

Should Computed Tomography be Performed in All Chest Trauma Patients

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ABSTRACT

Background: Occult hemothorax is detected by Computed Tomography (CT) chest but missed initially by chest X-ray. Supine position, presence of less than 300 ml of blood, and intrapleural adhesions are all causes of missed hemothorax on initial chest x-ray.

Patients and methods: In this retrospective study, we revised 864 patients who had blunt chest trauma at Mansoura Emergency Center from January 2016 to January 2020 and for them chest X-ray and CT chest were done. Patients having hemothorax (320) were divided into occult and non-occult. The outcomes included patients' demographic data, number of patients in each group, associated injuries, and lines of management.

Results: Chest X-ray helped diagnosis of 143 cases (44.68%) (Non-occult hemothorax). There were significant statistical differences between the two groups as regard chest tube drainage (686±456 ml Vs 871±603 ml), hospital stays (3-5 Vs 5-6 days), conservatively managed cases (33 (18.64%) Vs 3 (2,1%)), and surgical exploration for significant bleeding (2 (1.13%) Vs 18 (12.58%)). On the other hand, there was no significant statistical deference as regard age group, patient's gender, mortality, chest tube insertion, and exploration for associated injuries.

Conclusion: CT chest is the gold standard imaging tool for victims of chest trauma as it helps patient's evaluation and diagnose occult cases of hemothorax who were missed in initial chest X-ray.

Keywords: Chest trauma, Computed tomography, Occult hemothorax.

INTRODUCTION

Hemothorax is a collection of blood in the pleural cavity, which is usually the result of blunt trauma. Chest X-ray has historically been the imaging tool once patient arrives to the hospital ⁽¹⁾.

It has been reported that chest traumas are considered one of the most significant reasons of mortality among the persons in the 4th decade of life. The use of different modalities of imaging such as plain chest X-ray (CXR) computed tomography (CT) scan, and ultrasonography (US) is essential. In addition, it is essential to declare that CT scan is the best modality with highly significant diagnostic value for soft tissue and occult injuries. On the other hand, limited CT scan availability in the medical centers, limitations in the transfer of patients to radiology department and exposure to radiation are the chief drawbacks ⁽²⁾.

Chest CT can diagnose more injuries than CXR, the so-called occult injuries. Of these occult injuries is occult hemothorax, which is defined as that one detected by CT chest but missed initially by chest X-ray ⁽³⁾.

Upright CXR helps diagnosis by finding blunting of the costodiaphragmatic recess, which is the commonest sign of pleural effusions and hemothorax. In the supine position, which is the case in most severely injured

patients, the distribution of blood will be along the whole posterior surface of the pleural space in the affected side rather than the costodiaphragmatic recess, this results in less apparent hemothorax and occasionally missed completely ⁽⁴⁾. Chest X-ray has its own limitations.

Additionally, it is important to recognize that blunting the costophrenic angle requires 300–500 ml of blood. Up to 1000 ml can be missed in the supine position. intrapleural adhesions can alter the collection of fluid that will cause any fluid or blood to occupy spaces other than the costophrenic angle ⁽⁵⁾.

In the evaluation of blunt trauma in adult, the CT utilization has increased significantly in the last twenty years, and several centers of trauma perform pan-scan (head-to-pelvis CT) routinely for victims of major trauma, however this protocol is associated with clear and significant risk of cancer. American College of Surgeons in 2014 mentioned avoiding routine whole body trauma CT as one of its five choosing Wisely recommendations ⁽⁶⁾.

In this study we will discuss our experience with occult hemothorax, its percentage, management and our future view for the wider use of CT chest for all chest trauma patients and updating lines of management.

PATIENTS AND METHODS

This is a retrospective study in the time period from January 2016 to January 2020. We received a total of 2546 patients who had blunt chest trauma of varying degrees and attended our level 1 trauma center, Mansoura Emergency Hospital, only 864 patients had chest X-ray and CT chest, so were enrolled in our study.

It is our hospital policy to perform pan CT for severely traumatized patient. CT chest is performed only if there are chest X-ray abnormalities, chest wall tenderness, labored breathing, evidence of chest trauma as seat-belt marking, clear history of significant chest trauma or abnormal breath sounds on auscultation. We believe if none of these findings is present, CT chest will add nothing.

Our study included patient’s demographic data, number of patients in each group (occult and non-occult), associated injuries, and lines of management in each group.

Ethical Consideration

This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans and has been approved by Institutional Review Board of Faculty of Medicine, Menoufia University, Egypt. All patients provided an informed written consent before enrollment.

Statistical Analysis

Categorical variables were expressed as numbers and percentages. Continuous variables were expressed as mean, median, minimum, and maximum values. Event rates of both groups were estimated with Kaplan-Meier curves and compared by the Log-rank test.

The association of selected variables with outcome were assessed with Cox’s proportional hazard model using stepwise multivariable procedures, a significance of 0.05 were required for a variable to be included into the multivariable model.

Hazard ratios (HR), with the corresponding 95% confidence interval (CI), were estimated. Statistical significance will be set at $P < 0.05$. Statistical Package for the Social Sciences (SPSS release 22, Chicago, IL) were used for the analysis.

RESULTS

Table (1) shows the associated injuries in these patients that was diagnosed either by CT chest alone (occult) or with chest X-ray also (non-occult).

Table (1): Associated injures

Finding	Number	Percentage to all cases (864)	Associated hemothorax
Hemothorax	320	37.04%	
Fracture rib	512	59.26%	290
Fracture sternum	8	0.93%	2
Pulmonary contusion	72	8.33%	32
Pneumothorax	389	45.02%	109
Diaphragmatic injury	7	0.81%	2
Aortic injury	4	0.46%	4
Myocardial contusion	6	0.69%	2
Tracheobronchial injury	11	1.27%	4

It is not our interest to mention all occult findings as pulmonary contusion and pneumothorax. As regard hemothorax, chest X-ray helped diagnosis 143 cases (44.69%) (Non-occult hemothorax). The characters of occult and non-occult cases are outlined in table (2).

Table (2): Differences in criteria of both groups

Character	Occult HTX	Non-occult HTX	P value
	No (177)	No (143)	
Age in years (Mean±standard deviation)	40±21	43±25	> 0.05
Sex (male %)	80%	77%	> 0.05
Large HTX	25	35	< 0.05*
	(14% of occult cases)	(24.47% of non-occult)	
Chest tube drainage (in ml) (Mean±standard deviation)	686±456	871±603	< 0.05*
Hospital stays (in days) (Mean± standard deviation)	5±3	6±5	< 0.05*
Mortality	4	3	> 0.05

As regard management of hemothorax cases, table (3) shows our lines of management.

Table (3): Lines of management.

Management		Occult (% to occult)	Non-occult (% to non-occult)	Number	P value
Chest tube insertion		136 (76.83%)	118 (82.51%)	254	> 0.05
Conservative		33 (18.64%)	3 (2.1%)	36	< 0.001*
Exploration	Bleeding	2 (1.13%)	18 (12.58%)	20	< 0.001*
	Ass. Air way injury	2 (1.13%)	2 (1.4%)	4	> 0.05
	Ass. Aortic injury	1 (0.56%)	3 (2.1%)	4	> 0.05
	Diaphragmatic injury	1 (0.56%)	1 (0.7%)	2	> 0.05
Number		177 (55.31%)	143 (44.69%)	320	

Ass.: Associated

DISCUSSION

We reported 320 (37.04%) traumatic hemothorax out of 864 patient who were admitted in level 1 trauma center and had both chest X-ray and CT chest. In accordance with the National Trauma Data Bank (NTDB) Research Data Set in 2012, 738396 cases were admitted worldwide. The number of patients with blunt chest trauma was 73809 (10%) and the number of patients who had hemothorax from them was 12200 (16.5%)⁽⁷⁾.

The trauma patient may initially be evaluated by means of chest X-ray plus or minus US to rapidly assess the injuries extent as a bed side modality, especially in cases of hemodynamically unstable patient but on achieving stability, a chest CT, rather with IV contrast, can be carried out to assess further detailed pathology. It has been reported that CT can recognize further injuries in 20–30% of cases having an abnormal Chest X-Ray. In the hemothorax cases, CT can detect hemothorax missed by the chest radiograph⁽⁸⁾.

In our study, chest X-ray helped diagnosis of 143 patients (44.68%), which means 55.31% of our patients are occult hemothorax cases. We observed no statistical differences between the 2 groups as regard age and sex distribution.

Tataroglu et al. registered only 15 cases of hemothorax diagnosed by chest X-ray while 24 patients were diagnosed by CT chest (62.5%) and concluded that chest X-ray should not be used as sole diagnostic imaging tool for exclusion of hemothorax, pneumothorax or pulmonary contusion in thoracic trauma patients⁽²⁾. Additionally, it is important to mention that **Patel et al.** in their study on 5451 consecutive blunt trauma patients found 402 patients (7.4%) had pneumothorax, hemothorax or both, and had both CXR and CT chest. Patients with only hemothorax were 88, fifty-four (61.36%) had occult hemothorax⁽⁹⁾.

Other studies showed higher percentages of occult hemothorax, may be the cause is their routine use of CT chest for every trauma patient, but on the other hand, many of these patients had minimal hemothorax that required no treatment, that means the discovery of this finding did not change their management. **Langdorf et al.** studied 2048 patients who had chest injury on chest radiography or chest CT and found that chest X-ray detected all injuries in only 29.0%. The remaining were diagnosed by CT chest (71.0% occult injuries). The cases of occult hemothorax were 184 patients out of total 230 hemothorax (80.0%). Seventy-five cases of these occult hemothorax (40.8%) required chest tube insertion⁽³⁾. In our study the cases of occult hemothorax were 177 patients out of 320 (55.31%). The number of patients who required tube insertion in both groups is 254 (79.37%). There was significant deference between the two studies, our percentage is double their one and this may be related to the more advanced trauma patients in our study due to patient selection based on presence of initial radiological or clinical findings or may be related to our reluctance in managing hemothorax conservatively except in mild to minimal hemothorax.

Chardoli et al. studied 200 hemodynamically stable patient with blunt chest trauma. Two hundred patients (16% female and 84% male) were included with a mean age of (37.9±13.7) years. The sensitivity of CXR for hemothorax was 20%⁽⁸⁾. We reported male patients in 80% of the occult group, their mean age was 40±21 years.

On the other hand, **Trupka et al.** in their study had 21 patients (20.38%) who were missed by initial chest X-ray and were diagnosed by CT chest. May be the relative low percentage of occult hemothorax is that the study was designed for cases of severely chest trauma patients⁽¹⁰⁾. Also, **Stafford et al.** in 2006 reported only

(21.4%) of their blunt trauma patient to have occult hemothorax⁽¹¹⁾.

Traub et al. in their comparative study between CT chest and chest X-ray in major blunt trauma patients found highly significant values in favor for CT chest (P value less than 0.001) in cases of pneumothorax, pulmonary contusion, rib fractures, sternal fractures, and hemopneumothorax. But as regard hemothorax, CT diagnosed 16 (11.3%) Vs 10 (7.1%) diagnosed by chest X-ray (P value 0.263)⁽¹²⁾.

In the occult group, we reported 14% of patients (25) had large hemothorax, and the total drainage in the 136 (76.83%) patients who had chest tube was 686±456 ml. On the other hand, the non-occult group had 35 patients (24.47%) having large hemothorax, and the total drainage in the 118 (82.51%) patients who had chest tube was 871±603 ml. The hospital stay in days was 5±3, 6±5 in both occult and non-occult groups respectively.

Patel et al. studied the differences between chest tube drainage, duration and patient length of stay, for cases of blunt trauma having occult versus non-occult hemothorax. They found no significant differences between both groups. The aim of the study was to assess chest tube value for occult injury versus expectant management⁽⁹⁾.

Rodriguez et al. found that of the 8,661 patients who underwent both a chest X-ray and a chest CT, 319 (3.7%) had a hemothorax, with 254 (80%) occult cases. Patients with occult hemothorax had lower chest tube placement rate (49% versus 68%; Δ -19%; 95% CI -31% to -5%) but similar admission rate, mortality, and median length of stay compared with patients with hemothorax observed on chest radiograph and CT⁽¹³⁾.

Bilello et al. in 2005 studied the role of CT chest in stable blunt-trauma patients as regard predicting which patients with occult hemothorax are likely to undergo intervention. Patients with hemothorax ≥ 1.5 cm on CT were 4 times more likely to undergo drainage intervention compared with those having hemothorax < 1.5 cm⁽¹⁴⁾.

Malekpour et al. in a more accurate complimentary study recommended chest tube insertion for hemothorax measuring above 3 cm, while hemothorax greater than 2 cm had more than 50% chance of receiving a chest tube⁽⁷⁾.

Out of our 320 patients, only 36 patients were treated conservatively (11.25%). We generally believe that it is important to drain every case of traumatic hemothorax, in selected cases the collection was minimal, so we tried conservative treatment, which seemed logical especially in the absence of concomitant pneumothorax. None of these patients developed empyema or fibrothorax later on. Out of these 36 patients, 33 were occult cases.

Eastern Association for the Surgery of Trauma guidelines recommended chest tube insertion for all traumatic hemothoraces. However, previous research has

suggested that observational management in some traumatic hemothoraces may be safe⁽¹⁵⁾.

Gilbert et al. in a systemic review of blunt trauma patients who had occult trauma and were managed either by tube thoracostomy or by conservative management, found failure rate in the conservative group (23.1%) [95% confidence interval, 17.1-29.1%]. They concluded the presence of hemothorax greater than 300 mL and the need for mechanical ventilation predicted failure of conservative treatment in such patients⁽¹⁶⁾.

Kea et al. in 2013 studied 589 patients who had chest CT following normal CXR result, 483 (82.0% [95% confidence interval]) had normal CT results, and 106 (18.0% [95% CI, 15.1%-21.3%]) had additional findings like rib fractures, pulmonary contusion, and minimal pneumothorax. They concluded that CT chest after a normal CXR in trauma patients can detect injuries, but usually do not affect patient's management⁽¹⁷⁾.

Mahmood et al. in a similar study avoided chest tube insertion in up to 83% of their patients. They inserted chest tube for patients with progression of hemothorax, desaturation, and delayed hemothorax⁽¹⁸⁾.

A total of 749 hemothorax in 635 patients (94 bilateral hemothorax) were included in the study of **Wells and colleagues**⁽¹⁹⁾. Overall, 491 cases were drained while 258 (34%) were managed conservatively. Independent predictors of chest tube placement included concomitant ipsilateral flail chest, the size of the hemothorax or pneumothorax. Tube insertion was associated with a 47.14% increase in hospital length of stay. Empyema (n = 29) occurred only among drained patients. **Demetri et al.** also found that patients who had chest tube, had more empyema and were discharged to rehabilitation rather than home⁽¹⁵⁾.

We explored only 30 patients (9.37%). The main cause was significant bleeding in 20 patients (6.25%) most of them were from the non-occult group (p value = 0.653). Other causes were 4 air way injury, associated aortic injury in 4 patients, and 2 cases of diaphragmatic injury. We mentioned 30 indications for exploration in 30 patients that don't mean there were not combination of these injuries, but we mentioned the single main cause for exploration.

Meyer et al. found that operative intervention is necessary in minority of individuals. He also found that it is the associated organ damage not the degree of hemothorax that is responsible for life-threatening process⁽²⁰⁾.

We have 7 mortalities in both groups with no significant statistical difference. The main cause of death was deterioration of severely traumatized mechanically ventilated patients with associated injuries. Two patients died intraoperatively from bleeding during repair of aortic injury, one in each group.

CONCLUSION

CT chest is the gold standard imaging tool for victims of chest trauma who have clinical findings or any chest X-ray abnormality. It helps patient's evaluation and diagnose occult cases of hemothorax who were missed in initial chest X-ray, our work is in need to be expanded to see if it is beneficial to do CT chest for every trauma patient, and can we expand our scope for conservative treatment for such patients.

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