data: Age, sex, occupation, residence, patient's file number, Timing of injury and timing of admission, mechanism and type of injury, associated co-morbidity e.g. common endocrinal, cardiovascular, Drug abuse or previous disability.

Clinical examination

Vital signs

Pulse, blood pressure, respiratory rate. Glasgow Coma Scale (based on eye, verbal and motor response) to assess cases severity. Local chest examinations for contusion, laceration, fracture rib, or flail segment.

Laboratory measurements

(All laboratory data was done at Suez Canal University lab). Hemoglobin concentration, hematocrit, prothrombin time, arterial blood gases.

Imaging

Transthoracic ultrasound

- The ultrasound set which was used to examine our patients was Phillips HD11EXm. Linear probe with

frequency ranging from 3.5-7.5 MHZ. while the CT set was ALEXION Toshiba multidetector 16 slice

- Ultrasound examinations was performed immediately after the primary clinical survey in the ED and with the patient supine while the trauma team members continuing their routine trauma evaluation and procedures and was instructed not to allow the ultrasound examinations to interfere with patient management
- The physician examined four points on each chest hemisphere according to BLUE protocol. BLUE protocol examines a total of eight points over the entire thorax (4 points on each side).[18-20]
- Diagnosis of Pneumothorax was made by absence of lung sliding and absence of comet tail. B line appears as a vertical shared of light that extends from the pleural surface to the deep portion of image
- Diagnosis of haemothorax was made by detection of fluid in the costophrenic angels
- Diagnosis of lung contusion was made by detection of air bronchogram, the air filled bronchi (anechoic) become more pronounced by the opacification (echoic or hypoechoic) of the surrounding contused alveoli which is filled by blood and inflammatory fluids, lung consolidation (c profile). Multiple comet tail is a strong sign of lung contusion.[21]

Chest X-ray

- Supine anteroposterior radiographs was obtained for various reasons, including decreased level of consciousness, cervical spine precautions, orthopedic injuries, and hemodynamic instability. CXR scan interpretations were performed by the attending radiologists. 3- Transthoracic computed tomography.
- CT scan was performed
- CT scan interpretations were performed by the attending radiologists who were blinded to the ultrasound finding.

Findings of both ultrasound and supine CXR was compared by the results of CT scan as the reference standard method or by the results of tube or open thoracotomy if it were done.

Data management

- Data entry and analysis was done using a standard statistical program SPSS version 18 (SPSS Inc., Chicago, IL, USA) for windows program by aid of the following statistical tests
- Student's t-test for continuous variables
- Differences were considered statistically significant if p value < 0.05
- Sensitivity and specificity using ROC curves for chest US and supine chest X-ray using CT scan as the gold standard method.

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Confidentiality and anonymity were maintained according to the regulations of the Research Ethics Committee of Faculty of Medicine Suez Canal University. The study subjects were explained the purpose of study, assured privacy and a written consent was obtained from them. Participation in the study was voluntary and was explained to the participants or their relatives. Trauma physicians were instructed not to allow the ultrasound examinations to interfere with patient management.

RESULTS

This study was conducted on 50 patients with chest trauma in the emergency department of Suez Canal university hospital to assess the accuracy of chest US and supine CXR in detection of pneumothorax, haemothorax and lung contusion and comparing its results with the gold standard computed tomography.

Table 1: Demographic data of the patients (N = 50).

Age (years)	**Mean±SD** **Rang**	**32.5±10** **16 - 51**	
Sex	Male	46	92%
	Female	4	8%
Duration between injury and hospital arrival (hours)	Mean±SD Rang	4.9±13.9 0.5- 72	
Trauma type	Isolated chest	24	48%
	Multiple trauma	26	52%
Context	Fall	6	12%
	MCA	34	68%
	Stab chest	10	20%

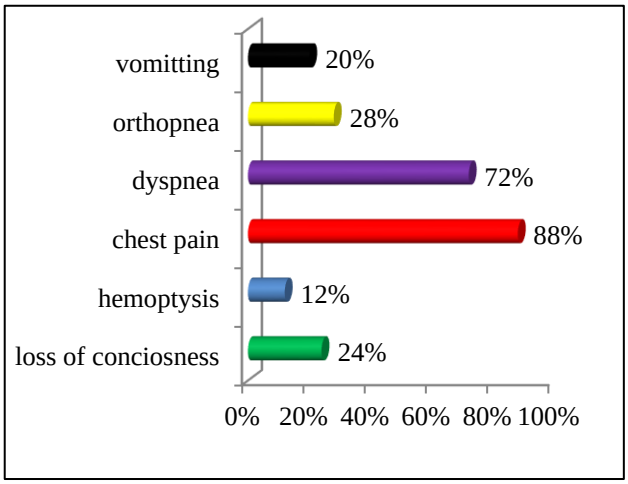

Figure 1: Illustrate the clinical presentation of the patients (n = 50).

Table 1 demonstrates that the mean age group of the patients affected by chest trauma is 32 years old and males are affected more than females. Motor car accidents is the most common cause (68%) so that multiple trauma was more common than isolated chest

trauma (52%). The most common presentation of the patients with chest trauma is chest pain (88%), and dyspnea (72%) (Figure 1). The ability of the test to roll in pneumothorax is 81% (sensitivity). While the ability of the test to roll out is 100% (specificity) and the overall accuracy is 88% (Table 2).

Table (3) shows that the ability of this lung point sign to roll in pneumothorax is 76% (sensitivity). While the ability of the test to roll out is 75% (specificity) and the overall accuracy is 76%. The ability of the test to roll in pneumothorax is 75% (sensitivity). While the ability of the test to roll out (specificity) is 88.9% (specificity) and the overall accuracy is 80% (Table 4). The ability of the test to roll in haemothorax is 100% (sensitivity). While the ability of the test to roll out is 88.9% (specificity) and the overall accuracy is 96% (Table 5). The ability of the test to roll in lung contusion is 90% (sensitivity) (Table 6). While the ability of the test to roll out is 60% (specificity) and the overall accuracy is 84%.

Table 2: Measurement of accuracy of chest US in patients with pneumothorax (N = 50).

	Gold standard chest C.T				
	Positive	**Negative**			
Positive	26	0			
Negative	6	18			
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**	
81%	100%	100%	75%	88%	

Table 3: Measurement of accuracy of lung point sign in detection of patients with pneumothorax (N = 50).

	Gold standard chest C.T				
	Positive	**Negative**			
Positive	20	6			
Negative	6	18			
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**	
76%	75%	76%	75%	76%	

Table 4: Measurement of accuracy of supine CXR in patients with pneumothorax (N = 50).

	Gold standard chest C.T						
	Positive		**Negative**				
Positive	24		2				
Negative	8		16				
Sensitivity	**Specificity**	**PPV**	**NPV**	**LR+**	**LR-**	**Accuracy**	
75%	88.9%	92.3%	66.7%	1	0.89	80%	

Table 5: Measurement of accuracy of chest US in patients with haemothorax (N = 50).

	Gold standard chest C.T						
	Positive		**Negative**				
Positive	32		2				
Negative	0		16				
Sensitivity	**Specificity**	**PPV**	**NPV**	**LR+**	**LR-**	**Accuracy**	
100%	88.9%	94.1%	100%	9	0	96%	

Table 6: Measurement of accuracy of chest ultrasound in patients with lung contusion (N = 50).

	Gold standard chest C.T						
	Positive		**Negative**				
Positive	36		4				
Negative	4		6				
Sensitivity	**Specificity**	**PPV**	**NPV**	**LR+**	**LR-**	**Accuracy**	
90%	60%	90%	60%	2.25	0.16	84%	

Figure 2 shows that the best sensitivity was in rolling in haemothorax and best specificity was in rolling out pneumothorax.

The best accuracy was in detecting haemothorax.

DISCUSSION

The present study demonstrates the accuracy of chest ultrasound in the detection of pneumothorax, haemothorax and lung contusion and comparing it with

supine chest X-ray accuracy regarding the gold standard chest computed tomography.

In the current study, males were more common than females (92%), the mean age was 32 years old, and blunt trauma (due to MCA and falling from height) was more than penetrating one (80%) (Table 1). In agreement with the results of other study which conducted on 135 chest trauma patient, males were 84% of the total population and the average age was 45 years old, and all patients suffered from blunt trauma, including motor car accidents (61.55) and falls (20.7%).[22] And this is the usual data distribution in case of trauma as adult male is suspected to be more active and driving cars more than females.[23]

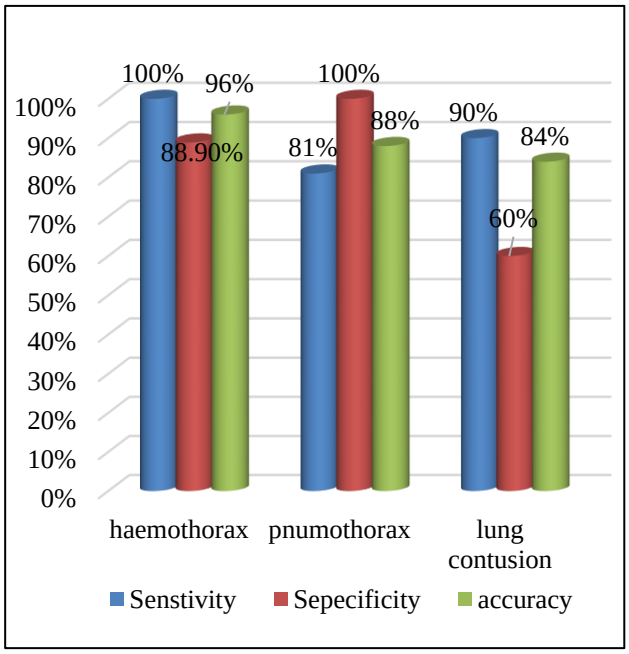

Figure 2: Comparison between the accuracy of chest US in the detection of pneumothorax, haemothorax and lung contusion (N =50).

In the current study, the most common presentation of the patients was chest pain and dyspnea (Figure 1). In agreement with the quantification of pneumothorax size by chest US, as he found that pain was found in 90% of patients and dyspnea in 62% of them.[24,25]

In the current study, specificity of chest ultrasound in diagnosing pneumothorax was higher than sensitivity, 100% and 81% respectively; with over all accuracy 88%, which was diagnosed on the base of absent lung sliding, sign (Table 2, Figure 2).

In agreement with the previous study for detection of pneumothorax by chest US in chest trauma patient's sensitivity were 86.2%, specificity was 97.2% and the overall accuracy is 94.8%.[22] Another study, found also higher numbers in chest ultrasound sensitivity in detecting pneumothorax 95.5%, 100% specificity and diagnostic accuracy about 98.9%.[26] lower number were found on one point probing chest ultrasound that was examining only the 3rd intercostal space, midclavicular line for detection of pneumothorax found sensitivity of 92% and specificity of 78% which is lower than our results.[27]

Study couldn't detect lung point be in six patients with pneumothorax and this is due to the position of such points were different from the position of the four points of BLUE protocol. This could explain why lung point showed sensitivity of 76%, specificity 75% and 76% accuracy (Table 3, Figure 2). Other studies showed sensitivity of (79%) close to our result (76%), while their specificity was higher (100%) than our (75%).[28] While other showed 100% sensitivity in rolling in pneumothorax.[29]

Lung point may be confusing as it may be doubled if the pneumothorax is trapped between two pleural adhesion, or it may be absent if the lung is totally collapsed. Pneumothorax size is not the main determinant of the way management of the emergency chest trauma patient, it depends more on the clinical picture and the associated injuries of the patient.[28,29]

Supine CXR showed sensitivity (75%), specificity (88.9%) and accuracy (80%) which is good numbers but still lower than chest US (Table 4). Close to our results sensitivity of supine CXR was 60%, specificity 98% and accuracy 80%.[30] In contrast other study showed 27.6% sensitivity, 100% specificity and 84% accuracy and we couldn't explain their lower sensitivity.[22]

Detection of haemothorax by chest ultrasound is well-established technique in most of the trauma center worldwide and it had been a part of the routine FAST examinations. In the current study, it showed 100% sensitivity, 90% specificity and 96% accuracy (Table 5, Figure 2).

In agreement with the results of the systematic on the accuracy of sonography in pleural effusion sensitivity was 93% and specificity 96%.[31] And also going on with results of comparing the accuracy of chest sonography by chest radiograph for the detection of haemothorax, there were no difference between their accuracy; sensitivity for both was 96.2%, specificity 100%, and accuracy 96.2%.[32]

The lung contusion by chest ultrasound depended on observation of dynamic air bronchogram and multiple B line and we found 90% sensitivity, 60% specificity and 84% accuracy (Table 6, Figure 2).

Other studies showed 97% sensitivity, 90% specificity and accuracy 96% (16). This result is slightly higher than our results and this may be due to the different examinations technique. Another study were close to our results as 92% - 94.6% sensitivity, 89% - 96.1% specificity and accuracy of 73% - 95.4%.[33-35]

CONCLUSION

Chest ultrasound is highly accurate tool for detection of pneumothorax, haemothorax and less accurate for lung contusion in chest trauma patients. Chest ultrasound is a useful tool for the emergency physician for bedside rapid and accurate diagnosis without interruption of the resuscitation and without transferring the patient for the radiology unit.

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