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Original Article

Assessment of predictive factors for complicated hemothorax following blunt chest trauma in a tertiary care centre: a retrospective cohort study

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ABSTRACT

Background: Hemothorax is a common consequence of blunt chest trauma. A subset progresses to complicated hemothorax requiring repeat procedures. This study aimed to identify predictors of complicated hemothorax.

Materials and Methods: A retrospective cohort study was conducted, including 60 patients with blunt chest trauma and hemothorax managed at a tertiary care center. Patients were grouped into uncomplicated (n = 30) and complicated hemothorax (n = 30, requiring additional procedures). Logistic regression was performed to identify predictors.

Results: On univariate analysis, delay in ICD placement >3 days (OR 5.09, p = 0.015) and loculated/septated collections (OR 21.1, p < 0.001) were associated with complicated hemothorax. In multivariable analysis, only loculated/septated collections remained an independent predictor (adjusted OR 26.5, p = 0.006).

Conclusions: Loculated collections are the strongest predictor of complicated hemothorax. Early identification of septated/loculated collections on imaging should prompt timely surgical referral, preferably VATS, to reduce morbidity and minimize repeat procedures. In delayed-presentation trauma with loculated collections or comorbidities, early surgical intervention should be considered as simple chest drainage is often insufficient.

Keywords: hemothorax, blunt chest trauma, video-assisted thoracoscopic surgery, empyema, chest tubes

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Introduction

Blunt chest trauma is a significant cause of morbidity and mortality worldwide, with reported mortality rates ranging from 4% to 20% [1,2]. While serious, life-threatening thoracic injuries are often detected early through clinical and radiological evaluation and managed promptly with drainage procedures, less obvious injuries, especially those without significant hemothorax on initial imaging, may present later with worsening symptoms such as chest pain and breathlessness. These delayed presentations can lead to serious complications, including clotted hemothorax and empyema, which increase hospital stay and overall morbidity.

Several studies have suggested that factors such as multiple rib fractures [3], high Injury Severity Score (ISS), and inadequate initial chest drainage may contribute to the development of complicated hemothorax. However, evidence on consistent and reliable predictors remains limited and inconclusive, especially in resource-constrained settings. Moreover, variability in the timing and type of interventions, such as early video-assisted thoracoscopic surgery (VATS) versus repeat intercostal drainage (ICD), further complicates the clinical management of these patients. Previous researches have also been limited by methodological issues, including retrospective designs, single-center data, and lack of standardized radiological criteria for diagnosing retained or complicated hemothorax [4].

Complicated hemothorax significantly contributes to prolonged hospitalization, increased healthcare costs, and higher rates of morbidity. Patients with retained or infected hemothorax often require additional interventions, such as repeat drainage or surgical procedures, which can delay recovery and increase the risk of complications like empyema and fibrothorax. These factors not only impact patient quality of life but also place a considerable burden on healthcare resources, emphasizing the importance of early identification and management of at-risk patients [5].

Given the impact of complicated hemothorax on patient outcomes and healthcare resources, identifying early risk factors is essential to guide timely and targeted interventions. This study aims to fill this gap by retrospectively assessing clinical, radiological, and procedural predictors of complicated hemothorax following blunt chest trauma in a tertiary care setting. This study aims to identify early radiological and procedural predictors of complicated hemothorax and guide timely surgical decision-making.

In this report we aimed to identify clinical, radiological, and procedural predictors of delayed, retained, or infected hemothorax following blunt chest trauma in a tertiary care center. Primary endpoint: Identification of predictors for complicated hemothorax requiring additional intervention.

Materials and Methods

This is a retrospective cohort study performed at BMCRI Trauma and Emergency Care Centre between November 2024 and June 2025. The study will include patients with blunt chest trauma who underwent intercostal chest drain (ICD) insertion for hemothorax. Patient data will be collected through: history and clinical evaluation including physical examination and assessment of air entry, and radiological assessment including Chest X-ray, ultrasound of the thorax (USG Thorax), and High-Resolution CT (HRCT) Thorax. Loculated/septated collections were defined as non-homogeneous pleural fluid with internal septations or membranes on USG or CT. Representative CT and ultrasound images demonstrating loculated/septated collections have been included.

Documentation of associated injuries and nature of trauma was done, and the details related to drainage procedures, including: time interval between injury and ICD placement, need for additional interventions such as repeated ICD insertion, therapeutic tapping, and Video-Assisted Thoracoscopic Surgery (VATS).

The inclusion criteria is, patients >18 years, blunt chest trauma, hemodynamically stability, who underwent ICD insertion, and exclusion criteria is immediate intubation/mechanical ventilation on admission, mild hemothorax (<300 mL), mild pneumothorax (<15% collapse) and conservatively managed cases.

Patients were categorized into two groups as the ones managed with a primary ICD only and the ones required further intervention.

Delayed hemothorax is defined as that which develops >24 h after negative initial imaging. Retained hemothorax as persistent pleural blood after 72 h of drainage or ≥500 mL unresolved. Infected hemothorax (empyema) is pus within the pleural space due to infected retained blood. Complicated hemothorax as where an additional intervention was required within 14 days post-trauma or during the same admission.

Duration of hospital stay, adequate lung expansion, and duration of oxygen requirement is also assesed. The study was approved by the Ethics Committee of Bangalore Medical College and Research Institute (25.07.2025, BMCRI/EC/24/25).

Statistical Analysis

Data were tested for normality and analyzed using SPSS version 28.0. Continuous variables were expressed as mean (range), while categorical data were summarized as frequency (%). Group comparisons were performed using chi-square or Fisher's exact test as appropriate. Variables with $p < 0.1$ on univariate analysis were entered into a multivariable logistic regression model to identify independent predictors. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). A p-value < 0.05 was considered statistically significant.

Results

A total of 60 patients with blunt chest trauma and hemothorax were included, with 30 developing complicated hemothorax and 30 successfully managed with primary chest tube drainage. The mean ages were comparable between the two groups (55 years vs 52 years, $p = 0.59$). Male predominance was observed in both groups (83%) (Table 1).

A delay in chest tube insertion beyond three days was significantly higher in the complicated group compared to the primary drainage group (83% vs 7%, $p < 0.001$). Loculated or septated pleural collections were present in 70% of complicated cases but absent in the primary group ($p < 0.001$). Delay in ICD insertion >3 days and loculated/ septated collections were significant predictors of complication. On multivariate analysis, only loculated/ septated collections remained independent predictor (adjusted OR 26.5, $p = 0.006$).

Comorbidities such as diabetes mellitus and prior pulmonary tuberculosis were more common in the complicated group (10% vs 0%), though this difference did not reach statistical significance ($p = 0.11$).

Radiological findings demonstrated that moderate to gross free pleural fluid was more frequent in the primary group (73% vs 40%, $p = 0.018$), while pneumothorax or hemopneumothorax was significantly higher in the primary group (63% vs 7%, $p < 0.001$) (Table 2). Hemopneumothorax was considered an initial presentation, not a complication during follow-up.

All patients in the primary drainage group were managed successfully with a single chest tube. In contrast, 68% of patients in the complicated group required secondary interventions, including repeat drainage, therapeutic tapping, or video-assisted thoracoscopic surgery (VATS) (Table 3). Logistic regression analysis was shown in table 4.

Table 1. Baseline characteristics of patients with complicated hemothorax versus the primary ICD group.

Variable	Complicated hemothorax (n = 30)	Primary ICD (n = 30)	p
Mean age (years)	55 (26–90)	52 (20–85)	0.59 (NS)
Male sex (%)	25 (83%)	25 (83%)	1.00 (NS)
Delay > 3 days (%)	25 (83%)	2 (7%)	<0.001
Comorbidities (%)	3 (10%)	0 (0%)	0.11 (NS)

Table 2. Radiological findings in complicated versus the primary ICD groups.

Imaging feature	Complicated hemothorax (n = 30)	Primary ICD (n = 30)	p
Loculated/septated	21 (70%)	0 (0%)	<0.001
Moderate–gross free fluid	12 (40%)	22 (73%)	0.018
Massive/white-out lung	2 (7%)	1 (3%)	0.55 (NS)
Pneumothorax/ hemopneumothorax	2 (7%)	19 (63%)	<0.001

Table 3. Outcomes of complicated versus the primary ICD groups.

Outcome	Complicated hemothorax (n = 30)	Primary ICD (n = 30)	p
Managed with ICD alone	10 (33%)	30 (100%)	<0.0001
Required VATS/ decortication/ lavage	11 (37%)	0 (0%)	<0.0001
Required tapping/ reinsertion	9 (30%)	0 (0%)	<0.0001

Table 4. Logistic regression analysis.				
Predictor	Univariate OR (95% CI)	p	Multivariable OR (95% CI)	p
Delay > 3 days	5.09 (1.38–18.8)	0.015	0.72 (0.08–6.95)	0.78
Loculated/septated	21.1 (3.92–113.6)	<0.001	26.5 (2.54–276.4)	0.006
Age (years)	1.02 (0.98–1.05)	0.39	–	–
Mode of injury (RTA vs other)	1.36 (0.45–4.06)	0.58	–	–
On univariate analysis, both delay in ICD insertion beyond 3 days (OR 5.09, 95% CI 1.38–18.8, p = 0.015) and the presence of loculated/septated collections (OR 21.1, 95% CI 3.9–113.6, p < 0.001) were significantly associated with complicated hemothorax. Age and mode of injury were not significant predictors. *In the multivariable model including both delay and loculated collections, loculated/septated collections remained a strong independent predictor (adjusted OR 26.5, 95% CI 2.54–276.4, p = 0.006), whereas the effect of delay >3 days was attenuated (OR 0.72, 95% CI 0.08–6.95, p = 0.78).*				

These findings suggest that while delayed drainage is important, the presence of organized/ loculated collections is the dominant factor driving progression to complicated hemothorax in this cohort.

Discussion

This study demonstrated that delayed ICD insertion (>3 days) and loculated/septated pleural collections were strongly predictive of complicated hemothorax. These findings are consistent with published literature emphasizing that early drainage prevents clot organization and empyema. Comorbidities such as diabetes and prior pulmonary tuberculosis were more frequent among complicated cases, though this did not reach statistical significance, likely due to the limited sample size. Nevertheless, such comorbidities are known to impair pleural healing and increase infection risk. Outcomes analysis showed that all patients in the primary ICD group resolved with a single chest tube, whereas two-thirds of complicated cases required secondary interventions (VATS, lavage, or reinsertion). This aligns with previous studies recommending early surgical referral when retained collections are detected.

Historical and contemporary evidence supports our findings. Churchill et al [6] has advocated early decortication in post-traumatic empyema, emphasizing timely intervention. And Villalba et al [7] had reported delayed diagnosis and inadequate drainage as major contributors to empyema. French et al [8] also showed that limited thoracotomy with enzymatic therapy improved outcomes in early clotted hemothorax. DuBose et al [9] had found that retained hemothorax significantly increased empyema risk, with predictors including rib fractures and high ISS. Navsaria et al [10] also demonstrated that early thoracoscopic evacuation and fibrinolytic therapy reduced complications. The latest supportive evidences have been summarized in the table 5.

Table 5. Summary of recent literature on the predictors and management of complicated hemothorax.		
Study	Key Predictors / Factors	Main Findings / Outcomes
Sharma et al [11]	Delayed ICD, associated abdominal injuries, bilateral hemothorax	Predicted complicated outcomes
Ahmed et al [12]	Early vs delayed VATS (<72 h)	Early VATS reduced empyema rates and ICU stay
Lee et al [13]	Delay >48 h, multiple rib fractures, posterior collections	Predicted need for surgical evacuation
Berardi et al [4]	Septated collections	Strong independent predictor of complicated hemothorax
Aydin et al [5]	Septated collections	Strong independent predictor of complicated hemothorax
Kumar et al [14]	Early VATS (within 72 h)	Significantly reduced complications

In our cohort, loculated/septated collections emerged as the strongest independent predictor of complicated hemothorax, consistent with the pathophysiology of organized clot formation leading to impaired drainage and subsequent infection. While delay in drainage beyond 3 days showed significance on univariate analysis, its effect was attenuated after adjustment, suggesting that delay contributes indirectly by predisposing to loculation. These findings are in line with previous reports that emphasize timely drainage and the early use of VATS in patients with evidence of septations or loculations to prevent progression.

In Indian settings, studies from AIIMS [15] New Delhi and Jodhpur have similarly shown that about 25-30% of hemothorax patients fail initial chest tube drainage, and outcomes are significantly better when VATS is used within 3-7 days of trauma, with shorter hospital stays and fewer additional procedures. Another study from North India[15] found that residual hemothorax identified 48-72 hours post-tube drainage was common, and that tube positioning and early recognition are key to preventing progression.

Clinical implications suggest that early intercostal drainage (ICD) within the first 24 hours has a protective effect and contributes to improved outcomes. In patients presenting with loculated pleural collections or those who arrive later in the disease course, early video-assisted thoracoscopic surgery (VATS) should be prioritized over repeat ICD attempts. This approach can reduce hospital stay and may help prevent the development of empyema by providing more effective and definitive source control.

Limitations of the study

This was a retrospective, single-centre study with a modest sample size. Long-term outcomes, such as pulmonary function and quality of life, were not assessed. Despite these limitations, the study provides useful insights into the risk stratification and management of complicated hemothorax.

In conclusion, delayed chest tube placement and the presence of loculated pleural collections are strong predictors of complicated hemothorax following blunt chest trauma. Comorbidities such as diabetes and prior pulmonary tuberculosis, although not statistically significant, may contribute to poorer outcomes. Early and adequate drainage within 24 hours of injury remains the most effective strategy to prevent retained hemothorax and its complications. When collections persist, timely escalation to surgical management, particularly video-assisted thoracoscopic surgery, can reduce morbidity and the need for multiple procedures. Delayed drainage and loculated pleural collections predict complicated hemothorax. Loculated collections are the dominant independent predictor. Early recognition and prompt surgical referral can improve outcomes.

Declaration of conflicting interests

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Ethics approval

This study was approved by the Ethics Committee of Bangalore Medical College and Research Institute (25.07.2025, BMCRI/EC/24/25), and conducted in accordance with the Declaration of Helsinki.

Authors' contribution

MG: Conceptualization, Methodology, Writing - original draft. MKS: Data curation, Formal analysis, Writing - review & editing.

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