COMPLICATIONS ASSOCIATED WITH TUBE THORACOSTOMY: A LARGE SINGLE-CENTER DESCRIPTIVE ANALYSIS FROM A TERTIARY THORACIC SURGERY UNIT

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ABSTRACT

Background: Thoracostomy tube placement is among the most commonly performed emergency procedures in thoracic and trauma care. It remained associated with a wide range of complications.

Objectives: To describe the frequency, clinical spectrum, patterns of complications, and post-insertion management problems associated with tube thoracostomy in a high-volume tertiary thoracic surgery center.

Methods: A retrospective observational study was conducted, including 1,560 consecutive patients who underwent tube thoracostomy between May 2020 and April 2025 at a tertiary thoracic surgery unit. Demographic data, indications, operator type, and complications related to tube insertion were recorded. Data were analyzed descriptively using frequencies and percentages.

Results: The cohort comprised 1,109 males (71.1%) and 451 females (28.9%), with most patients aged 12–50 years (68.6%). Traumatic indications accounted for 53.6% of cases, including hemopneumothorax, while non-traumatic indications included massive pleural effusions and pleural infections. Overall, complications were documented in 388 patients (24.85%). The most frequent complication was intrapulmonary chest tube placement (259 cases; 66.8% of complications), followed by extrapleural placement (20.1%). Major visceral or vascular injuries were uncommon but lethal. Post-insertion management problems were observed in 408 cases (26.14%), including ineffective drainage requiring reinsertion and post-procedural empyema.

Conclusion: Tube thoracostomy was associated with a substantial burden of insertion-related complications and post-procedural management problems, particularly in emergency conditions and referred cases. These findings highlight the need for strict adherence to anatomical principles, appropriate supervision, training, and standardized chest tube care protocols to minimize preventable morbidity.

Keywords: Tube thoracostomy; Chest tube complications; Pulmonary parenchymal chest tube (PPcT); Chest tube malposition; Empyema thoracis; Thoracic surgery audit

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INTRODUCTION

Tube thoracostomy is one of the most frequently performed, life-saving procedures in thoracic and trauma care. It is an essential for managing pneumothorax, hemothorax, hemopneumothorax, and pleural sepsis, with its primary goal being rapid evacuation of air or fluid to restore lung expansion and adequate oxygenation.[1-3] Despite its widespread use and well-established indications, tube thoracostomy is associated with a substantial risk of

complications, particularly in emergency settings or when performed by inexperienced personnel. Reported complication rates in the literature vary widely, reaching up to 30%, and include insertional, positional, and infectious events.[2-5, 7] Injuries to the lung parenchyma, intercostal vessels, diaphragm, abdominal organs, or mediastinal structures have all been described, and also tube malpositions such as intrafissural, extrapleural, or subcutaneous placement.[8, 9] Such complications reported in our study is shown in Figures 1- 3.

In Punjab, Pakistan, the Department of Thoracic Surgery of Services Hospital, Lahore, functions as one of three major tertiary-care referral units for thoracic surgery and receives a large volume of complex and previously manipulated cases from across the province, covering a population of 140 million. Because of the high case burden, emergency workload, and frequent referral of malpositioned or nonfunctional chest tubes, this center offers an ideal environment to evaluate real-world complications and system-related hazards of tube thoracostomy. Although various options exist for managing pleural pathologies, including thoracentesis, VATS, thoracotomy, and conservative care, tube thoracostomy remains the most common initial intervention.[6, 7]

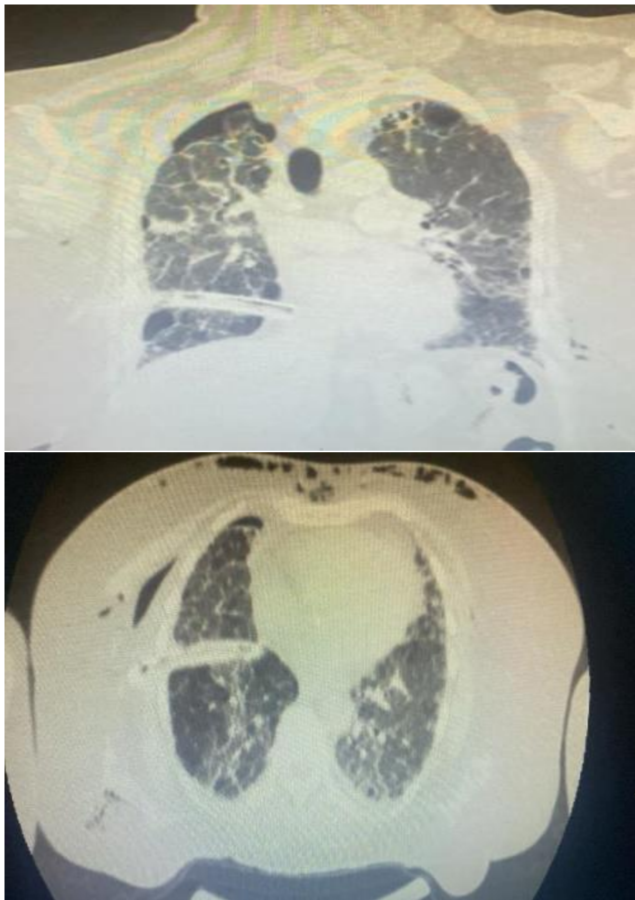

Figure 1: Chest Tube in Lung Parenchyma

Several factors affect complication rates, including the operator's level of training, tube size, insertion technique, and the use of imaging guidance. Importantly, following anatomical landmarks, particularly the "triangle of safety," is central to safe practice.

The present study aims to provide a comprehensive analysis of the frequency, nature, and contributing factors of complications and post-insertion management problems associated with tube thoracostomy in a high-volume thoracic surgery center. The findings are intended to guide improvements in procedural training, patient safety, and institutional protocols.

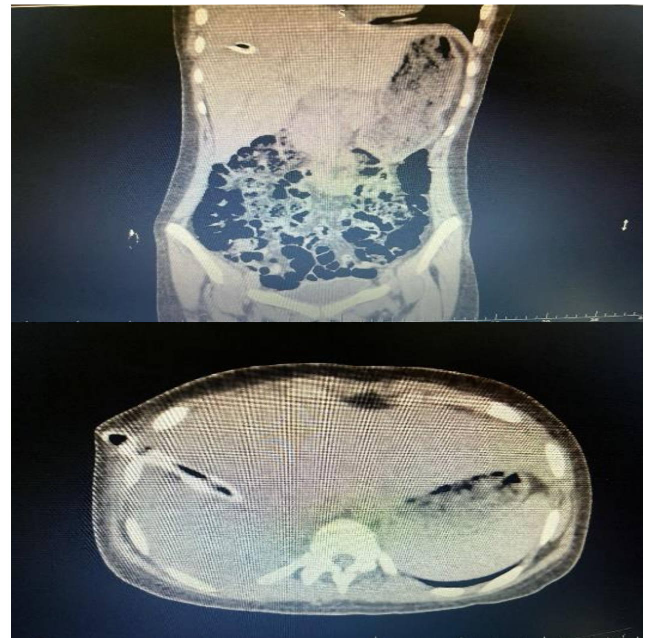

Figure 2: Chest Tube in Liver Parenchyma

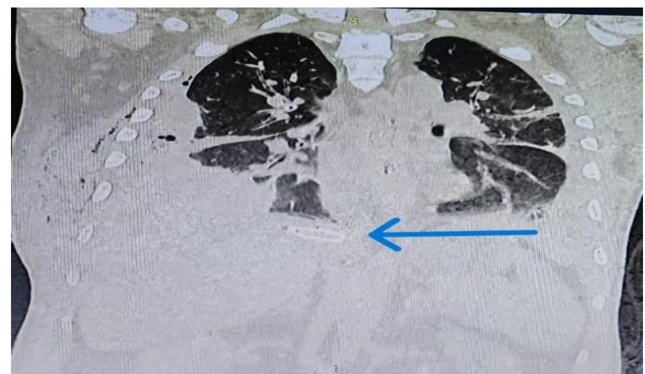

Figure 3: Chest tube piercing Inferior Vena Cava

METHODS

Study Design and Setting: This was a retrospective observational study conducted at the Department of Thoracic Surgery, Services Institute of Medical Sciences (SIMS), Services Hospital, Lahore, Pakistan. The study period encompassed all patients who underwent tube

thoracostomy at our center, as well as referred cases from peripheral hospitals, over five years from May 2020 to April 2025.

Patient Selection: A total of 1,560 patients who underwent tube thoracostomy were included. Inclusion criteria were all patients requiring tube thoracostomy for traumatic or non-traumatic indications. Patients with incomplete records or lost to follow-up were excluded. Age, sex, indication for tube thoracostomy, and referring status were recorded. Patients were categorized by age into <12 years, 12–50 years, and >50 years.

Tube Thoracostomy Procedure: Tube thoracostomies were performed by the thoracic surgery team, general surgery units, or other referring teams in emergency, intensive care, or ward settings. The open blunt dissection technique was the standard approach in our center. All procedures follow the "triangle of safety" for insertion, with post-procedural confirmation of placement with chest radiograph. For referred patients, procedural details and initial management were obtained from referral documentation.

Data were collected on indication (traumatic vs non-traumatic), type of chest tube, operator, and procedural setting, as well as complications (e.g., lung parenchymal injury, abdominal injury, hemothorax, major airway injury) and post-insertion management problems (e.g., ineffective drainage, empyema, inappropriate clamping, suction system errors, tube dislodgement).

Outcomes: The primary outcome was the incidence and pattern of complications following tube thoracostomy. The secondary outcome was the incidence of post-insertion management problems.

Statistical Analysis: All data were entered into Microsoft Excel and analyzed descriptively. Frequencies and percentages were calculated for categorical variables. No inferential statistical tests were performed, findings are presented as descriptive outcomes to characterize patterns of complications and hazards.

RESULTS

A total of 1,560 patients undergoing tube thoracostomy were included in the study. Age was stratified into three categories. Demographics are shown below in Table 1.

Table 1. Demographic Characteristics

Variable	Frequency	Percentage
Age <12 years	48	3.1%
Age 12–50 years	1070	68.6%
Age >50 years	442	28.3%
Male	1109	71.1%
Female	451	28.9%

Out of 1,560 chest tubes, 800 (51.3%) were inserted by the thoracic surgery team in the emergency department, medical wards, ICUs, or emergency operating theaters. 376 (24.1%) were placed by general surgery units in accident and emergency departments, while 384 (24.6%) were referred cases with tube thoracostomy performed at peripheral government or private hospitals.

Indications were broadly categorized as traumatic and non-traumatic. Traumatic indications included 836 cases (53.6%), and non-traumatic indications included 724 cases (46.4%).

Indications for tube thoracostomy and frequencies are shown in Table 2 below.

Table 2. Indications for Tube Thoracostomy

Category	Indication	Frequency	Percentage
Traumatic	Pneumothorax	224	26.8%
	Hemothorax	164	19.6%
	Hemopneumothorax	336	40.2%
	Lung contusion + hemopneumothorax	69	8.2%
	Flail chest	43	5.2%
Non-traumatic	Secondary spontaneous pneumothorax	125	17.2%
	Massive pleural effusion	235	32.5%
	Pyothorax	173	23.9%
	Pyopneumothorax	191	26.4%

Overall, 388 complications were recorded, yielding a complication rate of 24.85%. The most common complication was intraparenchymal (lung) tube placement i.e 259 cases (66.8%) of total complications.

Extra pleural tube placement accounted for 78 cases (20.1%). Major visceral or vascular injuries were infrequent but clinically significant.

Table 3. Complications of Tube Thoracostomy

Complication	Frequency	Percentage
Lung parenchymal tube placement	259	66.8%
Extrapleural tube placement	78	20.1%
Massive subcutaneous emphysema	27	7.0%
Abdominal organ injury	9	2.4%
Massive hemothorax requiring thoracotomy	5	1.2%
Major airway injury	5	1.2%

A total of 408 post-insertion management problems were identified, representing 26.14% of all procedures.

The most frequent post-insertion management problem was ineffective chest tube placement requiring readjustment, 143 cases (35.0%), followed by post-procedure empyema and clotted hemothorax necessitating decortication, 102 cases (25.0%).

Table 4: Post-insertion management problems of Tube Thoracostomy

Post-insertion management problems	Frequency	Percentage
Ineffective tube placement	143	35.0%
Empyema / clotted hemothorax	102	25.0%
Inappropriate clamping	44	10.8%
Improper suction system	35	8.6%
Covered bottle outlet vents	28	6.8%
Spontaneous tube dislodgement	25	6.1%
Loss of underwater seal	23	5.6%
Persistent pneumothorax	8	1.9%

DISCUSSION

Tube thoracostomy is among the most frequently performed emergency procedures in thoracic practice; however, it continues to be associated with a broad spectrum of complications and management-related problems. These risks are particularly magnified in emergency settings, where time-sensitive decision-making, suboptimal procedural environments, and operator inexperience predispose to technical errors. In the present study, more than half of chest tubes were inserted under emergency conditions, mostly by junior residents or non-specialist teams, which likely contributed to the substantial rates of complications (24.85%) and post-insertion management problems (26.14%) observed.

The early complications identified in our cohort, including tube malposition, kinking, blockage, dislodgment, and injury to intrathoracic structures, closely mirror those reported in previous studies. Serious iatrogenic injuries involving the lung parenchyma, diaphragm, major vessels, and abdominal viscera have been well documented in the literature.[10, 11] In accordance with earlier reports, the majority of complications in our series occurred when thoracostomy was performed in unstable patients in emergency departments or intensive care units, where distorted anatomy, limited patient positioning, and urgent circumstances increase procedural difficulty. [12, 13]

One of the most concerning findings in our study was intra-abdominal placement of chest tubes, accounting in 9 cases, approximately 2.4% of all complications. Although relatively uncommon, such injuries carry significant morbidity. We documented hepatic parenchymal injury, diaphragmatic perforation, and gastrointestinal perforations, including gastric and ileal injuries, patterns that have been previously described.[14.] These injuries are anatomically plausible, as the diaphragm may ascend to the level of the fifth intercostal space during expiration, particularly in supine or critically ill patients. Strict adherence to the "triangle of safety," insertion at or above the fifth intercostal space, and digital confirmation of intrathoracic entry is an essential preventive measure.[15] Liver and stomach injuries following tube thoracostomy have been reported predominantly in emergency settings or when the procedure is performed without adequate anatomical guidance or imaging support[14,16], with management ranging from conservative observation to operative intervention depending on patient stability.

Lung parenchymal injury was the most frequent complication in our cohort, accounting for nearly two-thirds of all recorded complications. Patients with reduced lung compliance, pneumonia, and pleural adhesions are particularly at risk, as normal lung displacement during tube insertion is impaired. Although the use of trocar techniques has declined because of their association with higher complication rates [20–22], our findings demonstrate that malposition can still occur with the open blunt dissection technique, especially during repeat tube thoracostomies or in patients with chronically diseased or fibrotic lungs. Diagnosis of intraparenchymal placement was occasionally delayed, as radiographic findings may be subtle or masked by pre-existing pulmonary pathology. [17–19]

Vascular injury, although infrequent in our series (approximately 1.2% of complications), represents a potentially life-threatening event. Injuries can result from dissection along the inferior rib margin, where the intercostal neurovascular bundle resides. Consistent with published recommendations, dissection along the superior border of the rib remains crucial to minimizing hemorrhagic complications.[23–25] Our findings further reinforce the importance of anatomical technique, even during urgent insertions.

At our institution, the open blunt dissection technique is the standard approach and was associated with fewer complications during first-time tube insertions performed by the thoracic surgery team. However, repeat procedures and insertions in patients with chronic lung disease were technically more challenging and were associated with malposition and ineffective drainage. Ineffective chest tube placement was the most common post-insertion management problem, accounting for approximately 35% of all problems, frequently necessitating reinsertion or placement of an additional tube to achieve adequate pleural drainage.

A substantial proportion of patients in our study developed empyema or organized collections following tube thoracostomy. While procedural factors may contribute, many of these patients initially presented with infectious pleural pathologies such as pyothorax or pyopneumothorax. Moreover, a large number of referred cases arrived with delayed presentations, prolonged tube duration, or inadequately managed initial drainage. Empyema is a well-recognized complication of tube thoracostomy, with reported incidences ranging from 1%

to 25% depending on patient comorbidities, sterility conditions, and procedural technique. [26, 27]. In our series, this complication frequently necessitated surgical decortication, contributing to increased morbidity and resource utilization.

Inappropriate clamping of chest tubes was another notable post-insertion management problem, particularly in patients with massive pleural effusions. Although brief clamping may be indicated in selected situations to prevent re-expansion pulmonary edema, prolonged or inadvertent clamping can cause worsening of respiratory distress, retained collections, and trapped lung. This finding highlights important training gaps, consistent with previous reports describing insufficient knowledge of chest drain care and monitoring.[28] Similarly, mismanagement of suction systems, such as inadequate underwater seal filling, covered outlet vents, or premature application of suction, was frequently observed and contributed to preventable complications.

Air leaks secondary to inadequate closure of the thoracostomy site were also encountered, particularly when skin incisions were disproportionately large relative to tube diameter. These issues were generally correctable with reinforcement of sutures, but show the importance of attention to details during both insertion and post-procedural care.

Overall, our findings demonstrate that tube thoracostomy, despite being a routine and often life-saving intervention, requires meticulous technique, sound anatomical knowledge, and strict adherence to established guidelines. Preventable complications and hazards remain common, particularly in high-volume emergency centers where trainees perform a substantial proportion of procedures. Structured supervision, competency-based training, simulation-assisted education, and standardized chest tube care protocols are essential to improving safety, reducing morbidity, and optimizing patient outcomes.

Limitation: This was a single-center, observational study, which may limit generalizability. The analysis was primarily descriptive, and subgroup comparisons were not statistically tested. Many procedures were performed in emergency settings, often by junior or non-specialist staff, which may have influenced complication rates. Operator experience and supervision were not consistently documented. Some late complications, particularly in referred patients, may have been underreported, and routine imaging guidance was not available during the study period.

CONCLUSION

Tube thoracostomy was associated with a substantial rate of complications (24.85%) and post-insertion management problems (26.14%) in this large single-center series. Lung parenchymal injury and ineffective tube placement were the most common adverse outcomes, with higher risk observed in referred cases, non-specialist insertions, traumatic indications, especially hemopneumothorax, and pediatric patients. These findings highlight that tube thoracostomy is a high-risk procedure requiring meticulous technique, structured supervision, and standardized post-insertion care. Competency-based training, simulation, and early specialist involvement are essential to reduce preventable morbidity and improve patient safety.

ETHICAL APPROVAL

Ethical approval of article was granted by the Institutional Review Board of Services Institute of Medical Science, Lahore vide reference No. IRB 2025/1541/SIMS dated 05 Mar, 2025.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTIONS

ZS: Data collection, data analysis, manuscript writing

MSN: Conceived idea, review of manuscript, supervision

RS, MA, HR: Data collection, review of manuscript

All Authors: Approval of the final version of the manuscript to be published

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