

# Comparative study of open thoracotomy and thoracoscopy on the efficacy of treatment and complications of patients with stage II thoracic empyema

Manouchehr Aghajanzade<sup>1</sup>, Babak Karimi<sup>2</sup>, Hossein Torabi<sup>2</sup>, Kasra Shirini<sup>3\*</sup>, Siavash Katebi<sup>3</sup>

<sup>1</sup>DEPARTMENT OF THORACIC AND GENERAL SURGERY, GUILAN UNIVERSITY OF MEDICAL SCIENCES, RASHT, IRAN

<sup>2</sup>DEPARTMENT OF GENERAL SURGERY, POURSINA MEDICAL AND EDUCATIONAL CENTER, GUILAN UNIVERSITY OF MEDICAL SCIENCES, RASHT, GUILAN, IRAN

<sup>3</sup>DEPARTMENT OF GENERAL SURGERY, IRAN UNIVERSITY OF MEDICAL SCIENCE, TEHRAN, IRAN

## ABSTRACT



**Background.** Thoracic empyema is an inflammatory condition of the pleura that can cause many complications and can even threaten people's lives. So, choosing the right treatment method from all available methods can improve the prognosis, reduce costs and post-treatment complications, thus improving the health of patients after the disease. Video-assisted thoracoscopic surgery (VATS) and open thoracotomy are the most commonly used surgical methods. In this study, these two surgical methods have been investigated, in terms of duration of hospitalization, postoperative pain level and the possibility of air leakage (as postoperative complications). **Methodology.** Patients with thoracic empyema stage II referred (between 2011 and 2020) to the Poursina and Razi Hospital Medical Center, Rasht, Iran were included in a retrospective cohort study. SPSS software and other statistical tests such as the Shapiro-Wilk test, Mann-Whitney non-parametric test, and Chi-square test were used for statistical analysis, and a P-value of less than 0.05 was considered an acceptable value. **Results.** The investigation on different qualitative and quantitative factors and complications after surgery showed that patients who underwent a VATS procedure had a shorter hospital stay ( $5.09 \pm 1.67$  vs.  $7.61 \pm 2.03$ ), had a lower pain level ( $4.81 \pm 2.22$  vs.  $8.24 \pm 2.39$ ), and the possibility of air leakage as a postoperative complication (41% vs. 56%) was lower than in the case patients who have undergone open thoracotomy. **Conclusions.** It can be concluded that choosing the VATS method instead of the open thoracotomy can reduce postoperative complications (such as length of hospital stay, pain level and possibility of air leakage) and can reduce the costs of treatment and the degree of health system use, especially during Covid-19 pandemic.

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### \*Corresponding author:

Kasra Shirini,

Department of General Surgery, Iran University of Medical Science, Tehran, Iran

E-mail: [KasraShirini21@gmail.com](mailto:KasraShirini21@gmail.com)

## Introduction

Thoracic empyema is an inflammatory process defined as the accumulation of pus in the anatomical space between the visceral layer and the parietal layer of the pleura. This disease and its initial treatment, which was purulent drainage, was first discovered in Hippocrates and has since been considered a significant therapeutic challenge [1]. This disease could be caused by several causes, including pneumonia, penetrating chest trauma, thoracic surgery, and esophageal rupture [2]. Risk factors for this disease include age under 60 years old, poor oral hygiene, disorders with a predisposition to aspiration (seizure, alcoholism, and central nervous system disease), intravenous drug misuse, diabetes, cardiovascular disease, liver cirrhosis, and other

immunocompromised states such as HIV infection and malignancy [3].

Thoracic empyema consists of three separate stages. The first stage (I) is an acute exudative phase in which the visceral pleura stays elastic, and the physiological dimensions of the thoracic cavity are preserved. The second stage (II) is the subacute fibrinopurulent phase. This stage, investigated in this article, is characterized by turbid, infected fluid with fibrin deposits constructing bridges that separate the effusions. Finally, the last stage (III) is the chronic organizing phase, in which this construct is superseded by formal granulation tissue [4].

Patients who experience re-expansion or lung failure in the second stage should receive intrapleural fibrinolytic such as streptokinase and alteplase or early surgical

treatment as soon as possible [4,5]. Different surgical methods used for treating these patients include thoracentesis, tube thoracostomy, video-assisted thoracoscopic surgery (VATS), open decortication, open thoracostomy, and vacuum-assisted therapy [6]. Among the most widely used surgical methods are open thoracotomy and VATS. The main goal in treating this disease is to remove and evacuate pus from pleural space in different methods. The use of any of these methods depends on the patients' conditions and the decision of the surgical team [5]. If not treated promptly and adequately, the disease can progress rapidly, indicating the importance of choosing the correct method for treatment [7]. Numerous studies have been performed to compare the effective factors and postoperative complications after surgery of different surgical methods, including open thoracotomy and VATS, to treat thoracic empyema, and diverse and different consequences have been reported [8-11].

Therefore, this study was performed due to the issue's importance. In this study, 218 patients, half of whom underwent open thoracotomy and half underwent VATS in terms of postoperative complications such as duration of hospitalization after surgery, postoperative pain level, bleeding from the operation site, air leakage from the operation site, and postoperative fever. In addition, during this study, some individual factors such as sex, age, preoperative fever, preoperative dyspnea, preoperative chest pain, past medical history of diabetes, history of tuberculosis, and smoking were considered.

## Materials and Methods

Patients with stage II thoracic empyema were referred to the Poursina and Razi Hospital medical centers between 2011 and 2020 and were identified through a retrospective cohort review. This study was conducted as an analytical cohort study after the approval of the research assistant and receiving the code of ethics (IR.GUMS.REC.1397.425). Patients' medical histories were reviewed, and 218 of them whose medical information was complete and available were examined in this research project.

### *Inclusion criteria:*

- Patients over 18 years old with dyspnea, fever, sputum cough, or chest pain and patients that pleural fluid was seen on thorax Chest X-ray (CXR) or thorax computed tomography (CT) scan.
- Patients diagnosed with pneumonia followed by stage II empyema and were candidates for surgery.
- Patients who had seen free pleural fluid on their thorax CXR or thorax CT scan.
- Presence of loculated pleural fluid (cell chamber) in thorax CT scan of the patients.
- The patients' thoracentesis fluid pH is below 7.2.

- Patients' thoracentesis concentration glucose less than 60 mg/dL.
- Positive gram staining or positive microbial culture in the patients' thoracentesis fluid.
- Existence of significant pus in the patient's thoracentesis fluid.
- If patients' thoracentesis concentration lactate dehydrogenase (LDH) level was more than three times average (normally it should be under 280 in adults).

However, among patients who were referred to our medical centers, patients with stage I or III empyema, patients who did not consent to surgery due to empyema, patients with stage II thoracic empyema who died before the time of surgery, patients with a history of receiving anti-tuberculosis treatment who have been diagnosed with empyema due to tuberculosis, and or patients who had pleural fluid in chest X-ray or CT-scan of the thorax but the diagnostic thoracentesis for them was dry. No specific fluid was seen in it (Dry Tap), which was a sign that these patients with stage III empyema were not entered into the project. In addition, patients who died during surgery or before surgery, or after surgery but during hospitalization, patients with empyema who did not consent to surgery, patients who did not cooperate properly to answer questions and clinical examination related to research data postoperatively, patients who had contracted empyema due to trauma, patients infected with viral respiratory infections, and or patients with empyema for unknown and idiopathic reasons were excluded from the study.

The collected data were first encoded and then analyzed using the statistical package for the social sciences (SPSS edition 21) software in this study. Mean and standard deviation and median and quartile amplitude were used to describe the quantitative variables. Qualitative variables were also described based on number and percentage. The subgroups' normal distribution of quantitative variables was measured using elongation and skew values, Q-Q Plot, and Shapiro-Wilk test. Mann-Whitney non-parametric test was used to compare quantitative variables due to abnormal distribution in them. On the other hand, Chi-Square non-parametric test was used to compare qualitative variables due to abnormal distribution in the two groups. The significance level in all tests was considered 0.05, which means P-value < 0.05 was significant.

## Results

This retrospective cohort study selected 218 patients, which met the inclusion criteria with stage II empyema admitted to the Poursina and Razi Hospital Medical Center, between 2011 and 2020. Our population consisted of 144 males (66.1 %) and 74 females (33.9 %), while the mean age was 38.96 years old. The patients were divided into two equal groups. The first group was the patients with Stage II

thoracic empyema who underwent open thoracotomy, and the second group was the patients with stage II thoracic empyema who underwent VATS procedure.

In continue, various qualitative and quantitative factors were investigated among both groups. Quantitative factors were included items such as age, pain level after surgery, and duration of hospitalization after surgery. Qualitative factors were included items such as sex, fever before surgery, dyspnea before surgery, chest pain before surgery, past medical history of diabetes and tuberculosis, history of smoking, bleeding from the operation site, air leakage from the operation site, and postoperative fever. Our study showed that among all of these factors, just the differences in the duration of hospitalization after surgery, air leakage from the operation site, and patients' pain level after surgery between two patients' groups were significant, as can be seen in Tables 1-3 presented below. One of the most valuable ways to assess and measure the severity of patients' pain is to use the visual analog scale (VAS) [12]. In this study, patients were asked to describe their pain in VAS and give it a score from zero to ten. The lowest score was one, and the highest score was nine.

Statistical analysis of data showed that age, sex, preoperative fever, dyspnea, chest pain before surgery, bleeding from the site of surgery, postoperative fever, and history of smoking, diabetes, and tuberculosis did not have any significant differences between the two patients' groups.

<b>Table 1.</b> Duration of hospitalization after surgery (open thoracotomy vs VATS).			
P-Value	Middle (first quarter-third quarter)	Mean $\pm$ standard deviation	Surgical method
<0/001	8.00 (7.00-9.00)	7.61 $\pm$ 2.03	Open thoracotomy
	5.00 (4.00-6.50)	5.09 $\pm$ 1.67	VATS

<b>Table 2.</b> Patients' pain level after surgery (open thoracotomy vs VATS).			
P-Value	Middle (first quarter-third quarter)	Mean $\pm$ standard deviation	Surgical method
0.015	7.00 (3.00-9.00)	8.24 $\pm$ 2.39	Open thoracotomy
	5.00 (3.00-7.00)	4.81 $\pm$ 2.22	VATS

<b>Table 3.</b> Air leakage from the surgical site (open thoracotomy vs VATS).			
P-Value	VATS procedure	Open thoracotomy	Air leakage
0.041	41 (37.6 %)	56 (51.4%)	Yes
	68 (62.4 %)	53 (48.6%)	No

As the results of statistical analysis of data show, in all these three factors, the patients who underwent the VATS procedure, had significantly better conditions.

## Discussion

Thoracic empyema is a life-threatening disease caused by pneumonia, penetrating chest trauma, thoracic surgery, and esophageal rupture [1,2]. This condition can lead to high mortality and morbidity rates [13-15]. Therefore, if not diagnosed correctly and in time, this disease can progress to higher stages and endanger a patient's life; it is essential to pay attention to this disease, evaluate and diagnose it accurately, and choose the appropriate treatment method for its treatment [6]. As mentioned, many studies have been done on the influential factors and postoperative complications of different surgical methods to treat thoracic empyema [8-11]. Statistical analysis of results which were obtained from the research in this study, which was performed on the effect of different factors and differences in postoperative complications between the two surgical methods open thoracotomy and VATS procedure, in patients with stage II thoracic empyema, showed that the choice of VATS procedure method, could reduce duration length of hospitalization after surgery, patients' pain level after surgery, and suspicion of air leakage from the surgical site.

Our results showed that patients with stage II thoracic empyema who had undergone VATS procedure with an average of 5.09 $\pm$ 1.67 days were hospitalized for a shorter time after the surgery than patients who had undergone open thoracotomy with an average of 7.61 $\pm$ 2.03 days. Therefore, it can be concluded that the VATS procedure significantly reduces the time length of hospitalization of these patients after surgery.

Our results also showed that patients with stage II thoracic empyema who had undergone VATS procedure with an average of 4.81 $\pm$ 2.22 had less pain after the surgery than patients who had undergone open thoracotomy with an average of 8.24 $\pm$ 2.39. Therefore, it can be concluded that the VATS procedure significantly reduces patients' pain after surgery.

In addition, the results also showed that VATS procedure selection to treat these patients could reduce the probability of air leakage from the surgical site compared to patients who had undergone open thoracotomy. The possibility of air leakage from the surgical site was 37.6 % in patients who had undergone VATS procedure and 51.4% in patients who had undergone open thoracotomy, respectively.

Nowadays, the world is affected by the COVID-19 pandemic, which is viral pneumonia that affects many organs, especially the lungs. Until know, few studies have been performed on the association between COVID-19 and thoracic empyema and have emphasized the existence of a

relation between COVID-19 and thoracic empyema [16-18]. Furthermore, these studies showed that COVID-19 could increase the length of hospitalization. Furthermore, increasing the length of hospitalization can increase the risk of developing COVID-19 disease between patients referred to the medical centers for any reason [19-21].

## Conclusions

Based on this study, it can be concluded that it is essential to choose an adequate treatment method in treating patients with stage II thoracic empyema to enhance the prognoses and decrease postoperative complications. In this study, 218 patients' medical and surgical histories, half of the underwent VATS procedure, and half of the underwent open thoracotomy, were investigated about age, pain level after surgery, duration of hospitalization after surgery, sex, fever before surgery, dyspnea before surgery, chest pain before surgery, past medical history of diabetes and tuberculosis, history of smoking, bleeding from the operation site, air leakage from the operation site, and postoperative fever.

On the other hand, the risk of COVID-19 increases by increasing the duration of hospitalization and being in hospital areas. The obtained results showed that the selection of the best method between VATS and open thoracotomy could reduce the need for treatment and hospitalization and subsequently the risk of COVID-19 by reducing the pain level after surgery and postoperative complications such as the possibility of air leakage from the surgical site and reducing the duration of the time required for postoperative hospitalization.

The results of this study which is the only case of such studies in Iran, confirm the results of other studies in this field from other regions and countries. Based on these results, it can be concluded that choosing the VATS method can eventually reduce the patients' health costs and the double pressure on the treatment system, especially these days that the COVID-19 pandemic spread worldwide.

## Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

## Compliance with ethical standards

Any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the paper.

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