Evaluation of the role of video - assisted thoracoscopic surgery in management of empyema

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Background Video-assisted thoracoscopic surgery (VATS) is effective for fibropurulent thoracic empyema and less invasive, and it may be important as a bridge between minimally invasive and conventional open thoracic surgical management.

Aim The aim of this study was to determine the optimal treatment of parapneumonic effusion in the fibrinopurulent stage comparing blind thoracostomy versus VATS with regard to efficacy, duration of hospitalization and intercostal tube (ICT) insertion, and need for further surgery or not.

Patients and methods This study was a prospective comparative randomized study conducted on 60 patients with confirmed parapneumonic effusion where they were classified into two groups. The blind thoracostomy group: 30 patients underwent blind thoracostomy and the VATS group: 30 patients underwent VATS.

Results The incidence of clinical improvement was more in the VATS group when compared to the blind thoracostomy group. The hospital outcome in the VATS group was much better than in the blind group, where in the VATS group, the postoperative length of hospital stay was around 4.8 days and the time of ICT removal was after 5 days from insertion, whereas in the blind group, the length of hospital stay was around 9.7 days and the time of ICT removal was after about 6 days of insertion. The incidence of postoperative complications was higher in the blind group than in the VATS group.

Conclusion VATS provides more accurate staging for parapneumonic effusion, an excellent surgical view for a complicated empyema cavity, thus making it possible to perform a sufficient evacuation of all empyema membranes.
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Introduction

Thoracic empyema is a dynamic process, inflammatory in origin that occurs within a preformed space between both the visceral and parietal pleura. It is a complex clinical entity, which is neither a sole clinical laboratory, nor a radiologic diagnosis [1].

The most common form of empyema is postpneumonic or parapneumonic, representing 40–60% of all cases. A continuously evolving process empyema can be differentiated into three phases, exudative (stage I), fibrinopurulent (stage II), and organizing (stage III) [2].

Different modalities are established to treat a case of parapneumonic effusion. This depends mainly on staging and the general condition of the patient where in the exudative stage, just antibiotic therapy can be efficient, whereas in the fibrinopurulent stage, drainage is mandatory either by simple thoracostomy or guided thoracoscopy, and finally in the organization phase, decortication or pneumonectomy is the last option [3].

Video-assisted thoracoscopic surgery (VATS) is effective for fibropurulent thoracic empyema and less invasive, and it may be important as a bridge between minimally invasive and conventional open thoracic surgical management where the VATS procedure using two or three ports gives capability to preserve chest wall muscles, and this made it possible to use these muscles for future thoracoplasty [4].

Aim

The aim of the study was to compare the efficacy of blind thoracostomy versus VATS in the management of parapneumonic effusion.

Patients and methods

This was a prospective comparative randomized study conducted in Ain Shams University Hospital (Chest and Cardiothoracic Departments) from June 2015 to June 2017 on 60 patients with confirmed parapneumonic effusion in the fibrinopurulent stage [pH <7.2, glucose <60 mg/dl, lactate dehydrogenase

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>1000 or three times normal limit, white blood cells (WBCs) high with isolation of an organism with the Gram stain, or the presence of pus cells by Leishman stain]. Informed consent was taken from all patients (or their legal guardians) who were invited to participate in the research as regards confidentiality, right to refuse or withdraw, and in case of refusing to participate in the research, the patient will be followed up and will receive his treatment as planned. The consent was revised and approved by the ethical committee of scientific research.

Patients were admitted from the outpatient clinic to our chest department and they were subjected to the following:

(1) Informed consent from the patients or their guardians before their enrollment in the study.
(2) Detailed history taking, including past and family history and thorough clinical examination (general and local examination).
(3) Full laboratory investigations, including complete blood count, C-reactive protein (CRP), liver enzymes (aspartate transaminase and alanine transaminase) and kidney functions (blood urea nitrogen and creatinine), and the coagulation profile.
(4) Radiologic assessment in the form of chest radiograph of posteroanterior view to assess the presence of pneumonia and pleural effusion and computed tomography (CT) scan to assess the presence of pleural effusion, pleural thickening, and lung entrapment.
(5) Chest ultrasound using MINDRAY DP 1100 ultrasound (Shenzhen Mindray Bio-Medical Electronics Co., Ltd., Mahwah, New Jersey, USA) was done for all patients before receiving either of the two treatment modalities to make a sonographic staging for parapneumonic effusion and to take pleural fluid samples to be sent for chemical analysis (pH, glucose, and lactate dehydrogenase), bacteriological analysis (WBCs count, Gram stain, Leishman stain, and culture and sensitivity), and cytology for confirming the criteria of parapneumonic effusion in the fibrinopurulent stage.
(6) The ultrasonographic finding was classified into four stages according to the pleural effusion characteristics [5]:
    (a) Stage 1–free effusion (simple anechoic).
    (b) Stage 2–effusion with little septation (simple septated).
    (c) Stage 3–septated, thick effusion (complex septated).
    (d) Stage 4–multiloculated effusion, with organizing debris.
(7) An ECG was done to patients above 45 years old.
(8) A broad-spectrum antibiotic regimen was started for all patients according to the standard regimen for parapneumonic effusion [third-generation cephalosporins (ceftazidime) and clindamycin] were given before any procedure and to be continued for 7 days.

After which the 60 patients with confirmed parapneumonic effusion were classified into two groups using a simple randomization method.

Blind thoracostomy group

Thirty patients underwent blind thoracostomy under local anesthesia with insertion of an intercostal tube under a water seal. After insertion of the ICT, a daily chart was done to assess the amount of pleural fluid and the presence of air leak or not.

The chest radiography was performed daily to assess lung re-expansion and chest ultrasonography was carried out to assess the residual amount of pleural fluid remaining and to assess the staging of parapneumonic effusion. When lungs were successfully reinflated, patients were followed up till removal of ICT, whereas the patients who had the same procedure, but the lungs were not reinflated with residual septations and loculations seen by chest ultrasonography were transferred to cardiothoracic surgery to assess the possibility of VATS or decortication.

Video-assisted thoracoscopic surgery group

Thirty patients underwent video-assisted thoracoscopy. VATS using KARL STORZ (KARL STORZ SE & Co. KG Tuttlingen, Germany) telescope (2014, 10-mm port with endoCAMeleon lens working in all directions from 0 to 120° and HD monitor; Germany) was done for all patients under general anesthesia. The VATS approach is performed by three incisions that are 5 cm apart to avoid overlap between the instruments as the instruments are not curved; this is called the baseball diamond approach:

(1) An initial 1-cm incision was made in the seventh or eighth intercostal space at the mid axillary line for placement of the telescope coupled to the video camera.
(2) Two additional 1–2-cm incisions are placed along the line of the standard posterolateral thoracotomy incision. These two incisions are in the fifth intercostal space, one at the anterior axillary line and one at the posterior axillary line. When such a triangular configuration is achieved, it facilitates the placement and manipulation of instruments.

These incision sites vary slightly with the proposed procedure and the location of the pathology.

A 10 mm trocar was inserted, followed by a 30° optical telescope and connected to a videotape camera and monitor. The pleura was carefully inspected through the thoracoscope. The closed biopsy forceps, step by step, was used to perforate fibrinous septa, and fluid and fibrinopurulent material was aspirated and removed from the pleural cavity.

Adequate drainage was performed, and the debridement, lysis of adhesion, and irrigation with warm saline followed. A partial decortication was performed if seen to be necessary, and adequate lung expansion was assured at the end of the procedure. A chest tube is always inserted at the end of the procedure and connected to a thoracic drainage device to assure complete lung re-expansion and evacuation of the pneumothorax.

A follow-up of the chest tube in the form of chest radiograph to assess full lung expansion, the amount of pleural fluid drained daily, and the presence of air leak or not was done. Daily dressing was also done for the port site for avoidance of infection. Ultrasonography was done postoperatively to assess pleural space and if pleural effusion is completely drained. There was removal of ICT after full expansion of the lung.

Patients were randomly allocated to receive either of the two treatment modalities, and outcome analysis was done with respect to treatment efficacy (duration of hospitalization, duration of ICT insertion, radiologic and laboratory improvement, and further need for surgery or not).

Exclusion criteria:

(1) Pediatric patients up to the age of 14.
(2) Any adult patients having contraindications for general anesthesia and surgery.
(3) Tuberculous empyema.

Statistical analysis

Descriptive statistics for relevant baseline characteristics are provided with the corresponding frequency, or mean and SD.

The presence of any differences between the patients of both groups were tested with Fisher's exact test for categorical variables and with an independent sample *t*-test for continuous parametric variables and Mann–Whitney test for continuous nonparametric variables.

Comparisons with a *P* value of less than 0.05 will be significant. Pearson's correlation was used to evaluate relations between two variables with linear distribution.

All analyses were performed with SPSS software, version 20.0 (SPSS Inc., Chicago, Illinois, USA).

Results

The distribution of age, sex, and smoking index among the studied population is shown in Table 1. The most common risk factor of parapneumonic effusion was diabetes mellitus followed by intravenous drug addiction (Table 2).

Pathologic staging of parapneumonic effusion by CT in the VATS group (Table 3) turned out to be less accurate than chest ultrasonography staging (Table 4) as it completely missed stage 2 when compared to the pathologic staging of parapneumonic effusion by VATS (Table 5). Also, there was a significant correlation between US staging and the pathologic stages in the VATS group in all stages. The sensitivity of ultrasound staging increases with the progression of the VATS pathologic staging (Table 6).

There was no statistical difference as regards postoperative clinical improvement between both the groups (Table 7). Both groups had a significant decrease in the mean TLC after intervention,

Table 1 Demographic characteristics among the studied population

	Blind thoracostomy group (*N*=30)	VATS group (*N*=30)	Both groups	*P* value
Age				
Mean±SD	44.86±14.55	46.36±12.93	45.3±11.8	0.675
Sex [*n* (%)]				
Male	20 (66.73)	21 (70)	41	0.742
Female	10 (33.37)	9 (30)	19	0.513
Smoking index				
Mean±SD	41.9±17.7	38.2±11.3	40.3±10.4	0.437

VATS, video-assisted thoracoscopic surgery.

whereas the VATS group only had significant improvement in CRP after intervention (Table 8).

The hospital outcome was in favor of the VATS group where the preoperative length, length of hospital stay, and the duration of ICT was shorter than the blind thoracostomy group, whereas the operative time was longer in the VATS group than the blind thoracostomy group (Table 9). Also, the need for decortication was significantly higher in the blind thoracostomy group (Table 10).

Table 2 Distribution of risk factors of parapneumonic effusion among the studied population

	Blind thoracostomy group (*N*=30) [*n* (%)]	VATS group (*N*=30) [*n* (%)]	*P* value
No risk factors	6 (20)	6 (20)	0.970
DM	11 (36.7)	12 (40)	
Chronic liver disease	5 (16.7)	6 (20)	
Chronic renal disease	2 (6.6)	2 (6.66)	
IV drug addiction	6 (20)	4 (13.34)	

DM, diabetes mellitus; IV, intravenous.

Table 4 Chest ultrasonography pathologic staging of parapneumonic effusion in both groups

	Blind thoracotomy group (*N*=30) [*n* (%)]	VATS group (*N*=30) [*n* (%)]	*P* value
Stage 1	1 (3.3)	11 (36.67)	0.034
Stage 2	12 (40)	8 (26.7)	0.027
Stage 3	15 (50)	10 (30.3)	0.027
Stage 4	2 (6.7)	1 (3.33)	0.032

VATS, video-assisted thoracoscopic surgery

There was a significant difference regarding postoperative complications in favor of the VATS group. Only bleeding was higher in the VATS group (Table 11).

Discussion

In the current study, 60 patients with confirmed parapneumonic effusion were classified into a blind thoracostomy group: 30 patients (blind thoracostomy) and the VATS group: 30 patients (VATS).

The mean age of the VATS group was 46.36±12.93 and the mean age of the blind thoracostomy group was 44.86±14.55 with about 66–70% of the patients who were males in both groups with the smoking index of 42 pack/year in the blind group and 38 pack/year in the VATS group. The preoperative assessment was done by clinical examination, chest radiography, CT chest, and chest ultrasonography where ultrasound was used for staging of parapneumonic effusion and the

Table 3 Pathologic staging of parapneumonic effusion by computed tomography in the video-assisted thoracoscopic surgery group

CT chest	VATS group [*n* (%)]
Free mild/moderate pleural effusion +consolidation (stage 1)	26 (86.6)
Encysted pleural effusion (stage 3)	4 (13.3)
Encysted pleural effusion with pleural thickening (stage 4)	0 (0)

CT, computed tomography; VATS, video-assisted thoracoscopic surgery.

Table 5 Video-assisted thoracoscopic surgery pathologic staging of parapneumonic effusion

Pathologic stages [*n* (%)]			
Stage 1	Stage 2	Stage 3	Stage 4
3 (10)	13 (43.33)	10 (33.33)	4 (13.34)

Table 6 Correlation between pathologic video-assisted thoracoscopic surgery staging and ultrasound staging in the video-assisted thoracoscopic surgery group

	VATS pathologic stages [*n* (%)]				*P* value
Staging by ultrasonography	Stage 1	Stage 2	Stage 3	Stage 4	
Stage 1	3 (10)	8 (26.63)	0 (0)	0 (0)	0.0002
Stage 2	0 (0)	5 (16.63)	3 (10)	0 (0)	0.0002
Stage 3	0 (0)	0 (0)	7 (23.37)	3 (10)	0.0002
Stage 4	0 (0)	0 (0)	0 (0)	1 (3.37)	0.0002
Staging					Sensitivity (%)
Stage 1					27.2
Stage 2					62.1
Stage 3					70
Stage 4					100

VATS, video-assisted thoracoscopic surgery.

sensitivity of chest ultrasonography increases with the increase in pathologic staging, but the CT scan cannot correlate with the actual pathologic staging of parapneumonic effusion and provides insufficient information to distinguish between a loculated pleural effusion and a pleural peel where the CT findings show that 26 patients were in stage 1 pathologically and four patients were in stage 3 and no patients were in stage 4 pathologically.

This was similar to Luh *et al.* [6] study that was conducted upon 234 patients with parapneumonic effusion who have undergone blind thoracostomy followed by VATS with a mean age of 45±3.3 and 50% males with a smoking index of 35 pack/year.

This was also matching with Rodney *et al.* [7] study that was conducted on 76 patients with complex parapneumonic effusion who were approached with VATS after inadequate chest-tube drainage by blind thoracostomy. The mean age of patients was 47 years old (65% males and 35% females), with a smoking index of 40 pack/year. Preoperative assessment in this study was done by clinical examination and chest radiograph and CT chest, respectively.

The current study was in accordance with Cassina *et al.* [8] study that was conducted on 45 patients with a mean age of 48 years and 75% were males.

Also, the present study was similar to Molnar [9] study as it was conducted on 602 patients (417 in the VATS group and 185 in the blind group) from the period of April 2002 to March 2006. The mean age in the VATS group was around 55 years and 78% were males and the mean age in the blind group was 65 years and 75% were males. The assessment was done preoperatively

Table 7 Postoperative clinical improvement (symptoms and signs) in both the groups

	Blind thoracostomy group (*N*=30) [*n* (%)]	VATS group (*N*=30) [*n* (%)]	*P* value
Dyspnea	4 (44.4)	4 (80)	0.281
Chest pain	7 (58.3)	9 (81.8)	0.321
Both (pain and dyspnea)	5 (62.5)	12 (85.7)	0.364
Fever	15 (62.5)	21 (91.3)	0.754

VATS, video-assisted thoracoscopic surgery.

Table 8 Inflammatory markers after operation in both groups

Inflammatory markers	Blind thoracostomy group (*N*=30)	VATS group (*N*=30)	*P* value
Postoperative TLC			
Mean±SD	12820±1863	10566±895	0.002
Postoperative CRP [*n* (%)]			
Improvement	8 (26.70)	24 (80)	0.001

VATS, video-assisted thoracoscopic surgery.

Table 9 Hospital outcome in both groups

	Blind thoracostomy group (*N*=30)	VATS group (*N*=30)	*P* value
Chest tube removal time (days)			
Mean±SD	6.01±2.50	5.03±4.5	0.045
Postoperative length of hospital stay (days)			
Mean±SD	9.7±3.40	4.8±0.66	0.002
Operative time (min)			
Mean±SD	26.60±3.19	68.13±21.29	0.002

VATS, video-assisted thoracoscopic surgery.

Table 10 Need for decortication in both the study groups

	Blind thoracostomy group (*N*=30) [*n* (%)]	VATS group (*N*=30) [*n* (%)]	*P* value
No need for decortication	15 (50)	22 (73.33)	0.001
Decortications	15 (50)	8 (26.67)	0.002

VATS, video-assisted thoracoscopic surgery.

Table 11 Postoperative complications in both the study groups

	Blind thoracostomy group (*N*=30) [*n* (%)]	VATS group (*N*=30) [*n* (%)]	*P* value
No complications	7 (23.3)	15 (50)	0.048
Bleeding	4 (13.3)	8 (26.7)	
Hematoma	10 (33.3)	5 (16.7)	
Surgical emphysema	5 (16.7)	2 (6.7)	
Bronchopleural fistula	3 (10)	0 (0)	
Pneumothorax	1 (3.3)	0 (0)	

VATS, video-assisted thoracoscopic surgery.

through clinical examination, chest radiography, and CT chest, respectively, and this was also resembling Michael *et al.* [1] study where 20 patients were randomized to receive either of the two therapies and were classified into two groups where group A consists of 10 patients who underwent blind thoracostomy and group B consists of 10 patients who underwent VATS. The mean age in both groups was 42 years and 50% of the patients were males with a smoking index of 35 pack/year. The preoperative assessment was done through clinical examination, chest radiography, and CT chest, respectively.

Essam *et al.* [10] study was conducted on 60 patients with parapneumonic effusion who have undergone VATS only. The mean age was 43 years and 80% were males. The preoperative assessment was done through clinical examination, chest radiography, CT chest, and chest ultrasonography.

The present study was partially resembling Aziz *et al.* [11] study where in this study, the patients were divided into three groups: the blind group (group A), ICT followed by VATS (group B), and the VATS group from the start (group C) with a mean age of 35 and 70% were males. The preoperative assessment was done through clinical examination, chest radiography, and CT chest.

This came in accordance with Bénézit *et al.* [12] study that was conducted on 20 patients who have undergone VATS after blind thoracostomy with a mean age of 41 years and 70% were males.

In the current study, the distribution of the risk factors in both groups shows that the most common risk factors were diabetes mellitus followed by intravenous drug addiction (Table 2).

This was in agreement with Luh *et al.* [6], Michael *et al.* [1], Essam *et al.* [10], and Aziz *et al.* [11] studies where the distribution of risk factors showed that the most common risk factors were diabetes mellitus followed by intravenous drug addiction.

In the current study, there was significant correlation between US staging and the pathologic staging by VATS in the VATS group; in stage 1, the sensitivity of ultrasonography was 27.2%, in stage 2, the sensitivity was 62.1%, in stage 3, the sensitivity of ultrasound was 70%, and in stage 4, the sensitivity was 100% (Table 6).

This was similar to Cassina *et al.* [8] study where ultrasonography was able to properly stage 82% of cases. In 18% of cases, gas inclusions in the pleural fluid prohibit a satisfactory ultrasonographic examination leading to incorrect staging. They also found that the CT scan provides insufficient information to distinguish between a loculated pleural effusion, as in an early organizing phase, and a pleural peel requiring some amount of decortication, as in a later organizing phase. Conversely, ultrasonography provides major additional information.

Michael *et al.* [1] study showed that 91% of patients in the VATS group were in stage 2 (loculated effusion) and 89% of patients in the blind group were in stage 2, but during VATS, about 45% of the patients who were classified to be stage 1 pathologically and sonographically were discovered to be in stage 2, as some septa and loculations were found during inspection of pleura by thoracoscopy.

In the current study, the incidence of clinical improvement (as regards dyspnea, chest pain, and fever) was higher in the VATS group when compared to the blind group, although it did not reach a statistical significance (Table 7). This was in agreement with Rodney *et al.* [7] who reported 85% incidence of clinical improvement, and Essam *et al.* [10] who also reported 98% incidence of clinical improvement but their studies were conducted on VATS patients only.

The current study was matching with Cassina *et al.* [8] study where 91% of his VATS patients showed clinical improvement. In the same way, Molnar [9] and Bénézit *et al.* [12] studies agreed with the current study.

Michael *et al.* [1] study was in agreement with our study where the incidence of clinical improvement (as regards fever and chest pain) was higher in the VATS group than in the blind thoracostomy group.

Aziz *et al.* [11] study was also similar to the current study where the incidence of clinical improvement (fever and dyspnea) was higher in the VATS group (group C) than the blind group alone (group A) and the blind group followed by VATS (group B).

In the present study, there was a significant improvement of inflammatory markers (i.e. WBC count and CRP) after intervention in favor of the VATS group when compared to the blind group (Table 8) and this was matching with Rodney *et al.* [7], Molnar [9], Michael *et al.* [1], and Essam *et al.* [10] studies that showed the higher improvement in inflammatory markers in the VATS group.

In the current study, the hospital outcome in the VATS group was much better than in the blind group where in the VATS group, the postoperative length of hospital stay was significantly shorter than the blind group, but the operative time was of course longer in the VATS group than the blind group as it is a surgical procedure under general anesthesia (Table 9) and this was comparable with Rodney *et al.* [7], Cassina *et al.* [8], and Essam *et al.* [10] studies regarding the length of hospital stay, time of ICT removal, and the success rate. The results of Luh *et al.* [6], Molnar [9], and Aziz *et al.* [11] were in accordance with our results as the hospital outcome is better in the VATS group than in the blind thoracostomy group.

In the current study, the need for decortication was significantly higher in the blind group (Table 10). This was in accordance with other studies of Luh *et al.* [6], Rodney *et al.* [7], Cassina *et al.* [8], and Essam *et al.* [10] which reported that the need for decortication is lessened with the use of VATS.

The present study was matching with Molnar [9], where in the VATS group, seven patients required decortication, six patients required repetition of VATS, and five patients required pneumonectomy, whereas in the blind thoracostomy group, 15 patients required decortication and eight patients required pneumonectomy.

The study conducted by Michael *et al.* [1] was in accordance with our study where the patients in the VATS group did not need further surgical procedure, whereas one patient in the blind group needed decortication and this can be attributed to a lower number of patients included in his study.

Aziz *et al.* [11] study was in accordance to our present study, where in group A, nine patients needed decortication, whereas in group B, five patients needed decortication and in group C, two patients needed decortication.

In the current study, the incidence of postoperative complications was higher in the blind group than the VATS group, except for bleeding that was higher in the VATS group (Table 11).

This was similar to Luh *et al.* [6] study where the incidence of complications was higher in the blind group than the VATS group, where in the blind group, 32% of patients had air leak and 20% had pneumothorax, whereas in the VATS group, 18.5% of patients had bleeding and 3% had air leak.

This was matching with Rodney *et al.* [7] study where the incidence of complications was higher in the blind group before undergoing VATS where 35% of the patients had bleeding, 12.5% had bronchopleural fistula, and 21% had surgical emphysema.

Similarly, the current study was in accordance with Michael *et al.* [1] study where the incidence of complications was more in the blind group when compared to the VATS group where the most common complications in group A were surgical emphysema and pneumothorax, respectively.

Molnar [9] study was resembling our study where the incidence of postoperative complications was higher in the blind group than the VATS group, where in the blind group, surgical emphysema and bronchopleural fistula were the most common complications, and in the VATS group bleeding was the most common complication.

Essam *et al.* [10] study was compatible with our study where the incidence of postoperative complications was higher in the blind group when compared to the VATS group. In the blind group, 35% of patients had pneumothorax, 16% had air leak, and 25% had hematoma, whereas in the VATS group, 15% of patients had bleeding, and 5% had air leak, but his study was on the VATS group only and the blind group reports were taken from medical records.

Aziz *et al.* [11] study was in conformity with our present study where the incidence of postoperative complications was higher in the blind group (group A) when compared to groups B and C, where in group A, 50% of patients had air leak, in group B, 30% of patients had surgical emphysema, and in group C, 5% of patients had bleeding.

Conclusions

(1) VATS provides more accurate pathologic staging of parapneumonic effusion than radiologic staging.
(2) VATS constitutes an ideal treatment modality for parapneumonic effusion, with fewer postoperative complications, higher incidence of clinical improvement, shorter hospital stay, and a high cost-benefit ratio.
(3) VATS provides an excellent surgical view for a complicated empyema cavity, thus making it possible to perform a sufficient evacuation of all empyema membranes and fluids, and the removal of a fibrous peel in the same way as in open surgery.

(4) Chest ultrasonography is mandatory before any surgical procedure to assess the stage of parapneumonic effusion.

Recommendations

We recommend that ultrasonographic staging of parapneumonic effusion should precede any surgical maneuver to ensure accurate diagnosis and safe outcome. Further studies on a larger scale of patients should be conducted for proper assessment of the sensitivity of ultrasonograghic staging. We also recommend that VATS should be the standard maneuver for treatment of parapneumonic effusion.

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Conflicts of interest

There are no conflicts of interest.

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