COMPARISON OF LUNG EXPANSION AFTER UNIPORTAL AND MULTIPORTAL VIDEO ASSISTED THORACIC SURGERY FOR STAGE II POST-PNEUMONIC BACTERIAL EMPYEMA THORACIS

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ABSTRACT

Background: Empyema is a condition that thoracic surgeons encounter in daily practice. Traditionally, the surgical approach was open thoracotomy; then the multiportal VATS approach became more common. Recently, more surgeons are adopting the uniportal VATS approach, which has become a powerful surgical tool for managing stage II empyema.
Objectives: To evacuate the pus and fibrin deposits in the thoracic cavity for complete lung expansion.
Methods: This parallel-armed randomized controlled trial included 160 patients admitted to the Department of Thoracic Surgery, Services Hospital, Lahore, Pakistan. Patients were randomized equally into two groups: Group A underwent uniportal VATS, and Group B underwent multiportal VATS. Consecutive sampling was used. Lung expansion was assessed by chest radiographs on postoperative days 1, 3, 7, and 15. Operative time, intraoperative blood loss, postoperative pain using the visual analogue scale, and lung re-expansion rates were compared.
Results: Mean patient age was 35.73 ± 10.67 years (range: 20–73). Operative time was shorter in the uniportal group than the multiportal group (211.08 ± 12.92 vs. 226.94 ± 9.75 minutes). Mean blood loss was significantly lower in Group A (47.73 ± 11.11 ml) compared with Group B (97.49 ± 15.67 ml). Lung re-expansion was achieved in 95% of patients in the uniportal group and 93.75% in the multiportal group. Postoperative pain scores were lower in the uniportal group at all assessed time points.
Conclusion: Both uniportal and multiportal VATS are safe and effective for stage II empyema. Uniportal VATS achieves comparable outcomes with reduced surgical trauma and less postoperative pain in selected patients, without increased complications observed

Keywords: Empyema, Pleural, Thoracic Surgery, Video-Assisted, Thoracoscopy, Minimally Invasive Surgical Procedures, Pleural Diseases

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INTRODUCTION

Empyema thoracis, the collection of purulent fluid in the pleural cavity, commonly forms as a complication of pneumonia, although it may also occur secondary to tuberculosis (TB), post-traumatic injuries, surgical interventions, or abdominal infections [1, 2]. Approximately 50% of pneumonia patients develop pleural effusion, with 5–10% progressing to empyema despite antibiotic therapy [3]. Clinically, empyema presents with fever, chills, cough, dyspnea, and chest pain [4].

Empyema is categorized into three stages: the exudative phase (due to pleural permeability), the fibrinopurulent phase (characterized by fibrin deposition and loculations), and the organizing phase (marked by fibrous thickening and lung entrapment).[1] Treatment varies with disease stage and includes medical management, thoracentesis, tube thoracostomy, intrapleural fibrinolytics, video-assisted thoracic surgery (VATS), and thoracotomy with decortication.[5] While stage I often responds to conservative management, stages II and III typically require surgical intervention due to the presence of fibrin peel impeding lung re-expansion. Decortication remains essential in such cases to release the trapped lung and facilitate functional recovery [6, 29, 30].

Historically, open thoracotomy was the standard approach, but it is associated with greater morbidity and postoperative pain [1]. The advent of VATS in 1992 by Roviaro revolutionized thoracic surgery, offering comparable outcomes with significantly reduced invasiveness.[7] VATS, now a preferred option for early-stage empyema, is associated with faster recovery and reduced postoperative discomfort [8]. The technique has evolved from multiportal (three to four ports) to uniportal VATS, involving a single incision and offering enhanced cosmesis and potentially better postoperative outcomes. [9]

Recent studies comparing uniportal and multiportal VATS have demonstrated similar safety and efficacy profiles, with no significant differences in complications, mortality, or hospital stay between the two approaches.[9] Studies reported that, while operative variables were comparable, uniportal VATS was associated with reduced pain, earlier chest tube removal, and shorter hospital stays.[10,29,30]. Similarly, it is observed that uniportal VATS had advantages in terms of shorter operative time, less blood loss, and lower post-surgical pain scores.[11].

Ismail et al. demonstrated the feasibility of uniportal VATS in managing stage II and III empyema, reporting favorable long-term outcomes with minimal complications.[12] Bongiolatti et al. supported the use of uniportal VATS, highlighting its advantages in reducing blood loss, tube thoracostomy span, hospital stay, and complication rates compared to open decortication.[13]

Despite global evidence supporting the efficacy of uniportal VATS, there is a lack of local data on its use for empyema management in Pakistan. Therefore, the present study was conducted at Services Hospital, Lahore, to compare postoperative lung expansion outcomes between uniportal and multiportal VATS in patients with stage II empyema.

While both uniportal and multiportal VATS are used for managing stage II empyema, their comparative efficacy in achieving optimal postoperative lung expansion remains uncertain. This study aims to evaluate and compare lung expansion outcomes following these two approaches to guide surgical decision-making.

METHODS

This study was a parallel-arm randomized controlled trial comparing the effectiveness of uniportal versus multiportal video-assisted thoracic surgery (VATS) in achieving postoperative lung expansion in patients with stage II empyema. A total of 160 patients were enrolled. The sample size was calculated based on lung re-expansion rates, assuming 95% in the uniportal group and 85% in the multiportal group, with $\alpha = 0.05$ and power of 80%. This yielded 72 patients per group, and 80 per group were recruited to account for potential dropouts. The trial was retrospectively registered at ClinicalTrials.gov (NCT07137507).

Study Setting and Duration:

The study was conducted in the Department of Thoracic Surgery, Services Hospital, Lahore, Pakistan, from April 2023 to March 2025.

Sampling and Randomization:

Patients were selected using non-probability purposive sampling based on inclusion and exclusion criteria. Eligible participants were randomly allocated to Group A (uniportal VATS) or Group B (multiportal VATS) in a 1:1 ratio using a computer-generated random number table. Allocation concealment was maintained with sealed opaque envelopes prepared by an independent staff member not involved in recruitment or data collection.

Inclusion Criteria:

- Patients with stage II empyema
- Any age Patients deemed fit for intervention.
- Both genders
- Unintubated patients

Exclusion criteria:

- Patients with stages I and III empyema
- Patient with TB empyema
- Patient with Fungal empyema
- Patients unfit for general anesthesia.
- Unwilling to participate
- A pre-tested proforma was used to collect data on demographics (age, gender), clinical characteristics (comorbidities, empyema stage), intraoperative variables (operative time, blood loss), and postoperative outcomes (lung expansion on days 1, 3, 7, 15; chest tube duration; postoperative pain scores; complications). Radiologists assessing lung expansion were blinded to the surgical approach.

Statistical Analysis:

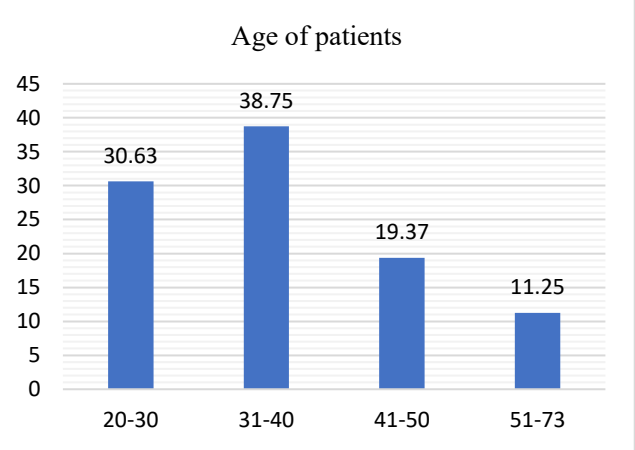
Data were analyzed using SPSS v27. Continuous variables were presented as mean ± standard deviation

(SD) and compared using independent t-tests. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test to assess associations. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 160 patients met the inclusion criteria, with 80 treated using uniportal VATS (Group A) and 80 managed with multiportal VATS (Group B). Among these patients, 30.63% were aged 20–30 years, 38.75% were 31–40 years, 19.37% were 41–50 years, and 11.25% were 51–73 years. Patient age ranged from 20 to 73 years, with a mean age of 35.73 ± 10.67 years

Figure 1: Distribution of age in both groups.



The mean age in Group A was 35.44 ± 10.06 years, while in Group B it was 36.02 ± 11.33 years. In terms of gender distribution, Group A included 62 males (77.5%) and 18 females (22.5%), whereas Group B comprised 61 males (76.25%) and 19 females (23.75%) (Table 1).

Table 1: Distribution of gender in group-A and group-B.

Gender	Group-A	Group-B	
Male	62 (77.5%)	61 (76.25%)	
Female	18 (22.5%)	19 (23.75%)	0.500
Total	80	80	

The mean operative time for Group A was 211.08 ± 12.92 minutes, compared to 226.94 ± 9.75 minutes in Group B (Table 4.4). Chi-square analysis indicated that this difference was not statistically significant (p = 0.100).

Table 2: Operation time (min) between group-A and group-B.

Groups	Mean ± SD	p-value
Group-A	211.08 ± 12.92	0.100
Group-B	226.94 ± 9.75	

The average intraoperative blood loss was 47.73 ± 11.11 ml in Group A and 97.49 ± 15.67 ml in Group B (Table 4.5). Chi-square analysis showed that the difference between the two groups was not statistically significant (p = 0.105).

Table 3: Comparison of blood loss (ml) between group-A and group-B.

Groups	Mean ± SD	p-value
Group-A	47.73 ± 11.11	0.105
Group-B	97.49 ± 15.67	

With regards to lung expansion, in group A 76 out of 80 patients showed Re-expansion of the lung, while 04 patients showed incomplete lung expansion, while in group B, 75 patients showed complete lung expansion, while 05 patients showed incomplete expansion of the lung (Table 4.6). The Chi Square test revealed that the difference between group A and group B (p = 0.749) was not significant. The success proportion of both groups showed Group A: 76/80 = 95% success rate and Group B: 75/80 = 93.75% success rate.

Table 4: Comparison of Re-expansion of the lung between group A and group B.

Groups	No	Yes	p-value
Group-A	04	76	0.749
Group-B	05	75	

The clinical improvement in pain, assessed on a 0–10 scale, showed that Group A had a mean preoperative pain score of 8.83 ± 0.84. This decreased to 3.48 ± 0.75 on postoperative Day 1, 2.63 ± 0.40 on Day 3, and 2.22 ± 0.53 by Day 7. In comparison, Group B reported a preoperative mean pain score of 8.95 ± 0.81, which reduced to 3.95 ± 0.87 on Day 1, 3.05 ± 0.81 on Day 3, and 2.53 ± 0.67 on Day 7. According to the Chi-square test, the difference in pain reduction between the two groups was not statistically significant.

Table 5: Outcome as pain in group A and group B.

Pain	Group-A	Group-B	p-value
Preoperative	8.83 ± 0.84	8.95 ± 0.81	0..339
1st Day	3.48 ± 0.75	3.95 ± 0.87	0.428
3rd Day	2.63 ± 0.4	3.05 ± 0.81	0.389
7th Day	2.22 ± 0.53	2.53 ± 0.67	0.258

Regarding postoperative complications, Group A experienced 12 cases, while Group B had 16 cases. In Group A, postoperative air leak occurred in 3.75% of patients and pneumonia in 6.25%. Subcutaneous emphysema after chest tube removal (1.25%) and re-empyema formation (3.75%) were also observed. In Group B, postoperative air leak and pneumonia were each reported in 7.5% of patients, while subcutaneous emphysema and re-empyema formation following chest tube removal occurred in 2.5% of cases each. According to the chi-square analysis, there was no statistically significant difference in complication rates between the two groups.

DISCUSSION

Treatment of pleural empyema aims to restore lung function, prevent chronicity, and control infection. In stage

I empyema, failure of chest tube drainage with persistent infection warrants surgery. However, preoperative staging is often difficult, complicating surgical timing.[14] Thoracotomy was historically standard, but VATS emerged as a less invasive alternative. Initially, complex pleural spaces were considered unsuitable for VATS.[15, 16, 17, 18] With growing experience, multiportal VATS proved as effective as thoracotomy, even in inflamed spaces.

The European Academy of Cardiothoracic Surgery now recommends multiportal VATS as first-line, though conversions and technical challenges, especially in organized empyema (>5 weeks), are anticipated .[19] In our study, multiportal and uniportal VATS for stage II empyema were feasible, with complication rates of 15% and 20% respectively, similar to previous reports.[20, 21] Only four cases required conversion to thoracotomy, showing most empyemas are manageable via minimally invasive techniques.

Table 6: Complications between group A and group B.

Complications	Group-A		Group-B		p-value
	Patients	%	Patients	%	
Prolonged air leak	3	3.75%	6	7.5%	0.757
Pneumonia	5	6.25%	6	7.5%	0.757
Subcutaneous emphysema after removal of the chest tube	1	1.25%	2	2.5%	0.563
Re-empyema formation	3	3.75%	2	2.5%	0.563
Total	**12**	**15%**	**16**	**20%**	

Uniportal VATS, the latest evolution, aims to reduce surgical stress by limiting access to one intercostal space. [22, 23] Despite its increasing use in other thoracic procedures, its role in empyema remains underreported.[24, 25] Song et al. initially reported a 50% conversion rate, but later studies show a reduced rate (~10%).[13, 26] Ismail et al. found good outcomes in 35 patients, with minimal complications (17%) and no conversions, aided by thorough decortication.[12] Our findings align with theirs, showing low complication rates and no need for reintervention in most patients.

Decortication achieved full lung expansion in more than 90% of the patients, supporting the feasibility of uniportal VATS even for complex empyemas. Still, this approach requires technical expertise. Our data reflect a transition from multiportal VATS (2010–2018) to uniportal (2019–present), likely contributing to the latter's slightly longer operative times. We expect parity in outcomes as experience increases.

Two chest tubes were used in multiportal VATS vs. one in uniportal. Chest tube practices vary widely.[27] Theoretically, one tube suffices after creating a single pleural space intraoperatively. Our data suggest single-tube outcomes are comparable to multi-tube drainage.

Postoperative hospital stay and drainage duration were relatively long (7–16 days), possibly due to institutional differences in postoperative care.[15] In some settings, patients are transferred to pulmonology for recovery; in others, they remain in surgical wards until discharge, making cross-study comparisons challenging.

A concern with minimally invasive approaches is incomplete evacuation of purulent material. However, our results and those in the literature show that both multiportal and uniportal VATS are effective for empyema management.[15, 16]

LIMITATIONS

This non-randomized study lacked allocation concealment, introducing potential selection bias due to surgeon discretion, disease severity, and operative choice. Additionally, the single-center setting may limit the generalizability of findings. Although costs related to implants, imaging, and medications were covered by institutional and public funding, this may not reflect broader healthcare settings.

CONCLUSION

For the treatment of stage II and III pleural empyema, the current analysis shows that both uniportal and multiportal video-assisted thoracoscopic surgery (VATS) are safe and efficient methods. Our results are consistent with previous data, demonstrating the technical viability and positive effects of multiportal VATS in this patient group. The growing importance of uniportal VATS as a practical and possibly better option is also supported by our statistics. We saw similar postoperative complication rates, no conversion, and effective decortication with the uniportal approach—even in well-organised empyema—despite early reservations about its suitability in advanced empyema.[28] Overall, uniportal VATS seems to be a technically viable and successful therapeutic option for stage II empyema, with increasing surgical proficiency. It offers comparable safety and efficacy to multiportal VATS and may also lower postoperative morbidity.

ETHICAL APPROVAL

Ethical approval of article was granted by the Institutional Review Board of Services Institute of Medical Sciences vide reference No IRB/2021/873/SIMS dated 23 September, 2021.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTIONS

HI: Manuscript writing, data collection, data analysis
MSN: perceived the concept, manuscript writing
ZS: Data collection, data analysis, trial registration
All Authors: Approval of the final version of the manuscript to be published

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