Thoracoscopic evacuation compared with reinsertion of thoracostomy tube in persistent traumatic hemothorax

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Objective
Hemothorax is the most frequent complication from chest trauma. In most of the cases, chest tube will be sufficient for treatment, but in a minority of patients, more intervention will be needed to evacuate a retained hemothorax. We aimed in this study to compare between video-assisted thoracoscopy (VATS) evacuation of retained clotted blood and reinsertion of thoracostomy tube to explore the safety and complications of such techniques.

Patients and methods
A prospective randomized case–control study was conducted on patients who presented with retained hemothorax admitted to trauma unit from July 2017 to July 2018.

Results
During the time frame from July 2017 to July 2018, our trauma unit got 44 879 patients. Approximately 14 722 of them needed admission, with only 288 patients requiring primary chest tube for hemothorax, of which 35 patients met the inclusion criteria of this study. They were then divided into two groups: group A (16 patients) underwent evacuation by VATS. The operative time for VATS ranged from 24 to 130 min, with mean time 79.8 min (after VATS), and needed drainage days range from 2 to 7 days, with mean of 3.31 days. One (6.25%) patient need thoracotomy. No wound infection or empyema was present in group A. Control group (group B) included 19 patients in whom the chest tube was reinserted. The needed days of drainage range from 4 to 10 days, with mean 6.47 days, with significant value ($P = 0.001$). Three (15.78%) patients had wound infection at the site of thoracostomy tube. On follow-up, we noticed four (20.05%) patients with empyema.

Conclusion
Early VATS for evacuation of retained hemothorax is feasible and safe in trauma patients. Moreover, VATS evacuation leads to shorter hospital stay and less need for open thoracotomy in comparison with reinsertion of a chest tube.

Keywords:
hemothorax, trauma, video-assisted thoracoscopy

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Introduction

Trauma is the most common cause of death all over the world. Morbidity and mortality in the multiple injured patients accounts for 25% of deaths annually in American trauma centers [1]. Mortality from chest trauma is the second highest after head injury; approximately two-thirds of the patients have thoracic trauma [2].

In a study conducted between 2002 and 2009 at Assiut University Hospital, Egypt, chest injuries (17.7%) were considered as the second leading cause of mortality after head injuries (34.6%) of the registered deaths caused by injury at the trauma unit [3,4].

Hemothorax is the most frequent complication from chest trauma, which has no exact incidence. A rough estimate of hemothorax related to trauma in the USA reaches 300 000 cases over the year [5].

Moreover, in Egypt, in a study published in 2017, chest trauma is responsible for more than 20–25% of all traumatic deaths [6].

There are three major effects of hemothorax, two acute and a chronic third one. The acute effects of a hemothorax are those of both hypovolemia and disruption of respiratory mechanism. Appropriate management of hemothorax depends on a patient's vital signs. A thoracostomy tube and thoracotomy are typically performed to control bleeding in patients with hypovolemia, and when patients are stabilized, the next step is to treat post-traumatic

complications. The more chronic effect of hemothorax is owing to significant amount of retained clot and empyema formation [7].

The percentage of retained hemothorax varies in numerous research studies, with incidence rates from 5 to 30% having been reported [8].

Owing to the advances in endoscopic instruments and technology, minimally invasive surgery is widely applied to manage chest trauma and its complication.

We aimed in this study to compare between video-assisted thoracoscopy (VATS) evacuation of retained clotted blood and reinsertion of thoracostomy tube to explore the safety and complications of such techniques.

Patients and methods

This study was conducted in Assiut University Hospital after approval of the protocol by the ethical committee of Assiut University, Faculty of Medicine, and approval from ClinicalTrials.gov was obtained NCT03501524.

It represents a prospective randomized case–control study of patients presented with retained hemothorax admitted to trauma unit from July 2017 to July 2018.

Inclusion criteria

The following were the inclusion criteria:
(1) Ages between 18 and 60 years (adult).
(2) Failure to drain by thoracostomy tube within 5–7 days from first insertion.

Exclusion criteria

The following were the exclusion criteria:
(1) More than one thoracostomy tube drainage in the same side.
(2) Unable to consent.
(3) Coexisting pathology requiring other surgical interventions in the chest.
(4) Patients who underwent urgent interventions.

Operative technique

Initial assessment, resuscitation, and stabilization were performed in the emergency department.

Patients were evaluated by chest radiography, and further imaging modalities were performed.

Tube thoracostomy was performed based on evidence of hemothorax.

Patients were considered for the study if chest radiography showed a retained hemothorax or within 5–7 days of the initial thoracostomy tube placement if hemothorax failed to resolve. Patients were divided randomly into two groups: the first group (group A) underwent VATS, and the second group (group B) underwent reinsertion thoracostomy tube. They were compared for complication and hospital stay.

VATS (group A) was performed only in patients who are hemodynamically stable in the operating room under general anesthesia.

A double-lumen endotracheal tube was used or a single-lumen tube was also used with intermittent apnea in patients having difficulty in insertion of double-lumen tube.

VATS was performed with patients in the lateral decubitus position. It is typically started with one port, as uniportal VATS, from the beginning. Moreover, if needed, one or two more ports were added, employing 12-mm ports (multiport) VATS.

Postoperative pleural drainage was established with a single chest tube.

Conversion to thoracotomy was needed in patients with intractable bleeding and inability to complete evacuation in the patients who need further intervention.

Patients were assigned to group B (reinsertion of thoracostomy tube) after placement of the initial first chest tube. The intervention was performed at the available operating room time under local anesthesia.

After either procedure, thoracostomy tubes were removed at the following criteria: minimal drainage (<100 ml/8 h), no air leak, and lung is fully expanded.

Research outcome measures

(1) Primary (main): duration of hospitalization.
(2) Secondary (subsidiary): number of patients who develop empyema and number of patients requiring thoracotomy.

Statistical analysis

Analysis of the data was done using SPSS Inc. (Chicago, Illinois, USA). All variables were expressed as frequency and percentage. Quantitative variables were presented in terms of mean ± SD. Level of significance '*P*' value was evaluated, where *P* value less than 0.05 was considered statistically significant.

Results

During the time frame from July 2017 to July 2018, our trauma unit got 44 879 patients. Approximately 14 722 of them needed admission, with only 288 patients requiring primary chest tube for hemothorax, of which 35 patients met the inclusion criteria of this study. They were then divided into two groups: group A (16 patients) underwent evacuation by VATS and control group (group B) (19 patients) in which the chest tube was reinserted again to evacuate retained hemothorax.

Male dominance was noticed in this study, as in Fig. 1, with no significance value as in Table 1.

Age of patients ranged from 18 to 60 years. The mean age of group A was 38.2 years, and the mean age of group B was 35.9 years, as in Fig. 2.

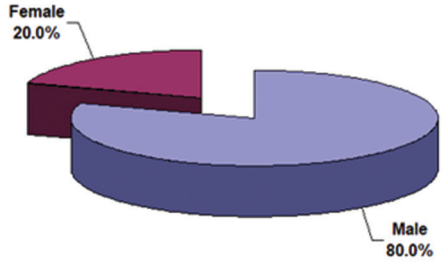
The most common mode of trauma was blunt trauma (62%), followed by penetrating trauma (31%), and iatrogenic trauma (5.7%), as shown in Table 2.

In patients subjected to VATS, the mode of anesthesia used was general anesthesia in 14 patients, local anesthesia in two patients, and the other one by using thoracic epidural anesthesia as awake VATS procedure.

Operative time for VATS evacuation ranged from 24 to 130 min, with mean time 79.8 min. A strong positive linear correlation was found between the operative time and the duration between initial chest tube at trauma unit and second intervention (VATS evacuation) (r = 0.702 and P = 0.002) as in Fig. 3.

In patients who needed blood transfusion (approximately 20.05%), the operative time range from 110 to 130 min, with mean of 121.25 min. whereas in patients without the need for blood transfusion (78.94%), the time range from 24 to 106 min, with mean of 66.08, with a significant P value of 0.004, as in Fig. 4.

Figure 1



Sex distribution of the studied patients.

According to the number of ports used at VATS, 50% of our patients (eight patients) went through multiport VATS evacuation with operative time range from 32 to 130 min, with mean of 96.25 min, and the other 50% (eight patients) by uniportal VATS evacuation, with operative time range from 24 to 110 min, with mean of 63.5 min, which was significant (P = 0.024).

Fig. 5 shows the comparison between the two group in the drainage days, which was significant (P = 0.001).

Regarding complications, only one (6.25%) patient needed thoracotomy opening (failed VATS) owing to extensive fibrosis.

On follow-up, none of the patients presented with wound infection or residual amount or empyema in group A, and of all patients of group B, three (15.78%) patients had wound infection at the site of thoracostomy tube. On follow-up, we noticed four (20.05%) patients with empyema, as shown in Table 3.

In group B, three (15.8%) patients needed third thoracostomy tube, and four patients (21.1%) needed an open thoracotomy.

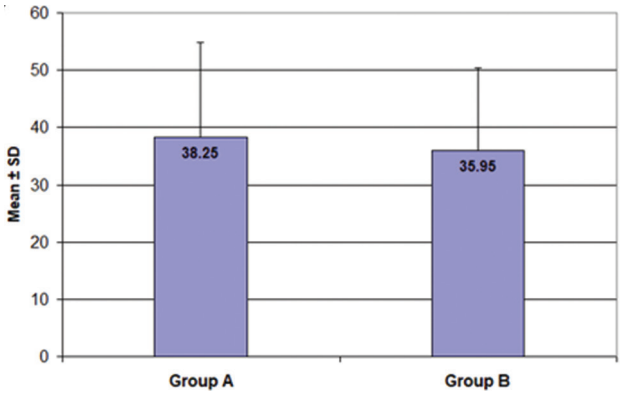
Table 1 Sex distribution of the studied groups

Sex	Group A (n=16) [n (%)]	Group B (n=19) [n (%)]	P
Male	14 (87.5)	14 (73.7)	0.415
Female	2 (12.5)	5 (26.3)	

Table 2 Mode of trauma

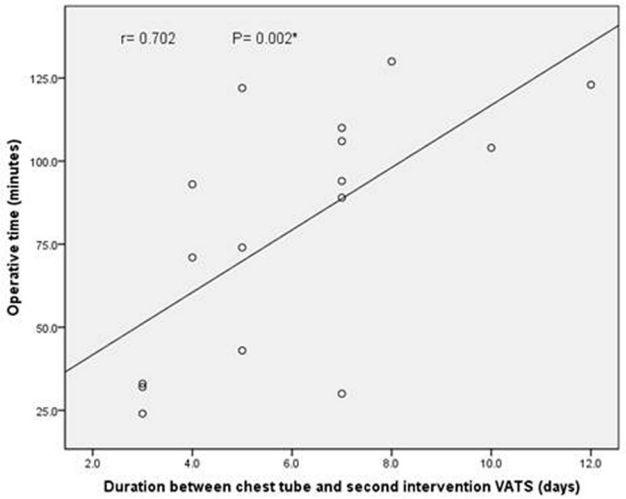
Mod of trauma	n=35 [n (%)]
Stab injuries	10 (28.6)
Road traffic accident	18 (51.4)
Fall from height	3 (8.6)
Fire arm injury	1 (2.9)
Animal kick	1 (2.9)
Iatrogenic	2 (5.7)

Figure 2



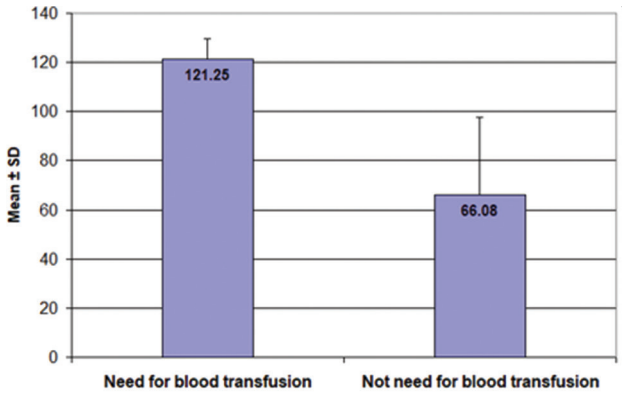
Mean age of the studied groups.

Figure 3



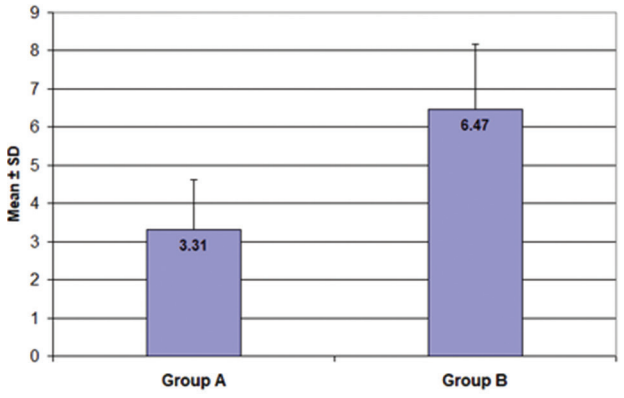
Correlation of duration between chest tube and second intervention with operative time.

Figure 4



Blood transfusion according to operative time.

Figure 5



Drainage days after second intervention.

Discussion

Chest trauma is a critical problem in our society owing to the large number of blunt and penetrating trauma. Traumatic injuries managed with tube thoracostomy include pneumothorax, hemothorax, and hemopneumothorax. In most cases, this treatment together with respiratory therapy and pain management suffices. Some other patients require elective thoracotomy owing to increase in complications, such as retained hemothorax and empyema [2–4,9].

Table 3 Complications of group B

	n=19 [*n* (%)]
Wound infection	3 (15.7)
Empyema	4 (20.05)

Observation is the first approach for managing ~30% of patients with retained hemothorax, which results in a resolution rate of up to 82% [10].

We conduct this prospective, randomized study aiming to compare VATS with reinsertion of thoracostomy tube in patient with retained hemothorax.

Our study included 35 patients who had a confirmed diagnosis of retained hemothorax.

The percentage of patients included in the study and confirmed to have retained hemothorax accounted for 12.15% from all the patients presented with chest trauma and needed an thoracostomy tube; this is considered as a low number owing to the lack of follow-up and refusal of surgical intervention, although this value is within the range described in the world literature of 2–20% [9,11].

Sex distribution in our study showed high incidence of retained hemothorax among male than female patients (4: 1), which is near to the results of Huang [12] *et al.*, with male dominance of approximately 73.8%; this might be attributed to the more liability of males to trauma.

In contrast to others studies [9–19], in our study, the percentage of blunt trauma (62%) was higher than that of penetrating trauma (31%), which is near to that reported by Lin *et al.* [13]. The incidence of retained hemothorax was more with blunt trauma owing to laceration of great vessels, and acceleration and deceleration injury of lung parenchyma, and the most common cause was the displacement of fractured ribs.

The use of VATS is recommended in the first 3 days of injury [14]. This is to prevent the occurrence of dense adhesion, which may need conversion to thoracotomy. In another opinion [15], the early intervention (<48 h) with VATS may be more efficient and economical for managing retained hemothoraces [14,15].

In our study, the mean duration between the injury (first chest tube) and VATS evacuation was 5.4 days,

and range was 3–12 days, and operative time in our study ranged from 24 to 130 min, with mean time of 79.8 min.

In our study, there is a strong positive linear correlation between the operative time and the duration between first tube and VATS evacuation ($r = 0.702$ and $P = 0.002$), which can be explained by thickened fibrin layers on both visceral and parietal pleura, adhesion formation, and small lung lacerations that occur with long period of incomplete evacuation of retained hemothorax. These causes in addition to bleeding during intervention attributed the need of blood transfusion, which was found in 20.05% of our patients.

Operative time with uniportal VATS ranged from 24 to 110 min, with mean of 63.5 min, and at multiport VATS, the time ranged from 32 to 130 min, with mean of 96.25 min.

The outcome of VATS in retained hemothorax is directly dependent on the timing of intervention, with a conversion rate diminished from 15.8 to7.7% if surgery is completed by the sixth post-traumatic day [16].

We found the conversion percentage to open thoracotomy in VATS group was 6.25% owing to the presence of pleural thickening and dense adhesions with extensive fibrosis between lung and chest wall. In contrast, the conversion percentage to open thoracotomy in reinsertion of second thoracostomy tube group was 21.1% (four patients); this comes in agreement with the result of Meyer *et al*. [15].

In a previous study conducted between March 2009 and May 2013 in our facility, Elkhayat *et al.* [17] reported that the need for conversion to open thoracotomy was seen in 20% of all traumatic patients.

On follow-up, none of the patients treated by VATS presented with wound infection or residual amount or empyema, which was similar to Smith *et al*. [18].

On the contrary, the patients who were treated by reinsertion of second thoracostomy tube complained of wound infection in 15.7% and empyema in 20.05% which is near to other studies in the literature [19,20].

The essence of comparison between the standard treatment of retained hemothorax (reinsertion of tube thoracostomy) and new technique (VATS) is to find the suitable method to reduce hospital stay and hospital cost.

Longer drainage days in our study is explained by inappropriate pain control, lack of organized chest physiotherapy program, and our intensive follow-up radiologically.

In a study conducted between 2006 and 2007, Morrison and colleagues, found that the mean hospital stay was 10.8 days using only VATS, and also Lin and colleagues reported different results of mean tube drainage days after VATS, which were 8.2, 11.6, and 19.8, depending on the time between trauma (first chest tube) and VATS evacuation. Moreover, Migliore and colleagues reported mean hospital stay after VATS evacuation was 5.7 days [13,21,22].

Our study managed to involve many varieties of traumatic hemothorax but the significant time interval between the diagnosis of retained hemothorax and intervention was an obstacle.

Limitations

Our study had a limited number of patients, which can be exemplified by the decreased number of cases presented to our center that matched the criteria of the study.

Conclusion

Early VATS for evacuation of retained hemothorax is feasible and safe in patients with trauma. Moreover, VATS evacuation leads to shorter hospital stay and less need for open thoracotomy in comparison with reinsertion of a chest tube.

Uniportal VATS evacuation can lead to similar results as multiport VATS:

It is recommended that more studies with a large sample size need to be conducted in comparing VATS with other modalities for treatment of clotted hemothorax.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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