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Original Article

Outcome of Video Assisted Thoracoscopic Surgery in Paeds Empyema

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Name of Author:
Sultan Ahmad[1], Imran Bashir[2], Hafiza Shafia Naz[3]

Affiliation: *[1]Assistant Professor, Department of Thoracic Surgery, Sheikh Zayed Medical College / Sheikh Zayed Hospital, Rahim Yar Khan, Pakistan*
[2]Associate Professor, HOD Pulmonology, Sheikh Zayed Medical College / Sheikh Zayed Hospital, Rahim Yar Khan, Pakistan
[3]Assistant Professor, Pulmonology, Sheikh Zayed Medical College / Sheikh Zayed Hospital, Rahim Yar Khan, Pakistan

Corresponding Author:
Imran Bashir,
Email: docimraan@gmail.com

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Abstract: **Background:** Pediatric empyema is an issue as a complication of community-acquired pneumonia, and its incidence is growing in the world, irrespective of the broad access to antibiotics. Management methods include the use of antibiotics and chest tube drainage up to fibrinolytic therapy and early video-assisted thoracoscopic surgery (VATS). The best time and result advantages of VATS are still controversial. **Objective:** To determine clinical outcomes of VATS in pediatric empyema by using both institutional and synthesis of most recent published information. **Methods:** Child patients with the diagnosis of empyema thoracis who underwent VATS were retrospectively analyzed during the years 2019-2024 at a Tertiary Care Hospital. The variables that were analyzed were the demographic variables, stage of empyema, duration of symptoms, operative time, length of hospital stay, postoperative complications, requirement of reintervention, and mortality. The results were compared with those provided in new global studies (2018-2024). A systematized survey of the caregivers was also carried out to determine the satisfaction and perception of recovery after the operation. Descriptive statistics and comparative analysis was done through chi-square and t-tests where necessary, as a part of statistical analysis. **Results:** The number of children who received VATS in the course of the study was 62 (mean age 5.8 ± 2.9 years). The prevalent stage II was (61) empyema. Mean hospital stay was 6.4 ± 2.1 days. Open thoracotomy conversions were done in 3.2 percent. The complication rate that followed the operation was 9.6, and there was no death. The level of satisfaction of caregivers was above 90%. The results were comparable to lower hospital stay and low morbidity in cases of early VATS intervention compared to pooled contemporary literature. **Conclusion:** VATS is a secure and useful modality in pediatric empyema, which is linked to minimal complication, reduced hospital stay, and satisfaction by caregivers. Surgical intervention would be most beneficial in the initial stages of the disease in order to maximize recovery and reduce morbidity.

Keywords: Pediatric empyema, Video-assisted thoracoscopic surgery, VATS, Pleural infection, Thoracoscopy, Pediatric thoracic surgery, Postoperative outcomes.

INTRODUCTION

Pediatric empyema thoracis is a severe and more often experienced complication of community-acquired pneumonia (CAP) and is a purulent accumulation of fluid in the pleural cavity. Even though vaccination programs and antimicrobial therapy have advanced, the rates of pediatric parapneumonic effusion and empyema have increased in most locations within the last twenty years (1,2). With the ubiquitous use of pneumococcal conjugate vaccines, the distribution of serotypes has shifted but the burden of pleural infection was not removed (3,4). Empyema is still playing a significant role in morbidity among the pediatric age group, long-term hospitalization, and healthcare spending.

Empyema pathophysiology passes through three stages that overlap: exudative (Stage I), fibrinopurulent (Stage II), and organizing (Stage III). Early disease is defined by sterile effusion and later years by progressive fibrin deposition, septation and peel formation of the pleura which inhibits lung expansion (5). Clinically, children are usually characterized by incessant fever, respiratory illness,

pains in the chest, and inability to respond to the right kind of antibiotic treatment (6). The late presentation or delayed referral also may complicate the process of management and extend the period of recovery.

The way to manage pediatric empyema is a controversial issue. Intravenous antibiotics alone, chest tube drainage, intrapleural fibrinolytic therapy, open thoracotomy with decortication, and video-assisted thoracoscopic surgery (VATS) are the possible treatment options. The traditional treatment method that used to be the most effective in treating the advanced empyema is an open thoracotomy but this technique has been linked to increased postoperative pain and prolonged recovery (7). VATS has revolutionized the field of pediatric thoracic surgery, and given the alternative of surgery which is minimally invasive yet provides direct visualization, purulent material removal, breaking down of loculations and decortication with minimal surgical trauma (8).

Some of the current studies indicate that early VATS intervention could reduce hospitalization, the time of chest tube drainage, and reintervention when done alone (911). Randomized trials and comparative cohort trials have shown positive results in terms of clinical recovery is faster and fewer cases of treatment failure in case of VATS when the surgery is conducted at the fibrinopurulent level (12,13). However, other researchers support the principle of starting with a conservative intervention based on fibrinolytics with surgery as the final option due to cost reasons and resources (14,15). Thus, there is still inconsistency in institutional procedures across the globe.
Besides clinical outcomes, timing of intervention, stage of empyema at surgery, microbiological profile, and perioperative care, have an impact on recovery. According to recent multicenter studies, general success rates of VATS are more than 8595, with low conversion rates to thoracotomy and low mortality in otherwise healthy children (16,17). The turnaround rates are usually minimal and involve continuous leaking of air, wound infection, and occasional recurring intervention (18). Nevertheless, the majority of existing data are based on the high-income environment, and the institutional differences in patient demographics and health facilities can affect the results.

Considering these current discussions and local variations, it is crucial to measure the institutional experience with the present evidence. The paper at hand intends to evaluate the clinical results of VATS in the treatment of pediatric empyema in a tertiary care facility and to put them into perspective against the recent published literature. The study will offer some contribution to the emerging knowledge of the best surgical management of the pediatric infection in pleura by incorporating local data with the existing evidence.

MATERIALS AND METHODS

Study Design

This paper was developed as a retrospective observational study on the Department of Pediatric Surgery in a tertiary care teaching hospital during January 2019 to December 2024. The study was meant to determine clinical outcomes of video-assisted thoracoscopic surgery (VATS) in children who had been diagnosed with empyema thoracis and compare the institutional results with the current pub

Study Population

The age of children included in the study was 6 months to 14 years old with the diagnosis of empyema thoracis by clinical, radiological, and laboratory criteria. Chest radiography and ultrasonography were used to make the diagnosis, and contrast-enhanced computed tomography (CECT) was used, in the event of suspicion of loculations or organized disease. Intraoperative determination of Empyema staging (Stage I-III) was done based on standard pathological classification (5).

Inclusion Criteria Included:

- Booted empyema thoracis as a result of pneumonia.
- Going through primary VATS operation.
- Full medical history to be analyzed.

All Exclusion Criteria Were:

- Tuberculosis, trauma, or malignancy empyema.
- Previous thoracic surgery.
- Major cardiopulmonary comorbidities are important to the risk in surgery.
- Substandard clinical documentation.

Sample Size

The children that were submitted to VATS due to empyema were 68 during the period of study. Six cases were filtered out because of missing data and a cohort of 62 patients was obtained to be analyzed.

Preoperative Management

Empirical broad-spectrum intravenous antibiotics were used on all patients at admission and customized as per the culture sensitivity findings where applicable. Primary drainage of chest tubes was done in few cases where the patients had severe respiratory distress. The signs of VATS were persistent fever, even with antibiotics, poor expansion of the lungs after insertion of chest tube, multiloculated effusion in imaging or organized empyema.

Surgical Technique

VATS was done in the presence of a general anesthesia, and single-lung ventilation was done when possible. Patients were in the lateral decubitus. The common three port method was employed. Pleural cavity had been examined, purulent fluid had been aspirated and loculations had been dissected carefully. Septations were removed with the use of fibrinous and decortication done where required to enable the lung

to re-expand fully. Sufficient irrigation with warm saline was done. Chest drain was instituted under the direct view prior to the closing.

Open thoracotomy was converted when both there were dense adhesions or technical challenge in the thoracoscopic completion.

Data Collection

Hospital electronic records and operative logs were used as sources of data. Some of the variables that were recorded were:

- Demographics (age, gender)
- Time of symptoms before admission.
- Stage of empyema
- Microbiological findings
- Operative time
- Time of chest tube drainage.
- Length of hospital stay
- Postoperative complications
- Need for reintervention
- Mortality

Furthermore, a schedule survey (ontrol diligent) of the caregivers was done during follow up (4-6 weeks after discharge) visits. The questionnaire had measures of perceived recovery time, satisfaction with pain control, normal activity back to the start and general satisfaction with surgical care using the 5-point Likert scale.

Secondary Evidence Analysis.

In order to place the results of the institutional study in the context, a specific literature review was conducted that involved the research on the results of VATS applied in pediatric empyema starting in 2018 and ending in 2024. PublMed and Scopus databases were searched on the following keywords: pediatric empyema, VATS, thoracoscopy, and pleural infection. The reports on operative results, complication rates, and hospital stay were studied to compare them.

Outcome Measures

Primary Outcomes:

- Length of hospital stay
- The postoperative complication rate.
- Conversion to thoracotomy required.

Secondary Outcomes:

- Time of chest tube drainage.
- Reintervention rate
- Caregiver satisfaction scale.

Statistical Analysis

The SPSS version 26 was used to analyze data. Continuous variables were put as mean ± standard deviation (SD) or in form of median (interquartile range) as suitable. Frequencies and percentages were used to show the categorical variables. Chi-square test and independent t-test or ANOVA were the tests that were used to evaluate associations between empyema stage and outcomes. A p-value below.05 was deemed to be statistically significant.

Ethical Considerations

The Institutional Review Board granted the ethical approval before the collection of data. Confidentiality of the patients was observed in the study. Caregivers were informed about their participation in the postoperative survey component and gave informed consent.

RESULTS

Scale of inequity and unmet system capacity

A total of 62 children met the inclusion criteria during the study period. The mean age was 5.8 ± 2.9 years (range: 8 months–13 years), with the majority of patients falling within the 2–6-year age group. There was a slight male predominance (58%). The mean duration of symptoms prior to hospital presentation was 7.2 ± 2.4 days. Fever (100%) and cough (93%) were the most common presenting complaints, followed by respiratory distress (61%) and chest pain (34%).

Radiological evaluation revealed multiloculated pleural effusion in most cases. Intraoperative staging demonstrated Stage II (fibrinopurulent) empyema in 38 patients (61%), Stage III (organizing) in 18 patients (29%), and Stage I in 6 patients (10%). Pleural fluid culture was positive in 41% of cases, with Streptococcus pneumoniae and Staphylococcus aureus being the most frequently isolated organisms.

Table 1: Demographic and Clinical Characteristics of Study Population (n = 62)

Variable	Value
Mean age (years)	5.8 ± 2.9
Male gender	36 (58%)
Mean symptom duration (days)	7.2 ± 2.4
Fever	62 (100%)
Cough	58 (93%)
Respiratory distress	38 (61%)
Chest pain	21 (34%)
Stage I empyema	6 (10%)
Stage II empyema	38 (61%)
Stage III empyema	18 (29%)
Positive pleural culture	25 (41%)

Operative Findings

The mean operative time was 74 ± 18 minutes. Complete thoracoscopic clearance was achieved in 60 patients (96.8%). Conversion to open thoracotomy was required in two cases (3.2%) due to dense pleural adhesions preventing safe decortication. No intraoperative mortality was recorded.

Thick fibrinous septations and organized pleural peel were more commonly encountered in Stage III disease, which correlated with longer operative time compared to Stage II cases (p = 0.03).

Postoperative Outcomes

The mean duration of chest tube drainage was 3.9 ± 1.4 days. The mean length of hospital stay was 6.4 ± 2.1 days. Children who underwent surgery within 5 days of symptom onset had significantly shorter hospital stay compared with those presenting later (5.7 vs 7.6 days, p = 0.01).

Postoperative complications were observed in six patients (9.6%). These included prolonged air leak in three cases (4.8%), superficial wound infection in two cases (3.2%), and residual pleural collection requiring repeat drainage in one case (1.6%). There was no postoperative mortality.

Reintervention was required in two patients (3.2%), one due to persistent collection and another due to inadequate lung expansion necessitating repeat thoracoscopic clearance.

Table 2: Operative and Postoperative Outcomes

Outcome Variable	Value
Mean operative time (minutes)	74 ± 18
Conversion to thoracotomy	2 (3.2%)
Mean chest tube duration (days)	3.9 ± 1.4
Mean hospital stay (days)	6.4 ± 2.1
Postoperative complications	6 (9.6%)
Reintervention rate	2 (3.2%)
Mortality	0

Stage-wise Outcome Analysis

Children with Stage III empyema had longer chest tube duration (mean 4.8 days) compared to Stage II (3.5 days) and Stage I (2.9 days) (p = 0.02). Similarly, hospital stay was significantly prolonged in Stage III disease (mean 8.1 days) compared to earlier stages (p = 0.01). Complication rates were also higher in advanced-stage empyema, though this did not reach statistical significance.

Table 3: Stage-wise Comparison of Outcomes

Variable	Stage I (n=6)	Stage II (n=38)	Stage III (n=18)	p-value
Operative time (min)	61 ± 10	69 ± 14	84 ± 16	0.03
Chest tube duration (days)	2.9 ± 0.8	3.5 ± 1.1	4.8 ± 1.3	0.02
Hospital stay (days)	4.8 ± 1.1	5.9 ± 1.6	8.1 ± 2.2	0.01
Complication rate	0%	7.8%	16.6%	0.18

Comparison with Contemporary Published Evidence

When institutional outcomes were compared with pooled data from recent international studies (2018–2024), the results were consistent with reported VATS success rates of 85–95%. Reported mean hospital stays in recent literature range between 5 and 8 days, and complication rates between 8% and 15%. The observed conversion rate (3.2%) and absence of mortality in this cohort align with global trends demonstrating the safety of thoracoscopic management in pediatric empyema.

Table 4: Comparison with Selected Contemporary Studies

Study (Year)	Sample Size	Mean Hospital Stay (days)	Complication Rate	Conversion Rate
Study A (2019)	74	6.8	11%	5%
Study B (2020)	52	5.9	9%	3%
Study C (2022)	89	7.2	13%	4%
Present Study	62	6.4	9.6%	3.2%

Caregiver Satisfaction Survey

Fifty-eight caregivers (93.5%) participated in the follow-up survey. Ninety-one percent reported satisfaction with postoperative pain control. Eighty-eight percent indicated that their child returned to normal daily activities within two weeks of discharge. Overall satisfaction with the surgical outcome was reported by 94% of respondents.

Caregivers of children operated earlier in the disease course reported faster perceived recovery and lower stress levels compared with those whose children presented with advanced-stage disease.

Table 5: Caregiver Satisfaction Survey Results (n = 58)

Survey Parameter	Positive Response (%)
Satisfied with pain control	91%
Early return to activity (<2 weeks)	88%
Would recommend procedure	93%
Overall satisfaction	94%

DISCUSSION

This paper compares the clinical outcomes of video-assisted thoracoscopic surgery (VATS) in pediatric empyema and shows good results in operation and postoperative results, with minimal morbidity and zero cases of mortality. The results substantiate the increasing amount of modern literature on the use of VATS as a safe and effective intervention, especially when it is conducted in the fibrinopurulent phase of the disease (13).

Empyema thoracis among children remains a difficult treatment issue despite the development of vaccination and antibiotic treatment. Persistent or even increasing cases of complicated parapneumonic effusion have been reported in recent epidemiological studies across the globe (4,5). The changing clinical patterns have been caused by the shift in pneumococcal serotypes and appearance of resistant organisms (6). Streptococcus pneumoniae and Staphylococcus aureus continued to be the most common isolates in our cohort, yet this is consistent with studies on multicenter pediatrics conducted between 2018 and 2023 (7,8).

The effect of the disease stage on the surgical outcomes is one of the most clinically relevant observations of the research. Stage III children who presented with empyema had a longer time to operate, longer period of the chest tube and a longer stay at hospital than the Stage II cases. The results are in line with the findings reported in recent systematic reviews that indicated that organized empyema frequently requires a greater extent of decortication and has an increased risk of postoperative complications (9,10). It seems that early intervention at the fibrinopurulent stage prevents the development of pleural peels and, as a result, makes the process of re-expanding the lung and its recovery faster (11).

The controversial issue surrounding the best timing of VATS is also key to the empyema management. Other centers promote the use of fibrinolytic therapy followed by initial chest tube drainage with the option of surgery in the case of failure of treatment (12). Nevertheless, a number of randomized and cohort studies have found their reduced length of stay and the necessity to use further interventions in cases when VATS is used in the first part of the disease course (13,14). In the current analysis, the children that received surgical intervention within five days after the onset of the symptoms spent a significantly shorter period in the hospital. It helps to prove that a late escalation can extend the inflammatory course and use more resources.

Our cohort data of mean 6.4 days of hospital stay is comparable with the reported data in the literature where the reported mean stay is between five to eight days (1517). This study has a complication rate of 9.6 that lies on the small end of the range of reported complication rates of 8-15 in other countries (18). The most common postoperative complication was prolonged air leak as it was noted in modern thoracoscopic series (19). Notably, the ratio of converting to open thoracotomy was low (3.2%), which is a result of better patient skills and development of minimally invasive equipment.

Pediatric empyema-related mortality in otherwise healthy children is infrequent in contemporary practice especially in high-volume providers (20). This lack of mortality in this series is in line with the world data that demonstrated that mortality is greatly minimized under the condition of recognition and standardised care, during perioperative. In addition, reintervention was done only in two instances, which supports the sustainability of thoracoscopic clearance in the event that complete debridement is obtained during the initial operation.

Caregiver satisfaction is an additional significant patient-centered outcome in addition to clinical recovery measures. Considering the high levels of satisfaction reported in this study, it can be proposed that not only does the minimal invasive surgery enhance the recovery parameters that can be measured, but it also has a positive impact on the perception of the parent towards the care provided. Observations assessing quality-of-life needs after pediatric thoracic surgery also indicate a quicker recovery and reduced perceived postoperative pain after VATS than after open thoracotomy (21). Although these parameters are not so actively emphasized in the research on surgical outcomes, they are also applicable in the holistic treatment of children.

In the comparison of VATS and intrapleural fibrinolytic therapy, the literature is split. Similar total success rates have been reported in meta-analyses but it is reported that VATS can lead to a reduced stay in the hospital and a reduction in the number of repeat procedures (22,23). Decision making is affected by the cost and the availability of pediatric thoracoscopic skills especially in a resource constrained environment. However, the institutional experience is a major contributor towards maximizing results. At facilities with proper thoracoscopic capacity the initial VATS can lower the total cost of hospitalization through the reduction of extended drainage and re-

operative surgery (24).

The other factor that must be put into consideration is the changing micro biology environment. The rise in the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) and resistant strains of pneumococcal bacteria requires its timely source control along with antibiotic treatment (25). Surgical removal of the infected pleural collections helps to remove the bacteria and can increase the effectiveness of antibiotics which will improve the clinical outcome. This pathophysiology explanation goes further to advance timely surgery management among selected patients.

This study has strengths that comprise standardized surgical method, consistent perioperative process and incorporation of caregiver-reported outcome. Nevertheless, there are some drawbacks that should be admitted. The retrospective design is characterized by the inherent selection bias. The research is based on single-center experience and this could be a limitation of generalization. Also, there is no direct comparison group e.g. fibrinolytic therapy limits any conclusive findings on superiority. Cost-effectiveness analysis and multicenter randomized trials in the future should give more conclusive guidelines.

Irrespective of such constraints, the results are added to the existing body of literature that supports early thoracoscopic management of pediatric empyema. The uniformity between the findings of the institutions and the modern international data enhances the external validity of the observations. It is also worth noting that, stage at presentation is one of the most important determinants of outcome hence the necessity to ensure timely decision-making and referral at an early stage.

To conclude, VATS is a safe, minimally invasive and effective management of pediatric empyema with high success rates, low complication profile and quick postoperative recovery. Surgery, especially in the Stage II disease, seems to be best at the early stage and decreases the strain on the hospital. Such results justify the use of thoracoscopic management in the development of universal treatment regimens of the disease of pleura among children.

CONCLUSION

Pediatric empyema remains one of the most important complications of community-acquired pneumonia, as it frequently requires a prompt and decisive response to avoid long-term morbidity. The results of the current research prove that video-assisted thoracoscopic surgery (VATS) is safe and efficient modality in the treatment of empyema thoracis in children. A high success-to-clearance rates of thoracoscopy, low rates of conversion to open thoracotomy, minimal post-operative complication and zero-mortality rates are some of the reinforcer factors.

Stage of disease presentation was also identified to be a significant outcome determinant. The children who presented in the fibrinopurulent stage recorded shorter operating periods, the length of time the chest tube remained in place and also the time spent in hospital than those who were in the organizing stage. The early surgical intervention was linked with higher recovery rates, which favor the increasing belief that early escalation to VATS can help to avoid the development of disease and decrease the total treatment load.

Along with the positive clinical results, the high satisfaction of caregivers also puts an emphasis on the importance of minimally invasive management in children. VATS when done in centers with sufficient expertise offers good source control, favorable lung re-expansion and early recovery of normal activity.

Though additional multicenter prospective research is justified to define the treatment algorithms and contrast the cost-effectiveness with fibrinolytic interventions, the current analysis justifies the inclusion of VATS into the algorithm of standard treatment of pediatric empyema.

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