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Original Article

Malpositioned chest tubes and their indications; an experience from Addis Ababa, Ethiopia

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Abstract

Background: *Placement of a chest tube drain is the commonest procedure performed, especially in an emergency setting to evacuate fluid, blood, and air from the pleural cavity. Even if it is a simple procedure, it is associated with tube malposition and related complications, which sometimes may lead to death. So, This study analyses malpositioned chest tubes as seen on Computerized tomography (CT) scans.*

Method : *This is a retrospective record review of CT images of patients who have a diagnosis of malpositioned chest tubes.*

Results: *Most of the indications for chest tube placement were done for pleural fluid drain and pneumothorax. The retrospective CT analysis showed most of the chest tubes inserted were for the wrong diagnosis. Most malpositioned chest tubes were located in the normal or diseased lung. Intra-abdominal tube malpositions were seen in the spleen, liver, and retroperitoneum.*

Conclusion: *Chest tube insertion without proper indication may result in a malpositioned drainage tube . Abnormal tube positions may also cause injury to intrathoracic or intra-abdominal organs.*

Keywords: Chest tubes, Ethiopia, Malposition
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Introduction:

Whether the accumulation of air or fluid is rapid as in trauma or gradual as in malignant effusions, placement of a chest tube allows for continuous drainage of the collection until the underlying pathology can be more formally addressed. Most chest tube drain insertions everywhere are done in the emergency setting, particularly in traumatic thoracic emergencies (1).

Knowing and understanding the insertion techniques has paramount importance in reducing tube malposition and associated complications. The level of expertise and years of experience are also shown to affect the rate of complications associated with the insertion of chest tubes (2). So most guidelines recommend that all personnel involved with the insertion of chest drains should be adequately trained and supervised (3, 4). It's also mandatory in some institutions that all doctors who were expected to insert a chest drain should get adequate training using a combination of didactic lectures, simulated practice, and supervised practice until considered competent to reduce the rate of complications associated with the procedure (3).

The rate of complication associated with chest tube insertion is shown to vary among residents in training in different disciplines. Surgical residents were significantly less likely to have complications than nonsurgical residents (risk ratio 0.4, 95% confidence interval [CI] 0.16–0.96) (1).

Even if some previous studies have shown a lower risk of complication and high yield of pleural aspiration when done in the hands of experienced operators without image guidelines (5), most guidelines recommend the use of ultrasound guidance to avoid complications and dry plural tap associated with blind pleural aspirates (3, 6). It is strongly recommended that all chest drains for fluid should be inserted under image guidance even if there is less evidence comparing ultrasound guidance against clinical guidance for chest drain insertion than there is for pleural aspiration. Studies showed that a high level of efficacy and low rate of complication could be achieved when chest tube drain for pleural effusion and pneumothorax was done under ultrasound guidance (7-9).

Proper positioning, aseptic procedures, and proper technique of insertion guidelines should be followed strictly for all levels of expertise. Directly observed procedures and expert supervision during the procedure also improve accuracy and lowers the rate of complications when performed with medical students and residents (1).

The British society of thoracic surgery recommends the percutaneous insertion of chest drains in the safe triangle bordered by the anterior border of latissimus dorsi posteriorly and lateral border of the pectoralis major muscle anteriorly and a horizontal line crossing lateral from the nipple, with the apex below the axilla (4). Drains inserted in this space have a minimal rate of complication. All operators are expected to be appropriately trained and have been initially supervised by an experienced trainer. In addition, the UK national patient safety agency (NPSA) guidance and the new BTS guideline both recommend ultrasound guidance for inserting an intercostal drain for fluid.

It is also a routine practice in most institutions to get a post-procedure radiograph to check the position of the inserted tubes, even if malpositioned tubes may be missed on post-insertion radiographs. Sometimes, malpositioned / misdirected chest tubes may injure not only intrathoracic but also intra-abdominal vital organs resulting in life-threatening hemorrhages (10) and maybe even be fatal(11).

Sensitivity of a chest radiograph to diagnose malpositioned tubes is low and can diagnose only $1/5^{th}$ of the misplaced chest tubes (12). So CT is used for malpositioned chest tubes, and this study reviews malpositioned chest tubes and their complications and the primary indication and appropriateness of chest tube drain insertion.

The rationale behind this study is to evaluate the locations of malpositioned chest tubes and their clinical indication based on the imaging study done after the tube was inserted and to evaluate the value of computed tomography in localizing the exact anatomic location of malpositioned chest tubes.

Methods

This is a retrospective institutional-based study done at Wudassie Diagnostic Center by collecting all CT imaging studies done to asses the inserted chest draining tube and diagnosed to have malpositioned tubes.

Research setting

The study was conducted at Wudassie Diagnostic Center, one of the diagnostic centers located in the capital city, of Addis Ababa. The center has two CT scan machines at the time of data collection. More than ten radiologists are working on a full-time and part-time basis. All imaging was done based on the request made by the referring physician as a routine workup of patients.

In addition to the clinical information documented by the treating/refereeing physician, the full clinical history of the patient were taken by trained nurses before the scanning using a structured electronic record to complete all the necessary information which is needed for imaging, that contains age and sex of the patient, clinical symptoms, vital signs, indication for imaging, previous medical or surgical conditions, history of drug and contrast allergy. All the above procedures are routine practices at the imaging institution for all patients referred for imaging evaluation. The imaging request which is brought by the patient will be scanned and electronically recorded together with the clinical history and consent form.

Data collection.

The electronically archived chest imaging reports were retrieved, and all those reports with the conclusion of mispositioned chest tubes were selected. All imaging studies, with the diagnosis of mispositioned tubes were reviewed to assess the position of the tubes, and other clinical information recorded and stored electronically were also retrieved. A structured questionnaire was used to collect the data, which contains the age and sex of the patient, indication for insertion of chest tube, chest CT findings, assessment of the primary indication based on chest findings, and side and position of the inserted tube.

The primary indication for chest tube insertion was retrieved from the patient's records (from both imaging requests and electronic records of the institution). Findings are displayed using tables and representative images from the chest scan were also selected and displayed too.

Ethical considerations

This is a retrospective review of and imaging study was not done for the research purpose but performed as a routine workup of the patient when requested by the treating physician. All images were anonymized and all individual and institutional identifiers are removed from the data. permission to use the images from the institution server was obtained from the institution.

Results

There were a total of 19 cases over 16 months period from November 2019 up to March 2020 who were diagnosed as having malpositioned chest tubes with chest CT scans. As seen in Table 1 below, Patients' age ranged from 11 years up to 88 years, and a median age of 34 years. Among the cases, 14/19 were males, and 5/19 were females. Most chest tubes 11 (57.9%) were inserted with a clinical indication of pleural effusion, and 5/19 of the chest tubes were inserted for either traumatic or spontaneous pneumothorax. Most of the indica-

Table 1: Patient characteristics, indication, and findings of chest CT scan done for assessment of tube position

Case No.	Age	Sex	Presumed indication	Indications for CT	Chest CT finding	Indicated based on the imaging?	Site of chest tube	Position of the tube
1	11	M	Pleural effusion	No drainage	LLL consolidation	No	L	In consolidated lung
2	11	M	Pleural effusion	No drainage	Anterior mediastinal mass with massive pleural effusion	Yes	L	In mediastinal mass
3	49	M	Pleural effusion	No drainage	Basal atelectasis	No	L	Crossed the mediastinum anterior to the aorta with the tip abutting the right atrium
4	25	M	hemothorax	No drainage	Lung contusion	No		Lung parenchyma
5	25	M	Unknown	No drainage	Bilateral basal atelectasis	No	R	Crossed through the liver and punctured the kidney with perirenal hematoma
6	26	F	Trauma with pneumothorax	Suspected malposition	Diaphragmatic hernia with bowel herniating	No	L	Abutting bowel wall
7	26	F	Trauma with hemothorax	No drainage	Right hydropneumothorax and minimal left hemothorax	Yes	R	In the liver parenchyma
8	27	M	Pleural effusion	No drainage	Pancreatitis with left pleural effusion	Yes	L	Within spleen parenchyma
9	34	F	Pleural effusion	Reduced drainage	Right pleural effusion	Yes	R	Crossed through the lung and abuts the right atrium
10	34	M	Penetrating chest injury with hemothorax	No drainage	Right lung contusion and rib fractures	No	R	Within the contused lung
11	34	M	Pleural effusion	No drainage	Left pleural effusion	Yes	L	Within the oblique fissure
12	42	F	Pleural effusion	Reduced drainage	LLL consolidation and pleural effusion	Yes	L	Crossed through the lung with the tip in the sup mediastinum abutting the left SCA
13	42	M	Pleural effusion	No drainage	Left intrathoracic mass filling the thoracic cavity and right basal atelectasis	No	L	Within the intrathoracic mass
14	43	M	Pneumothorax	Workup for the cause	Lung fibrosis with giant bulla	No	R	Within the bulla
15	48	M	Pleural effusion	No drainage	Complete right lung fibrotic atelectasis with the heart being in the right thoracic cavity and hyperinflated left lung and iatrogenic left pneumothorax	No	R	Crossed from the right anterior to the right ventricle within the left pleural cavity causing left pneumothorax
16	55	F	Pleural effusion	No drainage	Left lung consolidation	No	L	Within the consolidated lung, the tip abuts the thoracic aorta
17	55	M	Pneumothorax	No clinical improvement	Pneumothorax	Yes	R	Within the atelectatic lung
18	65	M	Unknown	Routine workup	Pleural-based RLL mass	No	R	Within the mass
19	88	M	Trauma with pneumothorax	No clinical improvement	Left diaphragmatic hernia with bowel herniating	No	L	Within the lung in the LUL

The absence of clinical improvement was the indication for two cases and CT was done as a routine follow-up in two cases. Only in one case, the indication for tube insertion was for a suspected mispositioned chest tube. Based on the finding of the CT scan done to assess the position of the draining tubes, there was no clear indication for the chest tube insertion in 11/19 of the cases (table 1). Most chest tubes 11/19 were inserted on the left side with one of the tubes inserted on the right side with the tube crossed to the left, causing left iatrogenic pneumothorax (Figure 6).

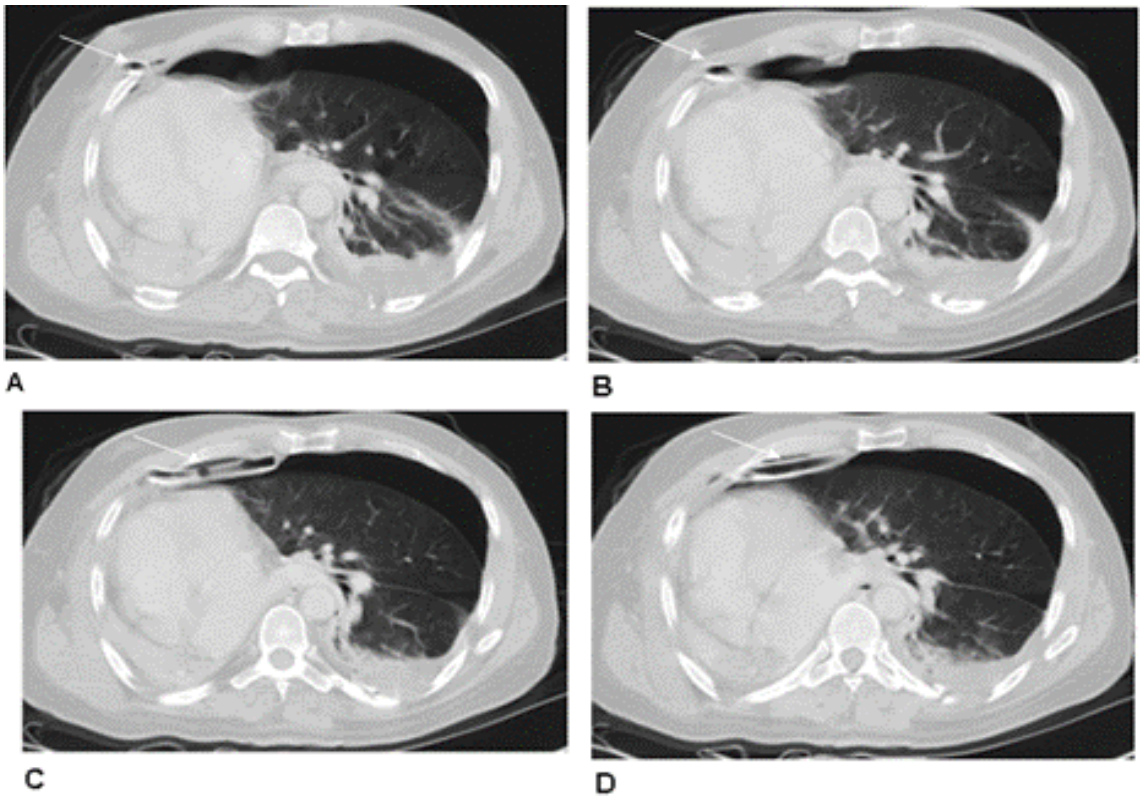

Figure 1 (Case 15): 48 years old male presented with right side chest discomfort and difficulty of breathing. The chest tube was inserted with a clinical diagnosis of right pleural effusion. Chest CT showed a completely collapsed right lung with the heart occupying the right hemothorax. Chest tube inserted from the right side crossed anterior to the heart and punctured the hyperinflated left lung causing left pneumothorax.

One tube was inserted into the destroyed lung with the clinical diagnosis of pneumothorax (figure 4). For two patients, 26 years old female and 88 years old male, the chest tube was inserted with the clinical indication of pneumothorax but later was diagnosed as having a diaphragmatic hernia. The chest tube was extrapleural in the former and crossed to the upper lobe with the tube in the lung parenchyma on the latter (figure 3).

The chest tube in one patient was in the left oblique fissure (figure 5). The chest tube is located within the mass lesion in two cases (figure 1). The chest tube was also located within the abdominal cavity within the spleen (figure 2), liver, and right renal parenchyma.

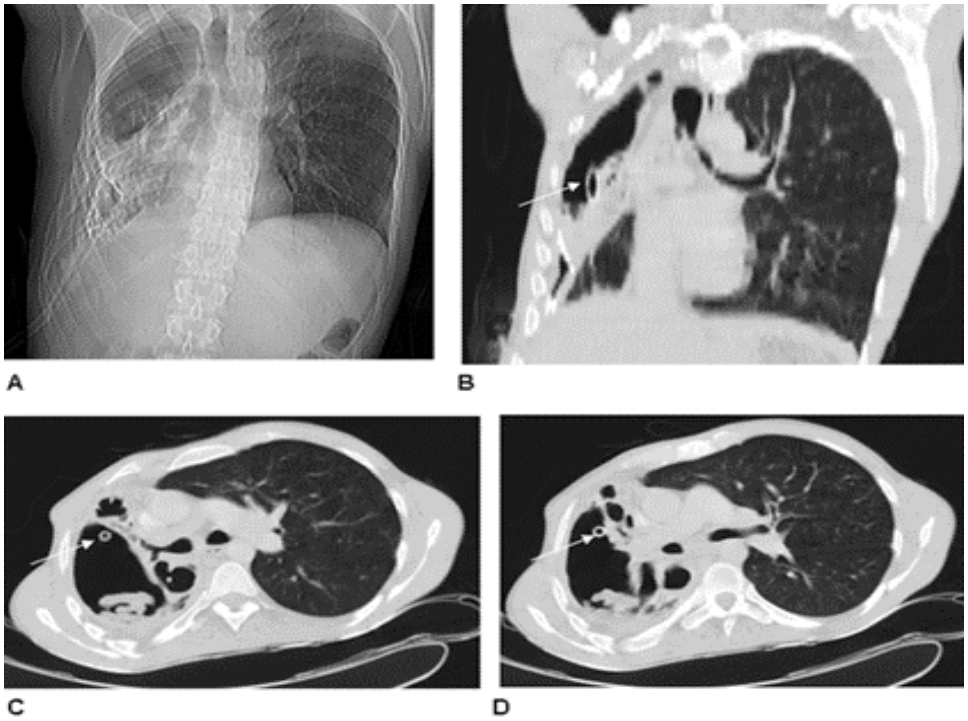

Figure 2 (Case 14): 43 yrs old male presented with chest pain and dyspnea with the CXR and CT scans showing a destroyed right lung with thickened and calcified pleura with a chest tube (arrows) in the destroyed

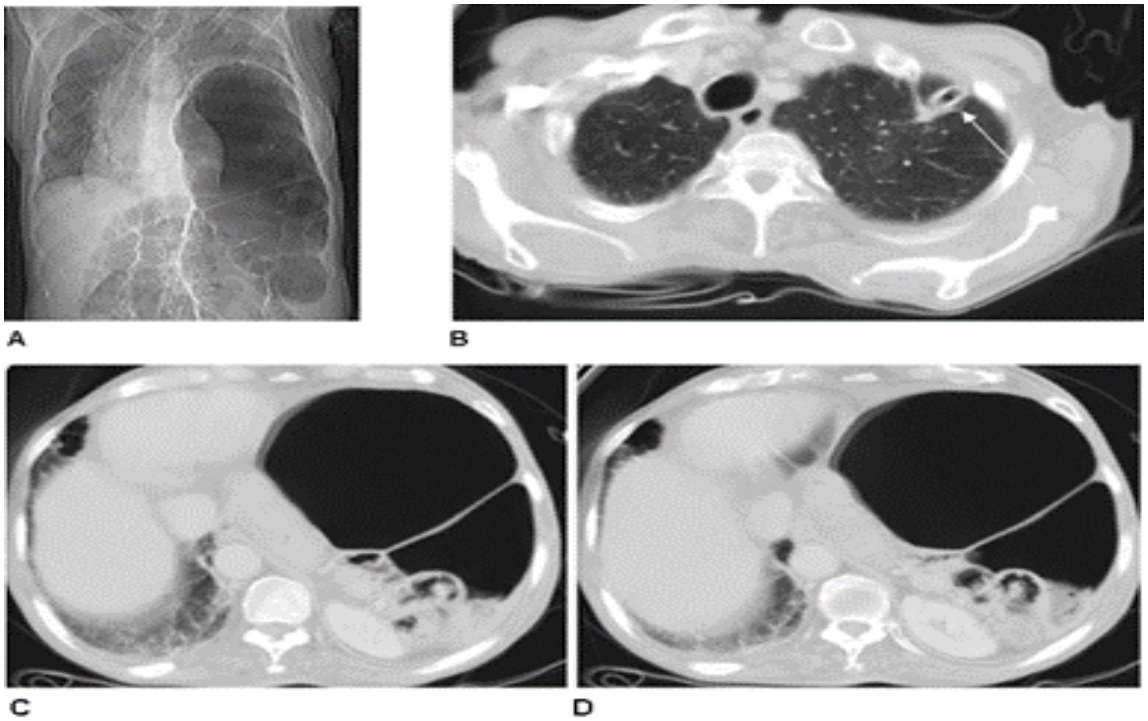

Figure 3 (case 19): An 88yrs old male presented after a fall accident. The scout film and the axial scans showed a diaphragmatic hernia with bowels herniating through the defect. The chest tube (arrow) extends above the herniated bowel into the apical lung.

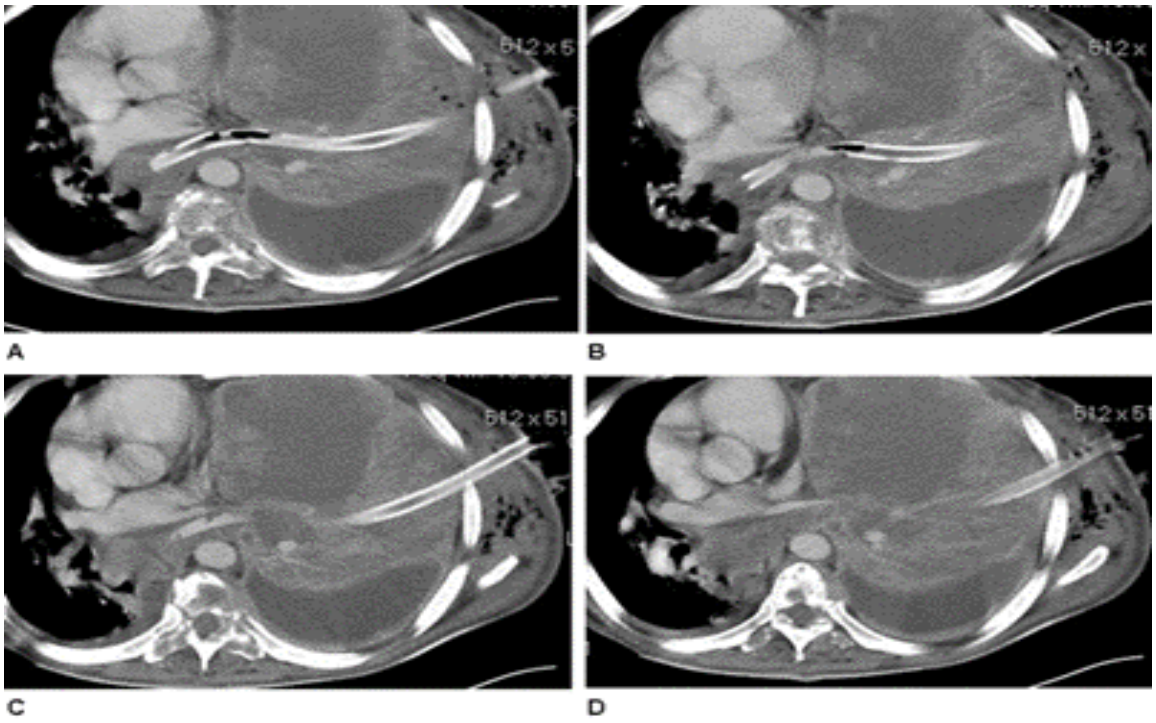

Figure 4 (Case 2): A 49 years old male presented with respiratory distress and a chest scan showed a huge LLL lung mass with massive left pleural effusion and vertebral metastasis. Chest tube inserted on the left passing through the lung mass crossing the mediastinum to the right anterior to the thoracic aorta with its tip adjacent to

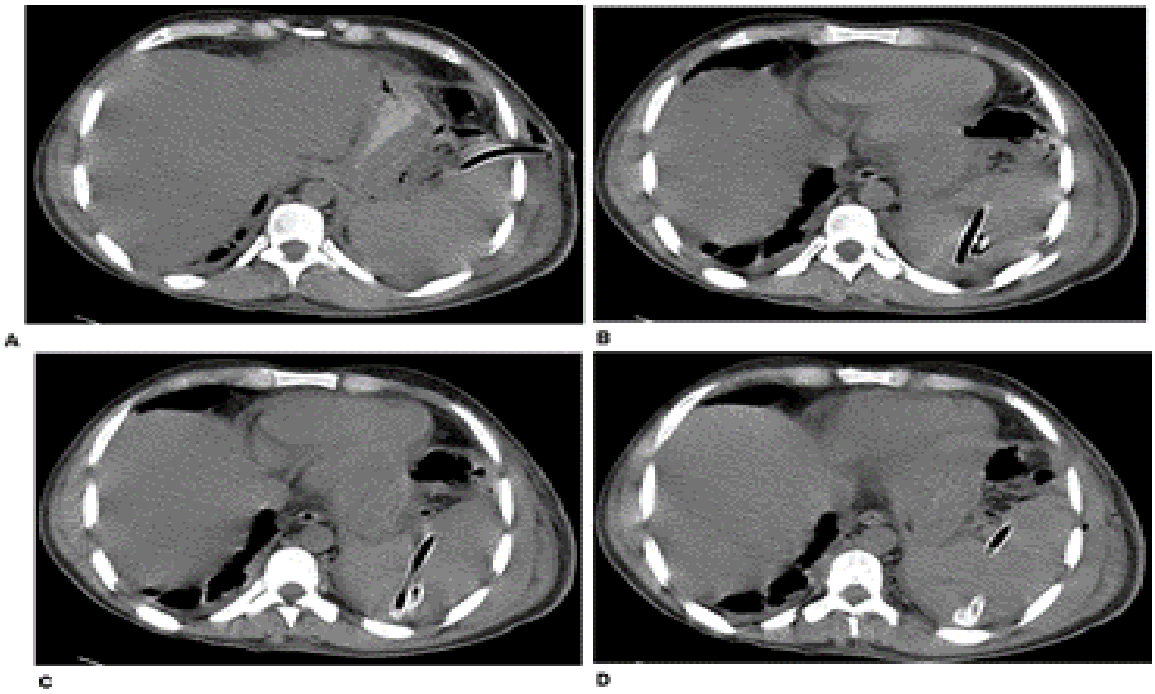

Figure 5 (case 8): A 27 years old male with acute pancreatitis and left pleural effusion. The chest tube was inserted on emergency bases and the tube failed to drain. CT then was done to evaluate the tube position

Discussion

Our study showed that most of the malpositioned chest tubes were inserted for indication of draining a pleural fluid. The next common indication was pneumothoraces, either spontaneous or traumatic. Most of the CT after the procedure was done for an indication of either absent or reduced tube drainage. There were three tubes which were located in the abdominal cavity traumatizing the solid viscera.

Chest tube placement is one of the common procedures performed in the emergency department for both traumatic and nontraumatic pleural air and fluid collections. Proper insertion of chest tubes can treat life-threatening conditions even if there are associated complications, malpositioned chest tubes being the commonest complication which may occur in up to one-third of the procedures. (13). So, subsequent care after insertion of chest drain is of paramount importance for good clinical outcome of patients.

In addition to the wrong position, chest tube insertion may also be complicated by infection or injury to mediastinal structures of the chest. Complications, when they occur, may also be life-threatening (14).

Most of the indications for a chest drain in our study were pleural effusion, hemothorax, or pneumothorax from blunt or penetrating chest trauma. In most institutions, pneumothorax and pleural effusions are the most common indications (13).
Most of the presumed diagnoses or indications for tube placement were unjustified on a retrospective analysis of the control CT which was done for various indications, as seen in table 1.

Even if CT is superior to other modalities in evaluating clinical discissions, proper clinical evaluation and preprocedural imaging will enable treating physicians to make reasonable decisions and avoid unnecessary complications. Chest tubes were positioned outside the pleura in the lung and fissures. Tubes were also located in the mediastinum and crossed the mediastinum to the contralateral lung abutting the major vascular structures. Inserted thoracic draining tubes may be positioned anywhere in the thoracic cavity outside the pleura within the mediastinum (15).

As we can also see in this study tubes may also be positioned outside the thoracic cavity into the abdomen which may result in solid organ trauma like liver, kidney and spleen. Such small, position, tubes within the solid organs particularly in the liver and spleen sometimes cause life-threatening hemorrhage (10, 16). In addition, tubes may also be located anywhere within the hollow organs like the esophagus and stomach (15).

Even if chest tube malposition within the lung and fissures do not have life-threatening complications, it increases hospital stay. As it was seen in one of our cases, bullous emphysema may sometimes mimic a pneumothorax and patients may be subjected to chest tube insertion (17), In four of our cases, tubes were advanced more medial to the mediastinal vascular structures abutting the heart and great vessels and two of the tubes also crossed the mediastinum to the contralateral thoracic cavity with one of the tubes puncturing the contralateral hyperinflated lung causing pneumothorax.

Such location of the tubes may sometimes puncture mediastinal vascular structures resulting in life -threatening hemorrhage. the mediastinal location of the tubes has potential vascular complications and even may result in cardiac injury and life-threatening hemorrhage (11, 18). Huge intrathoracic and mediastinal masses as well as ruptured diaphragm with bowel herniating into the thoracic cavity can sometimes mimic pleural fluid or air collection and may end up in chest tube drain as seen in our cases. This may result in poor drainage and sometimes may result in injury of the herniated bowel (19).

It is well known that preprocedural imaging will play important role in confirming the indication and ruling out other mimickers of fluid and air collection in the pleural cavities but sometimes insertion may be done with clinical evaluation only and it is not uncommon to get tubes in lung bullae (17) as it also occurred in one of our cases. Moreover, giant bullous emphysematous may also obscure the actual finding which needs tube insertion on both clinical examination and preprocedural chest radiography. So, sometimes preprocedural computed tomography may be important in selected patients (20).

Preprocedural imaging should be properly interpreted as the chest tubes inserted in our series showed that most were inserted for a wrong indication. This may arise from using clinical judgments without preprocedural radiographs, wrong interpretation of the radiographs, or blind insertion of the tube. Image guided insertion of chest tubes has been shown to have high efficacy and low rates of complications (7-9). That is why most guidelines strongly recommend the use of ultrasound guidance modality for chest tubes for draining fluid collections (3, 4).

Extra thoracic visceral location of the tube is a rare phenomenon and can inadvertently be inserted into the liver, spleen, and retroperitoneum resulting in renal hemorrhage as seen in our case, and may also result in life-threatening hemorrhage from hepatic injury (10, 16, 21).

(10) and may even be fatal (11).

Sometimes malpositioned / misdirected chest tube may injure not only intrathoracic but also intra-abdominal vital organs resulting in life-threatening hemorrhages .

The rate of malposition and other related complications of chest tube drainage placement depends on the level of training and expertise. Chest tube thoracostomy placement outside the trauma bay residents without surgical training is also a predictor of complications (1).
So, many institutions and international thoracic societies have guidelines (3, 4, 22) on who and how to insert chest drains and reporting mechanisms to track down malposition and associated complications and devise mechanisms to reduce adverse effects. The British Thoracic Society guideline emphasizes that all doctors expected to be able to insert a chest drain should be trained using a combination of didactic lectures, simulated practice, and supervised practice until considered competent (3).

Even if our study would not consider who inserted the chest tube, significant associations between chest tube thoracostomy complications and specialty of resident physician were also observed in the works of literature (1).

Conclusion:
Malpositioned chest tubes may be located within the thoracic or extrathoracic locations. Extra thoracic location of the chest tube within the abdominal cavity may result in injury to the liver, spleen, and even the kidneys.

Limitation:
this is a retrospective analysis of the cases. We took the clinical indication written on the imaging request. The level of training who inserted the tube and the time difference between tube insertion and control CT scan was also not known.

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References

1. Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, Ng AK, et al. Chest tube complications: how well are we training our residents? Can J Surg. 2007;50(6):450-8.
2. Harris A, O'Driscoll BR, Turkington PM. Survey of major complications of intercostal chest drain insertion in the UK. Postgraduate medical journal. 2010;86(1012):68-72.
3. Havelock T, Teoh R, Laws D, Gleeson F. Pleural procedures and thoracic ultrasound: British Thoracic Society pleural disease guideline 2010. Thorax. 2010;65(Suppl 2):i61.
4. Laws D, Neville E, Duffy J, Pleural Diseases Group SoCCBTS. BTS guidelines for the insertion of a chest drain. Thorax. 2003;58 Suppl 2(Suppl 2):ii53-ii9.
5. Bartter T, Mayo PD, Pratter MR, Santarelli RJ, Leeds WM, Akers SM. Lower risk and higher yield for thoracentesis when performed by experienced operators. Chest. 1993;103(6):1873-6.
6. Raptopoulos V, Davis LM, Lee G, Umali C, Lew R, Irwin RS. Factors affecting the development of pneumothorax associated with thoracentesis. AJR American journal of roentgenology. 1991;156(5):917-20.
7. Akhan O, Ozkan O, Akinci D, Hassan A, Ozmen M. Image-guided catheter drainage of infected pleural effusions. Diagnostic and interventional radiology (Ankara, Turkey). 2007;13(4):204-9.
8. Keeling AN, Leong S, Logan PM, Lee MJ. Empyema and effusion: outcome of image-guided small-bore catheter drainage. Cardiovascular and interventional radiology. 2008;31(1):135-41.
9. Moulton JS, Benkert RE, Weisiger KH, Chambers JA. Treatment of complicated pleural fluid collections with image-guided drainage and intracavitary urokinase. Chest. 1995;108(5):1252-9.
10. Bae J-M. Life-Threatening Hemoperitoneum and Liver Injury as a Result of Chest Tube Thoracostomy. Clinical Medicine Insights: Case Reports. 2015;8:CCRep.S23139.
11. Kim D, Lim S-H, Seo PWJTKjot, surgery c. Iatrogenic perforation of the left ventricle during insertion of a chest drain. 2013;46(3):223.12.
12. Lim K-E, Tai S-C, Chan C-Y, Hsu Y-Y, Hsu W-C, Lin B-C, et al. Diagnosis of malpositioned chest tubes after emergency tube thoracostomy: Is computed tomography more accurate than chest radiograph? Clinical Imaging. 2005;29(6):401-5.
13. Remérand F, Luce V, Badachi Y, Lu Q, Bouhemad B, Rouby J-J. Incidence of Chest Tube Malposition in the Critically Ill: A Prospective Computed Tomography Study. Anesthesiology. 2007;106(6):1112-9.
14. Lamont T, Surkitt-Parr M, Scarpello J, Durand M, Hooper C, Maskell N. Safety Alerts Insertion of chest drains: summary of a safety report from the National Patient Safety Agency. BMJ (Clinical research ed). 2009;339:b4923.

15. Gayer G, Rozenman J, Hoffmann C, Apter S, Simansky DA, Yellin A, et al. CT diagnosis of malpositioned chest tubes. 2000;73(871):786-90.
16. Feola A, La Sala F, De Stefano N, Diurno F, B. DP. A rare case of splenic injury due to a chest drain. Chirurgia 2020;33(68).
17. Ferreira Junior EG, Costa PA, Silveira LMFG, Almeida LEM, Salvioni NCP, Loureiro BM. Giant bullous emphysema mistaken for traumatic pneumothorax. Int J Surg Case Rep. 2019;56:50-4.
18. Anitha N, Kamath SG, Khymdeit E, Prabhu M. Intercostal drainage tube or intracardiac drainage tube? Ann Card Anaesth. 2016;19(3):545-8.
19. Kar SK. Emergency Chest Tube Insertion in A Case of Thoracic Trauma with Hidden Diaphragmatic Rupture Resulted in Injury of Herniated Stomach- A Case Report. EC Anaesthesia. 2015;2(2):5.
20. Tsao Y-T, Lee S-W. Vanishing lung syndrome. Canadian Medical Association Journal. 2012;184(18):E977.
21. Serji B, Mirali H, Chablou M, Kamaoui I, El Harroudi T. Liver injury secondary to chest tube placement: a case report of conservative management and review of the literature. Clin Case Rep. 2017;6(1):45-8.
22. Eisen L. Chest Tube Insertion. In: Oropello JM, Pastores SM, Kvetan V, editors. Critical Care. New York, NY:McGraw-Hill Education.