# Ectopic chest tube insertions: diagnosis and strategies for prevention

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### Summary

In the six-month period from October 1999 to March 2000, the authors carried out a prospective study of ectopic chest tube placements (ECTP) diagnosed at the Assir Central Hospital, Abha, Saudi Arabia. During the reference period, 63 chest tube placements were carried out in 44 patients while one patient was from a medium-sized general hospital within a neighbouring city. The grades of the surgeons who had performed the ECTP were: surgeon specialists based at peripheral hospitals-5 (83.3%), and surgical resident in training at the regional referral centre-1(16.7%). Mean age = 29.7 years; M:F ratio = 2:1. A total of 6 cases of ECTP were found constituting 9.5% of all chest tube insertions mostly from small hospitals situated in the peripheral. non-urban areas The diagnosis of ECTP was made on plain chest radiographs in 3 patients (50%) and on the CT scans of the chest in 3 patients (50%). The ECTP was into the lung (2cases-33.3%), subdiaphragmatic, intraabdominal (3 cases-50%), and chest wall, subcutaneous (1 case-16.7%). Misdiagnosis and failure to carry out a finger exploration of the pleural cavity prior to the placement of the chest tube rather than the use of chest tubes with trocars was to blame. The incidence of ECTP (9.5%) is high and underlines the need for proper training in the methodology of chest tube insertion for junior surgical cadre.

**Keywords:** Diaphragmatic perforation; ectopic chest tube placement; finger exploration; lung perforation; tension gastrothorax.

## Résumé

Au cours de 6 mois entre octobre 1999 et Mars 2000, les auteurs ont fait une etude prospective des placements du tube ectopique de poitrine (ECTP) diagnostiques a l'hopital central d'Assir, Abha, Akabe Sauoudite. Au courant de la periode de reference, 63 tube ont ete places chez 44 patients alors que l'un des maladies etait d'un hopital general de taille moyenne d'une ville voisine. Les grades des chirurgiens qui ont accompli l'ECTP etaient: chirurgiens specialists bases dans des hopitaux peripheriques 5 (83,3%) et chirurgien en residence et en formation au centre de reference regional 1 (16,7%) Moyenne d'age 29,7 ans; rapport H:F=2:1. Un total de 6 cas d'ECTP ont ete diagnostiques. Constituant 9,5% de tous les insertions de tube dans la poitrine, surtout dans les petits hopitaux situes en zone peripherique non. Urbaine. Le diagnostic d'ECTP etait fait sur des radiographes de poitrine clairs chez 3 patients (50%) et sur le scanner CT de la poitrine chez 3 patients (50%). L'ECTP etait dans les poumons (2 cas, 33, 3%), sours - diaphragmatique, intra - abdominal (3 cas, 50%) mur de poitrine, sous - cutanees (1 cas, 16, 1%) Le mauvais diagnostic et le defaut de pleurale avant le placement des tubes plutot que l'usage des tubes avec trocar etait a blamer L'incidence de ETCP (9,5%) est eleve et soulique la necessite d'une formation proper de la methologie d'insertion de tube dan la poitrine pour les jeunes cadres chirurgiens.

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## Introduction

The insertion of a chest tube into the pleural cavity for the drainage of fluids (blood, effusions, chyle) and air is the commonest procedure in thoracic surgical patients<sup>1</sup>. Although the techniques of chest tube insertion are standardized, there continues to be reports of various complications due to ectopic chest tube placements (ECTP) into the heart, the lungs, the liver, the spleen, the colon, perforation of the diaphragm and insertion into posttraumatic tension gastrothorax[1-9]. Other forms of ECTP include subcutaneous placement especially in very obese patients[10]. Sudden death due to vagus nerve irritation during chest tube placement has been documented<sup>2</sup>. It is alarming that the reports of ECTP have a worldwide distribution[1-9].

Most cases of ECTP occur because of the failure of the operating surgeon to do a finger exploration of the pleural cavity before introducing the chest tube[11]. Misdiagnosis especially in posttraumatic tension gastrothorax, is also a contributory factor[3,4,8].

The aims of this report are to highlight the incidence of ECTP in our hospital's catchment area, to identify the causes of ECTP and to propose strategies for reducing the incidence.

## Clinical material and methods

In the six-month period from October 1999 to March 2000, we carried out a prospective study of ectopic chest tube placements (ECTP) diagnosed at the Assir Central Hospital, Abha, a regional referral and Level 1 trauma centre in the southern region of Saudi Arabia. All the patients who had chest tubes inserted in the hospital and those referred from other peripheral hospitals with chest tubes already inserted were included in the study. All the patients who had chest tubes inserted during thoracotomy were excluded.

The information documented included the ages of the patients, sex, referring hospital, presence of ECTP, status of the surgeon who inserted the chest tube(s), indications for the chest tube insertion, radiological investigations demonstrating the ECTP, position of the ectopically placed chest tubes and the outcome of management.

#### Results

In the six-month period of the study there were 63 chest tubes inserted in 44 patients. The mean age of the patients was 29.7 years. The male: female ratio was 2:1. All but one of the patients were Saudi nationals. Ten patients (15.9%) had bilateral chest tubes inserted following bilateral chest trauma and reinsertion of inadequately functioning chest tubes was carried out in 3 patients (4.8%). Six patients had ectopic chest tube placement. The clinical details of the six patients who had ECTP are shown in Table 2. Of the four patients who had MVA, one developed an encysted empyema and a left fibrothorax (Case #1). In this 24year old female, a left chest tube was inserted below the left hemidiaphragm and no drainage was observed despite the presence of a huge empyema (Fig.1). The second patient with

Table 1: Clinical data on patients with ectopic chest tube placement

Case No	Name	Sex	Age (Yrs)	Nationa lity	Diagnosis	Position of chest tube	Grade of surgeon	Manage- ment	Out- come	Mode of diagnosis of Ectp
1	NMA	F	24	Saudi	MVA, encysted left enmpyema, left fibrothorax	Subodiaphrag- matic (left side)	Surgeon specialist	Removal and reinsertion of chest tube	Good	Pain CX-ray (AP viwe). Clinical findings.
2	HFH	М	15	Saudi	Gun-shot wound of right chest, right haemopneumothorax	Right lung	Surgeon specialist	Removal and reinsertion of chest tube	Good	CT scan of chest
3	MA	М	50	Saudi	MV, bilateral fractured ribs bilate- ral haemophneumo- thorax, ARDS, lung contusion	Subdiaphrag- matic (left side), ? spleen	Surgeon specialist	Removal and reinsertion of chest tube	Good	CT scan of chest
4		М	19	Saudi	Stab wound of left chest, left haemopheumothorax	Left lung	Surgeon resident	Removal and reinsertion of chest tube	Good	CT scan of chest
5		F	45	Saudi	MVA, ruptured spleen and liver, bilateral haemopneumothorax	Left chest wall, subcutaneous	Surgeon specialist	Removal and reinsertion of chest tube	Good	Plain CX-ray (AP view)
6	AHS	Ν	M 25	Bangla- deshi	MVA, ruptured left hamidiaphragm. Tension gastrothorax	Intragastric	Surgeon specialist	Removal and reinsertion of chest tube, laparotomy and repair of ruptured laft hemidiaphragm	Good	Plain CX-ray (AP view)

MVA (Case #3) had bilateral fractured ribs and bilateral haemopneumothorax, lung contusion and adult respiratory distress syndrome (ARDS). The left chest tube was inserted in the left subdiaphragmatic region and it did not function. The diagnosis of ECTP was made by CT scan of the lower chest and upper abdomen. In the third patient with MVA (Case #5), there was ruptured spleen and liver, and bilateral haemopneumothorax. The 45-year old female patient was very obese and the chest radiograph showed the left chest tube located subcutaneously (Fig.2). The fourth patient with MVA (Case #6), a 25-year old male had a ruptured left hemidiaphragm with a tension gastrothorax. The stomach was markedly dilated and occupied most of the left hemithorax. This was misdiagnosed as a pneumothorax and a chest tube was inserted into the stomach.



Fig. 1: Chest radiograph (PAview) in a 24 year old female victim of an MVA who developed a post-traumatic left empyema and fibrothorax. There is a ground glass opacity of the left hemithorax and a shift of trhe mediastinum to the right. A left chest tube was inserted but it was very low and subdiaphragmatic.



Fig. 2: Chest radiograph (AP view) in a 45 year old obses Saudi female following an MVA. She had bilateral rib fractueres. Pulmonary contusion and bilateral haemopneumothax. The left chest tube is positioned subcutaneously.

Case #2 was a 15-year old male Saudi who had a right haemopneumothorax following an air-gun injury to the right chest. Right chest tube insertion failed to resolve the haemopneumothorax and the plain chest radiograph was not diagnostic of ECTP (Fig. 3A). A CT scan of the chest showed the chest tube in the right lung (Fig. 3B).



Fig. 3a: Chest radiograph (AP view) of a 15 year old male (Case #2) following an air-gun injury to the right chest. He presented with a right haemopneumothorax for which a right chest tube was inserted. There was persistence of the haemopneumothorax although the chest appeared to be well positioned. The metallic pallet was loged in the intercostal muscles in the 7th right intercostal space.



Fig. 3b: CT scan of the chest in the same patients showing the chest tube in the right lung.

Case #4 was a 19-year old male who sustained a penetrating stab wound of the left lung and presented with a left haemopneumothorax. A left chest tube was inserted (Fig 3A). A subsequent CT scan of the chest showed the left chest tube to be in the lung (Fig.3B).

## Discussion

The insertion of a chest tube into the pleural space for the drainage of haemothorax, pneumothorax, chyle or effusions is the commonest procedure performed in thoracic surgical patients[1,11,14]. Despite the innocuous nature of the procedure, it has been shown that there is no uniform, standardized technique

## of tube thoracostomy and chest tube mangement[6,9,14].

Several complications of chest tube insertion have been documented world wide. These include subcutaneous placement[10], laceration of the lung[10], intrapulmonary placement[1,15,16], interfissural placement[15], mediastinal perforation and contralateral haemothorax[17], placement of a chest tube into a tension gastrothorax following traumatic rupture of the left hemidiaphragm[3,4,8], delayed pulmonary perforation[11], sudden death due to vagus nerve irritation[2]. In our series of six patients with ECTP, the chest tube was placed subcutaneously in one patient who was very obese. This malpositioning of the tube was most likely due to the fact that the patient was very obese and the subcutaneous fat ample. In obese patients, a larger than usual thoracostomy incision may be indicated and a finger exploration of the pleural space through the thoracostomy ensures entry into the pleural space. The plain chest radiograph is adequate for the diagnosis of subcutaneous chest tube placement as is shown in our case #5.

The risk of intrapulmonary chest tube placement is increased if the patient has had previous intrapleural disease resulting in pleural symphysis and obliteration of the pleural space[1]. The mandatory finger exploration of the pleural space would in such cases confirm the pleural symphysis and contraindicate chest tube placement. The intrapulmonary placement of chest tubes is often blamed on the use of trocar cannula or the introduction of sharp instruments into the chest[18]. However, this is not borne out by the experience of those surgeons who advocate and use trocar-cannula for chest tube insertion[1]. Walksman et al[1] reported a 0.89% complication rate for chest tube insertion using a trocar-cannula. This in fact negates the statements in some textbooks of Surgery categorically forbidding the use of trocar chest tubes during chest tube insertion because of the perceived danger of injuring intrathoracic structures and ectopic placement into lung or the heart.

A rare but important complication of chest tube insertion is the placement of the chest tube into a tension gastrothorax which occurs when the stomach herniates through a ruptured left hemidiaphragm and becomes very distended[3,4,8]. Usually, the dilated stomach presents within the left hemithorax and can mimic a pneumothorax. In such situations, rather than inserting a chest tube inadvertently into the stomach, needle decompression of the gastrothorax is advised[3]. Nasogastric tube decompression has been advocated by Loiselle, et al[4] in such cases. However, failure to diagnose the gastrothorax usually leads to insertion of a chest tube into the dilated, herniated stomach as happened in our case #6. In traumatized patients who present with tension pneumothorax on the left side, the possibility of a ruptured left hemidiaphragm and a tension gastrothorax should always be considered[8].

Since it is not all patients who have chest tubes inserted undergo CT scan of the chest, it is not possible to quantify the extent of intrapulmonary chest tube placements[15]. The reported incidence of ECTP may thus not reflect the true incidence of the problem[15]. In our series, ECTP was found to be 9.5% (6/63). Daly, et al[13] reported an ECTP incidence of 1.8% (3/164) in 129 blunt trauma victims while Walksman, et al[1] reported an ECTP rate of 0.89% among 112 trauma patients. From Italy, Bergaminelli et al[10] reported an ECTP incidence of 1.5% (3/ 191) in trauma emergencies. A rather high ECTP incidence of 20% (8/40) was reported from Hamburg, Germany by Heim, et al<sup>15</sup> who carried out both chest radiography and CT scans of the chest in 31 severely injured patients. Although the plain chest radiographs did not diagnose a single case of ECTP, CT scan radiographs did not diagnose a single case of ECTP, CT scan revealed 8 cases (20%) of ECTP of which 6 were interfissural (15%) and two intrapulmonary placements (5%) were identified.

In patients with dilated cardiomyopathy, the myocardium is very thin and fragile and even finger exploration of the pleural space could lead easily to rupture of the heart in these patients. Extreme caution, a generous thoracostomy incision and gentle introduction of the chest tube is advised. If the chest tube function is less than optimal after insertion, ECTP should be suspected and every effort made to rule it out. When chest tube placement into the lung, fissure or subcutaneous space is diagnosed, the chest tube should be removed and a new one inserted.

In the 6 cases presented, the authors confirmed that failure of finger exploration of the pleural cavity prior to chest tube placement was responsible for the ECTP. All the 6 cases of ECTP in this report occurred in patients who had trauma. The possible explanation is that these patients presented as emergencies and the urgency of chest tube insertion may be responsible for the mistakes in placement.

## Conclusions

ECTP currently has an unacceptably high incidence in the Assir region of southern Saudi Arabia as well as worldwide. In our region, it occurs mostly in the peripheral hospitals due mostly to omissions in the standard procedure of chest tube insertion and misdiagnosis of the intrapleural or lung pathology. Diagnosis can sometimes be difficult on the plain chest radiograph when there is placement of the chest tube into lung parenchyma and only CT scan of the chest can conclusively demonstrate the ECTP.

Increased awareness, carrying out of finger exploration of the pleural cavity prior to tube introduction, local seminars on chest tube insertion techniques, would culminate in the reduction of the incidence of ECTP not only in our environment but also worldwide. Additionally, the development of standardized chest tube insertion and management protocols and correct diagnosis in chest trauma would be helpful in futher reducing the size of the problem of ECTP.

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