Video-Assisted Thoracoscopy and Open Thoracotomy for the Treatment of Stage III Empyema: A Comparative Study

Fariborz Rousta[1], Majid Montazer[2], Amin Barghan[3], Hadi Amirhooshangi[3], Seid Hadi Saghaleini[4], Mahta ZareDini[2]

[1] *Department of Cardiovascular Surgery, Sina Hospital, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran*
[2] *Department of Cardiothoracic Surgery, Imam Reza Hospital, Tabriz University of Medical Sciences, Tabriz, Iran*
[3] *Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran*
[4] *Department of Anesthesiology, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran*

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Abstract

Background: Pleural empyema can be fatal and requires surgery if untreated. Stage III empyema, marked by thickened pleura, necessitates surgical intervention. Both open thoracotomy (OT) and video-assisted thoracoscopic surgery (VATS) are viable options, but there is insufficient clinical evidence to determine which is superior.

Objective: This study evaluated the preoperative outcomes of VATS and OT in patients with stage III empyema

Methods: There were two groups of 30 patients with stage III empyema treated with OT or VATS. We measured patients' preoperative characteristics and analyzed them using t-tests and chi-square tests

Results: No difference was seen between the mean (± SD) age of the OT (40.38 ± 19.71) and VATS group (43.56 ± 19.82) (p-value = 0.796). The OT group's surgery and hospital stay (2.15 ± 0.58 hours) was about 1.5 times the VATS procedure (1.44 ± 0.37 hours) (p-value = 0.018). Tachypnea duration (p-value = 0.174) and chest tube duration (p-value = 0.417) were statistically similar between groups. OT patients experienced longer air leaks than VATS patients (p-value = 0.019).

Conclusions: Both procedures are effective, but VATS may be preferable due to shorter operation times, hospital stays, and its minimally invasive nature. Further clinical trials are needed for clearer guidance.

Keywords: Pleural Empyema, Thoracotomy, Video-Assisted Thoracoscopic Surgery

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Background

Pleural empyema is an infectious disease of the pleural space, primarily caused by bacterial invasion following pneumonia [1]. In the USA, about one million pneumonia-related hospitalizations occur annually, with 40% leading to pleural effusion and 15% to thoracic empyema [2]. Within the first year of empyema, the mortality rate or need for surgical intervention is approximately 20–30% [3].

Pleural empyema is classified into three stages based on its progression and chronicity: stage I (uncomplicated early exudative), stage II (complicated fibropurulent pleural effusion), and stage III (late pleural thickening) [4].

In the chronic phase, purulent organized pleural fluid becomes surrounded by collagen secreted by fibroblasts. This process constructs a rigid membrane called "the peel," which restricts the lung parenchyma and causes lung entrapment, affecting its function by reducing the forced expiratory volume in one second (FEV1), as well as forced vital capacity (FVC) [5].

Open thoracotomy (OT) is the primary surgical treatment for stage II and III empyema, although video-assisted thoracoscopic surgery (VATS) is also an option.

Recent reviews and guidelines recommend VATS soon after the diagnosis of stage II empyema, although it is less commonly used than OT for chronic stage III cases. For example, one study found that OT was performed approximately 10% more often than VATS in stage III patients [6–9].

OT is typically preferred in cases of delayed surgery or damaged lung parenchyma, though some evidence suggests that VATS is superior in terms of air leakage, hospital stay length, and recovery time [5, 6, 9, 10].

* **Corresponding author**: Dr. Mahta ZareDini
Department of Cardiothoracic Surgery, Imam Reza Hospital, Tabriz University of Medical Sciences, Tabriz, Iran
Tel.: +98 41 3335 5921 Email: mahtazareD1999@gmail.com, zaredini@tbzmed.ac.ir

Objectives

Due to insufficient evidence and ongoing debate regarding the outcomes of VATS versus OT in stage III empyema, we conducted a retrospective study to assess hospital stay duration, chest tube placement, air leakage, and tachypnea following OT or VATS surgery in stage III empyema patients.

Materials and Methods

Patient characteristics

This retrospective study analyzed 60 patients who received VATS or OT surgical decortication for chronic empyema at Imam Reza and Sina hospitals in our country between 2011 and 2015.

The sample size was determined by considering the number of patients diagnosed with stage III chronic empyema who were admitted to the thoracic department in the two hospitals. Exclusion criteria were: 1) patients with stage I or II empyema; 2) incomplete recordings.

Patient recordings were extracted from two hospitals' archives and then carefully organized by their unique numbers. An online random number table was then used to select 30 patients who underwent decortication surgery by OT and 30 patients who underwent surgery by VATS. The absence of incomplete information led to the removal of cases and replacement with cases that contained complete information.

We examined variables such as age, gender, surgical method, operation time, length of hospital stay, duration of chest tube placement, period of postoperative air leakage, and early surgical outcomes. Early outcomes after surgery were assessed by evaluating tachypnea in the days following surgery. The patients' daily tachypnea was measured after surgery while in the hospital. Tachypnea is defined as having a respiratory rate of over 30 breaths per minute.

The assessment of the stage of empyema was carried out in all patients, considering their clinical characteristics such as symptom duration and hospital stay length. In addition, characteristics observed in their chest CT scans—such as loculations, hydropneumothorax, air-fluid levels, and pleural thickening—and the American Thoracic Society staging system were used to classify the patients in the study. The development of empyema in these patients was due to postpneumonic pleural infection.

Prior to surgery, all patients underwent thoracentesis or chest tube insertion and were treated with multiple antibiotics. The surgical approach was determined based on the surgeon's preference. The study protocol was approved by the Tabriz University of Medical Sciences ethics committee [IR.TBZMED.REC.1398.283].

Surgical technique

All patients in this study underwent surgery under general anesthesia using a double-lumen endotracheal tube.

In the OT group, a postero-lateral serratus anterior-sparing thoracotomy with rib spreading was performed. The entire pleural surface was inspected and debrided, including both the visceral and parietal pleura, to ensure complete lung expansion. Two large-bore chest tubes were inserted at the end of the procedure.

For the VATS group, either a three-port or two-port procedure was performed. The intercostal spaces chosen for port placement were determined based on preoperative CT scans. The pleural collection was identified by fluid aspiration, and the first port was placed accordingly. Additional ports were placed under thoracoscopic vision, using caution to avoid lung injury. Complete lung decortication and removal of fluid, loculations, and septa were accomplished using a variety of instruments.

Regardless of the surgical technique used, patients were extubated and discharged from the ICU as quickly as possible to maximize their recovery potential.

Statistical analysis

The data obtained were presented as mean ± standard error of the mean (SEM), frequency, and percentage. The statistical software used was SPSS version 25. We compared quantitative variables using Student's t-test for independent samples and qualitative variables by contingency tables and the chi-square test. All results in the study were considered statistically significant at p-value ≤ 0.05.

Results

This study assessed the outcomes of two groups of patients who had pulmonary decortication. A total of 36 males (60%) and 24 females (40%) were included in this study, with 19 males and 11 females in the VATS group and 17 males and 13 females in the OT group. Gender and surgery type were found not to be significantly associated [p = 0.598] with each other. In the VATS group, the mean age (± SD) of patients was 43.56 ± 19.82 years, while the OT group had a mean age (± SD) of 40.38 ± 19.71 years, with no significant differences between the two groups [p = 0.796].

Table 1: Preoperative and demographic characteristics of patients

variables		VATS (n: 30)		OT (n: 30)		Total (n: 60)		p-value
		n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
Age			43.56 ± 19.82		40.38 ± 19.71		41.97 ± 19.67	0.796
Sex (n)	male	19(63.3%)		17(56.6%)		36(60%)		0.598
	female	11(36.6%)		13(43.3%)		24(40%)		
Duration of operation (hours)			1.44 ± 0.37		2.15 ± 0.58		1.8 ± 0.60	0.018
Hospital stay (days)			9.43 ± 2.58		14.33 ±7.78		11.88 ± 6.26	0.001
Duration of chest tube placement (days)			6.5 ± 5.28		6.63 ± 4.61		6.56 ± 4.91	0.417
postoperative air leakage (days)			0.26 ± 0.52		0.53 ± 0.86		0.40 ± 0.71	0.019
Postoperative tachypnea (days)			1.80 ± 1.39		2.23 ± 1.97		2.01 ± 1.71	0.174

SD; standard deviation, SE; standard error

Surgical outcomes

The average (± SD) surgery duration in the VATS group was 1.44 ± 0.37 hours and 2.15 ± 0.58 hours in the OT group, which were significantly different [p = 0.018]. There was no need for surgical conversion to OT for any of the patients who underwent VATS surgery.

Postsurgical outcomes

Both groups were assessed for the duration of air leakage following surgery. In the VATS group, the average duration (± SD) was 0.26 ± 0.52 days, while in the OT group, it was slightly longer at 0.53 ± 0.86 days [p = 0.019]. Patients who had thoracoscopic surgery spent an average (± SD) of 9.43 ± 2.58 days in the hospital, while patients in the OT group stayed 14.33 ± 7.78 days. Remarkably, the average hospital stay for the VATS group was significantly shorter than the OT group [p = 0.001]. The two groups did not experience any in-hospital mortality at the time of the study. The duration of tachypnea (± SD) was 1.80 ± 1.39 days in the VATS group and 2.23 ± 1.97 days in the OT group. There was no significant difference in tachypnea duration between the two groups [p = 0.174].

There is a comprehensive summary of all the data in Table 1.

Stage III empyema is characterized by thickening of the visceral pleura, thereby restricting lung expansion and causing dyspnea. In these cases, surgical therapy using OT or VATS in conjunction with complete decortication of fibrous tissue is mandatory. OT is a classical approach for stage III empyema and for incomplete lung expansion following VATS after unsuccessful lung decortication [11, 12]. A literature search found limited studies with an exclusive assessment of the differences in OT versus VATS operations in patients diagnosed with stage III empyema [10, 13, 14].

The purpose of this study is to compare two dominant surgical approaches to grade III empyema (VATS and OT). There were no significant differences between the VATS and OT groups in terms of gender or age. As compared to the VATS group, the length of surgery and hospital stay in the OT group was approximately 1.5 times longer.

Clinical outcomes shortly after surgery, such as the duration of tachypnea, were statistically similar in the two groups. Chest tubes remained statistically equal following VATS and OT procedures. No prolonged air leak was observed in either group, although OT patients had a longer air leak time than VATS patients.

A literature review of a PubMed database by Steen et al. [9], which investigated nine non-randomized retrospective studies, showed the advantage of the VATS procedure in preoperative outcomes such as shorter operating times and chest tube drainage for patients with stage II and III empyema.

As in our study, a recent systematic review and meta-analysis of 2,219 complicated stage II and stage III empyema patients requiring surgical decortication found that OT patients had significantly longer hospital stays and shorter surgical procedures than VATS patients [8]. In terms of preoperative mortality and prolonged air leak, no significant differences were seen between the two groups. This was consistent with our study, which showed no deaths and no cases with ≥ 5 days of air leak in either group [8].

In the study by Ricciardi et al. [6], the postoperative outcomes of 166 patients with stage III para-pneumonic empyema were analyzed. Sixty-seven patients (40.36%) were in the OT group, and 99 (59.63%) were in the VATS group. Air leaks and hospital stays were significantly lower in the VATS group compared to the OT group, a finding also reflected in our study.

In another retrospective study on 217 patients diagnosed with stage III empyema from 2002 to 2014, the mean ± SD operation time in the OT group and VATS group was 172.4 ± 70.72 minutes and 152 ± 68.14 minutes, respectively, which were significantly different [10].

Compared with our study, both procedures required longer operation times (86.4 ± 22.2 minutes in the VATS group and 129 ± 34.8 minutes in the OT group). This difference could be due to the older participants (61.3 ± 15.6 years in the VATS group and 54.2 ± 15.9 years in the OT group) compared with 43.56 ± 19.82 years in the VATS group and 40.38 ± 19.71 years in the OT group in our study.

The duration of the operation can also be affected by the etiologies of empyema, such as cancer, post-thoracic surgery, and chronic pleural fluid collection, along with additional surgeries (pulmonary resections or lymph node dissections), as well as surgical skills and experience.

In the study above, total hospital stay in both VATS and OT groups was statistically the same, with a mean (± SD) of 28.1 ± 30.7 days in the VATS group and 28.6 ± 25.5 days in the OT group [p-value = 0.1528]. However, the length of hospital stays in both groups of our study was shorter, and notable differences between the two groups were observed. The duration of chest tube drainage (6.8 ± 4.2 days in the VATS group and 6.6 ± 3.4 days in the OT group), ≥ 7 days of air leak, and mortality rate (6.5% in the OT group and 9.5% in the VATS group) were statistically the same between the two groups [10].

Shahin et al. retrospectively surveyed 52 stage III empyema patients (73% male) with a mean age of 52 years on the outcomes of VATS versus OT surgery [15]. Median days of total hospital stay in the VATS and OT groups were 5 and 8 days, respectively. Both groups did not record mortality, similar to our study.

A retrospective study evaluated the outcomes of 127 stage III empyema patients in two periods—group one from 2011 to 2012 and group two from 2012 to 2015—who underwent VATS surgery [11]. Operation time notably decreased from a mean (± SD) of 170.1 ± 73.6 minutes to 141.6 ± 61 minutes. Total hospital stay (22.2 ± 14.2 days vs. 30.4 ± 35.3 days) and chest tube placement duration (6.15 ± 3.02 days vs. 7.01 ± 4.45 days) remained statistically the same.

Various investigations have reported a 4.5% to 32.4% intraoperative conversion rate of VATS surgery to OT [6, 10, 15, 16]; however, as in the study by Chan et al. [10], we observed no procedural changes in the operating room. The conversion of VATS to OT depends on surgical progression, access to the pleural cavity, uncontrollable arterial bleeding, suspension of the surgical approach, and surgical skills [6, 10, 14, 15, 17–19].

The small sample size and possibility of recall bias were limitations of our study. In addition, selection bias based on surgeon preference in choosing between the two procedures and performance bias from surgeons, anesthesiologists, and other healthcare professionals can greatly impact operation time, conversion rate, complications, recovery, and hospital stays of patients [20].

Preoperative outcomes need to be investigated in future randomized clinical trials. Moreover, follow-up of patients for recurrent empyema, the need for reoperation, morbidity, and mortality should be considered.

Conclusion

As our study showed, both VATS and OT surgery can result in desirable preoperative outcomes, and both procedures are safe and effective to use. However, because VATS surgery takes a shorter period of time, uses fewer anesthetic drugs, and has a zero conversion rate, it may be the better option for treating stage III empyema patients.

Acknolewdegments

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Conflict of interest

No conflict of interest was reported.

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