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Comparative analysis of surgical outcomes of video-assisted thoracoscopic surgery versus open thoracotomy in the management of empyema

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Abstract

Background: Empyema thoracis is a complex pleural infection that evolves from a free-flowing exudative process to fibrin deposition, loculation and, in established disease, an organized pleural peel that restricts lung expansion. Timely drainage, antimicrobial therapy and appropriate escalation are essential to prevent chronic pleural restriction and systemic morbidity. Video-assisted thoracoscopic surgery (VATS) has progressively replaced open thoracotomy as the preferred surgical access for many adults requiring operative treatment, although the extent of surgery must be tailored to disease stage and the condition of the lung.

Objectives: To synthesize the comparative evidence on VATS and open thoracotomy for adult empyema, with emphasis on operative time, blood loss, chest-tube duration, hospital stay, postoperative pain, complications, conversion, treatment success, recurrence and mortality, and to integrate these findings with the clinical pathway described in the submitted dissertation summary.

Methods: A structured narrative synthesis was prepared from the supplied dissertation summary and supplemented with contemporary guidance and peer-reviewed literature. Particular emphasis was placed on the 2023 British Thoracic Society pleural disease guideline, the European Association for Cardio-Thoracic Surgery consensus statement, the MIST1 and MIST2 randomized trials of intrapleural therapy, and published comparative/meta-analytic evidence for VATS versus open decortication. Because no original patient-level

dataset was provided, numerical comparative outcomes in this manuscript are reported as published literature findings rather than as results of a new institutional cohort.

Results: The available evidence supports initial antibiotic therapy and appropriately positioned chest-tube drainage for established pleural infection, with intrapleural tPA-DNase considered when drainage leaves a residual collection. When surgery is required, VATS is favored as the initial access in most adults because it is associated with less immediate postoperative pain, shorter hospital stay and fewer postoperative complications, while maintaining high treatment success. A meta-analysis reported shorter operative time, hospital stay and chest-tube duration, and lower prolonged air leak, morbidity and mortality with VATS decortication compared with open thoracotomy, although the underlying evidence was heterogeneous and largely non-randomized. Open thoracotomy remains important when dense adhesions, a thick organized peel, difficult anatomy or incomplete lung re-expansion prevents adequate clearance through VATS. Conversion should therefore be viewed as a planned component of safe minimally invasive surgery rather than as a failure**.**

Conclusion: VATS should be considered the preferred surgical access for suitable adult patients requiring operative management of empyema, provided that the surgeon can achieve adequate drainage, debridement and lung re-expansion and can convert promptly when necessary. Open thoracotomy remains indispensable for selected advanced or technically difficult disease. Future prospective studies should standardize empyema stage, definitions of debridement/decortication, conversion criteria and patient-centered outcomes.

Keywords: Empyema Thoracis, Pleural Infection, Video-Assisted Thoracoscopic Surgery, VATS, Thoracotomy, Decortication, Debridement, Pleural Drainage, Tpa-Dnase, Minimally Invasive Thoracic Surgery.

Introduction

Empyema thoracis is the accumulation of infected, purulent fluid within the pleural cavity and represents an advanced manifestation of pleural infection. It commonly complicates bacterial pneumonia but may also follow thoracic trauma, surgery, esophageal disease or other sources of infection. The clinical problem is not simply the presence of infected fluid: fibrin deposition rapidly creates septations and loculations, while subsequent organization produces a restrictive visceral pleural peel. Without effective source control, this process may result in trapped lung, prolonged sepsis, respiratory impairment and prolonged hospitalization.[1,2]

The submitted dissertation summary emphasizes the classical three-stage progression: exudative, fibrinopurulent and organizing phases. In the early stage, antibiotics and drainage may be sufficient. During the fibrinopurulent stage, loculations can impair drainage and may necessitate intrapleural therapy or surgery. In the organizing stage, a thick pleural rind can mechanically prevent lung expansion and may require decortication[1].

Historically, open thoracotomy with evacuation and decortication was regarded as the definitive operation for advanced empyema because it permits direct access to the entire pleural cavity and facilitates removal of an organized peel. The major disadvantages are the morbidity of thoracotomy, including severe acute pain, respiratory impairment, wound morbidity and prolonged recovery. The development of VATS introduced a less invasive route for drainage, adhesiolysis, debridement and, in selected patients, decortication[1,3].

The contemporary debate is therefore not whether VATS or thoracotomy can treat empyema, but which patients benefit from each approach and how the operation should be timed within the broader medical-surgical pathway. The 2023 BTS guideline conditionally recommends VATS access over thoracotomy for adults undergoing surgery for pleural infection, while emphasizing that the chosen technique must permit adequate clearance and lung re-expansion[2].

This review expands the submitted dissertation summary into a publication-style manuscript and places its comparative observations in the context of current evidence. The central hypothesis is that VATS provides comparable infection control with lower perioperative morbidity in appropriately selected patients, while open surgery retains an essential role in advanced disease where minimally invasive clearance is inadequate.

Pathophysiology and Staging

Pleural infection is a dynamic process. During the exudative stage, increased pleural vascular permeability results in a relatively free-flowing sterile or minimally infected effusion. As bacterial invasion and inflammation progress, neutrophils, fibrin and inflammatory mediators accumulate. Fibrin bridges form between visceral and parietal pleura, producing loculations and restricting fluid movement. This fibrinopurulent phase is characterized by increasing turbidity or frank pus, reduced pleural fluid pH and impaired drainage. Finally, fibroblast proliferation and collagen deposition produce an organized pleural cortex that encases the lung[1,3].

The practical value of staging is that it links pathobiology to the expected effectiveness of an intervention. A simple drain is most effective when infected fluid remains freely accessible. Loculated disease may benefit from image-guided drainage and intrapleural enzyme therapy. A trapped lung or mature pleural rind may require surgical debridement and decortication. However, stage alone should not dictate the operation; patient physiology, duration of symptoms, imaging, sepsis trajectory, comorbidity and local expertise are also important.[2,3]

Stage	Pathological characteristics	Typical management implication
I — Exudative	Free-flowing effusion; limited fibrin	Antibiotics + drainage when indicated
II — Fibrinopurulent	Fibrin deposition, septations, loculations, infected fluid	Drainage ± tPA-DNase; VATS often considered when medical therapy fails
III — Organizing	Thick pleural peel, trapped/restricted lung	Surgical debridement/decortication; VATS when adequate clearance is feasible, conversion/open surgery when necessary

Diagnostic Evaluation

Diagnosis is clinical, radiological and microbiological. Fever, pleuritic pain, dyspnea, leukocytosis and inflammatory markers support the diagnosis, but none is sufficiently specific. Pleural fluid should be sampled promptly when pleural infection is suspected. Frank pus establishes the diagnosis; in non-purulent fluid, biochemical and microbiological assessment helps identify complicated infection[2,3].

Ultrasound is valuable for identifying septations and guiding drainage. Contrast-enhanced CT provides information about pleural enhancement, loculation, gas, adjacent parenchymal disease and the extent of pleural thickening. These findings help determine whether a collection is likely to respond to catheter drainage and whether an operative approach is likely to be technically demanding.

Microbiological sampling should include pleural fluid Gram stain and culture, with inoculation into appropriate blood-culture bottles when available, as well as blood cultures in systemically ill patients. Antibiotic selection should cover the expected community or healthcare-associated pathogens and should subsequently be refined according to microbiology and local resistance patterns[2].

Initial Medical and Drainage Management

Source control is the central principle of pleural infection treatment. Antimicrobial therapy should be initiated promptly, while drainage is undertaken when pleural infection is established. The 2023 BTS guideline recommends a small-bore chest tube, 14 F or smaller, for initial drainage and does not recommend immediate VATS or thoracotomy instead of chest-tube drainage as the universal initial treatment[2].

Drain position is more important than tube diameter alone. Imaging should guide placement into the largest accessible component of a loculated collection. Failure to improve should trigger reassessment of drain position, residual locules, microbiology, antibiotic adequacy and the possibility of a lung that is mechanically trapped.

Intrapleural enzyme therapy is an important intermediate step. In MIST2, combined intrapleural tPA and DNase improved radiographic drainage, reduced surgical referral and shortened hospital stay compared with placebo, whereas either agent alone did not provide the same benefit [4]. The BTS guideline recommends considering combined tPA-DNase when initial chest-tube drainage has ceased and a residual pleural collection remains.[2]

Indications and Timing for Surgery

The exact threshold for operative referral remains imperfectly defined. Surgery should be considered when there is persistent sepsis or a residual infected collection despite appropriate drainage and antibiotics, extensive loculation that cannot be adequately drained, failure or unsuitability of intrapleural therapy, persistent trapped lung, or established organizing empyema in a patient fit for an operation.[2,3]

Timing matters because advanced organization increases the technical difficulty of minimally invasive surgery. The submitted dissertation summary appropriately highlights early intervention and notes that VATS is particularly useful in early and intermediate disease, whereas dense adhesions and a mature pleural peel increase the likelihood of conversion to thoracotomy[1].

A multidisciplinary decision should incorporate anesthetic risk, nutritional status, frailty, respiratory reserve, duration of disease and radiological anatomy. Referral to a thoracic surgical service should not be delayed until a patient has developed severe physiologic deterioration, because a technically simpler operation is generally possible before complete organization.

VATS: Technique and Rationale

VATS permits visualization of the pleural cavity through small intercostal access ports. After entering the cavity, pus and fibrinous debris are evacuated, loculations are broken down and the pleural surfaces are assessed. Depending on the stage and the condition of the lung, the procedure may range from simple drainage and debridement to extensive visceral decortication.

The technical endpoint is not merely removal of visible pus. Adequate source control requires access to all clinically relevant locules, removal of obstructing fibrinous material, control of bleeding and, where appropriate, release of the lung sufficiently to permit re-expansion. The BTS guideline specifically emphasizes that the operation should be tailored to the patient and empyema stage, with decortication individualized for a trapped lung[2].

The advantages of VATS arise from reduced chest wall trauma, avoidance of a large thoracotomy incision and improved visualization of loculated spaces. Smaller incisions generally translate into less immediate postoperative pain, earlier mobilization and shorter hospitalization. The trade-off is that extensive peel removal can become technically difficult when the disease is chronic or densely adherent.

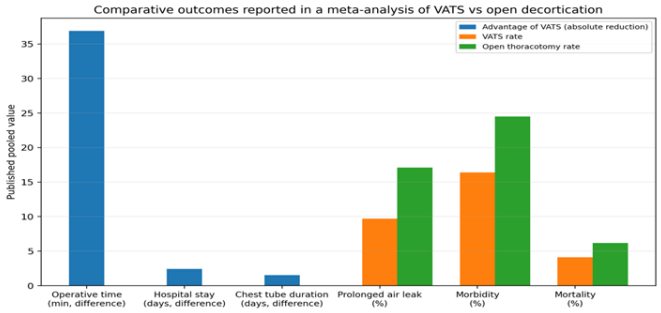

Figure 1. Published comparative outcomes from a meta-analysis of VATS versus open thoracotomy decortication. The first three measures are pooled reductions favoring VATS; the remaining measures are reported event rates.

Open Thoracotomy and Decortication

Open thoracotomy remains an important operation for advanced organizing empyema. Through a larger access incision, the surgeon can directly evacuate the infected material, separate adhesions, remove the pleural peel and perform extensive decortication. In chronic disease, this direct exposure may provide the most reliable route to complete lung release. The disadvantages are substantial. Rib spreading and greater muscle and intercostal tissue disruption contribute to postoperative pain, respiratory splinting and delayed mobilization. Larger wounds may also increase wound complications. These factors explain the contemporary movement toward VATS as the initial surgical access when adequate clearance can be achieved2,5. strategy. A VATS operation that cannot safely achieve source control should be converted rather than prolonged at the expense of incomplete drainage, excessive dissection or avoidable morbidity. The EACTS consensus similarly emphasizes the role of VATS while acknowledging the limitations of minimally invasive decortication in chronic disease[3].

Comparative Outcomes: VATS versus Open Thoracotomy

The dissertation summary reports several comparative studies demonstrating broadly favorable perioperative outcomes with VATS, while also noting that open surgery may achieve more complete decortication in advanced disease[1]. The evidence base is heterogeneous: studies differ in disease stage, definitions of debridement and decortication, surgeon experience, timing of referral and criteria for conversion. These factors make direct numerical comparisons difficult.

Open surgery should therefore be viewed not as an outdated technique but as an essential escalation.

Study	VATS n	Open n	VATS operative time	Open operative time	VATS hospital stay	Open hospital stay
Muhammed et al.	25	24	84.68 ± 23.98 min	137.37 ± 26.90 min	7.76 ± 4.63 d	8.87 ± 2.59 d
Cardillo et al.	185	123	79.7 ± 6.8 min	70.0 ± 7.4 min	8.6 ± 1.8 d	10.0 ± 7.8 d
Chan et al.	41	36	150 ± 57.6 min	228 ± 84 min	16 ± 6.5 d	21 ± 14.2 d
Tong et al.	326	94	97 min	155 min	7 d	10 d
Casali et al.	27	—	100.4 min	—	6.4 d	—

Table 2. Comparative studies summarized in the supplied dissertation. Values reproduce the ranges and means presented in the dissertation summary; the underlying original articles should be checked against their full texts before submission to a journal[1].

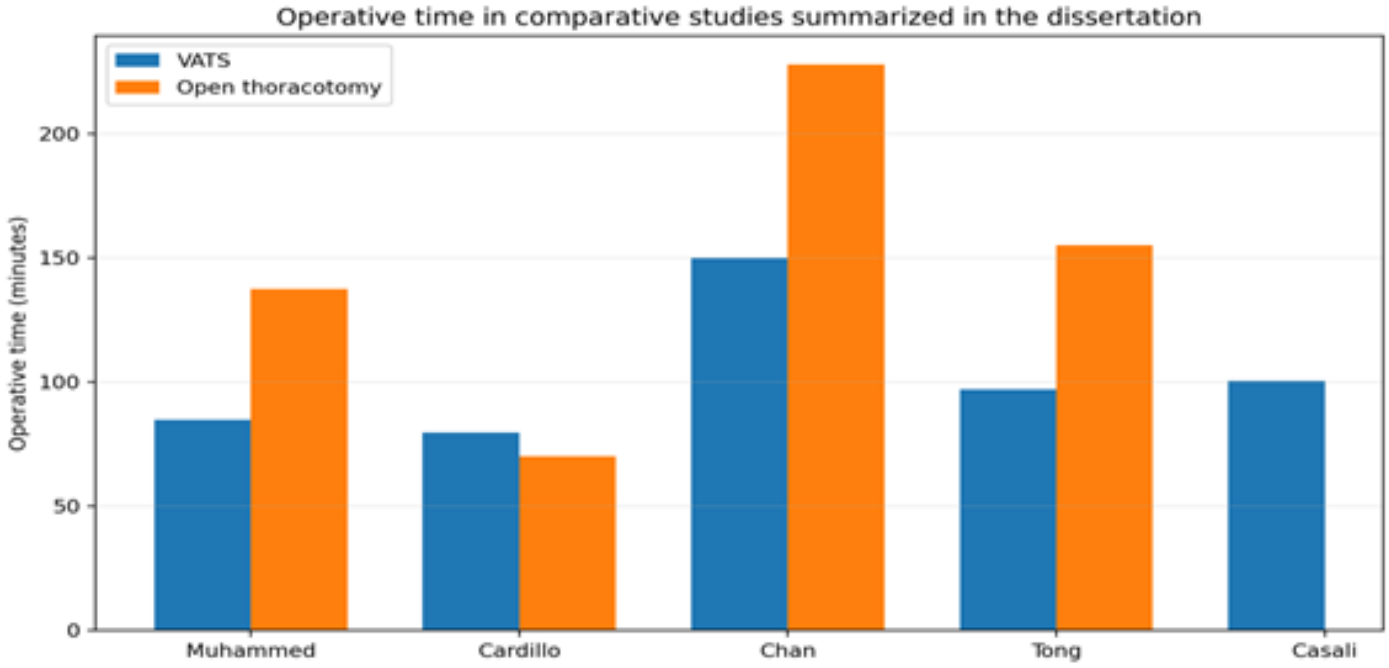

Figure 2. Operative time in comparative studies summarized in the dissertation. Missing values reflect data not presented in the supplied summary[1].

1. Operative time

Operative time is influenced by disease stage, surgeon experience and the precise procedure performed. The dissertation summary notes that VATS may initially take longer during the learning curve, but experienced teams can achieve operative times comparable with or shorter than open surgery[1]. The comparative studies summarized in Table 2 illustrate this heterogeneity. Importantly, operative duration alone should not be used as the principal determinant of approach; safe and complete source control is the priority.

2. Blood loss

VATS may reduce blood loss through magnified visualization and targeted dissection, although dense

inflammatory adhesions can produce significant bleeding during minimally invasive decortication. Open thoracotomy provides better tactile access and rapid control when extensive pleural dissection is required. Because the supplied dissertation does not provide a pooled institutional blood-loss dataset, no original numerical estimate is presented here.[1]

3. Pain and analgesic requirement

Postoperative pain is one of the clearest practical advantages of VATS. Smaller incisions and avoidance of extensive rib spreading reduce acute chest wall trauma. The BTS evidence review states that immediate postoperative pain appears lower with VATS and that hospital stay appears shorter, although the certainty of evidence for these outcomes is low[2]. Reduced pain facilitates coughing, physiotherapy and early mobilization, which are particularly important in patients with compromised pulmonary function.

4.Chest-tube duration and hospital stay

The dissertation summary reports shorter chest-tube duration and hospital stay after VATS in several comparative series[1]. The meta-analysis by Zhang and colleagues found a mean reduction of approximately 1.52 days in chest-tube duration and 2.41 days in postoperative hospital stay with VATS decortication compared with open thoracotomy[5]. These findings are clinically plausible because reduced tissue trauma and efficient clearance can accelerate mobilization and recovery.

5. Complications

Potential complications include prolonged air leak, pneumonia, wound infection, bleeding, residual collection, bronchopleural fistula and respiratory failure. The meta-analysis by Zhang et al. reported prolonged air leak in 9.7% of VATS patients versus 17.1% after open decortication, and overall morbidity of 16.4% versus 24.5%, respectivel.[5] The BTS guideline similarly concludes that VATS appears to cause fewer postoperative complications, while acknowledging very low certainty of evidence[2].

6. Treatment success, recurrence and mortality

Treatment success is best defined by eradication of infection, adequate lung re-expansion and freedom from reintervention rather than by a single technical endpoint. The BTS evidence review reports similar postoperative mortality and repeat-intervention rates between VATS and thoracotomy, despite advantages in pain, length of stay and complications[2]. The 2017 meta-analysis reported no statistically significant difference in relapse, despite lower pooled morbidity and mortality with VATS[5]. Because most comparative studies are observational, selection bias remains a major concern: patients with more advanced disease are more likely to undergo open surgery.

7. Conversion from VATS to thoracotomy

Conversion is an important quality and safety endpoint. Dense adhesions, severe bleeding, inability to identify planes, extensive pleural peel and failure of lung re-expansion are common reasons for conversion. The dissertation summary reports conversion rates in selected comparative series and emphasizes that advanced organizing disease has a greater likelihood of requiring open access.[6] Conversion should be regarded as an adaptive strategy that allows completion of source control rather than as a complication in itself.

Evidence Synthesis

Source	Design / population	Key finding	Implication
BTS Pleural Disease Guideline 2023	Evidence-based guideline, adults with pleural infection	Small-bore drainage initially; consider tPA-DNase for residual collection; VATS access favored over thoracotomy when surgery is required	Supports staged escalation rather than routine immediate surgery[2]
EACTS consensus	Expert consensus and evidence review	Stage 2/3 disease may benefit from operative debridement/decortication; VATS has an established role; chronic disease may be technically difficult	Supports VATS with readiness to convert[3]
MIST1	Randomized, 454 patients	Streptokinase did not reduce death, surgery or hospital stay	Routine streptokinase is not supported[6]
MIST2	Randomized factorial trial, 210 patients	tPA + DNase improved drainage, reduced surgical referral and hospital stay	Combined enzyme therapy is a useful intermediate option[4]
Zhang et al., 2017	Meta-analysis of VATS vs open decortication	VATS associated with shorter operative time, stay and tube duration and lower morbidity/mortality; relapse not significantly different	Supports minimally invasive access, with caution regarding selection bias[5]

Practical Management Algorithm

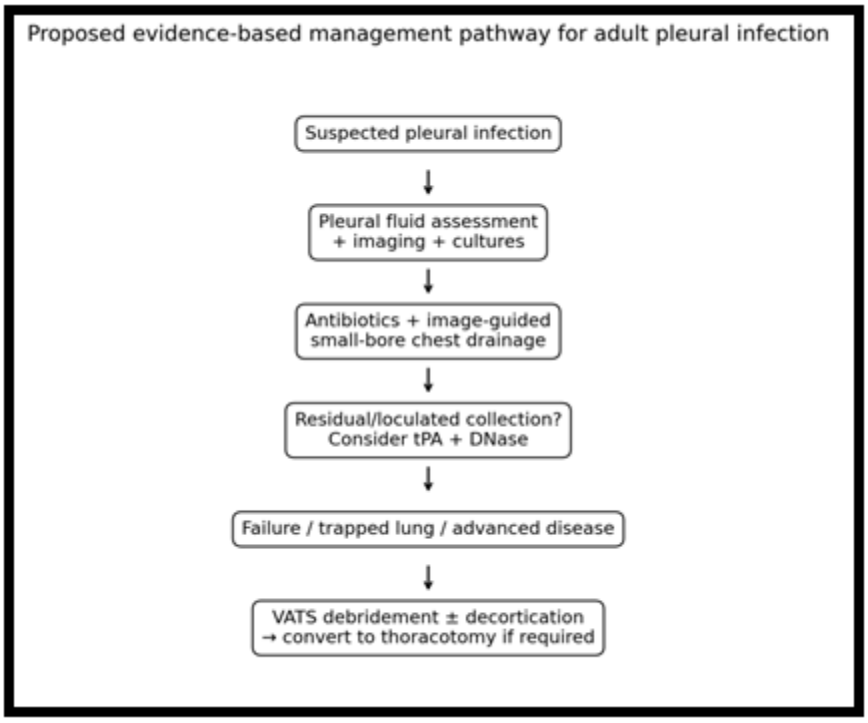

Figure 3: Suggested evidence-based management pathway integrating the supplied dissertation summary with current guidance.[1-4]

Discussion

The major finding of this evidence synthesis is that VATS has become the preferred surgical access for many adults requiring operative treatment of empyema, but its superiority should not be interpreted as an obligation to complete every decortication thoracoscopically. The goal of surgery is source control and lung re-expansion, not preservation of the minimally invasive route at all costs. The contemporary pathway begins with antibiotics and image-guided small-bore drainage. This is important because the evidence does not support replacing initial medical drainage with routine immediate surgery in all patients. When drainage leaves a residual collection, combined tPA-DNase can improve drainage and reduce the need for surgery in selected patients[2-4]. This staged approach avoids unnecessary operations while maintaining a clear route to surgical source control when medical therapy fails. For patients who require surgery, VATS offers a favorable morbidity profile. The pooled evidence indicates shorter hospitalization and chest-tube duration and fewer complications[5]. The clinical consequences extend beyond the numerical differences: less pain can facilitate respiratory physiotherapy, early mobilization and nutrition; shorter hospitalization may reduce nosocomial exposure and resource use. The dissertation summary also highlights the potential economic benefit of VATS despite higher capital and training costs, because shorter hospitalization and faster recovery may offset the initial investment[1]. However, the apparent benefits of VATS may be exaggerated by selection bias. Patients selected for VATS may have earlier-stage disease, fewer adhesions, lower comorbidity or treatment in centers with greater thoracoscopic expertise. Conversely, open thoracotomy is frequently reserved for the sickest patients and those with chronic organizing empyema. Therefore, lower mortality or morbidity in VATS cohorts cannot automatically be interpreted as a causal effect of the surgical access. The role of disease duration is especially important. As empyema organizes, the visceral peel becomes increasingly adherent to the underlying lung. Attempting aggressive thoracoscopic decortication in this setting can cause parenchymal injury and prolonged air leak. The EACTS statement and the supplied dissertation both recognize the limitations of VATS in chronic disease[1,3]. The appropriate response is not to reject VATS but to use it as the initial access when feasible and convert promptly if the operative objectives cannot be met safely. The distinction between debridement and decortication is also central. Not every patient requires a complete visceral decortication. In patients without a completely trapped lung, evacuation of infected material and breakdown of loculations may be sufficient. In a patient with a mechanically restricted lung, decortication becomes more relevant. The BTS guideline therefore recommends tailoring the extent of surgery and individualizing decortication according to the presence of a trapped lung, empyema stage and patient fitness[2]. Another important lesson is that conversion should be incorporated into the preoperative consent and operative plan. A thoracoscopic approach is not an irreversible commitment. The surgeon should anticipate the possibility of conversion, ensure appropriate positioning and access, and establish clear criteria for abandoning VATS when complete clearance or safe lung release cannot be achieved. This philosophy combines the recovery advantages of minimally invasive surgery with the definitive source-control capability of open surgery. The current literature also demonstrates the need for better prospective evidence. Existing comparative studies vary in staging, timing, antibiotic

protocols, use of fibrinolytics, definitions of success and surgeon expertise. Mortality is an uncommon outcome, making adequately powered randomized comparisons difficult. Future trials should prioritize patient-centered outcomes such as time to clinical stability, pain trajectories, quality of life, return to work, pulmonary function and health-economic endpoints, while using standardized definitions for residual disease and reintervention.

Extended Clinical Considerations

1. Patient selection and timing

Patient selection is the principal determinant of whether VATS can deliver definitive source control. A patient with an acute fibrinopurulent empyema, limited duration of symptoms, accessible loculations and preserved lung compliance is more likely to benefit from thoracoscopic drainage and debridement than a patient with a mature rind encasing a chronically collapsed lung. Conversely, severe systemic illness should not automatically be considered a contraindication to VATS; successful early source control may be particularly valuable when prolonged sepsis and ventilator dependence are likely. The decision should therefore integrate physiological fitness with anatomical complexity rather than relying on chronological stage alone.

2. Anesthetic and perioperative considerations

Thoracic surgery for empyema presents specific anesthetic challenges because patients may have sepsis, reduced pulmonary reserve, hypoxemia, malnutrition and concomitant pneumonia. One-lung ventilation can be difficult in patients with severe parenchymal disease. Preoperative optimization should include correction of major electrolyte abnormalities, assessment of cardiovascular and respiratory reserve, appropriate antimicrobial therapy and attention to nutritional status. Intraoperative communication between surgeon and anesthesiologist is particularly important during decortication because manipulation of an adherent lung can produce bleeding or air leak. The availability of blood products, postoperative respiratory support and an escalation plan should be considered before incision.

3. Postoperative care

Postoperative management is directed toward early lung expansion, effective analgesia, airway clearance and mobilization. Multimodal analgesia can reduce opioid exposure and facilitate coughing and physiotherapy. Chest drains should be managed according to air leak, fluid output and radiological lung expansion rather than by a fixed duration. Persistent air leak should prompt assessment for parenchymal injury, residual trapped lung or bronchopleural fistula. Respiratory physiotherapy, incentive breathing exercises when appropriate, early mobilization and thromboprophylaxis form important components of enhanced recovery. The less invasive access of VATS can facilitate these measures by reducing chest wall pain.

4. Definitions of success and failure

Comparative research in empyema is limited by inconsistent definitions of success. A clinically meaningful definition should include resolution of systemic infection, adequate drainage of the infected space, satisfactory lung re-expansion, absence of a persistent collection requiring additional intervention, and survival without major morbidity. Radiographic improvement alone is insufficient because residual pleural thickening may persist despite clinical cure. Conversely, an imperfect radiograph early after surgery does not necessarily represent failure if the patient is afebrile, inflammatory markers are falling and the lung is

progressively expanding. Future trials should predefine objective criteria for failure and reintervention.

5. Health-economic considerations

VATS requires specialized equipment, trained personnel and an institutional learning curve. These factors may increase direct procedural costs compared with open thoracotomy. However, an economic evaluation should include the entire episode of care. Reduced pain, shorter chest-tube duration, shorter hospitalization, fewer complications and earlier return to normal activity may offset higher theatre costs. The dissertation summary similarly identifies the potential for long-term cost effectiveness despite greater initial resource requirements[1]. Formal cost-effectiveness studies should incorporate local equipment costs, staff time, intensive-care utilization, readmission and productivity losses.

6. Resource-limited settings

The choice of surgical access must also reflect local infrastructure. Open thoracotomy may remain the most immediately available definitive procedure where VATS equipment, trained thoracoscopic surgeons or postoperative thoracic support are limited. Nevertheless, the absence of VATS should not result in delayed source control. Conversely, the availability of a thoracoscope should not encourage inexperienced operators to persist with a technically unsafe procedure. Training pathways, standardized protocols and early referral to higher-volume centers can improve outcomes while allowing institutions to develop minimally invasive capability.

7. Special populations

Children, older adults and patients with significant comorbidity require individualized planning. Pediatric empyema differs in microbiology, disease trajectory and evidence base, and pediatric thoracic surgical principles should be applied rather than directly extrapolating adult data. In older adults, reduced physiological reserve increases the value of minimizing surgical trauma, but frailty and anticoagulation may influence the choice and timing of intervention. Patients with immunosuppression, malignancy or healthcare-associated infection may require broader antimicrobial coverage and a lower threshold for multidisciplinary escalation.

8. Tuberculous and unusual empyema

Not all empyemas are equivalent. Tuberculous empyema, post-pneumonectomy empyema, fungal infection, esophageal perforation and empyema associated with malignancy can require different strategies. In particular, a bronchopleural fistula or post-pneumonectomy space may require procedures beyond routine VATS drainage or decortication. The EACTS consensus notes that post-pneumonectomy empyema should be individualized and may require fenestration, irrigation, muscle-flap or thoracoplastic techniques depending on the anatomy and presence of a fistula[3]. Such cases should be managed in specialized centers

9. Research priorities

Future comparative studies should prospectively classify empyema stage using standardized radiological and operative criteria and record symptom duration, prior drainage, intrapleural therapy and antibiotic exposure. Randomized trials comparing an early VATS strategy with optimized medical management would be particularly informative, but ethical and recruitment challenges are substantial. Where randomized trials are not feasible, prospective multicenter registries can use propensity methods to reduce confounding. Core outcomes should include mortality, treatment failure, reintervention, length of stay, chest-tube duration, prolonged air leak, postoperative pain, quality of life, pulmonary function and cost.

10. Surgical quality, learning curve and team expertise

The learning curve is an important but underreported determinant of VATS performance. Early in a surgeon's experience, operative time may be longer and conversion thresholds may vary. With increasing experience, visualization, port placement, adhesiolysis and management of bleeding become more predictable. Institutional volume may also influence outcomes through anesthesia expertise, postoperative critical care, physiotherapy and rapid access to thoracic imaging. Publications comparing VATS and thoracotomy should therefore report surgeon experience and center volume whenever possible. Importantly, a higher conversion rate in a low-volume center does not necessarily indicate inferiority of VATS; it may identify the need for training, supervision or earlier referral.

11. Interpretation of comparative evidence

The literature should be interpreted with attention to the direction of selection bias. Patients undergoing open thoracotomy often have longer symptom duration, thicker pleural peel, more extensive adhesions or failure of previous drainage. Consequently, an observed excess of morbidity after thoracotomy may partly reflect the underlying severity of disease rather than the incision itself. Similarly, a successful VATS series from a specialist center may not be generalizable to all hospitals. The most defensible conclusion is therefore that VATS is the preferred access for appropriately selected surgical candidates, while open thoracotomy remains a necessary rescue and definitive option for complex organizing disease.[2,3,5]

Limitations

This manuscript has important limitations. First, the supplied source is a seven-page dissertation summary rather than the complete dissertation or a patient-level research dataset. It describes comparative findings and cites prior studies but does not provide the original cohort's sample size, inclusion/exclusion criteria, baseline characteristics, statistical methods, confidence intervals or complete outcome tables. Therefore, no institutional results have been fabricated or reconstructed. Second, the literature synthesis is narrative rather than a registered systematic review and does not claim PRISMA-level completeness. Third, the comparative evidence for VATS versus open thoracotomy is predominantly observational and susceptible to confounding by disease stage and patient selection[2,5].

Before submission as an original research article, the authors should insert the actual study population, study period, ethical approval number, inclusion/exclusion criteria, operative protocols, baseline characteristics, statistical analysis, original outcome data and exact institutional results. If the intended publication is a narrative review, the current manuscript can be adapted accordingly by changing the article type and expanding the search methodology.

Conclusion

Empyema requires timely, coordinated management in which antimicrobial therapy and effective pleural drainage remain foundational. In patients with residual loculated infection, combined intrapleural tPA-DNase is an evidence-supported option. When surgery is required, VATS should generally be considered the preferred initial surgical access for adults because it is associated with less postoperative pain, shorter hospitalization and fewer complications while maintaining high treatment success. Nevertheless, the operative technique must be dictated by the anatomy and stage of disease. Advanced organizing empyema, dense adhesions, difficult bleeding or incomplete lung expansion may require conversion to

open thoracotomy and formal decortication. The optimal strategy is therefore not VATS versus thoracotomy as mutually exclusive choices, but a patient-specific escalation pathway in which VATS is used whenever it can achieve adequate source control and thoracotomy is employed without delay when it is needed.

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