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# Advancements in Pleural Empyema Management: Navigating Current Trends and Innovations through Anatomy-Guided Approaches

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## A B S T R A C T

**Background:** Pleural empyema, marked by pus accumulation around the lungs, presents a formidable clinical challenge. Current trends emphasize anatomy-guided approaches, leveraging advanced imaging and minimally invasive techniques. This shift recognizes the significance of precise anatomical localization for tailored interventions, promising improved outcomes.

**Objective:** This study aimed to find out the anatomy-guided approaches for pleural empyema and Outcomes of Surgical versus non-surgical treatment of pleural empyema.

**Methodology:** The current retrospective cohort research was conducted at LRH on hospitalized patients with empyema who received treatment on a regular schedule between January 2021 and 2023. The present retrospective cohort analysis was conducted in a single location using anatomy-guided approaches by surgery (VATS & open thoracotomy decortication techniques) and non-surgical (medical & chest tubes drainage with or without fibrin lytic drugs) treatments related to thoracic surgery/General surgery and respiratory medicine wards. The statistical test instrument used was the independent t-test on demographic data.

**Results**: out of 130 patients, the cure rate was 27 % (n=35), while the death rate was 0.3% (n=1). A VATS decortication was performed on 13 out of 149 individuals who were judged to be in Stage II. The technique was turned into an open procedure when the findings revealed a 0% success rate with decortication after thoracotomy. Patients who had thoracotomy decortication got a cure rate of 96.4%, and there were two deaths out of the 113 patients. N=2 (1.8%) required an open window thoracostomy due to an untreated empyema, whereas four (3.5%) required thoracoplasty. The patients treated with tube thoracostomy and chest incision decortication had total hospitalization durations of $15.4 \pm 2.1$ and $6.2 \pm 1.8$ days ($P < 0.001$). Accordingly, 98.2% and 27.1% were the success rates for surgical and non-surgical therapies.

**Conclusion:** Thoracotomy decortication treatment is generally the first rank choice with more excellent success rates than non-surgical approaches because of the advanced stages of empyema in our patients. However, these days, most research reports on the efficaciousness of non-surgical and VATS care of empyema.

**Keywords:** Chest Diseases; Empyema; VATS

## Introduction

An accumulation of pus in the cavity between the lungs is called an empyema. Although it is frequently linked to pneumonia, it can also appear following thoracic trauma or surgery. Anatomic anomalies of the pleura are rare but can cause confusing radiological patterns. Accessory fissures are frequently encountered intraoperatively, but only two types are commonly encountered intraoper-atively. The inferior accessory fissure separates the right lower lobe's medial basal segment from other lower lobe basal segments. Such cracks occur in 40-50% of people, usually in incomplete forms, invaginating the lower lobe at its diaphragmatic aspect. Superior accessory fissures are present in up to 30% of patients. These variants' fissures are roughly horizontal and separate the superior segment of a lower lobe from the basal parts of that lobe. They mimic a horizontal crack on the chest radiograph. Every year, there are roughly thirty-two thousand incidents in the UK. In the first year following the development of empyema, 20% to 30% of patients may either pass away or require further surgery, which is linked to increased morbidity and mortality. Early intervention is essential to treat empyema effectively.[1,2] As with other diseases, initiating medications and promptly controlling sources is crucial for effective management. Empyema is commonly treated through a combination of medical and surgical interventions. For cases of community-acquired empyema, a variety of either 3rd or 4th-generation cephalosporins plus metronidazole or amoxicillin plus beta-lactamase inhibitors is recommended to provide sufficient coverage. In instances of hospital-acquired, trauma-related, or surgery-related empyema, it is essential to include vancomycin, cefepime, metronidazole, or piperacillin-tazobactam in the treatment regimen to address Pseudomonas and MRSA. Given the challenge of isolating anaerobes, continued coverage for this bacteria is advised, even if cultures show conflicting results.

Anaerobes are hard to isolate; hence, covering for this kind of bacteria should continue even in opposing cultures. Intrapleural antibiotics have not been shown to have any benefits. Antibiotics should be administered for two to six weeks based on the organism, source control, and patient response.[3,4] Three phases comprise the development of empyema: the exudative phase (stage 1), the fibrino-purulent stage (stage 2), and the organizing stage (stage 3). Antibiotics and drainage are the medical treatments for stages 1 and 2.[5] In essence, surgery is used to treat stage 3. The four primary surgical techniques frequently used to treat ET are rib surgical removal, window operation (Eloesser flap), thoracoplasty, and decortication. There are specific differences between the surgical treatment of empyema in developed and underdeveloped countries. Patients with bacterial aetiology who frequently appear for surgery early in stage 3 in industrialized countries can benefit from video-assisted thoracoscopic surgery (VATS), washout, and tube drainage.[6] Additionally, several doctors observed that VATS decortication at the third stage of empyema had excellent results and that the same findings were applied to open thoracotomy decortication. However, there is still debate whether VATS can sufficiently decorticate lung tissue at Stage III. Furthermore, empyema patients cured by VATS decortication were primarily changed to open thoracotomy decortication in cases of delayed referral.[7] On the other hand, thoracotomy decortication is the most effective treatment for the late stages of empyema when a thick peel forms.[8] Nevertheless, the results of the previous research could not be trusted to determine which course of action was best because each study focused on a particular treatment method without making any comparisons between surgical and non-surgical procedures. Numerous cohort studies on empyema have been conducted.[9] The current study aims to evaluate anatomy-guided approaches, both non-surgical (tube thoracostomy and antibiotics, with or without fibrinolytic drugs) and surgical (VATS, thoracotomy decortication) outcomes for treating empyema.

## Objective

This study aimed to find out the anatomy-guided approaches for pleural empyema and outcomes of Surgical versus non-surgical treatment of pleural empyema.

## Methodology

The current retrospective cohort research was conducted at LRH on hospitalized patients with empyema who received treatment on a regular schedule. Between January 2021 and December 2023, after getting permission from the ethical committee and the STROCSS, a recommendation for improving the reporting of cohort studies in operation was followed in this study.[10]

Empyema therapy utilizes clinical criteria based on three distinct phases following post-infectious pneumonia. In stage I, lasting 1-5 days, a dry or exudative state is observed and is managed non-surgically. Transitioning to Stage II, a fibrin purulent condition emerges within the first three weeks of infection, warranting surgical intervention through Video-Assisted Thoracoscopic Surgery (VATS) or open thoracotomy decortication. Stage III, known as the organizing stage, may manifest after three weeks and is characterized by developing a thick pleural peel. In cases of Stage I or VATS surgical failures, open thoracotomy decortication is employed as an intervention strategy throughout all stages of empyema therapy.[11]

Table 1. Outcomes of Surgical and Non-Surgical treatment of Empyema (N=149)

| Parameters | Non-surgical procedures N = 130 (%) | Surgical procedures N= 113 (%) | p-value |
|---|---|---|---|
| **Gender** | | | |
| Male | 70 (53.84) | 69 (61) | 0.25 |
| Females | 60 (46.16) | 44 (38.9) | 0.25 |
| Age (years) | 43.12 ± 6.2 | 35.20 ± 5.7 | 0.17 |
| Cure rate | 35 (27) | 109 (96.4) | < 0.001 |
| Postoperative air leak | 5 (3) | 49 (43) | < 0.001 |
| **Hospital admittance time in days** | | | |
| Success rate | 15.4 ± 2.1 | 6.2 ± 1.8 | < 0.001 |
| Live | 35 (27.1) | 111 (98.2) | |
| Decease | 1(0.3) | 2 (1.8) | |

There were both surgical and non-surgical therapy options. The latter therapies involved combinations of antibiotics, thoracentesis, instillation of fibrinolytic therapy with drainage, and toilet of the pleural cavity. In contrast, the former treatments included VATS decortication and mini-thoracotomy or normal thoracotomy decortication.[7] All patients with pleuritic chest discomfort, breathing difficulties, microbial pleural drainage, and septicemia, including empyema. Individuals that had VATS decortication and were changed into included open thoracotomies performed either during or following surgery. Patients for whom non-surgical therapies had failed were also included.

In a study involving 153 patients, acute and chronic empyema features were observed. Among them, 142 patients had post-pneumonic infections, eight had trauma sequelae, and three showed an extension of the inflammatory process from the neck and mediastinum. Non-surgical treatment was administered to 130 patients, while 113 underwent surgical intervention. The non-surgical group received medical management, with or without the use of fibrinolytic drugs. The selected surgical approach for the study was open thoracotomy decortication, and the surgical group was categorized into three subgroups. The first subgroup comprised six patients who underwent open thoracotomy decortication therapy. The second subgroup included 94 patients who remained uncured following non-surgical care. Lastly, the third subgroup consisted of 13 patients who received treatment through Video-Assisted Thoracoscopic Surgery (VATS). This classification allowed for a comprehensive examination of each subgroup's outcomes and efficacy associated with the chosen surgical interventions. All patients, including those undergoing surgery, received preoperative treatment, including chest physical therapy, flexible bronchoscopy, and antibiotics. Under general anaesthesia, the surgical cohort underwent conventional posterolateral thoracotomy, with the lung parenchyma sutured using nylon or PDS (3-0) sutures throughout the decortication process.

Using three to four 5 mm to 10 mm ports and a thoracoscopic dissector or scissors produced by Storz and an Olympus device, the VATS methodology was carried out at the expected Stage (II). Three thoracic surgeons performed the VATS decortication surgery, whereas five seasoned surgeons with academic degrees performed the open thoracotomy decorations treatment. After decortication, the lung's full extension was measured to document a successful course of therapy. After that, the malnourished and sepsis patients were sent to an intensive care unit (ICU) for a period of two to five days. After receiving antibiotics, patients were observed in the thoracic ward. The resolution and advancement of empyema, recurrences, mortality, failure or converted operations to open thoracotomy decortication, success and cure rates were the measures used to determine the results of the two surgeries. Both primary and secondary endpoints were incorporated into the outcome measurements. The initial management of empyema was successfully treated using two procedures as the primary

outcome. After a treatment failure or failure, a secondary endpoint was noted.

The data were extracted from patients' hospital medical records and scrutinized for frequency, indications, symptoms, treatment modalities, and outcomes. The results were presented in percentages (N%) and the standard deviation (SD) for data variability. Statistical significance was considered at p-values below 0.05. Continuous variables were assessed using the test of independence (T-test), whereas the Chi-square or Fisher exact test was employed to analyze categorical variables. The statistical tool SPSS 16, designed for social sciences, was utilized for the data analysis.

## Results

The surgery group of patients were treated through poster-lateral thoracotomy. The lung-ripping tissue was bound with polyamide throughout the decortication process through a thoracoscopic dissector (made by Olympus ). The VATS technique was carried out. Three lung surgeons performed the VATS decortication surgery, whereas five doctors performed the surgical open thoracotomy decortication. After that, the lung's full extension was measured to document a successful course of therapy, and after five days, the sepsis patients were sent to an intensive care unit (ICU) for antibiotic treatment and observed in the thoracic ward. The measures used to determine the results of the two surgeries were the resolution and advancement of empyema, instances of recurring death, failure or converted operations to open an abdominal incision decoration, effectiveness, and cure rates. The primary and secondary endpoints were incorporated into the results of the measurements. The initial management of empyema was successfully treated using two procedures as the primary outcome. After a treatment failure or disappointment, a secondary endpoint was noted. The information from the hospital medical records was gathered and examined for frequency, indications and symptoms, treatment modalities, and results. N (%) and the data's standard deviation (SD) were displayed. P-values less than 0.05 were regarded as statistically significant, and T-test was used to analyze continuous data. A Chi-square or Fisher exact test was used to analyze quantitative variables. SPSS 16, a statistical tool for social science, was utilized and treated with therapeutic decoration using VATS and considered in the fibrinopurulent stage.

When the VATS decortication surgery failed to treat the empyema and the thick peel developed, the patients who were actually in Stage III had to have a surgery known as decoration procedure under the same anaesthesia a few days later. Additionally, six of the 149 patients were in Stage III. They were slated for open thoracotomy debridement, which involves decorating the parietal and visceral pleura in addition to extensively debriding the PEEL. Thoracotomy decortication was utilized to treat 113 individuals (69 males and 44 females) with mean ages of 35.20 ± 5.7 years. Additionally, the phases of empyema and patient care are shown in Figure 1.

There were no appreciable variations between the two groups' ages and sexes statistically. The individual' ages varied between 6 to 78 years old. The cure rates for surgical and non-surgical treated patients were 35/130 and 109/113, respectively. Before the treatment procedures, all patients had chest radiography (100% of participants), CT (70.9%), and sonography (50.3%). The surgical complications and patient death rates were contrasted. Sepsis claimed the lives of one and two of the patients receiving non-surgical and surgical care, respectively. Only 3% of the non-surgical patients developed post-operative air leaks, compared to 49 (43.3%) of the thoracotomy decortication group. The average duration of air leakage for patients who did not get surgery was 9.1 ± 1.6 days, whereas for those who did, it was 4.3 ± 0.7 days. There were significant differences ($P < 0.001$) between the two groups in terms of delayed air leak (PAL) timings. Chest tube drainage was used to treat pneumothorax and post-operative air

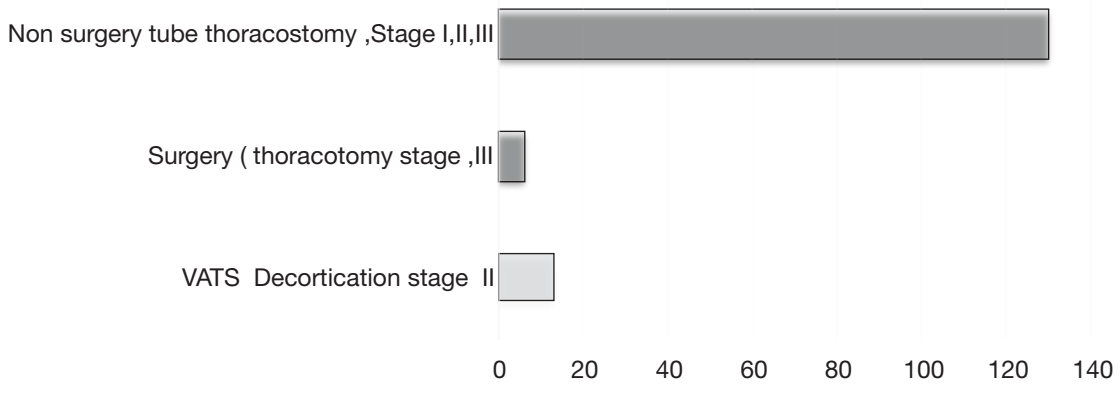


Figure 1. Displays the patients enrolled in the study and their allocated procedures

leakage in patients undergoing thoracotomy decortication.

Table 1 shows that the success rates for patients treated surgically and non-surgical were 98.1% (111 persons) and 27.1% (thirty-five participants), correspondingly ($P < 0.001$). In the end, four (3.5%) of the surgically treated group had any thoracoplasty operation. Two of them died, and the one with the formed lung and superficial abscess was treated with thoracoplasty, which closed on its own. Two patients had to have open window thoracostomies, which led to empyema necessities, which were incurable. Out of all the patients, only three needed a lobectomy or segmentectomy. Patients who did not get an operation had a more extended mean hospital stay ($15.4 \pm 2.1$ days compared to $6.2 \pm 1.8$ days) ($P < 0.001$). Adequate antibiotics given by IV were implemented in the therapy regimen over the whole hospital stay. When lung expansion was accomplished, and air leakage or drainage was not visible, the chest tubes were withdrawn during the post-operative period.

The choice of surgical methods, such as tube thoracotomy, VATS decoration, and thoracotomy decortication procedures, was made without bias, and the patients' follow-up periods ranged from two to eighteen months, with an average of 8 months.

## Discussion

After a diagnosis, the current study shows the anatomic variations of pleura and the prevalence of chronic and severe forms of empyema among poor socio-endemic areas. Thoracotomy decortication is hence often applied in the treatment of empyema. For the individuals who underwent VATS therapeutic decortication failure, either during or after the procedure, an open thoracotomy had to be performed. In the early phases of their illness, non-surgical methods were used to treat almost 1/4 of the patients. In the literature, the VATS was only used to diagnose pleural empyema in its early stages. Currently, thoracoscopic surgery for empyema is frequently applied to remove the locutions when medication has failed to resolve the condition after chest tube drainage and medicines. However, if full lung expansion or drainage is not accomplished following a failed thoracoscopic procedure, conversion to an open thoracotomy is unavoidable.[12, 13] Unfortunately, there is no clear way to discern between the organized empyema and the fibrin purulent stages regarding clinical symptoms, laboratory testing, and imaging data. As a result, choosing either VATS or open chest surgery decompression as the best course of therapy is still up for debate.[14] A previous study included thirteen research participants who had VATS decortication surgery at the third Stage. They reported that the likelihood of conversion to chest incision might rise from 22% to eighty-six between the twelfth and sixteenth day after the onset of clinical signs.[14] In another study non-surgical treatment was used treat several approximated stages of fibrin purulent, including stage I and Stage III. The enrolled 94 non-surgical treated patients needed to have decortication and a thoracotomy performed. In their study the empyema patients were treated thoracoscopically with VATS decortication, with a conversion rate to open thoracotomy of 61.6%.[15]

Another study shows that the rates of mortality as well as morbidity would be minimal if stage II empyema was initially treated with a VATS surgery.[16] The rate of occurrence of VATS decortication changed to open thoracotomy was 100% in the present research. Because the patients in this research had late stages of empyema, our study does not focus on the VATS method for therapy. Furthermore, a few literature findings suggest that VATS decortication may be less helpful in the early fibrinopurulent phases, although it is less beneficial in the fibrotic and organized stages.[17]

In contrary to our findings another study reported 38.1% conversion rate of VATS to open thoracotomy decortication.[18] Other studies support the findings obtained in this investigation when contrasting it with single-treatment studies. According to reports, open thoracotomy decortication was necessary for 39–58 present of patients despite primary empyema, with minimal rates of illness and mortality.[19] Despite this, the findings are contradictory, and as of now, there are no universally acknowledged primary modality or gold standard technique for managing the conditions studied.[20] The primary therapeutic approach for the exudative stage involves drainage. For early Stage II debridement, Video-Assisted Thoracoscopic Surgery (VATS) is a reliable, secure, and efficient technique.[21]

Furthermore, another study delved into the complexities of treating empyema thoracis, focusing on surgical interventions for patients in advanced disease stages with partial pus evacuation. Their results were similar to our study.[21] The European Association of Cardiothoracic Surgeons (EACTS) recommendation emphasizes a greater success rate of 68%–93% for VATS decortication during the initial phases (stages I and II) of empyema thoracic. It does, however, show certain limits in individuals whose illness history lasted more than five weeks and who were thought to be in Stage III.[12]

Furthermore, 96.4% of the patients had successful thoracotomy decortication surgery with low rates of mortality and morbidity, according to the study's data. Furthermore, all thirteen patients in the late stages who underwent VATS decortication surgery needed to switch to open thoracotomy decortication; this study supports the EACTS guidelines in this regard. Furthermore, 96.4% of the patients had successful thoracotomy decortication surgery with low rates of mortality and morbidity, according to the study's data. In comparison to non-surgical treated patients, a statistically significant decrease in complications was seen in a previous study.[22]

Despite the failure of the VATS decortication technique, the surgically treated patients in this research had better outcomes than the non-surgical treated individuals. Our study's results differ from those published in the literature since there were no fibrin lytic treatment problems in the pooled data. The study's most vital point is the effects of operative and non-surgical therapy of empyema therapy in poor socioeconomic areas. When evaluating the already presented findings, it is important to consider a few restrictions. Due to the study's single-centre design, little information is available, and potential biases may impact the selection criteria, further altering the findings. This study is subject to several potential limitations. Firstly, including only the surgeon's chosen procedure introduces a variable that may impact the generalizability of the findings.

Additionally, the absence of non-randomized clinical studies and the restriction to English-language papers could introduce selection bias. Another noteworthy limitation is the lack of diagnostic Video-Assisted Thoracoscopic Surgery (VATS) in the patient cohort, which may have influenced the precision of diagnostic evaluations. Further experimental validation studies are imperative to validate and extend our findings, particularly in low-socioeconomic areas, and extensive multi-centre studies with substantial sample sizes are warranted. These efforts would contribute to a more comprehensive understanding of the implications and applicability of the study's outcomes.

## Conclusion

In conclusion, Anatomy-Guided Thoracotomy-Decortication procedures emerge as a more pragmatic and successful approach, particularly in settings with higher prevalence and advanced stages of empyema in socioeconomically challenged regions. The existing body of research predominantly focuses on the success rates associated with medical treatments and Video-Assisted Thoracoscopic Surgery (VATS). However, the evidence suggests that the anatomical precision offered by Thoracotomy-Decortication procedures correlates with higher success rates, making it a promising avenue for effective intervention, especially in locations with limited resources and elevated prevalence of advanced empyema cases. Further comprehensive studies are needed to solidify these findings and optimize treatment strategies for diverse socio-endemic populations.

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