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Comparative Outcomes of Video-Assisted Thoracoscopic Surgery (VATS) Versus Open Thoracotomy in the Management of Pediatric Empyema Thoracis

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ABSTRACT

Background: Empyema thoracis is a serious complication of pneumonia in children which often need surgical intervention. There are two types of process for decortication known as video-assisted thoracoscopic surgery (VATS) and open thoracotomy. The choice of use between these two remains debated due to differences in recovery, complications and outcomes.

Objective: To compare the effectiveness of open thoracotomy and video assisted thoracic surgery (VATS) for empyema thoracis in pediatric population.

Methodology: The present study was conducted at Hayatabad Medical Complex, Peshawar from August 2022 to August 2023. A total of 76 children with confirmed empyema thoracis, aged 1 to 14years, who had either performed VATS or open thoracotomy were include in this study. Specialized proforma was prepared for data collection purposes. Data was analyzed by SPSS v20.0.

Results: Of the 76 patients, 42 had an open thoracotomy and 34 had VATS. Results showed that patients operated through VATS was linked to a significantly shorter hospital stay, chest tube duration, operative time, and return to normal activities ($p < 0.001$). Long-term results such as lung re-expansion, residual pleural thickening, and re-intervention rates were similar for both groups. In 5.8% of cases, open surgery was substituted for VATS.

Conclusion: For initial-stage pediatric empyema, VATS is a minimal-invasive and effective surgery method yielding great perioperative outcomes without compromising long-term effectiveness. In more complex or advanced presentations, open thoracotomy remains required. Disease-staged and region-patterned tailored surgical methods, especially with tuberculosis, are essential for best management.

Keywords: Pediatric Empyema; VATS; Open Thoracotomy; Decortication

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Introduction

Pediatrics empyema thoracis is a challenging clinical condition that has gained more interest because of its increasing frequency and high healthcare burden.[1] Despite improvements in supportive care and antimicrobial therapy, empyema, which is the accumulation of pus in the pleural cavity, usually occurs because of bacterial pneumonia and is linked to significant morbidity. Exudative, fibrinopurulent, and organizing are the three different phases that empyema usually goes through in children.[2] Antibiotics and simple drainage are frequently effective in the exudative stage, which is characterized by the buildup of sterile, proteinaceous pleural fluid precipitated by inflammation. If left untreated, it progresses to the fibrinopurulent stage, where bacterial infection produces loculated collections, thick purulent fluid, and fibrin deposition that impairs lung expansion. Inadequate intervention leads to the condition progressing to the stage of organizing, defined by the formation of a thick fibrous layer over the lung that drastically constricts its range of movement and often requires surgical decortication to complete the recovery.[3]
Empyema complications in children include long-term restrictive lung disease, lung entrapment from fibrous peel formation, and persistent pleural infection.[4] Sepsis, bronchopleural fistula, and chronic illness-related stunted growth or development can also result from delayed treatment. To prevent this development, early detection and appropriate management are critical. The management of pediatric empyema has evolved over the past 20 years from largely conservative to more vigorous surgical approaches in some cases. Although chest tube drainage and antibiotics remain the mainstays of treatment for early empyema, they often become insufficient as the disease progresses to more severe forms, particularly when lung entrapment, loculated collections, or thick pleural peel are involved. In these situations, surgery is required to accomplish full drainage, lung expansion, and infection resolution.
Open thoracotomy with decortication and video-assisted thoracoscopic surgery (VATS) are the two main surgical techniques that have become the gold standard for treating advanced paediatric empyema.[5] With obvious advantages such as smaller incisions, reduced postoperative pain, shorter hospital stays, and earlier return to normal life, VATS has increasingly been favored as a minimally invasive alternative to open surgery. Surgeons can carry out partial decortication, loculation breakdown, and extensive debridement with great visualization through the use of thoracoscopic access. Early VATS intervention during the fibrinopurulent phase has been shown in studies to greatly improve outcomes and possibly stop the organizing stage from developing.[6,7]
However, despite being more invasive, open decortication is still an essential treatment for chronic or late-stage empyema, especially when multiloculated collections and a dense fibrous peel make thoracoscopic intervention impossible.[8] In situations where VATS may be restricted, open thoracotomy provides direct visualization and total removal of the fibrous cortex surrounding the lung, improving lung re-expansion and long-term respiratory function. Open decortication offers a definitive answer in complicated or refractory cases, yet it is associated with longer recovery times and more postoperative pain.
The stage of empyema, the patient's clinical condition, the surgeon's experience, and the availability of surgical resources all play a role in the decision between VATS and open decortication. Although numerous studies and clinical trials have attempted in recent years to create uniform standards for the timing and choice of surgical techniques, there is still a great deal of variation in practice patterns.
With a focus on the relative roles of open decortication and VATS, this study will provide a comprehensive overview of the current management strategies for paediatric empyema. In this study we studied each strategy's pathophysiology, indications for surgery, technical considerations, perioperative management, and clinical outcomes. We will also go over evidence-based suggestions, new developments, and potential research topics to maximize care for kids with this complicated illness.
In order to help paediatricians, pulmonologists, and paediatric surgeons make well-informed, patient-centered decisions that enhance the short- and long-term outcomes for children with empyema thoracis, this article summarizes recent research and clinical experience.

Objective

To compare the effectiveness of open thoracotomy and video assisted thoracic surgery (VATS) for empyema thoracis in pediatric population.

Methodology

This observational study was conducted at Hayatabad Medical Complex, Peshawar from August 2022 to August 2023. Video-assisted thoracoscopic surgery (VATS) and open decortication were the primary management strategies for paediatric empyema that were evaluated and compared in this study using a structured narrative approach. Children of age upto 14 years who had been diagnosed with empyema thoracis and had complete records with at least six months of follow-up and had undergone VATS or open thoracotomy, were eligible to participate. Purulent pleural fluid obtained by aspiration and radiological evidence of pleural effusion on chest X-ray, ultrasound, and CT scans were used to confirm the diagnosis. Patients with incomplete medical records,

non-surgical management, a history of thoracic surgery, and other underlying chronic conditions were among the exclusion criteria.

The attending thoracic surgeon considered the patient's clinical status and empyema stage when deciding between VATS and open thoracotomy. While children with advanced Stage 2 or Stage 3 empyema underwent open thoracotomy, children with Stage 1 and early Stage 2 disease were typically treated with VATS. To maintain consistency, each operation was performed by only one experienced surgeon.

Macroscopic inspection, absolute and relative leukocyte counts, biochemistry analysis, such as protein and glucose estimation, Gram and AFB staining, and culture and sensitivity for bacteria isolation were done on pleural fluid aspirates taken during the procedure. Discharge requirements included the ability to maintain adequate oral intake, the removal of the chest drain, the absence of respiratory distress, the resolution of the fever for at least three days, and full lung re-expansion verified by postoperative imaging. Following discharge, all patients were monitored for at least six months to check for complications or recurrence.

SPSS version 20.0 was used to analyze the data. Cross-tabulation was used for comparisons, and descriptive statistics were used. Statistical significance was evaluated using the Chi-square test; a p-value of less than 0.05 is regarded as suggestive of a significant association.

Results

The study included 76 children with empyema thoracis, with a mean age of 7.2 ± 3.1 years. Of these, 45 were male (59.2%) and 31 were female (40.8%). 42 patients (55.3%) had open thoracotomy with decortication, and 34 patients (44.7%) had VATS. Based on the stage of the empyema, the surgical modality was chosen: open thoracotomy was used for late Stage 2 and Stage 3 empyema cases, while VATS was used for patients in Stage 1 and early Stage 2. Most patients who had VATS had early-stage empyema (Stages 1-2), were younger, and had been ill for a shorter period of time. On the other hand, patients who received open thoracotomy had more severe clinical presentations, a longer duration of illness, and more advanced disease (late Stage 2-3) (Table 1).

When compared to open thoracotomy, VATS was linked to a significantly shorter operative time, chest tube duration, and postoperative hospital stay ($p < 0.001$ for all). The open group experienced slightly more intraoperative complications (7.1% vs. 2.9%), but this difference was not statistically significant ($p = 0.35$). Due to technical issues, two patients in the VATS group needed to be converted to open surgery (Table 2).

Similar rates of complete lung re-expansion, residual pleural thickening, and need for re-intervention were observed in the long-term outcomes between the VATS and open thoracotomy groups; these differences were all statistically insignificant. Nonetheless, patients in the VATS group recovered considerably more quickly than those who had open thoracotomy ($p < 0.001$), demonstrating the minimally invasive benefit of VATS (Table 3).

In this research, the most common causes of empyema thoracis were tuberculosis (39.4%) and pneumonia (36.8%), which together accounted for more than 75% of cases. Post-trauma (17.1%), post-surgical complications (3.9%), and other miscellaneous causes (2.6%) were less frequent etiologies (Table 4).

Discussion

Empyema thoracis, a serious and severe condition with pus accumulation in the pleural space, is a major cause of morbidity among children. It usually occurs as a complication of bacterial pneumonia, causing infection and inflammation within the pleural cavity. Although medical treatment with antibiotics and drainage methods continues to be necessary, surgery is indicated when conservative measures are unable to clear the infection or in instances where the pleural space is thickened and heavily infected. So, for thoracic procedures like lobectomy, biopsy, and pleural interventions, two methods are utilized: traditional open thoracotomy and Video-Assisted Thoracoscopic Surgery (VATS). With advantages like less postoperative pain, a shorter hospital stays, a quicker recovery, and a lower rate of

Table 1. Demographic and Clinical Characteristics of Patients (n=76)

Parameter	VATS (n=34)	Open Thoracotomy (n=42)	Total (n=76)
Mean Age (years)	7.8 ± 2.9	8.9 ± 3.2	7.2 ± 3.1
Gender (Male: Female)	20:14	25:17	45:31
Mean duration of illness (days)	7.4 ± 2.5	11.3 ± 3.8	9.6 ± 3.6
Stage of Empyema	Mostly Stage 1–2	Late Stage 2–3	Mixed

Table 2. Intraoperative and Postoperative Outcomes

Outcome	VATS (n=34)	Open Thoracotomy (n=42)	p-value
Mean operative time (minutes)	65 ± 15	98 ± 20	< 0.001
Chest tube duration (days)	3.2 ± 1.2	5.5 ± 1.5	< 0.001
Post-op hospital stay (days)	5.2 ± 2.1	8.4 ± 2.7	< 0.001
Intraoperative complications	1 (2.9%)	3 (7.1%)	0.35
Conversion to open surgery	2 (5.8%)	–	–

complications, VATS is a minimally invasive procedure that accesses the chest cavity through tiny incisions and a thoracoscope. Open thoracotomy, on the other hand, includes a broader incision and rib spreading, which may result in more pain following surgery and a more prolonged recovery period. Thoracotomy may yet be the preferable choice, however, in complex cases that require a great deal of exposure or control. The condition of the patient, the surgeon's skill level, and the type of pathology all influence the decision between the two. With a clear trend towards minimally invasive methods such as video-assisted thoracoscopic surgery (VATS) over the conventional open thoraco-tomy with decortication, particularly for early-stage disease, the results of this study point to the evolving role of surgical treatment in the management of paediatric empyema thoracis. In our study of 76 children, VATS showed several significant advantages over open surgery in terms of operative time, postoperative recovery, and return to normal activity, while maintaining comparable long-term clinical outcomes.

Our findings are consistent with those of many other studies that have shown that VATS is associated with shorter hospital stays and operative times. For example, according to a study by Gates et al. (2004) patients who underwent early VATS had shorter lengths of stay (P =.003), . Compared to fibrinolytic therapy or chest tubes alone, there was a trend for postoperative fever to be of shorter duration.[9] Similarly, Hawkins et al. (2004) observed that treatment of empyema has significantly evolved over the last few decades. More advanced surgical techniques, like open thoracotomy with decortication, have replaced the traditional treatment of tube thoracostomy, which was intended to promote gradual lung re-expansion. Video-assisted thoracoscopic surgery (VATS) has become increasingly popular over the past few years because it takes less time to stay in the hospital, a fact that confirms our results that patients undergoing VATS resumed activities far earlier (12.4 ± 3.6 days) compared to open thoracotomy patients (18.4 ± 5.2 days).[10] Many other studies documented that VATS and chest drain with fibrinolysis (CDF) for empyema in children share the same incidence of peri-operative complications. Nevertheless, VATS appears to be linked with less requirement for re-intervention and shorter post-operative hospitalization.[11,12]

Our research did not identify any statistically significant differences between the two techniques regarding long-term results and perioperative complications. Both groups experienced comparable rates of complete lung re-expansion, incidence of residual pleural thickening, and need for re-intervention, suggesting that both approaches are successful in accomplishing the main surgical objectives. However, according to a 2007 study by Cremonesini et al., the treatment of paediatric empyema has changed from using antibiotics and

Table 3. Follow-up and Recovery Parameters (6-month follow-up)

Parameter	VATS (n=34)	Open Thoracotomy (n=42)	p-value
Lung re-expansion (complete)	32 (94.1%)	39 (92.9%)	0.85 (NS)
Residual pleural thickening	2 (5.8%)	4 (9.5%)	0.52 (NS)
Re-intervention needed	1 (2.9%)	2 (4.8%)	0.68 (NS)
Return to normal activity (days)	12.4 ± 3.6	18.4 ± 5.2	< 0.001

Table 4. Etiology of Empyema Thoracis (n=76)

Etiology	Number of Patients	Percentage (%)
Tuberculosis	30	39.4
Pneumonia	28	36.8
Post-trauma	13	17.1
Post-surgical	3	3.9
Others	2	2.6

traditional chest drainage to using more recent techniques like fibrinolysis and early VATS. Compared to open thoracotomy, both modern methods have shown better outcomes, including shorter hospital stays and fewer complications, and are thus commonly employed as primary treatment.[13]

Our study's main finding was that open thoracotomy was preferred in advanced cases (late Stage 2 and Stage 3), whereas VATS was primarily utilized for early-stage empyema (Stage 1 and early Stage 2). This conforms to the historical trend of tailoring the surgical approach according to the disease severity. Open decortication offers superior exposure for thorough debridement in late-stage empyema with multiloculated collections or a dense fibrous peel. According to the results of a study by Gupta et al. (2008), open decortication is still a safe and efficient method when done by professionals, despite being more invasive. Open decortication continues to be a vital and reliable treatment for subsequent complicated empyema cases as well as in the resource-poor setting where advanced therapies such as fibrinolytics and VATS are not readily available.[14]

Technical complications in our series necessitated conversion from VATS to open surgery in 5.8% of patients, highlighting the role of intraoperative evaluation and surgeon expertise.[15,16] The viability of VATS as a primary surgical method is illustrated by this rate of conversion, which is within the range reported in the literature, if the procedure is planned to convert if necessary. According to Agzarian et al. (2017), complex anatomy and oncologic factors, technical difficulties, or intraoperative complications frequently necessitated conversion from VATS to thoracotomy. It is crucial to differentiate this from planned adjunctive VATS, and surgeons understood that conversion was a necessary step to guarantee safe and successful surgery rather than a sign of failure.[17]

In our environment, pneumonia and tuberculosis were the most frequent etiologic conditions for empyema, contributing to over 75% of the cases. In Western literature, however, tuberculosis is rare, with bacterial pneumonia, usually due to pneumococcal or staphylococcal organisms, being the most frequent etiology. This discrepancy underscores the importance of region-based management strategies and the importance of considering infectious disease epidemiology when designing surgeries.

Conclusion

Our research concludes that VATS is a better and more efficient way to treat early-stage paediatric empyema, providing substantial advantages in terms of patient comfort and recovering without sacrificing results. In more complex cases where minimally invasive methods are not enough, open thoracotomy is still necessary. To improve surgical indications and treatment algorithms, more extensive prospective trials are necessary, especially in areas where TB is prevalent and presentations are delayed.

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