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ORIGINAL ARTICLE

Occult hemopneumothorax following chest trauma does not need a chest tube

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Abstract
Background The increasing use of thoracic computed tomography (CT) in trauma patients has led to the recognition of intrapleural blood and air that are not initially evident on admission plain chest X-ray, defining the presence of occult hemopneumothorax. The clinical significance of occult hemopneumothorax, specifically the role of the tube thoracostomy, is not clearly defined.
Objective To identify those patients with occult hemopneumothorax who can be safely managed without chest tube insertion.
Design Prospective observational study.
Methods During the recent 24 month period ending July 2010, comprehensive data on trauma patients with occult hemopneumothorax were recorded to determine whether tube thoracostomy was needed and, if not, to define the consequences of nondrainage. Pneumothorax and hemothorax were quantified by computed tomography (CT) measurement. Data included demographics, injury mechanism and severity, chest injuries, need for mechanical ventilation, indications for tube thoracostomy, hospital length of stay, complications and outcome.
Results There were 73 patients with hemopenumothorax identified on CT scan in our trauma registry. Tube thoracostomy was successfully avoided in 60 patients (83 %). Indications for chest tube placement in 13 (17 %) of patients included X-ray evidence of hemothorax progression (10), respiratory compromise with oxygen desaturation (2). Mechanical ventilation was required in 19 patients, five of them required chest tube insertion, and six developed ventilator associated pneumonia, while there were no cases of empyema. There was one death due to severe head injury.
Conclusions Occult hemopneumothorax can be successfully managed without tube thoracostomy in most cases. Patients with a high ISS score, need for mechanical ventilation, and CT-detected blood collection measuring >1.5 cm increased the likelihood of need for tube thoracostomy. The size of the pneumothorax did not appear to be significant in determining the need for tube thoracostomy.

Keywords Occult hemothorax · Occult pneumothorax · Chest trauma · Chest tube

Introduction

Little is known about the outcomes of occult hemopneumothorax in chest trauma patients. Pneumothorax and hemothorax from blunt trauma can be associated with complications such as respiratory distress, respiratory failure, retained clot, empyema, and extended hospitalization [1, 2]. On the other hand, placement of a thoracostomy tube is associated with complication rates as high as 25 % [3]. Selective placement of thoracostomy tubes for occult hemopneumothorax in blunt trauma patients may help to minimize this risk.

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CT scan is responsible for diagnosing occult hemopneumothorax in patients with a normal supine chest X-ray [4, 5] (Fig. 1). Many patients undergo tube thoracostomy presumptively or empirically after clinical symptoms occur or after pneumothorax or hemothorax is diagnosed by chest and/or abdominal CT. However, the size of the occult hemothorax or occult pneumothorax on admission that should prompt tube thoracostomy drainage has not been clearly defined. De Moya and Seaver [6] developed a scoring system in order to assist the management with their decision-making. Others have described both qualitative and quantitative evaluations of the pleural fluid with upright chest X-rays and pleural sonogram [7, 8].

In the supine position, free pleural fluid collects predominantly in the dependent posterior pleural space and appears as a sickle-shaped lamella on transverse view [7]. This lamella is also visible on chest CT scan, and the greatest measured thickness of the lamella can be considered a reflection of the total effusion volume [7, 9].

Eibenberger et al. [7] correlated effusion volumes with lamellar thickness (0.5 cm = 80 ml, 1.5 cm = 260 ml, 2 cm = 380 ml, and 2.5 cm = 580 ml) when effusions were tapped from the pleural space. Blackmore et al. [10] found 200 ml to be a good estimate of the minimal detectable volume on the posteroanterior radiograph that obliterates the costophrenic angle; at a volume of about 500 ml, the meniscus obscured the hemidiaphragm. These results are consistent with previous studies on cadavers by Collins et al. [11].

Methods

The study group consisted of all trauma patients admitted from July 2008 through July 2010 who had concurrent hemopnemothorax on chest CT that was not evident on initial supine chest X-ray. Follow-up erect P–A view chest X-rays (or if this was not possible, supine films) were obtained to evaluate hemopeumothorax progression during hospital stay or at outpatient follow-up in order to monitor the progression of hemopneumothorax.

Pneumothorax was quantified on CT by measuring the largest perpendicular distance in millimeters from the chest wall of the largest air pocket according to De Moya and Seaver [6]. Hemothorax was quantified on CT by measuring the deepest lamellar fluid stripe at the most dependent portion of the fluid collection (Fig. 1).

Demographic data, including age, sex, Injury Severity Score (ISS), chest Abbreviated Injury Scale (AIS), length of stay, mechanism of injury, and presence of lung contusions were abstracted from the trauma registry.

Further follow-up for each patient with an occult hemopneumothorax was performed to determine whether or not a chest tube was placed as part of management and for other indications. Outcomes such as pneumonia, empyema, and chest tube complications were recorded. The diagnosis of pneumonia was made on the basis of CDC criteria (fever, purulent sputum, infiltrate on chest radiograph, positive culture of endotracheal secretion and leukocytosis) [12]. CT scans were performed on Siemens Medical Systems 64-slice scanners using of 120 ml of Omnipaque injected at 3 ml/s. Images through the chest were reconstructed at 1.2, 2.5, or 5 mm slice thicknesses. Images were analyzed by a single trauma consultant radiologist (Saed Nabir).

Categorical and continuous data were expressed as frequency (%) and mean ± standard deviation (SD). Unpaired "*t*" and chi-square tests were used to compare quantitative variable means and qualitative variables (%) between the two groups. Univariate and multivariate logistic regression analysis [considering age, gender, number of rib fractures, hemothorax thickness, size of pneumothorax, lung contusion, and mechanical ventilation as independent variables and tube thoracostomy (yes/no) as the dependent variable] were performed to assess and quantify the effects of different possible risk factors and covariates on the tube thoracostomy. Results were reported in the form of odds ratio (OR), along with their corresponding 95 % CIs. A *P* value

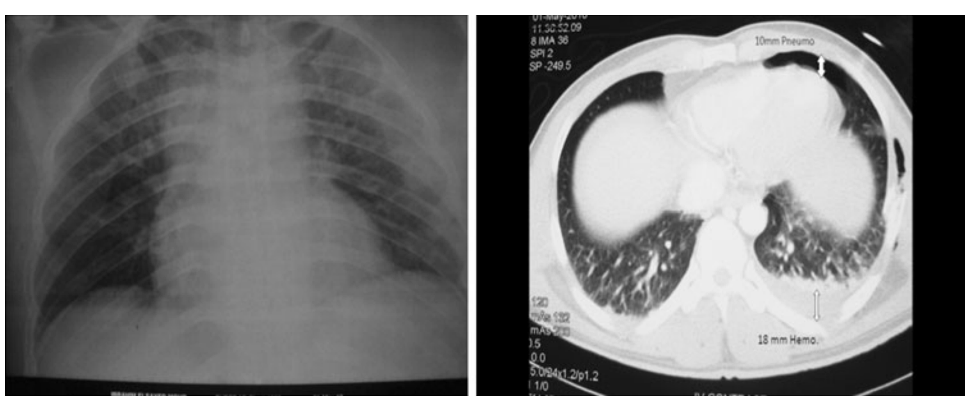

Fig. 1 Chest X-ray and corresponding CT scan of a patient with 10 mm pneumothorax and 18 mm hemothorax on the left side that was not identified on CXR

that was smaller than 0.05 was considered statistically significant. All statistical analyses were considered exploratory in nature due to the small sample size. All statistical analyses were done using the statistical package SPSS 19.0 (SPSS Inc., Chicago, IL, USA). Hamad Medical Research Committee approved the study. The purpose of this study was to evaluate occult hemothorax and occult pneumothorax when they occur together.

Results

During the study period, 73 patients were admitted to the hospital with occult hemopneumothorax following chest trauma. Seventy patients were men and three were women. The majority were involved in motor vehicle crashes or falls from height (84 %). There were two stabbings. The average age was 39 years, and the mean ISS was 18. The chest AIS averaged 2.8, 44 patients (69 %) had multiple rib fracture (Fig. 2), and 65 (89 %) patients had an associated lung contusion. Nineteen patients required mechanical ventilation, six patients developed pneumonia, while there were no cases of empyema.

Forty patients had a hemothorax thickness on CT scan of less than 9 mm, 23 patients had a thickness of between 10 and 14 mm, and ten patients had a hemothorax thickness of between 15 and 30 mm (Fig. 3). Thirty patients had a pneumothorax thickness of <9 mm, 27 patients had a thickness of between 10 and 19 mm, and it was between 20 and 80 mm for 16 patients (Fig. 4).

Sixty patients (82.19 %) were successfully treated without a tube thoracostomy, and 13 (17.81 %) patients underwent intervention. A comparison between those who were successfully treated expectantly and those who required intervention showed no significant difference with regard to age (mean 37.47 ± SD 13.25 vs. 31.83 ± 7.80; $p = 0.160$), number of ribs fractured (2.76 ± 2.029 vs. 3.17 ± 2.48; $p = 0.547$), size of pneumothorax (13.92 ± 14.49 vs. 19.58 ± 23.73; $p = 0.277$), hemothorax thickness

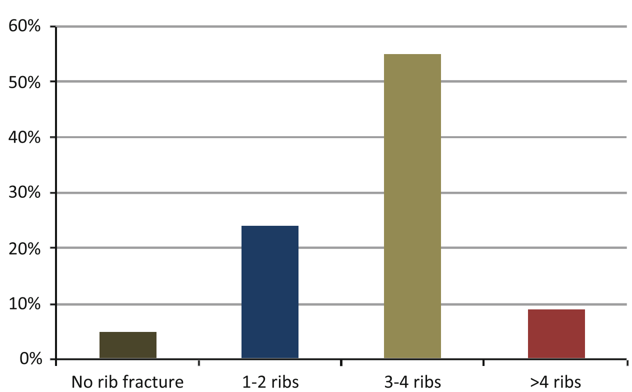

Fig. 2 Number of ribs fractured

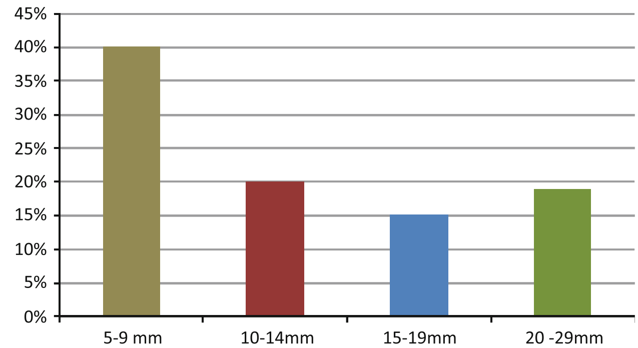

Fig. 3 CT scan hemothorax thickness in millimeters

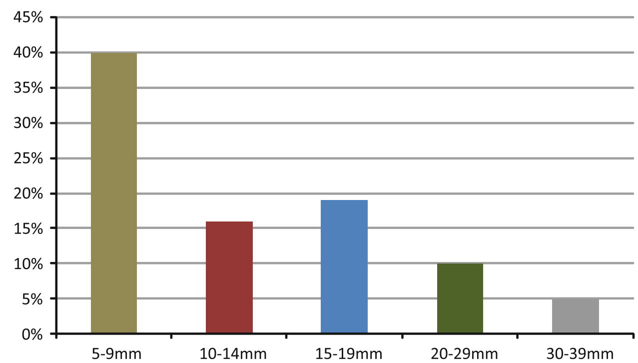

Fig. 4 CT scan pneumothorax thickness in millimeters

(10.19 ± 4.62 vs. 11.67 ± 8.87; $p = 0.584$), and gender (96.6 vs. 91.7 %; $p = 0.438$), but there were significant differences between the groups with regard to the need for mechanical ventilation (15.3 vs. 50 %; $p = 0.007$) and ISS (16.53 ± 6.09 vs. 25.33 ± 8.70; $p < 0.0001$). Mean ISS was significantly higher among tube thoracostomy group than the non-tube thoracostomy group.

Univariant logistic regression analysis revealed that only ISS and need for mechanical ventilation were significantly associated with tube thoracostomy. Increased ISS score led to a higher risk of tube thoracostomy [unadjusted OR = 1.17; 95 % CI (1.06, 1.29)]. A similar trend was observed when the effect of mechanical ventilation on the risk of tube thoracostomy was assessed [unadjusted OR = 5.56; 95 % CI (1.46, 21.13)]; i.e., those who required mechanical ventilation were 5.56 times more likely to require chest tube insertion than those in the non-mechanical ventilation group. Though it was not statistically significant, analysis revealed that a hemothorax thickness of more than 15 mm was 3.5 times more likely to require chest tube insertion than those with a hemothorax thickness of ≤15 mm [odds ratio = 3.58; 95 % CI (0.82, 15.63)]. Multivariate logistic regression analysis indicated that ISS was the only variable that was significantly associated with tube thoracostomy [adjusted OR = 1.16; 95 % CI (1.07, 1.29)].

Ten out of 73 patients had an obliterated costophrenic angle on follow-up chest X-ray, but all were successfully treated expectantly. Nine other patients showed obliteration of the hemidiaphram and costophrenic angle and required chest tube insertion. Average LOS was 11.5 days, with a minimum of 1 day and a maximum of 68 days.

Reasons for chest tube placement (between 24 and 48 h) varied. Nine patients had progression of the hemothorax on a follow-up chest X-ray (increased haziness with obliteration of the hemidiaphram and costophrenic angle). Two patients had increasing respiratory distress with oxygen desaturation. Two patients presented with delayed development of a hemothorax seven days later; in these cases, there was an X-ray evident hemothorax requiring tube thoracostomy despite the presence of a clear chest X-ray on discharge. There was one major complication (iatrogenic injury to the lung) in a patient undergoing chest tube placement which necessitated thoracotomy for clot evacuation; the patient recovered uneventfully. There was one death due to a severe head injury in the group that did not require chest tube insertion.

Discussion

The increased use of CT for the evaluation of the blunt trauma patient has led to the identification of so called "occult" pneumothorax and hemothoraces that are not seen on supine chest radiographs in 20–30 % of patients [13]. Wilson et al. [14] reported that pneumothoraces resolved uneventfully irrespective of ISS, need for ventilation, or placement of tube thoracostomy. Enderson et al. [15], in his prospective randomized study, noted that patients with occult pneumothorax who require positive pressure ventilation may develop tension pneumothorax and should undergo tube thoracostomy.

The significance of occult hemothorax is less clear. Three recent studies have addressed the specific management of occult hemothoraces. Stafford et al. [16], in his retrospective review of blunt trauma patients with occult hemothoraces, found that small, isolated, occult hemothoraces can be managed safely and conservatively in the stable patient, and patients who required a chest tube were more likely to have a higher ISS and an associated occult pneumothorax. Bilello et al. [17] and Mahmood et al. [18] reported that patients with a hemothorax thickness of 1.5 cm on CT were four times more likely to undergo drainage intervention compared with those with a hemothorax of thickness less than 1.5 cm. In our study, the majority were treated successfully without tube thoracostomy. Patients with a high ISS, a need for mechanical ventilation, and a maximum intrapleural fluid thickness of more than 1.5 cm were more likely to require tube thoracostomy. The size of the pneumothorax did not appear to be significant in determining the need for tube thoracostomy.

Conflict of interest None.

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