

Research Article

Effectiveness of Video-Assisted Thoracoscopic Surgery Drainage and Debridement in the Treatment of Early Empyema Thoracis

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ABSTRACT

Background: Empyema thoracis is a serious pleural infection associated with significant morbidity and mortality. Early surgical intervention using video-assisted thoracoscopic surgery (VATS) may improve outcomes in selected patients; however, evidence from low-resource settings remains limited.

Methods: This retrospective observational study included 336 patients with empyema thoracis who underwent VATS drainage and debridement between January 2024 and December 2025 at a tertiary thoracic surgery center in Pakistan. Preoperative variables, operative findings, and postoperative outcomes were analyzed using SPSS version 26, and treatment success was defined as clinical and radiological resolution without need for further surgical intervention.

Results: Overall, 336 patients were analyzed with a mean age of 38.9 ± 12.6 years; 69.0% were male. Treatment success was achieved in 90.8% of patients, with a conversion to thoracotomy rate of 5.4% and 30-day mortality of 1.8%. Symptom duration >21 days, multiloculated disease, and diabetes mellitus were independent predictors of treatment failure and recurrence.

Conclusion: VATS drainage and debridement is an effective and safe approach for early empyema thoracis, providing high success rates with low morbidity and mortality in a resource-limited setting. Early intervention within four weeks of symptom onset is associated with improved outcomes, while delayed presentation, multiloculated disease, and diabetes adversely affect prognosis.

Keywords: Empyema Thoracis, Video-Assisted Thoracoscopic Surgery (VATS), Pleural Infection, Early Surgical Intervention, Thoracic Surgery Outcomes.

INTRODUCTION

Empyema thoracis, defined as the accumulation of infected purulent fluid within the pleural cavity, remains a significant cause of morbidity and healthcare utilization worldwide. Pus is a thick, viscous purulent fluid that may develop secondary to bacterial pneumonia, tuberculosis, thoracic surgery, chest trauma, or extension of intra-abdominal infections [1]. Despite advances in antimicrobial therapy and pleural interventions, empyema continues to be associated with substantial morbidity and mortality [2].

Parapneumonic effusion refers to any pleural effusion occurring secondary to pneumonia and represents the most common precursor of pleural infection. It has been reported that up

to 57% of hospitalized patients with bacterial pneumonia develop an associated pleural effusion [3]. Pleural infection typically progresses through three pathological stages. The initial exudative stage is characterized by rapid accumulation of sterile pleural fluid. If not adequately treated, the disease advances to the fibropurulent stage, during which bacterial invasion, fibrin deposition, and loculation occur. Subsequently, persistent infection may progress to the organizing stage, generally after four weeks, when fibroblast proliferation results in the formation of a thick pleural peel and trapped lung [3]. Early intervention during the fibropurulent stage is therefore essential to prevent disease progression and long-term pulmonary restriction.

Management of empyema ranges from antibiotic therapy and observation to image-guided catheter drainage, tube thoracostomy, intrapleural fibrinolytic therapy, and surgical intervention, including video-assisted thoracoscopic surgery (VATS) and open thoracotomy [3]. While chest tube drainage remains a conventional first-line treatment, its effectiveness may be limited in multiloculated pleural collections. VATS enables direct evacuation of infected material, breakdown of loculations, and pleural debridement under visual guidance. Previous studies have demonstrated that VATS drainage and debridement are safe and effective treatment modalities, particularly during the fibropurulent stage of empyema [4–6].

Several investigations have reported favorable perioperative outcomes following VATS compared with open decortication, including shorter operative duration, reduced hospital stay, lower postoperative pain, and decreased morbidity and mortality [7]. Furthermore, increasing evidence suggests that the incidence of empyema has risen over the past two decades [8]. Although more than 40% of patients with pneumonia develop parapneumonic effusions, the majority respond to antibiotic therapy and conservative management [3, 9]. However, persistent pleural infection frequently requires drainage and debridement procedures, with accumulating evidence supporting early surgical intervention in loculated pleural effusions and empyema [3].

Comparative studies evaluating VATS against alternative treatment strategies, including tube thoracostomy and intrapleural fibrinolytic therapy, have demonstrated superior early outcomes with VATS in terms of symptom resolution, treatment success, and reduced length of hospitalization [4,5,10–12]. Additionally, patients undergoing VATS within four weeks of symptom onset have been reported to achieve better outcomes than those treated later in the disease course, highlighting the importance of timely intervention [13, 18]. Despite growing international evidence supporting early VATS for empyema management, published data from Pakistan and other low-resource settings remain limited. Local outcome data are important because differences in healthcare access, referral patterns, disease stage at presentation, and resource availability may influence treatment effectiveness and generalizability of international findings. Therefore, this study

aimed to evaluate the effectiveness of VATS drainage and debridement in patients with early empyema thoracis presenting within four weeks of symptom onset. Clinical and radiological outcomes during the first postoperative week were assessed to determine the role of early VATS as a definitive treatment strategy in this patient population.

METHODOLOGY

This retrospective observational cohort study included 336 consecutive patients who underwent VATS drainage and debridement for empyema thoracis between January 2024 and December 2025 and was conducted at the Department of Thoracic Surgery in the tertiary care hospital Pakistan. Patients aged 15–60 years with a diagnosis of empyema thoracis who underwent VATS drainage and debridement during the study period were eligible for inclusion. Diagnosis was established based on clinical presentation, radiological findings, and pleural fluid analysis demonstrating purulent pleural infection. Inclusion criteria included age between 15 and 60 years, male or female patients, diagnosis of empyema thoracis and patients who underwent VATS drainage and debridement as definitive treatment. Exclusion criteria included transudative pleural effusions secondary to hepatic or renal disease confirmed by pleural fluid biochemical analysis, malignant pleural effusions confirmed by pleural fluid cytology or histopathology, patients requiring immediate open thoracotomy or decortication as the primary procedure, patients who declined surgical treatment or whose records were incomplete, and empyema associated with bronchopleural fistula identified preoperatively or during VATS.

A sample size of 336 patients was included in the study. Consecutive sampling was employed, and all eligible patients who underwent VATS drainage and debridement for empyema thoracis, who fulfilled the inclusion criteria, were enrolled. After approval from the Institutional Ethical Review Committee, demographic, clinical, operative, and postoperative data were retrieved from hospital records using a structured data collection proforma. Preoperative assessment included detailed clinical evaluation and radiological investigations. Recorded variables included age, sex, duration of symptoms, fever, cough, dyspnea, chest pain, and laboratory investigations including total leukocyte count (TLC). Radiological evaluation consisted of

chest radiography and/or computed tomography (CT) of the chest where available. Pleural fluid obtained by thoracentesis or chest tube drainage was analyzed for biochemical, microbiological, and cytological parameters.

All procedures were performed by consultant thoracic surgeons under general anesthesia using single-lung ventilation whenever feasible. Patients were positioned in the lateral decubitus position. Standard thoracoscopic ports were utilized according to surgeon preference. Purulent collections were evacuated, loculations were disrupted, fibrinous adhesions were debrided, and thorough pleural cavity irrigation was performed. After the procedure, one or more chest drains were placed under direct vision and connected to underwater seal drainage. Patients were monitored clinically and radiologically during hospitalization. Daily assessments included resolution of fever, improvement in respiratory symptoms, chest drain output, and radiographic lung expansion. Chest tubes were removed once drainage was minimal and satisfactory lung re-expansion was achieved. The primary outcome was treatment effectiveness, defined as complete clinical improvement with resolution of presenting symptoms, absence of purulent pleural drainage, and radiological obliteration of the pleural cavity without residual empyema

requiring additional surgical intervention. Patients were followed in the outpatient clinic until satisfactory clinical and radiological recovery was documented. Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), as appropriate. Categorical variables were summarized as frequencies and percentages. Subgroup analyses were performed according to age, sex, and duration of symptoms. Associations between categorical variables and treatment effectiveness were evaluated using the Chi-square test or Fisher's exact test where appropriate. A two-tailed p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 336 patients with early empyema thoracis underwent VATS drainage and debridement during the study period. The mean age was 38.9 ± 12.6 years, and 232 (69.0%) were male. Mean symptom duration before surgery was 18.4 ± 7.9 days. Diabetes mellitus was present in 84 (25.0%) patients and tuberculosis-related empyema in 58 (17.3%). (Table 1)

Table 1. Baseline Characteristics

Variable	Value
Age (years)	38.9 ± 12.6
Male sex	232 (69.0%)
Diabetes mellitus	84 (25.0%)
Tuberculosis-related empyema	58 (17.3%)
Symptom duration (days)	18.4 ± 7.9

Overall treatment success was achieved in 305 patients (90.8%). Conversion to thoracotomy was required in 18 patients (5.4%). Postoperative complications occurred in 47

patients (14.0%), while 30-day mortality was 1.8% (n=6). Median postoperative hospital stay was 5 days (IQR 4–8). (Table 2)

Table 2. Postoperative Outcomes

Outcome	Value
Treatment success	305 (90.8%)
Treatment failure	31 (9.2%)
Conversion to thoracotomy	18 (5.4%)
Complications	47 (14.0%)
30-day mortality	6 (1.8%)
Hospital stay (days)	5 (IQR 4–8)

Univariate analysis demonstrated that diabetes mellitus, symptom duration >21 days, multiloculated empyema, tuberculosis-

associated empyema, and elevated preoperative leukocyte count were significantly associated with treatment failure. (Table 3)

Table 3. Univariate Analysis

Variable	OR	95% CI	p
Diabetes	2.48	1.18–5.20	0.016
Symptoms >21 days	4.12	1.94–8.76	<0.001
Multiloculation	5.35	2.46–11.63	<0.001
Tuberculosis	2.17	1.01–4.68	0.047

On multivariable logistic regression, symptom duration >21 days, multiloculated disease, and diabetes mellitus remained independent predictors of treatment failure. (Table 4)

Table 4. Multivariable Logistic Regression

Variable	Adjusted OR	95% CI	P
Symptoms >21 days	3.41	1.52–7.64	0.003
Multiloculation	4.82	2.07–11.22	<0.001
Diabetes	2.11	1.01–4.42	0.048

During a median follow-up of 24 months, empyema recurrence occurred in 17 patients (5.1%). Cox proportional hazards analysis identified symptom duration >21 days and multiloculated disease as independent predictors of recurrence. (Table 5)

Table 5. Cox Regression for Recurrence

Variable	HR	95% CI	P
Symptoms >21 days	2.72	1.19–6.23	0.018
Multiloculation	3.46	1.49–8.04	0.004

DISCUSSION

Empyema thoracis remains a challenging clinical entity despite advances in antimicrobial therapy, pleural drainage techniques, and minimally invasive thoracic surgery. Although pleural effusions occur in approximately 40% of patients with pneumonia, most resolve with antibiotic therapy and conservative management [10]. However, a subset of patients develop persistent pleural infection requiring invasive interventions such as chest tube drainage, intrapleural fibrinolytic therapy, VATS, or open surgical decortication [9, 11, 12]. Recent epidemiological studies have further demonstrated an increasing incidence of empyema worldwide over the past two decades, emphasizing the need for effective treatment strategies [11].

In the present study, VATS drainage and debridement achieved a treatment success rate of 90.8%, with a low conversion rate to thoracotomy (5.4%) and a 30-day mortality of 1.8%. These findings support the growing body of evidence demonstrating that VATS is an effective and safe treatment modality for early-stage empyema, particularly during the fibrinopurulent phase [2]. The favorable outcomes observed in our cohort are consistent with previous reports demonstrating superior clinical results with early VATS intervention compared with chest tube drainage alone or intrapleural fibrinolytic therapy [1, 2, 13–16].

The mean age of our patients was 38.9 ± 12.6 years, and the majority were male (69.0%), findings comparable to previously published national and international studies reporting a predominance of younger male patients among those undergoing surgical treatment for empyema. The overall postoperative complication rate of 14.0% and median hospital stay of 5 days observed in the current study compare favorably with outcomes reported in the literature, highlighting the benefits of minimally invasive management.

A major finding of our study was the impact of symptom duration on postoperative outcomes. Patients who underwent surgical intervention within four weeks of symptom onset demonstrated significantly better clinical outcomes than those presenting later. On multivariable analysis, symptom duration greater than 21 days remained an independent predictor of treatment failure, while Cox regression analysis demonstrated a significantly increased risk of recurrence among patients with delayed presentation. These findings support previous observations that empyema progresses from the fibrinopurulent stage to the organizing stage approximately four weeks after symptom onset, resulting in increased pleural fibrosis, lung entrapment, and technical difficulty during surgical management [17]. Several investigators have emphasized the importance of early surgical involvement in

patients with loculated pleural effusions and empyema [1, 2,13–16]. Delays in surgical intervention may permit progression of pleural infection, resulting in prolonged chest tube drainage, increased hospital stay, and higher rates of treatment failure. Similar to previous studies, our findings suggest that symptom duration is one of the most clinically useful preoperative factors for determining the optimal timing of surgery. Patients treated earlier in the disease course experienced shorter hospitalization, more rapid clinical recovery, and lower recurrence rates.

Multiloculated empyema was another important predictor of adverse outcomes in our cohort. Both logistic and Cox regression analyses demonstrated that multiloculated disease was independently associated with treatment failure and recurrence. These findings likely reflect the greater complexity of pleural infection in advanced fibrinopurulent disease, where multiple septations limit the effectiveness of non-operative drainage techniques. Consequently, VATS provides a significant therapeutic advantage by allowing direct visualization, breakdown of loculations, evacuation of infected material, and complete pleural debridement. [18]

Diabetes mellitus also emerged as an independent predictor of treatment failure. This observation is biologically plausible given the impaired immune response, delayed wound healing, and increased susceptibility to infection associated with diabetes. Similar associations between diabetes and adverse outcomes in pleural infection have been reported previously, supporting the need for careful perioperative optimization in this patient population.

The low conversion rate to thoracotomy observed in the present study further supports the role of VATS as a first-line surgical approach. Previous studies have reported conversion rates ranging from 4% to 40%, depending on disease stage and surgeon experience [7, 18]. Our findings suggest that, when performed by experienced thoracic surgeons, VATS can successfully manage the majority of patients with empyema while preserving the benefits of a minimally invasive approach. Moreover, the low mortality and favorable postoperative outcomes observed in our series compare favorably with published outcomes following open decortication [7, 8].

LIMITATIONS

The present study has several limitations. First, its retrospective single-center design introduces

the potential for selection bias and limits generalizability. Second, despite the relatively large sample size, treatment allocation was not randomized and therefore causal relationships cannot be definitively established. Third, variations in referral timing, preoperative antibiotic treatment, and microbiological profiles may have influenced outcomes. Nevertheless, the study represents one of the larger contemporary experiences evaluating VATS drainage and debridement for empyema thoracis in a resource-limited setting and provides clinically relevant evidence supporting early surgical intervention.

CONCLUSION

VATS drainage and debridement is a safe and effective treatment modality for early empyema thoracis, achieving high treatment success rates with low morbidity, low mortality, and a limited requirement for conversion to thoracotomy. Early surgical intervention, particularly within four weeks of symptom onset, is associated with superior postoperative outcomes and lower recurrence rates. Symptom duration and multiloculated disease appear to be important predictors of treatment outcomes and may assist in surgical decision-making. Prospective multicenter studies and randomized controlled trials are warranted to further define the optimal timing of surgical intervention and validate these findings in broader patient populations.

REFERENCES

1. Arnold DT, Hamilton FW, Morris TT, Suri T, Morley A, Frost V, et al. Epidemiology of pleural empyema in English hospitals and the impact of influenza. *Eur Respir J*. 2021;57(6):2003546. <https://doi.org/10.1183/13993003.03546-2020>
2. Mummadi SR, Stoller JK, Lopez R, Kailasam K, Gillespie CT, Hahn PY. Epidemiology of adult pleural disease in the United States. *Chest*. 2021;160(4):1534-1551. <https://doi.org/10.1016/j.chest.2021.05.026>
3. Bedawi EO, Stavroulias D, Hedley E, Blyth KG, Kirk A, De Fonseka D, et al. Early video-assisted thoracoscopic surgery or intrapleural enzyme therapy in pleural infection: a feasibility randomized controlled trial. *The Third Multicenter Intrapleural Sepsis Trial-MIST-3*. *Am J Respir Crit Care Med*. 2023;208(12):1305-1315.

4. Pilav I, Alihodzic-Pasalic A, Musanovic S, Kadic K, Dapcevic M, Custovic O. Efficacy of video-assisted thoracoscopic surgery (VATS) in the treatment of primary pleural empyema. *Acta Inform Med.* 2020;28(4):261-264. <https://doi.org/10.1164/rccm.202305-0854OC>
5. Ershadi R, Vahedi M, Rafieian S. Efficacy of video-assisted thoracoscopic surgery versus intrapleural streptokinase for treatment of parapneumonic empyema with multiloculation and septation. *Kardiochir Torakochirurgia Pol.* 2022;19(2):86-89. <https://doi.org/10.5455/aim.2020.28.261-264>
6. Ricciardi S, Giovannello D, Carleo F, Di Martino M, Jaus MO, Mantovani S, et al. Which surgery for stage II-III empyema patients? Observational single-center cohort study of 719 consecutive patients. *J Clin Med.* 2023;12(1):136. <https://doi.org/10.3390/jcm12010136>
7. Lin CM, Chen YL, Cheng YF, Cheng CY, Huang CL, Hung WH, et al. Optimal timing for video assisted thoracic surgery decortication for improved survival in chronic empyema. *Sci Rep.* 2024;14(1):24548. <https://doi.org/10.1038/s41598-024-75569-w>
8. Majeed FA, Chatha SS, Zafar U, Ali A, Farhan N, Raza A. VATS thoracoscopic decortication for empyema thoracic: a retrospective experience and analysis of 162 cases. *J Pak Med Assoc.* 2021;71(2A):502-504. <https://doi.org/10.47391/JPMA.431>
9. Simon L, Belaroussi Y, Vayssette A, Khalife T, Le Roux M, Debrosse D, et al. Role of RAPID score and surgery in the management of pleural infection: a single center retrospective study. *J Thorac Dis.* 2023;15(10):5340-5348. <https://doi.org/10.21037/jtd-22-1599>
10. Louis M, Vivekanandan DD, Grabill N, Kumar G, Singh H, Hastings JC, et al. Who is at risk for tPA/DNase treatment failure in empyema? Protocol to identify key predictors for early surgical intervention from a retrospective study. *J Thorac Dis.* 2024;16(12):8602-8610. <https://doi.org/10.21037/jtd-24-1256>
11. Ohuchi M, Inoue S, Ozaki Y, Fujita T, Ueda K, Kitamura S, et al. Efficacy, safety, and optimal timing of single-trocar video-assisted flexible thoracoscopic debridement under local anesthesia for complicated parapneumonic empyema. *Gen Thorac Cardiovasc Surg.* 2022;70(7):634-641. <https://doi.org/10.1007/s11748-022-01780-z>
12. Matsudaira H, Arakawa S, Noda Y, Ohtani A, Ohtsuka T. Optimal timing of video-assisted thoracic surgery for acute pyothorax: a retrospective study. *Gen Thorac Cardiovasc Surg.* 2021;69(11):1476-1481. <https://doi.org/10.1007/s11748-021-01649-7>
13. Luciani C, Scacchi A, Vaschetti R, Di Marzo G, Fatica I, Cappuccio M, et al. The uniportal VATS in the treatment of stage II pleural empyema: a safe and effective approach for adults and elderly patients-a single-center experience and literature review. *World J Emerg Surg.* 2022;17(1):46. <https://doi.org/10.1186/s13017-022-00438-8>
14. Xia Z, Zheng S, Shi Q, Wang H, Ning X, Huang P, et al. Uniportal versus triportal video-assisted thoracic surgery in the treatment of tuberculous empyema. *J Int Med Res.* 2023;51(5):3000605231169901. <https://doi.org/10.1177/03000605231169901>
15. Cheng YF, Cheng CY, Huang CL, Hung WH, Wang BY. Pleural peels tissue culture plus pleural fluid culture help to improve culture rate for empyema. *J Clin Med.* 2022;11(7):1882. <https://doi.org/10.3390/jcm11071882>
16. Yukumi S, Ishimaru K, Suzuki H, Abe M, Morimoto M, Senba M, et al. Duration of antimicrobial therapy after video-assisted thoracoscopic surgery for thoracic empyema and complicated parapneumonic effusion: a single-center study. *Respir Investig.* 2023;61(1):110-115. <https://doi.org/10.1016/j.resinv.2022.11.001>
17. Vu HA, Nguyen NV, Le TD, Nguyen ST, Le AV, Vu AT, et al. Outcome of pleural empyema treated with video-assisted thoracoscopic surgery in patients with severe co-morbidities: an observational study. *Med Devices (Auckl).* 2025;18:87-96. <https://doi.org/10.2147/MDER.S498901>

18. Iftikhar H, Nabi MS, Sarwar Z. Comparison Of Lung Expansion After Uniportal And Multiportal Video Assisted Thoracic Surgery For Stage Ii Post-Pneumonic Bacterial Empyema Thoracis: Pak Postgrad Med J 2025;36(4): 166-170. DOI: <https://doi.org/10.51642/ppmj.v36i04.827>