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Original Article

Catastrophic injuries caused by tube thoracostomy with trocar: a series of nine cases

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ABSTRACT

Background: Tube thoracostomy is a procedure that is frequently used in thoracic surgical practice. However, in certain circumstances, it may lead to serious complications during or soon after the procedure. Herein, we report a series of tube thoracostomies causing life-threatening intrathoracic and intraabdominal injuries.

Materials and Methods: This case series consisting of nine cases with serious organ and vascular injuries after tube thoracostomy between 2014 and 2021 are presented and the possible causes are discussed. The indications for tube thoracostomy were empyema, COVID pneumonia-related pneumothorax, traumatic pneumothorax, tracheal rupture related-hydropneumothorax during nasogastric tube application, and pleural effusion due to malignancy. A trocar was used in all patients for tube thoracostomy.

Results: Malpositioned thoracic drains included five pulmonary parenchymal lacerations and pulmonary artery, spleen, liver and stomach injuries; one of each.

Conclusions: In the light of these cases, all the procedures and the faults that caused those embarrassing complications have been reviewed honestly. Lessons learned from these events such as avoiding the use of trocars, and CT evaluation before the procedure may also help to prevent such complications in the future.

Keywords: malposition, chest tubes, injuries, tube thoracostomy

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Introduction

Pleural drainage is a procedure dating back to the time of Hippocrates, which is still clinically important with its basic principles [1]. Currently, this procedure continues to be a common surgical intervention in the thoracic surgery field, which is frequently performed in the presence of hemothorax and/or pneumothorax [2]. Various serious complications such as organ laceration, vascular injury, and infection may tend to develop after this procedure and it is important to be aware of these complications to be able to identify the risk factors, which have a significant risk in terms of morbidity and mortality, and to establish preventive strategies.

In this case series consisting of nine cases with serious organ and vascular injuries after tube thoracostomy (TT) between 2014 and 2021 is presented and the possible causes are discussed. This is the first case series of life-minatory complications of chest tube insertion encountered in the PubMed search. Considering the diversity of the cases and their post-complication processes, we believe that they may draw attention to the ones interested in the surgical field.

Materials and Methods

The cases of malpositioned thoracic drains; including five pulmonary parenchymal lacerations and pulmonary artery, spleen, liver, and stomach injuries are listed in table 1.

Results

Case 1 is a 94-year-old female patient with previously known diagnoses of bronchiectasis, type-2 diabetes and hypertension who was admitted to the emergency department with complaints of chest pain and dyspnea. On the thorax computerized tomography (CT), an image compatible with hydropneumothorax was observed in the right hemithorax. The patient, who already had a history of multiple thoracentesis due to pleural effusion, was consulted by our clinic. In thoracentesis, purulent fluid was aspirated and TT was performed with placement of 28 Fr chest tube to the right hemithorax. At the time of performing TT, she had a hemoptysis in the form of blood-streaked sputum. The chest tube was revised. In control CT, a laceration caused by the malpositioned tube was detected in the posterior segment of the right upper lobe (Figure 1).

Case 2 is a 43-year-old male patient who was admitted to the emergency department with a sudden onset of stabbing chest pain. Since the CT appearance was compatible with pneumothorax, he underwent a TT and his Covid-19 PCR test was positive. Massive air drainage prompted us to take a chest radiograph followed by CT which revealed the chest tube passing throughout the parenchyma of the left upper lobe.

Case 3 is a 72-year-old male patient who was admitted to the emergency room due to an in-vehicle traffic accident and was consulted to us for subcutaneous emphysema. Chest radiograph revealed bilateral pneumothorax and he underwent bilateral TT. CT demonstrated an intraparenchymal position of the chest tube (Figure 2). Due to a prolonged serious air leak, the operation was planned. Extensive adhesions between the lung and chest wall in addition to parenchymal damage were seen.

Table 1. Characteristics of the cases with catastrophic injuries.

No	Primary disease	Indication for TT	Injured structure
1	Bronchiectasis	Empyema	Lung
2	Covid-19 pneumonia	Pneumothorax	Lung
3	In-vehicle traffic accident	Pneumothorax	Lung
4	Tracheal rupture during the misplacement of nasogastric tube	Hydropneumothorax	Lung
5	Synovial sarcoma	Pleural effusion	Lung
6	In-vehicle traffic accident	Hemopneumothorax	Liver
7	In-vehicle traffic accident	Hemopneumothorax	Pulmonary artery
8	Anaplastic oligoastrocytoma	Pleural effusion	Spleen
9	Dehiscence of the diaphragmatic suture following partial resection	Assumed pneumothorax	Stomach

Abbrev.; TT: tube thoracostomy.

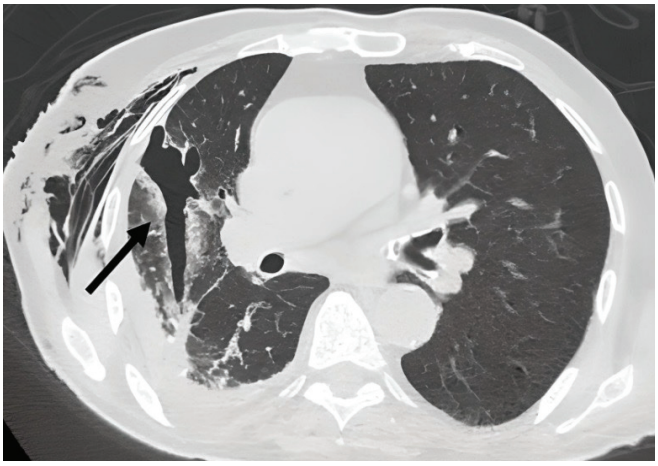

Figure 1. Pulmonary parenchymal laceration in the right upper lobe caused by the chest tube.

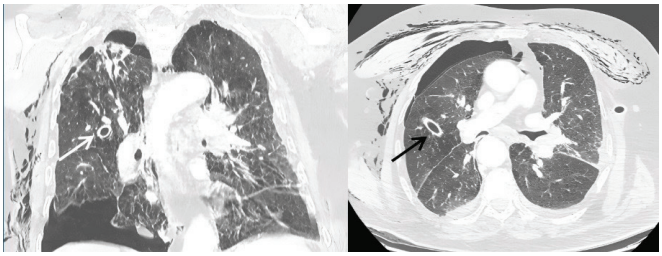

Figure 2. Thorax CT coronal and transverse sections reveal an intraparenchymal thoracic drain located in the right hemithorax and an appearance compatible with the right expansion defect.

Consultation was requested by neurology clinic for a 68-years-old male patient, who underwent thrombectomy due to occlusion in his left middle cerebral artery (MCA) and suffered iatrogenic lung parenchymal injury during insertion of a nasogastric tube (case 4). TT was applied to the patient whose nasogastric tube was seen traversing through the right hemithorax on thorax CT. The fluid is compatible with the enteral nutritional fluid drained from the chest tube due to nasogastric tube feeding. After performing TT, a CT scan showed that the chest tube was passing through the parenchyma of the right lung.

Case 5 is a 22-year-old male patient who was diagnosed with synovial sarcoma and followed up in the medical oncology clinic for chemotherapy and was examined for dyspnea. The chest radiograph showed a homogeneous density filling the right lower zone of the chest (Figure 3a). After sero-hemorrhagic fluid was aspirated by thoracentesis, TT was applied to the right hemithorax. Since there was no drainage, the chest tube was pulled out. Thorax CT revealed a 10x7 cm mass extending to the major fissure in the right lower lobe, which was seen to be penetrated by the chest tube (Figure 3b).

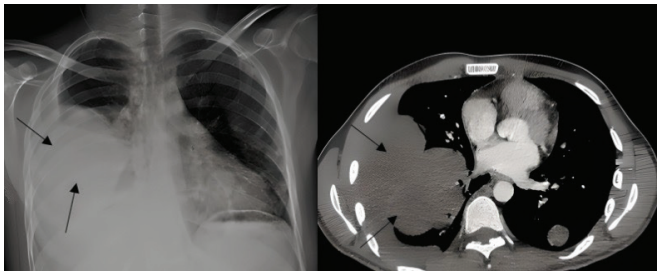

Figure 3. Homogenous density in the middle and lower zones of the right hemithorax **(a)**, and on CT, a 10x7 cm mass extending to the major fissure in the right lower lobe of the right lung, bilateral multiple metastatic foci having the dimensions of up to 2 cm and accompanying minimal pleural effusion **(b)**.

Case 6 is a 53-year-old male patient who was admitted to the emergency service after a traffic accident. On thorax CT, serial rib fractures on the right side, minimal pneumothorax, and hemothorax in the right hemithorax were observed. After a TT was performed there was no oscillation in the underwater sealed drainage system. The control chest radiograph demonstrated the tube in the subdiaphragmatic area (Figure 4a). CT showed that the tube which was inserted from the 8th intercostal space, traversed the entire liver (Figure 4b).

Case 7 is a 24-year-old female patient who was taken to the emergency room after a traffic accident with loss of respiratory sounds. Bilateral TT was applied as the air was aspirated following thoracentesis. Massive air drainage from the right chest tube and expansion defect in the right lung persisted on the control chest X-ray and thorax CT was taken afterward. An apical chest tube was inserted into the right hemithorax in addition to the existing tube. Following the procedure, the patient had 500 mL of sudden hemorrhagic drainage and was urgently taken to the operative room. At the operation, a coagulum-filled parenchymal defect and massive hemorrhage were detected on the anterior surface of the right upper lobe. It was observed that bleeding originated from one of the pulmonary artery branches in the lung parenchyma. The branch of the pulmonary artery branch was primarily repaired and the bleeding was ceased.

Case 8 is a 32-year-old male patient, who was under observation for anaplastic oligoastrocytoma and was consulted to our clinic due to dyspnea. On his CT scan, bilateral pleural effusion was seen, and bilateral TT was performed (Figure 5a). After the procedure, the patient had a sudden hemorrhagic drainage of about 1000 mL. Chest x-ray revealed an appearance compatible with hemothorax was seen in the left hemithorax (Figure 5b). The hypotensive and tachycardic patient was urgently taken to the operating room. On exploration, it was observed that the elevated diaphragm was lacerated and the spleen was lacerated by the chest tube. The patient underwent a splenectomy.

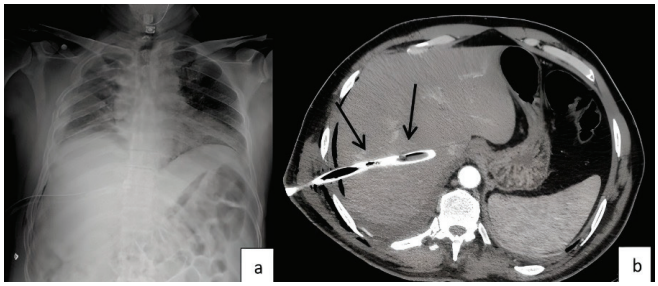

Figure 4. Posteroanterior chest radiograph showed the chest tube located in the subdiaphragmatic area on the right **(a)**, transverses the whole liver on CT **(b)**.

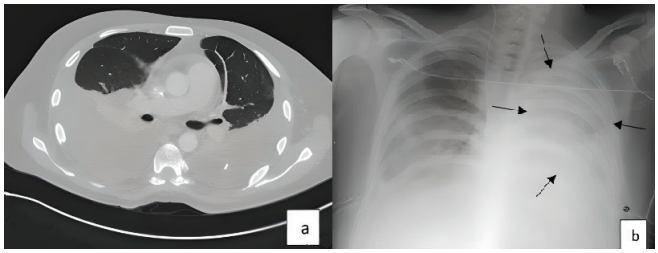

Figure 5. Appearance compatible with bilateral pleural effusion on thorax CT (a), increased opacity in the left hemithorax in the posteroanterior chest X-ray taken urgently after massive hemorrhagic drainage after tube thoracostomy (b).

The last case is a 67-year-old male patient who underwent left lower lobectomy and partial diaphragmatic resection due to the adenosquamous carcinoma of the left lower lung invading hemi-diaphragm. The defect in the diaphragm was primarily repaired with non-absorbable separated sutures. After removing the chest tube on postoperative 2nd day, the patient developed dyspnea. An appearance that could be compatible with hydropneumothorax was seen on the chest X-ray and TT was performed to the left hemithorax. Drainage of gastric content from the thorax tube prompted the surgical team to take a CT (Figure 6) and afterward the patient underwent re-operation in emergent condition. On exploration, a defect in the diaphragm, a part of the stomach and omentum entering into the thoracic cavity, and an iatrogenically injured gastric fundus by the chest tube were observed.

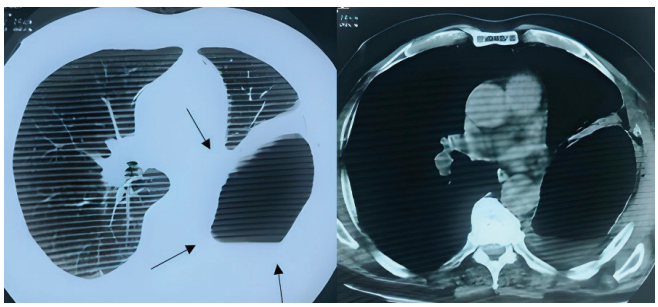

Figure 6. Air-fluid level on thorax CT was misinterpreated as hydropneumothorax in the left hemithorax.

Discussion

Tube thoracostomy is a minor surgical intervention frequently performed in the clinical practice of thoracic surgeons with various indications. Complications such as improper localization of the tube, infection, and organ injury may occur during or after the procedure, with malposition being the most common. Thoracic and abdominal organ damage and vascular injury are among the most serious ones for malpositioned TT, which may cause significant morbidity and mortality. There are nine cases in our case series for malpositioned thoracic drains; including five pulmonary parenchymal lacerations and pulmonary artery, spleen, liver, and stomach injuries; one of each.

In these cases, the indications for TT were empyema, COVID pneumonia-related pneumothorax, posttraumatic pneumothorax, and tracheal rupture related hydropneumothorax during nasogastric tube application, and pleural effusion due to malignancy.

In this series, a trocar was used in all patients who underwent tube thoracostomy. We also performed TT without trocar in our clinic. Within the scope of this study, patients who underwent TT in our clinic between 2014 and 2021 were examined retrospectively. As a result of the examination, it was determined that all patients who developed malposition or injury were patients in whom trocars were used. No catastrophic injuries occurred in patients who underwent TT without the use of a trocar. For this reason, although there may be patient groups in which the use of trocars may be relatively safe, such as patients with radiologically proven total pneumothorax, in our clinical practice we recommend that the use of trocars should be avoided, especially in patients with suspicion of pleural adhesion and in whom the lung parenchyma may have become fragile due to underlying diseases or TT will be performed through the lower level ribs (i.e., 9 to 12 ribs). Remérand et al investigated the incidence of chest tube malposition in critically ill patients and reported that the only factor that could be associated with malposition was the use of trocars during tube placement . It is well-known that, presence of the pleural adhesions, reduced lung compliance and underlying parenchymal consolidation may lead to parenchymal injury. In patients with suspected pleural adhesions (thoracotomy, pleurodesis, previous infection/empyema, chest trauma) and parenchymal lesions, it is important to examine the pre-procedural radiological images carefully to determine the

localization, avoiding the use of trocars and to explore pleural space digitally. In patients with a history of malignancy, similar appearance of mass and pleural effusion on plain radiographs may be misleading.

In a study in which TTs were applied in trauma resuscitation centers, the chest tubes causing pulmonary parenchymal injuries were detected in 11% of the cases [4], while 10 (9%) were reported in 106 TTs who were examined with CT in another study [3]. In the presented case series, there are five parenchymal injuries among all the 2,691 TT procedures (0.19%) between 2014 and 2021, either performed in emergent conditions or not.

The patient whose pulmonary artery was injured was the most catastrophic TT procedure among our case series. The number of TT cases resulting in pulmonary artery injury is quite limited in the literature and only 11 cases were reported in the PubMed field [5-15].

In our three cases with extrathoracic organ damages, one had a liver injury, another had a spleen injury, and the third had a stomach injury. It can be said that, if TT was performed through the lower level ribs (i.e., 9 to 12 ribs) by trocar technique, the risk of diaphragmatic and/or intraabdominal organ injury will be quite high. In the literature, various cases that developed liver injury; of which two of them were treated by embolization of the liver. Whereas major hemorrhage and/or hemodynamic instability in patients with liver injury, surgical exploration is often indicated [16-19]. Spleen laceration after TT often requires splenectomy. Although it is encountered rarely, hemoperitoneum and hemorrhagic shock may also occur in spleen injury [20].

In our case with the stomach injury, the patient developed a dehiscence of the diaphragmatic sutures in the early postoperative period after which the stomach was displaced towards the thoracic cavity. The appearance on the tomography mimicked hydropnomothorax. Some cases in which gastrothorax mimics pneumothorax have also been reported in the literature [21-22]. In partial resection of the diaphragm, a nasogastric tube should be inserted in the early postoperative period to reduce the tension in the diaphragm, unlike in the present case.

In conclusion, although TT is widely used as a life-saving surgical intervention, it also bears its risks in terms of various complications. Being familiar with the causes of these complications and discussing them is important in developing preventive strategies. Lessons learned over 7 years from these embarrassing complications led us to get some take of messages as follows:

First, if possible, the patient should be evaluated with chest CT before TT to avoid malposition and/or organ injury. However, in some cases, a CT scan is not possible because the patient is unstable, or because frequent measurements are wanted to track the progress of a bleed. In these situations, bedside sonography can also be used.

Second, the use of trocars during the procedure increases the risk of complications. The use of a trocar allows rapid drainage with a smaller incision, while the sharp trocar tip may lead to injury. Avoiding the use of trocars in patients can prevent the occurrence of complications.

Lastly, if there is still doubt about the indication or on which point to insert the tube into the chest cavity, to find the right way, one should not hesitate to get a second opinion, especially from a senior specialist.

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Informed consent and Ethical approval

Written informed consent was obtained from all participants or their legally authorized representatives. Ethics Committee approval was waived.

Availability of data

The dataset of the research presented in this article is under record. Corresponding author can be contacted to reach the required data network.

Authors' contribution

GKO; design, conceptualization, writing the paper, DG; design, conceptualization, collecting and processing data, UC; designed the research, conceptualization and supervision, AO,TIA,AGE,KT; supervision, co-writing, review and editing.

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