Original Article

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Assessment of Post-Procedure Complications Following Chest Tube Drainage in Pleural Effusion Patients: An Observational Retrospective Study

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Submitted 2 September 2024 **Accepted** 9 November 2024 **Published** 10 June 2025

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Citation

"Shahi R, Upreti A, Aryal P, Gurung KB, Pantha S, Verma A, Regmi G, et al. Assessment of Post-Procedure Complications Following Chest Tube Drainage in Pleural Effusion Patients: An Observational Retrospective Study. JBPKIHS. 2024;7(2):4-9."

https://doi.org/10.3126/jbpkihs.v7i2.68882

Abstract

Background: Pleural effusion is common in routine medical practice due to various underlying diseases. Chest tube drainage is a common therapeutic intervention for managing pleural effusion. Despite being an effective procedure, it carries the risk of multiple complications, which can significantly impact patient outcomes. This study aims to determine the incidence and different types of post-procedure complications following chest tube drainage in patients with pleural effusion.

Methods: We conducted an observational retrospective study at the department of Pulmonary, Critical Care and Sleep Medicine at B P Koirala Institute of Health Sciences, reviewing medical records of patients who underwent chest tube drainage for pleural effusion fulfilling the inclusion criteria from June 1, 2023, to May 31, 2024. Data collected included patient baseline characteristics, clinical symptoms, procedural details, and post-procedure outcomes. The primary outcome measures were the incidence and types of complications after chest tube drainage in patients with pleural effusion.

Results: A total of 55 patients were included in the study; a majority of patients 65.5%, were male and of total patients 61.8% were smoker. The most common clinical presentation were shortness of breath 74%, cough 72.7% and chest pain 43.6%. The common complications observed were pain 27.2%, tube blockage 10.9%, subcutaneous emphysema 10.9%, site infection 5.45%, bleeding 3.6% and pneumothorax 3.6%.

Conclusion: Chest tube drainage for the management of pleural effusion is associated with a significant risk of immediate and delayed complications. Understanding the frequency and types of these complications can inform clinical practice and improve patient outcomes.

Keywords: Chest tube drainage, Patient outcomes, Pleural effusion, Post-procedure complications

Declarations

Ethics approval and consent to participate: This study received prior ethical approval from the Ethical Review Board of BPKIHS (IRC/2889/024) and informed consent was obtained from all participants before their enrollment.

Consent for publication: Informed consent was obtained from the patient for the publication of identifying features along with the manuscript.

Availability of data and materials: The full data set supporting this research is available with the corresponding author upon request by the readers.

Competing interest: None

Funding: None.

Authors' contributions: RS, NB, DRM: Develop a concept and design of the study.RS, NB, DRM, AV, AU, PA: literature search and data collection. RS, KBG, SP, GR: data analysis, statistical analysis. All author contributes in manuscript drafting and critical review of manuscript.

Acknowledgement: The author would like to thank Department of Pulmonary, critical care and sleep medicine for providing time and support during data collection and data records.

BACKGROUND

A pleural effusion occurs when fluid collects within the pleural space, the area between the lungs and the chest wall. It accompanies a wide variety of disorders of the lung, pleura, and systemic disorders [1]. Common causes include congestive heart failure, tuberculosis, bacterial pneumonia, and malignancy [2]. Patients most commonly present with dyspnea on exertion, dry cough and pleuritic chest pain [1]. Chest tube placement (also called tube thoracostomy) is a common procedure which is performed to drain fluid, blood or air from the pleural cavity [3]. Managing pleural effusion often requires chest tube drainage, designed to alleviate symptoms, enhance respiratory function, and prevent complications related to fluid accumulation. The complications such as infection, bleeding, lung injury, organ injury, tube malposition, re-expansion pulmonary edema, subcutaneous emphysema can result due to knowledge gap regarding thoracostomy complications in pleural effusion which arise due to limited understanding of risk factors, variability in technique, impact of comorbidities, insufficient data on outcomes and role of imaging guidance. While the complication rate for most non-surgical pleural procedures is generally low, the proximity to vital organs means that complications can arise [4]. The use of chest ultrasound has further helped to reduce the rate of complications when accessing the pleural space [4]. There are many types of chest tubes or catheters, which are classified according to size and shape. They can be straight, angled or coiled at the end ("pig-tail")[3] By most prevalent convention, a tube of ≥20F is considered a large-bore chest tube and a tube <20F tube is considered a small-bore chest tube, although there are some studies that define a large-bore chest tube as >14F [5-7]. Failure to recognize and manage these complications could have fatal consequences. The purpose of this study was to investigate the occurrence and types of complications associated with chest tube drainage, analyze the outcomes of these complications, and identify risk factors linked to their development in patients with pleural effusion.

METHODS

This is a one-year observational retrospective study conducted in the department of Pulmonary, Critical Care and Sleep Medicine from June 1, 2023, to May 31, 2024, at B. P. Koirala Institute of Health Sciences, Dharan. The data were collected from the hospital records. Fifty five patients with diagnosed pleural effusion requiring chest tube drainage fulfilling the inclusion criteria, patients aged ≥18 years who underwent chest tube drainage for pleural effusion, from hospital record available from the department of Pulmonary, critical care and sleep medicine, BPKIHS were included in the study and patients with a history of prior thoracic surgery or chest trauma and patients who underwent chest tube drainage for conditions other than pleural effusion were excluded. The study protocol was submitted for ethical approval to the Institutional Review Committee, and ethical clearance to conduct the study was obtained before conducting the study. In this study, different types of chest tubes, such as pigtail catheter and different sizes of chest tube and pigtail catheter, has been used. A tube of ≥20F is considered a large-bore chest tube and a tube <20F tube is considered a small-bore chest tube.

Procedure Details: The placement of chest tube insertion was followed according to the protocol of the department of pulmonary, critical care and sleep medicine, BPKIHS, which has been explained in detail. After obtaining informed/written consent from the patient and explaining the procedure risks and benefits, the patient was positioned in a semi-recumbent position at a 45-degree angle with the arm on the affected side raised and placed behind the head to expose the axillary area. After identifying the insertion site (usually 4th or 5th intercostal space, anterior to the midaxillary line), with the help of ultrasound, the site of insertion was marked with a skin marker. All the necessary equipment were arranged, sterilization was done with an antiseptic solution in a circular motion, starting from the center and moving outward, draping the area with sterile drapes was done. Injection 2% xylocaine was used as local anesthesia which infiltrate the skin, subcutaneous tissue, intercostal muscles, and pleura to numb the insertion site. After that 2-3 cm horizontal incision was made over the selected intercostal space, and blunt dissection with a hemostat or Kelly clamp to create a tract down to the pleura, passing above the rib to avoid the neurovascular bundle located below each rib was done. A finger was inserted into the tract to confirm entry into the pleural space and to sweep for adhesions. The distal end of the chest tube was clamped, and the proximal end was advanced into the pleural space, directing the tube posteriorly and superiorly. The chest tube was secured to the skin with sutures to prevent dislodgement, chest tube was attached to an appropriate drainage system (water-seal or suction system). The drainage system was functioning correctly was checked by observing for bubbling (if connected to suction) and fluid oscillation (swinging) with respiration. Chest X-ray was done to confirm the correct placement of the chest tube and to check for any immediate complications such as pneumothorax or tube malposition.

All data related to chest tube insertion procedures for pleural effusion patients that had been systematically collected and documented in the hospital proforma were analyzed.

These records were transcribed into a standardized current proforma, and the resulting dataset were analyzed using appropriate statistical tools. Data were entered in Microsoft Excel and statistically analyzed by using Statistical Package for the Social Sciences (SPSS) software version 20.0 (SPSS Ltd, Chicago, IL, USA). Categorical data were presented as percentages and frequency while continuous data were presented as mean and standard deviation. Chi Square test was used for statistical analysis to see the association between categorical variables. A two-sided P value <0.05 was considered statistically significant.

Table 1: Demographic Characteristics of patients (n = 55)

	Patient Characteristics	Frequency	Percentage
Age Mean (SD)		55 (20.8)	
Gender	Male	36	65.5
	Female	19	34.5
Smoking Status	Smoker	34	61.8
	Nonsmoker	21	38.2
Clinical symptoms	SOB	41	74.5
	Cough	40	72.7
	Chest pain	24	43.6
	Fever	19	34.5
Comorbidities	Hypertension	8	14.5
	Diabetes Mellitus	10	18.2
	Pulmonary Tuberculosis	7	12.72
	Coronary Artery Disease	3	5.5
	Chronic Liver Disease	1	1.8
	Chronic Kidney Disease	4	7.3
	Chronic Obstructive Pulmonary Disease	6	10.9

RESULTS

This study observed 55 patients aged between 18 and 92 years, with a mean (SD) age of 55 (20.8) years. Among them, 36 (65.5%) were male, and 19 (34.5%) were female. The most commonly reported symptoms were shortness of breath in 41 patients (74.5%) and cough in 40 patients (72.7%). The most frequent comorbidities included diabetes mellitus followed by hypertension and pulmonary tuberculosis. **(Table 1)**.

The most common complications following chest tube drainage were pain in 15 (27.2%) patients, tube blockage in 6 (10.9%), subcutaneous emphysema in 6 (10.9%) followed by site infection in 3 (5.45%) patients. **(Table 2).** Depending upon the different sizes of chest tube and pigtail catheter, the immediate and delayed complications of chest tube insertion were further classified. **Table (3, 4, 5 & 6).**

Table 2: Analysis of complications (n = 55)

Complications		Number/ Percentage
Immediate complications	Pain	15/ 27.2
	Bleeding	2/ 3.6
	Pneumothorax	2/ 3.6
	Malposition of tube	1/ 1.8
	Subcutaneous Emphysema	6/ 10.9
Delayed complications	Site Infection	3/ 5.4
	Empyema	2/ 3.6
	Tube dislodgement	1/ 1.8
	Tube blockage	6/ 10.9
	Entrapment/Trapped lung	2/ 3.6
	Bronchopleural fistula	2/ 3.6

Table 3: Immediate complications of chest tube insertion according to the size of the chest tube

Size of Chest tube	Number of patients (N)	Pain (%)	Bleeding (%)	Pneumothorax (%)	Subcutaneous Emphysema (%)	Malposition (%)
20	11	0(0)	1(9.1)	0(0)	1(9.1)	0(0)
24	19	3(15.8)	0(0)	0(0)	1(5.3)	1(5.3)
28	6	5(83.3)	0(0)	0(0)	2(33.3)	0(0)
32	2	2(100)	0(0)	1(50)	0(0)	0(0)
Total	38	10 (26.3)	1(2.6)	1(2.6)	4(10.5)	1(2.6)

Table 4: Delayed complications of chest tube insertion according to size of chest tube

Size of Chest tube	Number of patients	Site Infection (%)	Empyema (%)	Broncho pleural fistula (%)	Chest tube blockage(%)	Dislodgement (%)	Entrapped lung (%)
20	11	0(0)	0(0)	1(9.1)	2(18.2)	1(9.1)	0(0)
24	19	1(5.3)	1(5.3)	0(0)	0(0)	0(0)	0(0)
28	6	0(0)	0(0)	0(0)	0(0)	0(0)	1(2.6)
32	2	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Total	38	1(2.6)	1(2.6)	1(2.6)	2(5.2)	1(2.6)	1

Table 5: Immediate complications of chest tube insertion according to size of Pigtail catheter

Size of Pigtail	Number of patients	Site infection (%)	Organ injury (%)	Empyema (%)	Bronchop-leural fistula (%)	Blockage (%)	Dislodge-ment (%)	Entrapment lung (%)
16	12	2(16.7)	0(0)	1(8.3)	1(8.3)	2(16.7)	0/(0)	1(8.3)
18	5	0(0)	0(0)	0(0)	0(0)	2(40)	0(0)	0(0)
Total	17	2(11.8)	0	1(5.9)	1(5.9)	4(23.5)	0	1(5.9)

Table 6: Delayed complications of chest tube insertion according to size of Pigtail catheter

Size of Pigtail	Number of patients	Site infec-tion (%)	Organ in-jury (%)	Empyema (%)	Bronchop-leural fistula (%)	Blockage (%)	Dislodgement (%)	Entrapment lung (%)
16	12	2(16.7)	0(0)	1(8.3)	1(8.3)	2(16.7)	0/(0)	1(8.3)
18	5	0(0)	0(0)	0(0)	0(0)	2(40)	0(0)	0(0)
Total	17	2(11.8)	0	1(5.9)	1(5.9)	4(23.5)	0	1(5.9)

DISCUSSION

Pleural effusion necessitates interventions such as chest tube drainage to alleviate symptoms and prevent complications. Chest tube insertion is an essential life-saving procedure, but due to its invasive nature, it carries inherent risks of complications. Early consequences may lead to organ injury such as lung perforation, perforation of the heart, stenosis of the subclavian artery, damage to the inferior vena cava, Horner's syndrome and damage to the intercostal vessels [8].

In our study, all chest tubes were placed under direct visualization using ultrasonography, ensuring accurate positioning and eliminating insertion-related issues. Among the immediate complications observed following chest tube drainage, pain was the most common, followed by subcutaneous emphysema and bleeding. Additionally, the most frequent delayed complication was tube blockage, followed by empyema and insertion site infection.

We observed 27.3% of patients who complained of pain during and after the chest tube placement. In contrast to our finding, in an audit by Hooper et al., 8% reported pain during chest tube placement and 15.6% reported delayed pain after chest tube placement [9]. The higher incidence of pain in our study might be due to the use of larger-sized range from 24 -32F chest tube compared to the study conducted by Hooper et al, where he used 6-16F size intercostal drains in the most cases. There was no difference in incidence of pain using chest tube or pig tail catheter, however we observed the larger tube sizes were associated with increased incidences of pain, which was statistically significance.

Jones M peter et al found 20% incidence of subcutaneous emphysema associated with chest tube drainage for pleural effusion whereas the study conducted by Jackson K et al and Hooper et al found incidence of subcutaneous emphysema as low up to 4.2 % [10-12]. However, subcutaneous emphysema was found to be 10.9% in our study which was minor and self-limiting after tubal blockage and in case where the migration of the sentinel hole of chest tube out of the pleural space was checked and managed.

Bleeding usually occurs due to laceration of the superficial vessel or trauma to the intercostals artery or vein. Guidelines recommend avoiding a posterior approach to the pleural space and instead approaching just above a rib. They also advise maintaining a platelet count of at least 50,000 per microliter of blood and correcting coagulopathies to ensure an international normalized ratio (INR) of less than 1.5 [12-14]. In the present study, bleeding occurred in 2 (3.6%) patients, which was managed by suture repair and no surgical intervention was required. A study conducted by Chad G ball et al, observed 6.7% bleeding due to laceration of intercoastal artery which was also managed by suture repair, however lower incidence of 6 (0.5%) bleeding was observed by Karl Jackson out of which there was five local hematomas and one intercostal artery rupture [15].

In present study, we observed chest tube blockage 10.9%

of the cases and almost all the blockage was found in the patients where smaller size chest tube (20F) was placed which were comparable to the finding observed by Davies HE et al and Hooper et al in their studies [9, 16]. Havelock reported the incidence of chest tube blockage to be 5.2% while using chest tube size of more than 20F suggesting that increasing the size of the chest tube decreases the incidence of tube blockage [17].

Malposition of the chest tube is characterized as intrafissural, intraparenchymal, or subcutaneous. If the chest tube is not draining, they should be suspected and chest radiography such as computed tomography, is required to better examine mispositioned tubes [18]. In this study, 1 (1.8%) case was found to be malposition of the tube. Vilkki et al in 2020 conducted a retrospective cohort study in 1169 procedures, where more than half were small-bore drain insertions, while 0.43% were inappropriate tube insertion [19].

Pleural infection, even in the general population, is a serious illness with significant mortality (as high as 20%) and morbidity [20]. Infection at the site of chest tube placement was found in 3 (5.45%) patients which was comparably higher than other studies conducted by Hooper et al [9] and Chad G Ball et al [15] who suggested that placement of chest tube in a sterile condition and with proper care of indwelling catheters, the rate of infection can be low.

Another complication observed related to chest tube placement was empyema. In this study we observed (3.6%) of empyema following chest tube placement. Similarly in a study done by Hooper et al in 2015 in 1394 procedures, in 88% of procedures using 6-16F size intercostal drains, empyema occurred in 0.4 % [9]. The occurrence of empyema may be lowered by giving antibiotics to individuals with chest tubes for thoracic injuries. A meta-analysis by Bosman et al that involved nearly 2,500 patients found that prophylactic antibiotics in patients receiving chest tubes for blunt or penetrating thoracic injuries had significantly lower rates of infections and empyema than did patients who did not receive the antibiotics [21]. Pleural space infection was found to be 0.4 %in small-bore drain insertions in a retrospective cohort analysis conducted by Jackson et al in 2021 in 879 patients [11].

In a retrospective cohort study done by Cavanna et al the risk of pneumothorax with ultrasound guidance chest tube insertion was observed to be 3.37 % which was similar to our study finding of 3.6% [22]. Whereas, in another retrospective cohort study carried out by Shechtman et al, the risk of pneumothorax increased upto 12%. The higher rate of pneumothorax was associated with congestive heart failure, mild pleural fluid, larger volume of fluid drained and bilateral procedures [23].

Re-expansion pulmonary oedema, a potentially fatal consequence is thought to occur as a result of rapid large volume removal or profoundly negative pleural pressure during pleural aspiration 24, 25]. In this study, the incidence of re-expansion pulmonary edema was 0%, which was similar to the study conducted by Jackson et al in 2021 in 879 patients' where re-expansion pulmonary oedema was also found to be 0 % [11].

Bronchopleural fistula is an infrequent complication of pulmonary tuberculosis, characterized by a spectrum of presentations, from asymptomatic cases detected incidentally to symptomatic manifestations. In our study 3.6% patients had a complication of bronchopleural fistula. In our study, 8 out of 55 cases were positive for mycobacterium in pleural fluid analysis. We observed the incidence of bronchopleural fistula were related to the cases of tubercular pleural effusion.

We found 1.8% of case of tube dislodgement in small-bore drain insertions. In a retrospective cohort analysis, conducted by Jackson et al. colleagues in 2021 in 879 patients tube displacement was found to be 3.9 % in small-bore drain insertions [11]. In a study done by Hooper et al in 1394 procedures, 88% using 6-16F size intercostal drains, drain displacement was found in 9.2 % [9].

A trapped lung is a condition in which the lung is unable to fully expand within the thoracic cavity due to the presence of a restrictive fibrous layer on the visceral pleura. In this present study, 3.6% cases of trapped has been seen. The exact incidence of trapped lung is not well established; however, research indicates that it occurs in approximately 5–10% of patients undergoing thoracentesis and in around 20% of those undergoing therapeutic thoracentesis and 30% of patients with malignant pleural effusions will ultimately have a trapped lung [26, 27].

CONCLUSION

The most common complications following chest tube drainage were pain in 15 cases (27.2%), tube blockage in 6 cases (10.9%), and subcutaneous emphysema in 6 cases (10.9%). Chest tubes are essential medical devices widely used by healthcare professionals of various specialties. Chest tube placement under ultrasonographic guidance ensured accurate positioning and minimized insertion-related complications. Immediate complications were relatively common, with pain being the most frequent, followed by subcutaneous emphysema and bleeding. Delayed complications were less frequent, with tube blockage being the most prevalent, followed by empyema and site infection. The type and frequency of complications varied based on the size of the chest tube or pigtail catheter, highlighting the importance of selecting an appropriate tube size and technique for minimizing risks. These findings emphasize the need for careful monitoring and tailored interventions to reduce complications and improve patient outcomes

This is a single-center-based study with a small sample size; involvement of multiple centers with more patients would have improved the statistical power of the study and would be more generalizable to a wider population.

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