Management of retained hemothoraces after chest tube thoracostomy for trauma

Abordagem do hemotórax residual após a drenagem torácica no trauma

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INTRODUCTION

Post-traumatic retained hemothorax significantly increases hospital length of stay; total hospital costs; and is a major cause of morbidity in trauma. Post-traumatic empyema for example, is 12 to 16 times more common in patients who develop a retained hemothorax[1,2]. The actual incidence of retained hemothorax in patients who undergo chest tube thoracostomy for trauma remains uncertain. According to epidemiological studies, its incidence may vary from 4 to 20% of all chest tube insertions following trauma[3,4]. Other controversies also exist regarding retained hemothorax, particularly the lack of a broadly accepted definition.

Even though retained hemothorax can be defined on chest computed tomography (CT) examination as an undrained collection in the pleural cavity, regardless of the volume of blood, some authors consider only those collections greater e" 500ml. Blunting of the costophrenic angle on chest radiograph (x-ray) has also been used to define retained hemothorax, regardless of the time interval between the initial chest tube thoracostomy and its identification by this imaging method. However, others consider that blunting of the costophrenic angle is only of clinical relevance when detected more than 72 hoursof the initial chest tube placement[5].

The best time to intervene in retained hemothorax is also a matter of debate. Early intervention is considered between 24 hours and 3 days after the diagnosis, while late intervention is performed between 4 and 10 days. Unfortunately, there is no available evidence supporting one particular strategy over another.

Currently, several options are available for the management of retained hemothoraces; the following strategies are commonly used: observation; image-guided percutaneous decompression (IGPD); placement of a second chest tube (2nd Chest Tube); intrapleural thrombolytic therapy; video-assisted thoracoscopy (VATS); thoracotomy; and pleurostomy.

The participants of the Evidence Based Telemedicine - Trauma and Acute Care Surgery (TBE-CiTE) Group conducted a critical review of the literature on the management of post-traumatic retained hemothoraces. Based on the discussion of the most relevant studies, recommendations were elaborated for the management of retained hemothorax after chest tube placement in trauma.

STUDY 1

"Early evacuation of traumatic retained hemothoraces using thoracoscopy: a prospective, randomized trial"[6].

Rationale

Retained hemothoraces can cause severe pleural complications. VATS is a minimally invasive technique that can be used to treat several intrathoracic complications. Therefore, early VATS may be an effective management strategy for the treatment of retained hemothoraces, reducing length of stay and hospital costs.

Question

What is the best strategy to treat retained hemothorax after chest tube thoracostomy for trauma: placement of an additional thoracostomy tube, VATS, or both?

Main findings of this study

The diagnosis of a retained hemothorax or a retained hemo-pneumothorax was made by chest x-ray

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within 72 hours of the initial chest tube placement. The Intent-to-treat analysis comparing early VATS (n=15 patients) to additional chest tube placement (n=24 patients) showed significant ($p < 0.02$) better outcomes favoring early VATS with respect to: duration of chest tube thoracostomy, length of stay after the procedure, total hospital length of stay, and costs. All outcomes measures had relative risk reductions of approximately 50%. Furthermore, none of the VATS group patients required additional treatment for retained hemothorax. Ten patients in the additional chest tube thoracostomy group did not improve after the procedure and underwent subsequent VATS or thoracotomy. At 6-month follow-up the authors reported no mortality among the patients. Atelectasis, residual pneumothorax and recurrent hemothorax were the complications, but there were no significant differences between the groups. Severe complications, such as, empyema and fibrothorax did not occur in either group.

Strengths

· It is a prospective randomized study. This is the only study meeting level I evidence criteria published since 1997;

· It included only stable patients who had sustained thoracic trauma, and undergone tube thoracostomy with chest tubes of the same size, thus reducing confounding factors. This is of particular importance in a study with a small sample size;

· Chest tube removal followed a pre-established protocol (< 80 ml /8h and absence of air leak), reducing variability;

· Antibiotic use was protocolized;

· Patients who presented with minimal costophrenic angle blunting were excluded. Other studies have shown that patients with minimal blunting of costophrenic angle do not require invasive procedures, and can be managed expectantly with success;

· The diagnosis of retained hemothorax was based on a single imaging method(chest x-ray). Even though, chest CT scan is more commonly used than x-ray, there are no good quality studies to support one method over another in the diagnosis of retained hemothorax;

· A 6-month follow-up allowed enough time to detect late complications as a result of the procedures.

Limitations of the study

· Small sample size (n=15 VATS group and n=24 in the additional tube thoracostomy group). The initial estimate of sample size to achieve statistical significance was 90 patients, but the study was interrupted with 39 patients after interim analysis showed statistical significance. Therefore, the study is limited by the small sample size and may be prone to a type I error, where one assumes that there is a difference between the groups when there actually is not; erroneously accepting the *null hypothesis* as true;

· The statistical method used for sample size calculation was not described in the study, as well as, the randomization process;

· Because of the nature of the interventions this study was not masked/blinded. Therefore, individual preference for a procedure is an important limitation;

· Hospital discharge criteria were not established previously, and could have varied amongst physicians;

· It is not clear in the study if the difference in sample size was accounted for in the calculation of hospital costs. An analysis involving the average cost per patient should have been performed;

· This is an old study, conducted over a long period (4 years), and therefore does not correctly represent the changes in clinical practice that have occurred;

· A clear definition of a retained hemothorax and a residual clot was not reported in the study. Even though they may be considered synonyms, it is important to define when they become clinically relevant;

· The authors did not report the volume or the radiologic findings of the retained hemothoraces. That information is important in the choice between conservative and surgical management;

· The authors did not report the number of patients that underwent chest tube thoracostomy for trauma and did not develop retained hemothoraces during the study period. Therefore, the incidence of retained hemothorax in their institution is unknown, and pre-emptive VATS in retained hemothoraces cannot be recommended;

STUDY 2

Management of post-traumatic retained hemothorax: a prospective, observational, multicenter AAST study[7].

Rationale

The natural history of retained hemothorax after chest tube thoracostomy for trauma is poorly understood. Management of post-traumatic retained hemothorax is currently controversial. Outlining independent predictors of successful management would provide valuable information about the treatment of retained hemothoraces in trauma.

Question

What are the current practices in the management of post-traumatic retained hemothorax? What are the factors involved in successful management? What are the independent predictors of the need for thoracotomy?

Main findings of this study

A total of 20 institutions from the United States, Canada and South America (including Brazil) participated in the study. During a 2-year (2009-2011), 328 patients were enrolled in the study.

The time from the initial chest tube placement for trauma and the diagnosis of retained hemothorax ranged from 1 to 30 days; 32% were diagnosed within 72 hours and 87.2% within 10 days. The presence of a hemothorax was the main reason for initial chest tube placement (53.4%), and the procedure was conducted in the emergency department for 65.5% of the patients. The majority (60%) of the hemothoraces were considered small (d" 300ml). Six different management strategies for retained hemothoraces were reported: observation, IGPD, second chest tube, intrapleural thrombolytic therapy, VATS, and thoracotomy. The most successful management strategy was observation (82.2%) (Table-1). A 2nd procedure was necessary in 112 patients (34.1%) and still a 3rd procedure was necessary in 18 patients (5.4%). There were no significant differences among the strategies used as 2nd and 3rd procedures; nonetheless, observation was never used. Infectious complications were common among study participants. More than a quarter of the patients (26.8%) developed empyema and 19.5% developed pneumonia. Both complications significantly increased intensive care unit and hospital length of stay. Prophylactic antibiotics were used in less than half the cases (40.6%).

Using demographic data, trauma characteristics, and the treatment strategy, the authors identified factors independently associated with the need for thoracotomy. Additionally, independent factors associated with successful intervention of each of the management strategies were also identified after stepwise logistic regression (Table - 1). The authors also investigated whether the timing of VATS correlated with treatment success for retained hemothorax, and no correlation was noted. Ultimately, the authors examined the correlation between the CT scan estimation of retained hemothoraces volumes and the results of operative evacuations (VATS or thoracotomy); results showed a weak correlation between the two (Pearson Product-Moment Correlation Coefficient (r) = 0,246; r^2 = 0,06; p = 0,004).

Strengths

· Multicenter, prospective study meeting level II evidence criteria, involving several institutions in different countries;

· Clear definition of the objectives and a concise methodology;

· Clear definitions for retained hemothoraces and complications;

· Large sample size obtained in a short period of time, and the data reported is recent;

· The study sample represents the general trauma patient population with respect to: age, gender, and mechanisms of injury; which allows generalization of study findings;

· Logistic regression analysis was used to identify independent predictors of successful intervention of each of the 6 types of management choices of retained hemothoraces.

Table 1 - Management strategies of retained hemothoraces, success rates, and independent predictors of successful management* (DuBose et al.)[6]

Management strategy	Number of patients (%)	Success rate	Independent predictors of success	Adjusted OR (95% CI*)
Observation	101 (30,8%)	82,2%	Retained hemothorax d" 300ml initial pneumothorax; left side thoracostomy	3,7 (2,0 - 7,0); 2,7 (1,5 - 4,8); 2,1 (1,2 - 3,8); respectively
Thoracotomy**	24 (7,3%)	79,2%	Diaphragmatic injury;** retained hemothorax > 900ml;** no antibiotic prophylaxis**	4,9 (2,4-9,9) 3,2 (1,4-7,5) 2,3 (1,2-4,6) respectively
VATS	110 (33,5%)	70,0%	No diaphragmatic injury; antibiotic prophylaxis; retained hemothorax < 900ml	4,7 (1,6 – 13,7); 3,3 (1,2 – 9,0); 3,9 (1,4 – 13,2); respectively
IGPD	17 (5,2%)	58,8%	Initial pneumothorax; retained hemothorax < 300ml	3,7 (1,5 - 9,1); 3,4 (1,3 – 8,9) respectively
2nd Chest tube	61 (16,6%)	36,1%		
Thrombolytics	15 (4,6%)	33,3%	(no data)	(no data)

**After stepwise logistic regression; **Independent predictors of the need for thoracotomy in retained hemothoraces.*

Limitations of the study

· The study was observational, without a control group to compare management strategies;

· The lack of pre-established diagnostic criteria, as well as, diagnostic methods among the participating centers, may have contributed to increase variability in the study;

· The confidence intervals in the logistic regression analysis were relatively large, indicating less precise estimates of effects;

· The logistic regression analysis included too many variables increasing the likelihood of collinearity and overfitting of the model; The first may obscure the independent contribution of certain variables, while the latter may inaccurately demonstrate significance of prognostic variables;

· The authors did not report the number of patients that underwent chest tube thoracostomy for trauma and did not develop retained hemothoraces during the study period. Therefore, the incidence of retained hemothorax in the study population is unknown.

· Management of retained hemothoraces was based on the discretion of the surgeons of each participating center, and hence increasing the possibility of variances. Furthermore, the role of different resources and capabilities of each institution was not investigated, adding another limitation to the conclusions.

· The average ISS of the study population was 20.7. However, only 12% of the trauma patient population present ISS values within that range 16-24. Therefore, management strategies described in this study may not be applicable to less severely injured patients who develop retained hemothoraces.

· The weak correlation between CT scan estimation of retained hemothoraces volumes and the results of operative evacuations raisessome skepticism about the reliability of the method, and may have interfered with the results.

· Independent predictors of successful intrapleural thrombolytic therapy were not described.

STUDY 3

Best timing for thoracoscopic evacuation of retained post-traumatic hemothorax[8].

Rationale

The literature shows that the incidence of retained hemothorax after chest tube thoracostomy is approximately 5 to 30%. Thoracotomy and VATS are among the surgical interventions commonly used to treat retained hemothoraces. However, such procedures are not without complications, and the best time to perform them remains undetermined. Therefore, standardizing various strategies of retained hemothorax management may improve patient outcome.

Question

What is the best time to perform VATS for retained hemothorax after chest tube thoracostomy for trauma in order to enhance the safety and the effectiveness of the procedure?

Main findings of this study

Patients who underwent VATS for the management of retained hemothoraces (average volume 452 ml) within the first 5 days after trauma had a success rate greater than 73.4%.

Strengths

· The authors assessed the relative risk of the need for thoracotomy if VATS was not performed within the first 5 days post-trauma (RR 1.99);

· A detailed description of the operative procedure was provided by the authors;

· The authors assessed the relative risk of unsuccessful evacuation of retained hemothoraces in the presence of parietal and visceral pleural thickenings; respectively (RR 2.44 and 3.11);

· The authors also emphasize that CT scan findings are helpful to determine the indication for VATS procedure, and that chest x-ray is a useful first imaging test;

· The study recommends that evacuation of retained hemothoraces by VATS, after chest tube placement for trauma, should be done within the first 5 days after the initial injury;

Limitations of the study

· This is a prospective cohort study that has no control group;

· There were no adjustments made for potential confounding factors that could have had an impact on the results, such as, associated injury, injury severity, and pre-existing medical conditions;

· Even though the two diagnostic methods used in the study, chest x-ray and CT scan, are in accordance with the literature, the indication for chest CT scan in retained hemothorax was not well defined by the authors;

· The role of a positive pleural fluid culture was not assessed in the study;

TBE-CITE CONCLUSIONS

The conclusions are predominantly based on the three studies discussed by the TBE-CiTE Group.

· The lack of a widely accepted definition for retained hemothorax after chest tube thoracostomy in trauma constitutes an important limitation for developing practice management guidelines;

· Chest x-ray is frequently used as a first imaging method, but chest CT scan is becoming the most common diagnostic modality for post-traumatic retained hemothorax;

· Blunting of the costophrenic angle on a posterior to anterior (PA) chest x-ray corresponds to a pleural fluid collection of approximately 300ml;

· The risk of thoracic infectious complications increases in the presence of a retained hemothorax;

· The size of the retained hemothorax affects the success rate of the management strategy used; particularly when observation is utilized;

· The time interval between diagnosis and treatment of a retained hemothorax affects the type and the success rate of the intervention used. Available evidence from a randomized controlled trial supports the early use of VATS in the treatment of retained hemothoraces after chest tube thoracostomy in trauma; reductions in lengths of stay and hospital costs were demonstrated.

TBE-CiTE RECOMMENDATIONS for the "Management of retained hemothoraces after chest tube thoracostomy in trauma".

1. Small retained hemothoraces (d" 300ml) after chest tube thoracostomy for trauma, with no evidence of infectious complication, should be observed.

2. Placement of a 2nd thoracostomy tube to treat retained hemothoraces should be avoided; particularly in pleural fluid collections > 300ml.

3. VATS should be performed between the 3rd and the 5th days after the diagnosis of a retained hemothorax; thus increasing the success rate of the procedure.

4. Thoracotomy is the best surgical option to treat large and complicated retained hemothoraces; particularly when other strategies have failed.

REFERENCES

1. Aguilar MM, Battistella FD, Owings JT, Su T. Posttraumatic empyema. Risk factor analysis. Arch Surg. 1997;132(6):647-50; discussion 650-1.
2. Karmy-Jones R, Holevar M, Sullivan RJ, Fleisig A, Jurkovich GJ. Residual hemothorax after chest tube placement correlates with increased risk of empyema following traumatic injury. Can Respir J. 2008;15(5):255-8.
3. Heniford BT, Carrillo EH, Spain DA, Sosa JL, Fulton RL, Richardson JD. The role of thoracoscopy in the management of retained thoracic collections after trauma. Ann Thorac Surg. 1997;63(4):940-3.
4. Smith JW, Franklin GA, Harbrecht BG, Richardson JD. Early VATS for blunt chest trauma: a management technique underutilized by acute care surgeons. J Trauma. 2011;71(1):102-5; discussion 105-7.
5. Smith RS, Fry WR, Tsoi EK, Morabito DJ, Koehler RH, Reinganum SJ, et al. Preliminary report on videothoracoscopy in the evaluation and treatment of thoracic injury. Am J Surg. 1993;166(6):690-3; discussion 693-5.
6. Meyer DM, Jessen ME, Wait MA, Estrera AS. Early evacuation of traumatic retained hemothoraces using thoracoscopy: a prospective, randomized trial. Ann Thorac Surg. 1997;64(5):1396-400; discussion 1400-1.
7. Dubose J, Inaba K, Demetriades D, Scalea TM, O'Connor J, Menaker J, et al. Management of post-traumatic retained hemothorax: a prospective, observational, multicenter AAST study. J Trauma Acute Care Surg. 2012;72(1):11-22; discussion 22-4.
8. Morales Uribe CH, Villegas Lanau MI, Petro Sánchez RD. Best timing for thoracoscopic evacuation of retained post-traumatic hemothorax. Surg Endosc. 2008;22(1):91-5.

Declaração: As recomendações e conclusões deste artigo representam a opinião dos participantes da reunião de revista TBE-CiTE e não necessariamente a opinião das instituições às quais eles pertencem.

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