

Fatal misadventure of trocar-iatrogenic right atrial perforation during tube thoracostomy in a patient with cardiomegaly: a case report and review of literature

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ABSTRACT

Background: Tube thoracostomy is a routine life-saving procedure with vast implications in the management of various thoracic conditions that include pleural effusion, pneumothorax, empyema, blunt, and penetrating thoracic trauma. Though a simple procedure, a high rate of morbidity and mortality is associated if a complication occurs.

Case Presentation: An intercostal chest tube was inserted by trocar method in a 47-year-old female with rheumatic heart disease associated cardiomegaly, which resulted in right atrial perforation. The patient was managed successfully by an emergency thoracotomy followed by cardiac repair surgery. Our case report demonstrates a very unusual yet life-threatening complication of a simple intervention such as intercostal chest tube insertion and highlights the management of the same. Aim of this case report is to discuss the clinical implications and literature pertaining to the iatrogenic cardiac injury during tube thoracostomy.

Conclusion: The use of the blind method of intercostal chest drain insertion using a trocar should be discouraged, particularly in cases with dense pleural adhesions or cardiomegaly.

Keywords: Cardiac perforation, cardiothoracic surgery, healthcare improvement, patient safety, tube thoracostomy.

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Background

Tube thoracostomy is the insertion of an intercostal chest drain (ICD) in the pleural cavity that aims at adequate lung expansion by the evacuation of accumulated air, water, blood, chyle, or pus, etc. from the pleural space. It is a simple basic procedure but often a lifesaving one too. But this procedure is associated with significant morbidity and occasional mortality [1]. Tube thoracostomy is a widely used invasive procedure for treating pneumothorax and pleural effusions and used commonly to manage blunt and penetrating chest trauma. There are various methods of intercostal chest tube insertion that include—1) Standard blunt dissection open method, 2) Seldinger guide wire method, 3) Trocar puncture method, and 4) Imaging guided chest tube placement using ultrasonography, fluoroscopy or computed tomography.

The risk of iatrogenic injury is highest with blind methods of chest tube insertion such as the Seldinger method or Trocar method. Most confronted complications include intercostal vessel bleeding and visceral injuries that include diaphragm or lung laceration, and sometimes damage to intrabdominal organs [2]. Major cardiac and vascular injuries are rare but have a dramatic presentation [3].

Case Presentation

A 47-year-old female patient, who was a known case of rheumatic heart disease with an antecedent history of mitral valve replacement done 27 years ago, presented with a complaint of mild abdominal pain. On evaluation, she was found to have a right-sided ovarian mass which on histopathology revealed a malignant epithelial neoplasm. She was also found to have cardiomegaly along with right-sided pleural effusion on chest X-ray.

She underwent ovarian staging laparotomy but recovery from anesthesia was not smooth and a significant reduction in breath sounds along with presence of crackles on the right side was found on clinical examination. On initial evaluation, the chest radiograph showed cardiomegaly with right-sided pleural effusion. It was planned to manage the patient in the intensive care unit with an endotracheal tube *in situ*. Immediate postoperative bedside ultrasonography chest was done which was suggestive of 1,000–1,200 ml fluid collection in the right hemithorax. Needle thoracocentesis was hemorrhagic in nature. A 28F intercostal drainage tube was inserted in fifth intercostal space in mid axillary line using an old-fashioned metal trocar. 1,000 ml of hemorrhagic fluid was drained

immediately, following which the ICD was clamped. After 4 hours, the patient was extubated and the ICD clamp removed, and no outflow from the tube was seen. For the next 2 days, the tube output was nil. The patient was mobilized on third postoperative day and there was a sudden gush of 1,000 ml blood in the ICD. Subsequently, the patient developed hemodynamic instability and complained of dizziness. After sudden sanguineous drainage from the chest drain on third postoperative day, the patient was stabilized hemodynamically by giving intravenous (i/v) fluids and three units of red blood cell transfusion. Thereafter, an emergency contrast enhanced computed tomography (CECT) scan of the chest was done which revealed that the tip of the ICD was in the right atrium [Figure 1(A-D)]. Emergency right anterolateral thoracotomy was carried out. There was massive cardiomegaly that was pushing right lung upward and posteriorly. ICD tip was in the right atrium (Figure 2). The pericardium was opened and purse-string sutures with prolene 5-0 were taken on right atrium around the entry site of the ICD. The tube was gently pulled out with simultaneously tightening of purse-string sutures. The intracardiac portion of the ICD tube had an intraluminal blood clot, the probable reason for discontinuous ICD output. The pericardium was closed thereafter. The patient recovered uneventfully and was discharged on the sixth postoperative day of thoracotomy. After getting discharged, the patient was followed

up for 3 months. Though the patient complained of pain at the operative site, which was well controlled with oral analgesics, She did not experience any complications or sequelae with her health being completely restored. She was able to resume her daily routine activity 1 month after being discharged from the hospital, the main reason for this long-duration being the thoracotomy associated pain.

Discussion

The technique of intercostal drainage using a chest tube has been modified several times over the past few decades. In 1876, Hewitt was the first to use a completely closed intercostal drainage system, but it was not until World War II that tube thoracostomy became common in the treatment of injured patients [4].

ICD insertion is a life-saving procedure, but if an iatrogenic injury occurs, it is also associated with high morbidity. The injury during tube thoracostomy is usually the result of lack of adequate training and surgical expertise. Furthermore, many of these studies use partial or complete insertion with the trocar puncture technique, a method associated with a greater incidence of lung and other thoracic injuries, compared with the more widely accepted blunt dissection technique [4].

An iatrogenic injury during tube thoracostomy, resulting in a cardiac perforation, is an extremely rare complication. After an extensive review of literature using

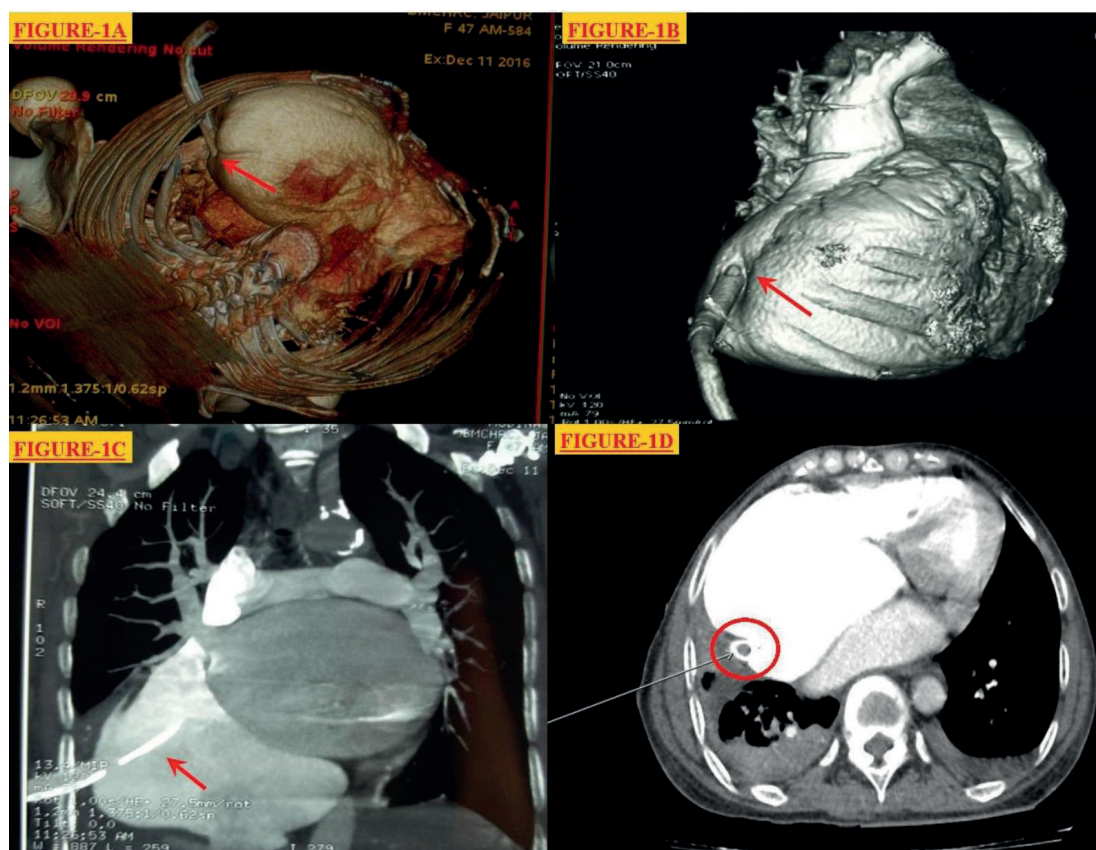


Figure 1. (A, B) Arrow showing ICD entering the right atrium; (C) arrow showing ICD inside the right atrial chamber and (D) circle showing ICD entering the right atrium.

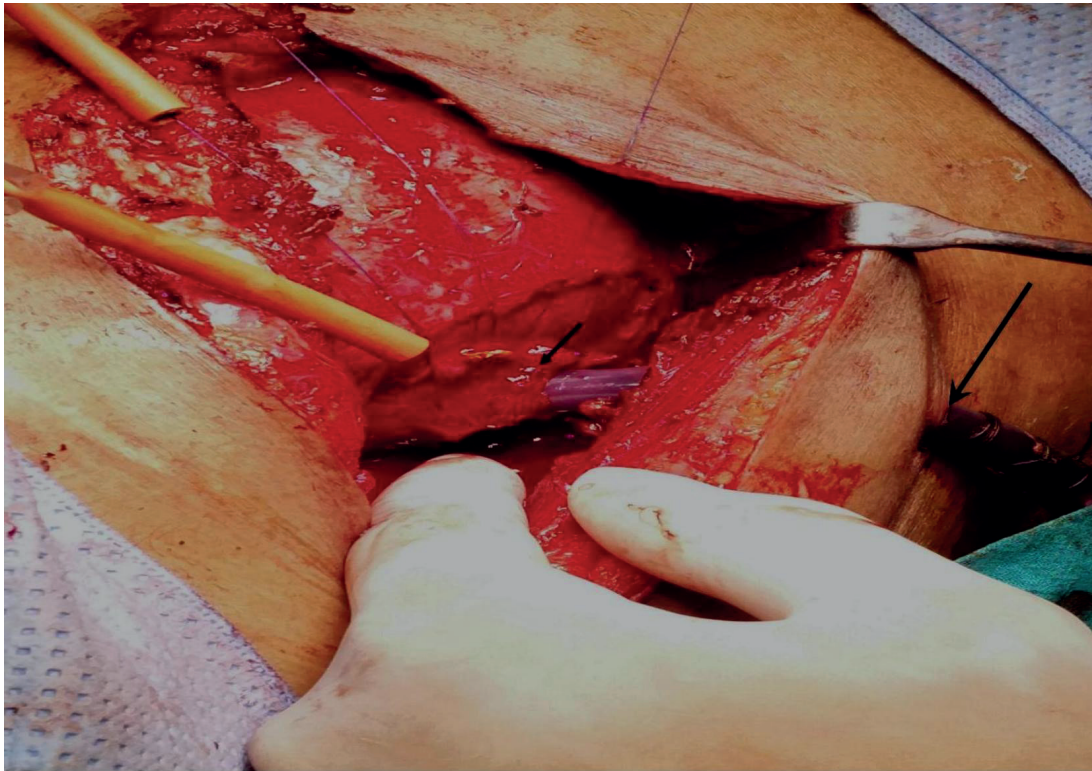


Figure 2. Intra-operative photograph showing chest wall entry site of ICD (large arrow) and ICD entering the right atrium (small arrow).

MEDLINE, PubMed databases with a combination of following terms “Cardiac perforation”; “Cardiac injury”; “Tube thoracostomy”; “Chest tube insertion”; “ICD insertion” and “Chest tube drainage”, we conclude that the cardiac perforation due to tube thoracostomy has been reported only 17 times till date (Table 1). Including the current case, ICD insertion was done on the left side in 11 out of 18 patients (61.1%) and on the right side in 7 out of 18 patients (38.9%). Out of the total 18 patients who sustained cardiac injury after ICD insertion, left ventricle was the most commonly injured cardiac chamber (8 out of 18, 44.4%), whereas left atrium was the least injured cardiac chamber (2 out of 18, 11.1%). Both right atrium and right ventricle were injured in 4 out of total 18 patients (22.2%). Including the current case, underlying cardiomegaly was seen in 7 out of the total 18 cases (38.9%) been reported so far in the literature. This suggests that presence of cardiomegaly might increase the risk of cardiac injury while performing a tube thoracostomy. While surgical intervention was required in the majority of the cases, i.e., 15 out of total 18 patients (83.3%), it is interesting to note that the outcome is also favorable in most of the cases as 13 out of total 18 patients survived the life-threatening misadventure of tube thoracostomy (72.2%). In 1 patient out of 15 patients undergoing some sort of intervention, as reported by Shah et al. [17], percutaneous intervention was done and all the remaining underwent open cardiac surgery via either median sternotomy or thoracotomy. Another interesting fact to note is that out of the four times when right

ventricle was injured, the outcome was fatal in three cases and the single patient that survived was the same who underwent percutaneous intervention.

During ICD insertion, the likelihood of an injury to the heart increases manifold, if there is a presence of a severe chest injury in the past, significant cardiomegaly, mediastinal shift, significant anatomical variations, and dense pleural adhesions. Therefore, one must be cautious and avoid blind tube thoracostomy in such cases. If the thoracic anatomy is distorted due to the above-mentioned causes, needle aspiration of the air/fluid can guide the subsequent safe insertion of the ICD. As per the current guidelines for chest drain placement, failure of the needle aspiration necessitates further radiological evaluation like CECT scan before one can proceed with the ICD insertion [21]. Also, thoracic ultrasound is a valuable modality, when it comes to chest tube insertion. Studies have shown high efficacy and low complication rate with the use of ultrasound guidance while inserting a chest tube [22,23]. After having failed management with standard non imaging guided chest tube insertion, van Sonnenberg et al. [24] successfully treated empyema in 76.5% of the cases using imaging guidance to insert small bore catheters. Also, the British thoracic society pleural disease guideline group strongly recommends that all the chest drains for fluid should be inserted under image guidance [25].

If despite all precautions, the heart is perforated, the drain must be clamped and computed tomography of the chest should be performed immediately as long as the

Table 1. Summary of the review of literature.

No.	Author	Publication year	Underlying condition	Chest tube side	Cardiac chamber	Surgical intervention	Outcome
1.	Casillas et al. [5]	1983	Post pneumonectomy, broncho-pleural fistula with hydropneumothorax	Right	Right atrium	No	Survived
2.	Brahams [6]	1986	Pericardium adhered to chest wall	Right	Right ventricle	No	Death
3.	Meisel et al. [7]	1990	Extremely short stature with pronounced kyphoscoliosis	Right	Right atrium	Yes	Death
4.	Shih et al. [2]	1992	Right atrial enlargement	Right	Right atrium	Yes	Survived
5.	Fernandez et al. [8]	1995	Blunt trauma chest	Left	Right ventricle	Yes	Death
6.	Kopec et al. [9]	1998	Post pneumonectomy bronchopleural fistula	Left	Right ventricle	No	Death
7.	Abad et al. [10]	2002	Spontaneous pneumothorax	Left	Left ventricle	Yes	Death
8.	Kerger et al. [11]	2007	Massive cardiomegaly	Right	Left atrium	Yes	Survived
9.	Asopa et al. [12]	2009	Malignant lymphoma	Left	Left ventricle	Yes	Survived
10.	Goltz et al. [13]	2011	Hypertrophic left ventricle	Left	Left ventricle	Yes	Survived
11.	Haron et al. [14]	2010	Pulmonary tuberculosis	Left	Left ventricle	Yes	Survived
12.	Schorl et al. [15]	2012	Postpneumonic pleural effusion	Left	Left ventricle	Yes	Survived
13.	Kim et al. [16]	2013	Congestive heart failure with massive cardiomegaly	Left	Left ventricle	Yes	Survived
14.	Shah et al. [17]	2016	Congestive heart failure	Left	Right ventricle	Yes ^a	Survived
15.	Alsaiedi et al. [18]	2017	Post cardiac surgery, worsening pleural effusion	Left	Left ventricle	Yes	Survived
16.	Deshpande et al. [19]	2018	Congestive heart failure with chronic pleural effusion	Right	Left atrium	Yes	Survived
17.	Varghese et al. [20]	2019	Colo-pleural fistula with abscess	Left	Left ventricle	Yes	Survived
18.	This case	-	Rheumatic heart disease with massive cardiomegaly	Right	Right atrium	Yes	Survived

^aPercutaneous intervention was done.

patient is in a stable hemodynamic condition [13]. In most of the reported cases, the perforation repair was done successfully and the drain removed intraoperatively. Prompt evaluation, timely surgical repair and perfect hemostasis was possible in most of the cases without any need for cardiopulmonary bypass.

Conclusion

This case report highlights the fact that it is important to keep in mind that iatrogenic right atrial perforation is a rare lethal complication which can occur in the patients undergoing tube thoracostomy. Though the safest method of ICD insertion is by using image guidance like ultrasound, the blind trocar puncture method should be avoided especially if dense pleural or pericardial adhesions are anticipated, the operator is in the training period and does not have adequate experience of performing tube thoracostomy procedure or there is a presence of massive cardiomegaly. The open method of ICD insertion is the standard of care today and a safer alternative to the trocar method. We believe that an iatrogenic cardiac injury following ICD insertion should be promptly evaluated and usually warrants management by open thoracotomy procedure.

List of Abbreviations

CECT	Contrast enhanced computed tomography scan
ICD	Intercostal chest drain
i/v	Intravenous fluids

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this case report.

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Consent for publication

Written informed consent was taken from the patient.

Ethical approval

Ethical approval is not required at our institution for publishing an anonymous case report.

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Summary of the case

1	Patient (gender, age)	Female, 47 years old
2	Final diagnosis	Iatrogenic right atrial perforation during tube thoracostomy
3	Symptoms	Dizziness
4	Medications	i/v fluids, blood transfusion
5	Clinical procedure	Emergency right anterolateral thoracotomy
6	Specialty	Emergency Medicine, Oncology, Critical Care