Suez Canal University Medical Journal Vol. 25 (4), 2022
Pages 40-48

Assisted Thoracoscopic Intervention Versus Conventional Thoracotomy for Management of Trapped Lung Syndrome

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Abstract

Background: **Trapped lung syndrome is defined by the inability of the lung to expand and fill the thoracic cavity because of a restricting "peel." Video-assisted thoracoscopic surgery (VATs) can take part in the management of trapped lung syndrome more easily on the behalf of pleurectomy/ decortications *Aim:* to evaluate the prevalence of postoperative complications of thoracoscopic management of trapped lung syndrome. *Patients and Methods*: This study was held at Suez Canal university hospitals and as a randomized control clinical trial. It included all patients who presented with trapped lung syndrome. Patients were divided into 2 equal groups (conventional thoracotomy group and VATs group). *Results:* the total mean age was 52.45±13.6 yrs. (range 19-80 yrs.). 64% of the patients were males. The preoperative symptoms were fever in 70% of patients, cough in 30%, chest pain in 24%, and dyspnea in 66%. The mean operative time was 130.31±38.024 min. (Range 50-240 min.). The Mean postoperative air leak days were 4.71±2.802 days (Range 0-11 days). The mean postoperative VAS score for pain was 3.28±3.178, (Range 0-9). The mean Postoperative total hospital stays. Group A (7.06±1.69 days), group B (5.13± 2.45 days) (Multiport VATS 4.95±3.0 days Uniportal VATS 5.33±2.22 days) (p = 0.0001). The mean VAS score for pain at 6 months follow-up was 0.29± 0.72, (Range 0-3). *Conclusion:* operative time was lesser in VATs group than thoracotomy despite being no statistical significance between 2 groups regarding concomitant techniques which mean that VATs can do the same job in lesser operative time and decrease operative bleeding & risk, also zero conversion rate displays the learning curve and feasibility of both VATs techniques.**

Keywords: trapped lung, VATs, pleurectomy, decortication

Introduction

Trapped lung syndrome is defined by the inability of the lung to expand and fill the thoracic cavity because of a restricting "peel." This restriction may be secondary to the inflammatory or fibrotic cortex or to a malignant visceral pleural tumor[1]. The management of trapped lung syndrome is surgical mainly, with the removal of the fibrotic visceral pleura to allow for the expansion of the underlying lung[2]. Video-assisted thoracoscopic surgery (VATs) can take part in the mang-

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-ment of trapped lung syndrome more easily on the behalf of pleurectomy/ decortications and also provide more safe options with good results for malignant and terminal cases[3].

Patients and Methods

Study design

This study was carried out from March 2018 to august 2020. The study was designed as a randomized control trial. And included all patients who present with trapped lung syndrome and require thoracic surgical intervention at Suez Canal University Hospitals. Patients diagnosed with trapped lung including (post thoracic surgery, clotted hemothorax, empyema, malignant pleural effusion, encysted pneumothorax, and encysted effusions), and aged above 18 years of both genders were included. While patients with uncontrolled chronic illnesses, bleeding diathesis, coagulation disorders (INR>1.5), or treatment with anticoagulants or endobronchial obstruction were excluded. Fifty patients were included and divided into 2 equal groups (conventional thoracotomy group and VATs group).

Pre-operative assessment

Full history taking and complete clinical examinations were applied for all patients also full preoperative investigations including a full blood count, coagulation screen and renal and liver function testing. In addition, all patients had a chest radio graph and chest CT scan.

Conventional thoracotomy group

All operations have been performed under general anesthesia with single-lung or double lung ventilation as tolerated. The patient was placed in a lateral decubitus position, and the chest cavity was accessed through a posterolateral thoracotomy. Extrapleural stripping was performed as needed by blunt dissection to mobilize the corticated part of the lung and the thickened parietal pleural cortex incised. The pleural cavity was evacuated of all fluid and debris, samples of which were sent for microbiological staining and culture and histopathological examination. Decortication was undertaken by complete resection of the visceral cortex over the entire lung surface including the fissures until full lung re-expansion was achieved. The pleural cavity has been lavaged with warm saline or water and dilutes povidone-iodine (10%). Closure in layers with the pleural cavity has been drained with one or more large-bore (34 or 36 Fr) chest drains. Suction was applied to these drains at 20 cmH_2O.

VATs group

For most VATS procedures, general anesthesia with selective single-lung ventilation using a double-lumen endotracheal tube has been preferred. Left-sided intubation is usually performed unless a left pneumonectomy is anticipated. A single-lumen endotracheal tube with a bronchial blocker or CO_2 insufflation in triportal model was an acceptable alternative. The patient is turned to a full lateral decubitus position and the operating table is flexed to widen the rib spaces on the operation side. The positions of the surgeon and assistant depended on the expected site of the pathology as suggested by preoperative imaging. We used a single incision of 3–4 cm if uniportal technique or 3ports of 1 cm in multiportal VATs planned according to the ultrasonographic appearance of the pleural space for 5 mm or 10 mm 30° camera and endoscopic and standard

instruments. The first phase involved the removal of all adhesions and inflammatory effusion. After complete debridement, the inflammatory peel was separated from the visceral pleura and subpleural lung with a blunt and sharp dissection avoiding important parenchymal injury. The diaphragm will be also cleaned up by the typical inflammatory reaction and diaphragmatic surface of the lung will be completely freed to restore the diaphragmatic movements. In some cases, we will perform lung or pleural biopsies or even wedge resections. The procedure ended when we accomplished a full lung re-expansion and placed chest tubes under endoscopic vision on diaphragm and at the apex curved tube with extra holes or 2 tubs in triportal model.

Statistical Analysis

Data was collected throughout pre- and post-operative questionnaires, clinical assessment & operative data. Statistical analysis was done by statistical package for social science (SPSS) version 25. Chi square was used to compare different frequencies. T test was similarly used for mean correlation and F test for comparison between different means. Results were statistically significant if p was <0.05.

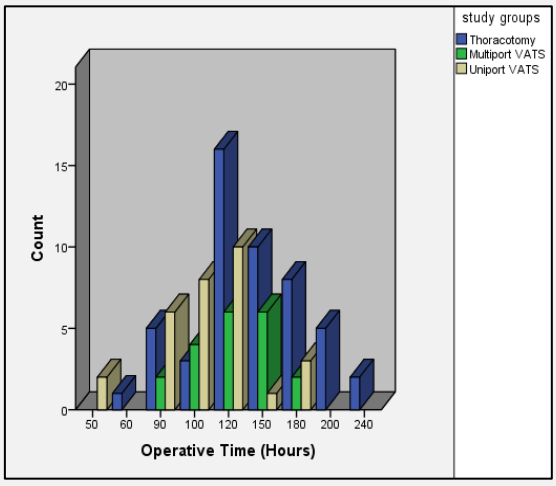

Figure 1: The operative time in study groups

Results

Demographic and preoperative Data

We found that the total mean age was 52.45 years ranging from 19 to 80 years with standard deviation of 13.62. Most of our patients were males (64 patients with percentage of 64%) and this was statistically insignificant. In our study we found that 66% of patients were smokers, 13% were diabetics, 7% of patients gave history of ischemic heart disease, hypertension was present in 33% of the patient, 4% of patients gave history of pulmonary tuberculosis, 23% of patients were complaining of chronic obstructive pulmonary disease, 5% of the patients are on regular dialysis for end stage renal disease and 21% of patients gave history of different types of thoracic trauma. Empyema was the commonest cause of trapped lung with 41% and malignant effusion comes in the second place by 23% then clotted hemothorax by 17% then

encysted pneumothorax by 13% and finally chronic nonspecific effusion by 6%. Also, there was no statistical significance between both groups. Fever was the leading preoperative symptoms as 70% of our patient complained of fever, 30% complained of cough and 24% complained of chest pain while dyspnea was present in 66% of patients. No significance was found between group A and group B.

Table 1: relations between concomitant techniques and surgical techniques

Variables	Group A (Thoracotomy)	Group B (VATS)		Total	P value
		Multiport VATS	Uniportal VATS		
Concomitant Technique					
No	22	8	5	35	0.123
Bullectomy	4	4	3	11	
Pleural Biopsy	14	6	15	35	
Parietal Pleurectomy	10	2	7	19	
Total	50	20	30	100	

Operative Data

Operative time mean was 130.31 minutes standard deviation 38.024 minimum time 50 minutes and maximum was 240 minutes, and by application of ANOVA mean comparison test we found that in group A mean operative time was 143±44.3 min and in group B it was 128±27.8 min in multiportal patient and 111±33.8 min in uniportal patients and this was statistically significant (P= 0.014, figure 1). Mean blood loss was 697±348.28ml the minimum loss was 200 ml and maximum loss was 1500 ml and, we found very strong statistical significance between intraoperative blood loss and surgical technique p= 0.0001

Concomitant techniques

During surgery we did 35 pleural biopsies, 19 parietal pleurectomy and 11 bullectomy. There was no statistical significance between surgical technique and concomitant technique (p= 0.123, table 1).

Postoperative Data

1. Air leak

Mean postoperative air leak days 4.71 days with standard deviation 2.802 minimum was zero day and maximum 11 days. There was statistical significance regarding postoperative air leak between thoracotomy and VATS groups as and 0.05. There was no statistical significance between postoperative air leak time and etiology as P value was0.23, and while we found very strong statistical significance between ultrasound preoperative assessment and post-operative air leak (p = 0.0001). No cases of postoperative respiratory failure have been recorded in our study

2. Postoperative pain

The mean postoperative VAS score for pain was 3.28 with standard deviation 3.178 the minimum score was zero and maximum score was 9. There was very strong statistical significance between surgical technique and postoperative pain VAS score p = 0.0001

3. Wound infection

Regarding postoperative wound infection assessed by ASEPSIS score we found that mean score was 19.11 with a standard deviation 14.89 minimum score was 4 and maximum score was 70. Regular daily dressing was sufficient in

87% of patients and we required vacuum in 7% of cases and operative debridement in 6% of cases and there were strong statistical relations between wound management technique and surgical technique (p= 0.025).

Postoperative total hospital stay
The mean Postoperative total hospital stay Group A (Thoracotomy) was 7.06±1.69 days and for group B was 5.13± 2.45 days (Multiport VATS4.95±3.0 days Uniportal VATS 5.33±2.22 days) and this relation showed very strong statistical significance (p=0.0001).

One month's follow up
The mean VAS score for pain at 1 month follow up was 0.98 with standard deviation 1.35 the minimum score was zero and maximum score was 5. There was statistical significance between surgical technique and post-operative pain VAS score at 1 month follow up (p = 0.029).

VAS score 6 months follow up
The mean VAS score for pain at 6 moths follow up was 0.29 with standard deviation 0.72 the minimum score was zero and maximum score was 3. There was no statistical significance between surgical technique and postoperative pain VAS score at 6 months follow up (p = 0.151).

Mortality
No cases of mortality were recorded during hospitalization or follow-up period.

Discussion

Most of data collected was similar to our study regarding the age and sex distribution and etiology of trapping as Hassan et al, found that in both groups the majority of the cases, pneumonia was the leading cause of empyema, in the form of 24 cases (80%) and 22 cases (73.3%) in group A and group B respectively. However, the remaining 6 (20%) patients in group A were caused by infected posttraumatic hemothorax while in Group B only 2 (6.7%) cases were posttraumatic, 2 cases (6.7%) were caused by spread from a sub-phrenic abscess, and 4 cases (13.3%) due to lung abscess[4]. Tong et al who reported that, Empyema was presented in 35.9% of patients , Complex effusion in 33.3%, recurrent effusion in 11.4% , Hemothorax in 12.3% and Others in 6.9%[5]. Bongiolatti et al reported that the prevalent cause of pleural empyema was complicated bacterial pneumonia (85%); other causes were chest trauma and subsequent retained hemothorax (11%) and previous thoracentesis (4%)[6]. Ismail, et al reported that in 85.7% of the cases, empyema was related to a complicated parapneumonic effusion; while, in only 5 cases it was a postsurgical consequence[7]. Regarding operative time most of data was in favor of our results as Tong et al reported an operative time of 97 minutes for VATs group compared to 154 minutes for open thoracotomy (*p* value=0.001)[5]. Also, according to Bongiolatti et al the operative time (m) in uniportal VATs group was 116±28 in open thoracotomy group 135±43 (p=0.04)[6]. And Ismail et al reported that the mean operation time for U-VATS approach was 128.29±66.51 min.[7]. Also Chung et al operative time was near to our time but the study targeted VATs cases only but the main different factors was the time of intervention as they reported that Duration of surgical procedure (minutes) in VATs group operated in the first 3 weeks 100.93 +/- 46.014 and in VATS

group operated within 3 to 6 weeks 125 +/- 66.450 and in VATs group operated after 6 weeks 138.57 +/- 52.057 with a P value of 0.015 and this show how delayed intervention can elongate operative time[8]. Similarly another study should that the mean operative time for decortication cases was 116.68 min (86-140 min)[9]. While less operative time was reported by Cardillo et al as operative time which was 79.6+/- 6.8 min and 70+/- 7.4 min, respectively, in open thoracotomy and VATs groups respectively (p < 0.0001)[10]. Also Kermenli et al reported a mean operation time of 64.75±18.3 (45 - 100) minutes for VATS[11]. And Waller et al reported that operating time was significantly shorter for VATS debridement than thoracotomy and decortication: 86.2 +/-(10.4) min vs. 128.2 +/- (7.9) min (P = 0.003). and this can be explained with more experienced surgeons in highly specialized centers[12]. And on the other side more operative time recorded by Thori et al focused in relation of VATs to empyema stage and reported that Average operative time was 102min (range 90–120min) for stage I, 178.8min (range 120–240min) for stage II and 323min (range 240–400min) for stage III[13], and Zhou et al reported the median operative time was 3.5 (2.1-4.5) hours which was the longest time[14]. Similarly, Hassan et al reported long operative time of 173.93±57.95 for VATS and 179.00±35.66 for thoracotomy. No statistical significance as P value 0.496[4] and this can be explained by nature of study populations in both literatures as they were focused in TB empyema and chronic empyema respectively. Regarding post operative air leak data like our study reported by Cardillo et al, as postoperative air leak was 3.9 +/- 4.3 days in thoracotomy group and 2.8+/- 2.4 days in VATs group (*p*= 0.0040[10] And Bongiolatti et al showed that air leak was 5.6±1.4 days in uniportal VATs group and 10.6±4.2 days in thoracotomy group <0.001[6]. Also, Ismail et al noted that no air-leakage > 5 days was recorded. In 94.3% of patients (33 cases) there was a good re-expansion of the lung, with only 2 cases of trapped lung not responsive to surgical treatment. The only significant risk factor for postoperative trapped lung was the presence of a tracheotomy before the operation[7]. While Hassan et al announced that most of the patients in both groups had successful surgery achieving fully expanded lungs (93.3% in VATs group and 80% in thoracotomy group), with exception of 2 patients (6.7%) had residual pouches in VATs group, and 6 patients (20%) in thoracotomy group. Yet there was no significant difference (p=0.129)[4]. Kermenli et al showed that prolonged air leakage and expansion defect were seen in 3 (16%) patients[11], also according toTong et al prolonged air leak (18.9%) in open thoracotomy and (6.5%) (p= 0.0003)[5], and Chung et al announced that prolonged air leakage occurred (2.7%) of cases in VATS group operated in the first 3 weeks of presentation, (3%) of cases in VATS group operated from 3weeks to 6 weeks of presentation and (28.6%) of cases in VATs group operated after 6 weeks of presentation (p <0.001)[8] and Hajjar et al in comparison of Stage III VATS and Stage III open surgery cases showed significance difference for the air leak duration (7.84±3.33 days for VATS and 15.92±8.2 days for cases of open thoracotomy)[15]. Pan et al explained the prolonged air leak, which is defined as air leakage lasting more than 7 days after surgery, is the most common complication of decortication. Due to the chronic

infection and fibrino-purulent pleurisy, the adhesion of visceral and parietal pleura is very solid. The priority of decortications is to separate the adhesion and release the lung. It may lead to visceral pleura damage inevitably. In both surgical approaches, chest tubes will be inserted after the operations which are used for air and residual fluid drainage. The longer chest tube duration may attribute to the longer air leakage. The duration of prolonged air leak and chest tube in VATD group is longer than the OTD group. It suggests that VATD may have less damage than OTD when separating the adhesion between visceral and parietal pleura[16]. Regarding postoperative pain similar data to our study was reported by Kermenĭi et al showed similar results as postoperative pain assessment of the patients was done with Visual Analogue Scale (VAS). The mean VAS score in the first 24 hours postoperatively was 2.7±0.92[11]. Also, Ismail et al noted the postoperative level of pain was found to be very low (mean value measured on VAS scale in I postoperative day: 1.83±1.53) and the mean duration of pain was 2.63±2.23 days, No correlation between post-operative pain and factors like chest tube duration, number of drainages, age, days of painkiller assumption and sex was found. Painkillers were taken for 4.34±4.39 days and the main types were paracetamol and NSAIDs. Among the 35 patients, 2 had undergone a previous contralateral thoracotomy and confirmed a less postoperative pain after U-VATS approach[7]. While Cardillo et al showed slightly higher VAS score median In-hospital pain level (at 1 and 6 days after surgery) was 6 for open thoracotomy group and 5 for VATs group and this show very strong statistical significance as P value <0.0001[10]. Regarding wound infection our study and all data collected showed superiority of VATs over thoracotomy regarding decrease postoperative wound infection as Hassan et al reported that Wound complications (0.0%) in VATs group and (13.3%) in open thoracotomy and this was statistically significant as P value 0.038[4]. Also Kermenĭi et al (12%) patients developed wound infections[11]. While Ismail, M. et.al, reported that the cosmetic result was good or excellent for the 100% of the series (2.44±0.51, evaluated on a scale from 1 to 3 points). No wound infection was recorded. Two patients (5.7%) complained medium level paresthesia of the wound 7 days after the operation, spontaneously resolved during the follow-up[7] and Hajjar et al showed the same and noted No wound infection occurred in VATs group and in 16% in open thoracotomy group and this was statistically significant as P value 0.035[15]. Regarding Postoperative total hospital stay Also our study and all of collected data show superiority of VATs over thoracotomy regarding decrease postoperative hospitalization as Cardillo et al recorded Hospital stay (days) 10 +/- 7.8 days in open thoracotomy group and 8.6 +/- 1.8 days in VATs group and this was statistically significant as P value 0.020[10]. Also, Hassan et al reported that The postoperative hospital stay showed a statistically significant variation between VATs group (5.27±3.90) and thoracotomy group (8.07±5.36). Statistically significant (p=0.003)[4] and Kermenĭi et al the hospitalization day was 9.4±2.45 (7 - 14) days[11], and Tong et al noted that the median length of stay was 10 days for the open thoracotomy group and 7 days for the VATs group and this was statistically significant as (*p* 0.001)[5], also Chung et al

reported that Postoperative hospital stay (days) 9.49 +/- 4.25 days in VATS group operated in the first 3 weeks of presentation, 3 9.73 +/- 4.237 days in VATS group operated from 3weeks to 6 weeks of presentation and 13.5 +/- 6.382days in VATs group operated after 6 weeks of presentation this was statistically significant as P value 0.011[8]. Bongiolatti et al Hospital stay, days 6.7±1.9 days in uniportal VATs group and 12.2±4.7days in open thoracotomy group and this was statistically significant as P value <0.001[6], moreover Elsayed et al recorded the mean in-hospital stay for thoracoscopic decortication was 4.1 days [2–14][17]. And Pan et al said that the postoperative hospital stay [mean difference −2.41; 95% confidence interval (CI), −3.74 to −1.09; P=0.0004][16], and Hajjar et al noted that postoperative hospital stay for Stage III VATS required 9.65±4.1 days. Whereas, patients who underwent open thoracotomy took a longer time of 21.82±16.35 days and this was statistically significant (p= 0.001)[15].

Conclusion

In our study operative time was much lesser in VATs group than thoracotomy despite being no statistical significance between 2 groups regarding concomitant techniques which mean that VATs can do the same job in lesser operative time and decrease operative bleeding & risk, also zero conversion rate shows that the learning curve and feasibility of both VATs techniques (uniportal & multi-portal). Postoperatively there was no difference between both groups regarding postoperative ventilation, ICU stay and immediate lung re-expansion, but statistical significance was in favor of VATs group regarding postoperative air leak, postoperative blood transfusion, postoperative VAS score, postoperative ASEPSIS score and postoperative hospital stay. At one month follow up VAS score was better in VATs group but AT six months was equal, there was no recurrence of trappment or collection during the study also there was no cases of mortality.

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