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Original Article

Optimum Timing of Video Assisted Thoracoscopic Surgery in Acute Chest Injury

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ABSTRACT

Objective: To compare the clinical outcome in terms of length of hospital stay, duration of chest tube drainage, conversion to open thoracotomy and post-injury chest infections; between the Early VATS and Late VATS groups.

Study Design: Cross-sectional comparative study.

Place and Duration of Study: Department of Surgery, Benazir Bhutto Hospital, Rawalpindi Pakistan, from Oct 2020 till Sep 2022.

Methodology: Sixty-two patients undergoing VATs for acute chest injury were divided into two groups; early VATs within first 5 days of chest injury and late VATs after 5th day of chest injury. Outcome variables compared between the two groups were length of hospital stay, duration of chest tube drainage, conversion to open thoracotomy and chest infection rate. Numerical data were compared using the independent sample T-test and categorical variables were compared using the Chi square test. A *p*-value of <0.05 was considered statistically significant.

Results: In our study the Early VATS group had a significantly shorter length of hospital stay, lesser days on ventilator, shorter total duration of chest tube drainage as compared to Late VATS group. However, duration of post VATS tube drainage, requirement for secondary VATS and conversion rate to open thoracotomy were similar in both groups. Moreover, infection rate was significantly lower in the Early VATS group.

Conclusion: Early VATS in chest injury is associated with better clinical outcome.

Keywords: Chest injury, Early VATs, Hemothorax, Pneumothorax, VATs.

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INTRODUCTION

Injury is the leading cause of death in adults; according to Centers for Disease Control and Prevention, these deaths constitute about 9% of total deaths.[1] Chest injury accounts for 30-60% of all injury cases,[2] and is third most common cause of death after abdominal and head injuries in polyinjury patients.[3] After chest injury 85% patients can be managed conservatively with analgesia, resuscitation and tube thoracostomy. However, the remaining 15% require intervention for further evaluation and treatment.

The use of VATS was first recorded in 1946 by Branco in penetrating chest injuries,[4] later its use was described by Jackson and Ferreira in 1976,[5] and by Jones *et al.* in 1981.[6] Despite these early reports, VAT became popularized for the management of chest injury only recently.

In chest injury most hemothoraces and pneumothoraces are managed by tube thoracostomy.[7] Patients with hypovolemic shock usually warrant an emergency thoracotomy. However, when the vitals are stable they can be managed with video-assisted thoracoscopic surgery (VATS). This technique is advantageous because of its safety, simplicity and efficacy in acute phase as well as in treatment of complications.[8]

VAT has been found to be an effective and safe method for managing patients with thoracic injuries for indications like persistent pneumothorax, retained hemothorax, empyema and for diagnosis of diaphragmatic, esophageal or mediastinal injuries. VATS has mostly been employed in chronic complications of thoracic injury. There is little data available about its use in more acute settings. There is a wide variation in the exact recommended time for operation after injury in different studies. We have been performing VATS for chest injury for the last some years. We hypothesized that VATS is associated with better clinical outcome in acute management of chest injury patients when performed within first 5 days of injury.

METHODOLOGY

It was a cross-sectional comparative study carried out at Department of Surgery of Benazir Bhutto Hospital, affiliated with Rawalpindi Medical University, Rawalpindi Pakistan. The study was carried out over two years from October 2020 till September 2022.

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We collected data of patients undergoing VATS for chest injury.

In the injury patients initial evaluation, resuscitation and stabilization was performed in the emergency. All patients underwent a chest X-ray. A CT thorax was also performed in patients if there was a suspicion of great vessel or vascular injury and an echocardiography was performed if cardiac injury was suspected. Based on clinical and radiological evidence of pnemohemothorax chest tube was passed and the initial and subsequent drainage output was used as a guide for the need of subsequent intervention.

Inclusion Criteria: VATS was performed in patients who were hemodynamically stable with systolic BP >90mmHg if: chest tube drained >1000ml blood immediately after its insertion or there was continuous bleeding in chest tubes more than 250ml/hour for four hours after chest tube insertion, retained haemothorax (residual clots at least 300 ml large, or in which at least one-third of the blood in the pleural space cannot be drained by a chest tube after 72 hours), persistent pneumothorax (ongoing bubbling of air from an in situ chest drain, 48 h after its insertion), evaluation of the diaphragm in penetrating thoraco-abdominal injuries, for management of infected pleural space collections, suspected esophageal or mediastinal injury and/or suspected foreign body in thoracic cage.

Exclusion Criteria: The patients were excluded from the study if patient was hemodynamically unstable with systolic BP less than 90 mm Hg, inability to tolerate single lung ventilation, associated head injury or abdominal injuries requiring laparotomy, presence of flail chest, patients with disruption of mediastinal structures including heart, great vessels tracheob-ronchial tree, and patients with serious medical disorders like liver cirrhosis, congestive cardiac failure, renal failure on dialysis, chronic obstructive lung disease and respiratory failure patients.

VATS was performed by the surgical specialist on duty. It was performed in the operating room under general anesthesia and selective single lung ventilation was used.

The patient was placed in lateral position on the healthy side. The ipsilateral arm was abducted at the shoulder to 90^o. This position was selected because if thoracoscopy was not successful, it could easily be converted to open thoracotomy. Three small incisions were made; one for camera port and the other two for instrument ports. We used three 12mm ports. First incision for camera port was made at 7th or 8th intercostal space just anterior to the mid-axillary line. Second incision was given at the anterior axillary line, which allowed adequate inspection of the thoracic cavity. Third incision was made posteriorly at the 5th or 6th intercostal space, adjacent to scapula. All patients had collections evacuated, clots removed, the pleura decorticated, lung lacerations were stitched and pleural cavity was irrigated with normal saline. Thereafter, lung was re-expanded and a 32Fr chest tube was inserted for drainage. If we needed to convert it to open thoracotomy we connected the anterior and the posterior port sites through an incision. Prophylactic antibiotic (3rd generation cephalosporin) were given at time of induction of anesthesia and continued till the chest tube was out.

After the procedure the patient was transferred to ICU for further postoperative care. Patients postoperative ABGs guided to the need of ventilator support. The chest drains were removed if the drainage volume was <100ml/day and no air leak was detected. Patients were followed up in the surgical OPD 2 and 4 weeks after discharge.

Secondary VATS was repeat VATS which was performed for retained volumes exceeding 300ml or para-pneumonic effusions appearing on CT as separate loculated collections.

Post injury chest infections included; pus in pleural cavity confirmed on fluid culture; pneumonia as confirmed on sputum culture or sepsis confirmed by positive blood cultures.

Patients undergoing VATS were divided into two groups; patients undergoing VATS in the first 5 days of chest injury and were categorized as "Early VATS Group"; while those undergoing VATS after the fifth day of chest injury and were categorized as "Late VATS Group".

RESULTS

A total of 62 patients undergoing VATS were included in the study. Out of these 27(43.5%) underwent VATS in the first 5 days of chest injury and were categorized as "Early VATS Group". Remaining 35 (56.5%) patients underwent VATS after the 5th day of chest injury and were categorized as "Late VATS Group". All patients had a chest X-ray performed, 17 had a CT chest and all patients had a chest tube placed.

Chest injury was either penetrating injury in 33(53.2%) patients; out of these 20 had gunshot injury and 13 had stab injury. Remaining 29 had blunt chest injury; out of these 11 had history of fall, 16 had a road traffic accident and 2 had history of violence.

Demographic characteristics of the two groups are summarized in Table-I. The mean age of the patients in the Early VATS group was 38.7±16.25 and in the Late VATS group was 44.48±15.65 years; the two groups were not statistically different with respect to age distribution (*p*=0.161). In the early VATS group 19 were males and 8 were females. In the Late VATS group 16 were males and 19 were females; gender distribution was not statistically different between the two groups (*p*=0.879). In the Early VATS group 17 had penetrating injury and 10 had blunt chest injury. In the Late VATS group 16 had penetrating injury and 19 had blunt chest injury; distribution of type of injury was not statistically different between the two groups (*p*=0.177). sForty (64.5%) patients had right sided chest injury and 22(35.5%) had left sided chest injury. The proportion of patients with right sided chest injury was higher in the Early VATS group; *p*=0.05.

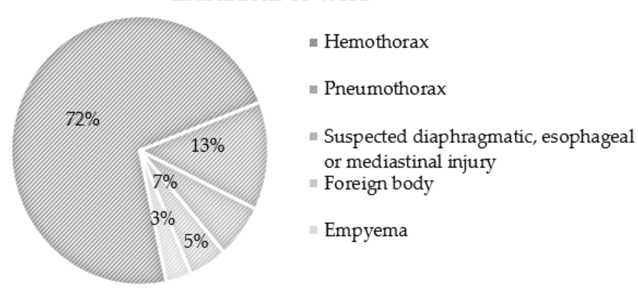

Figure: Indications of VATS in chest injury patients

Table-I: Demographic characteristics; Early VATS vs. Late VATS groups

Patient characteristic	Early VATS 27(43.5%)	Late VATS 35(56.5%)	*p*-value
Age, in years±SD	38.7±16.25	44.48±15.65	0.161
Gender			
Male	19	24	0.879
Female	8	11	
Type of injury			
Penetrating injury	17	16	0.177
Blunt injury	10	19	
Side of injury			
Right	21	19	0.05
Left	6	16	

VATS was performed due to hemothorax in 45(72.5%), persistent or open pneumothorax in 8(13%) patient, and suspected diaphragmatic, esophageal or mediastinal injury in in 4(6.5%) patients, foreign body in 3(4.8%) and empyema in 2(3.2%) patients.

Among the 45 hemothorax patients, blood was evacuated, thirty of them had active bleeding in which the bleeding vessel was sutured. Eight patients had wound in the chest wall which were repaired. Twenty had lung lacerations which were stitched. The patients in whom there was a suspicion of diaphragmatic rupture, one had it confirmed but was repaired through the abdominal approach. In 8 persistent pneumothorax patients lung lacerations were repaired. No mediastinal or esophageal injury was found. In Late VATS group two had empyema which required decortication.

The two groups were compared with respect to clinical outcome. Length of hospital stay (LOS) was significantly longer in the Late VATS group; 13.74±3.80 days in Late VATS vs. 7.77±2.32 days in Early VATS; *p*≤0.00. Number of post VATS ventilator days were significantly more in the Late VATS group; 2.54±2.33 days in Late VATS vs. 0.925±1.49 days in Early VATS; *p*=0.003. Total duration of tube drainage was significantly more in the Late VATS group; 10.82±3.04 days in Late VATS vs. 5.96±1.84 days in Early VATS; *p*≤0.00.

However, duration of post-VATS tube drainage was similar in the two groups; 4.76±2.47 days in Late VATS vs. 4.07±1.81 days in Early VATS; *p*=0.230

Table-II: Clinical outcome; Early VATS vs. Late VATS groups

Clinical Outcome Parameter	Early VATS (27)	Late VATS (35)	*p*-value
Timing of VATS, days	3.14±0.66	7.28±1.39	<0.001
Hospital length of stay (LOS), days	7.77±2.32	13.74±3.80	<0.001
Number of post VATS ventilator, days	0.925±1.49	2.54±2.33	0.003
Duration of total tube drainage, days	5.96±1.84	10.82±3.04	0.00
Duration of post VATS tube drainage, days	4.07±1.81	4.76±2.47	0.230
Requirement of secondary VATS	3(11.11%)	7(20%)	0.345
Conversion to open thoracotomy	1(3.7%)	3(8.6%)	0.439
Post-injury infections	2(7.4%)	11(31.4%)	0.021
Mortality	0	1(2.8%)	0.376

Three out of 27(11.11%) patients in the Early VATS and 7 out of 35(20%) patients in the Late VATS group required a second VATS; frequency was not significantly different between the two groups; *p*= 0.345. One out of 27(3.7%) patients in the Early VATS and 3 out of 35(8.6%) patients in the Late VATS group required conversion to open thoracotomy, in majority due to presence of adhesions. Two(7.4%) patients in the Early VATS and 11 out of 35(31.4%) patients in the Late VATS group developed post injury infection in the form of positive pleural fluid bacterial culture; *p*= 0.021. No mortality occurred in the early VATS group and 1(2.8%) dies in the Late VATS group because of respiratory failure.

DISCUSSION

The aim of current study was to identify the most appropriate time for performing VATS in patients with chest injury. Typically VATS has been used in management of thoracic injury in the subacute and chronic setting usually days or weeks after the initial injury.[9] In these settings the usual indications include empyema, retained hemothorax, removal of foreign bodies, and treatment of thoracic duct injuries. We aimed to present the utility and safety of VATS in acute settings (within 5 days of chest injury). We chose a cut off limit of 5 days for categorization of Early VATS group on the basis of the study by Lin *et al.*[10] who showed that early VATS within 5 days was associated with better clinical outcome.

In our study the Early VATS group had a significantly shorter length of hospital stay, lesser days on ventilator, shorter total duration of chest tube drainage as compared to Late VATS group. However, duration of post VATS tube drainage, requirement for secondary VATS and conversion rate to open thoracotomy were similar in both groups. Moreover, infection rate was significantly lower in the Early VATS group.

After chest injury the most important factor influencing the length of hospital stay is in fact "post-injury infections".[11] They are secondary to retained pleural collections. VATS provides excellent visualization of pleural cavity which helps in effectively clearing the pleural collections thus minimizing the infection rate.[12]

VATS applied after the first 5 days of chest injury may encounter the presence of adhesions, converting the plain thoracoscopy into a complex one, increasing the risk of parenchymal injury with air leaks and the development of empyema.[13] Considering these risks many suggest to utilize VATS as early as possible after chest injury but there is little data available about using VATs in the acute and early setting after chest injury. Landreneau *et al.*[14] suggested that VATS should be performed early but they did not mention the exact time. Heniford *et al.*[15] recommended that VATS should be performed within 7 days after injury.

Meyer *et al.*[16] also evaluated the benefits of early VATS for retained haemothorax and indicated that replacing additional tube thoracostomies with early VATS performed within three days after injury may shorten overall durations of tube thoracostomies and in-hospital length of stay. The same results were obtained by Smith *et al*.[13] except that the time for VATS perfor-mance was suggested within five days after injury. Morales Uribe *et al.*[17] also supported that early VATS within five days after injury could increase the success rate and decrease the rate of conversion to thoracotomy. However, recent research by the American Association for the Surgery of Injury (AAST) Retained Haemothorax study group found no relationship between timing and success rate of VATS.[18] Although there is a tendency that VATS should be considered as early as possible in many studies, the definite timing is not very clearly understood.

Another study conducted by Lin *et al.*[10] categorized patients into Group-1, undergoing VATS in first 3 days of chest injury; Group-2, undergoing VATS in from 4-6 days and Group-3, undergoing VATS after 6th day. They found that Group-3 had the highest rate of infections. Ultra-early VATS in Group-1 led to the lowest infection rates. The length of stay, duration of ventilator support and duration of tube drainage were significantly shorter for Group-1 and 2 as compared to Group-3. They predicted that these benefits might have been derived from prevention and early control of post-injurytic chest infections. Early VATS also helps in early restoration of lung, since the retained pleural collections induce the lungs to collapse. Early VATS leads to early expansion of lung. They finally concluded that clinical outcome were significantly better for patients undergoing VATS within 3 days. They suggested that VATS might be delayed by associated injuries but it should not exceed 6 days after injury.

Smith *et al*.[13] presented a retrospective review of 83 patients who underwent VATS for chest injury. Majority of the patients (73%) were for retained hemothorax, 10% for persistent air leak and 18% for empyema. In this study VATS performed early i.e. ≤5 days was associated with a lower conversion to open thoracotomy (8% vs. 29.4%, $p<0.05$). Moreover early VATS was also associated with significantly shorter length of hospital stay (11±6 vs. 16±8, $p<0.05$). No patients treated with early VATS had persistent empyema. However, in delayed VATS 5% patients required further intervention for thoracic infection.

Goodman *et al.*[19] presented data of 23 patients who underwent VATS within 24 hours of admission. They found early VATS to be effective and safe in managing chest injury patients.Three patients (13%) had blunt chest injury and 20(87%) had penetrating chest injury. Indications included diaphragmatic/ esophageal injury, ongoing hemorrhage, and open pneumothorax. No conversions to thoracotomy were required and no patient required re-operation. Mean length of hospital stay was 5.6 days and mean duration of chest tube drainage was 2.9 days. They demonstrated that VATS is safe and effective in acutely injured patients. The outcome are similar to those reported by Meyer *et al.*[16] In this study patients who failed non-operative management with tube thoracostomy were randomized to VATS or thoracotomy at 72 hours after injury. Patients undergoing VATS had significantly shorter postoperative length of stay and chest tube duration compared to patients undergoing thoracotomy.

In our study majority patients underwent VATS for hemothorax; other studies have also mentioned it to be the most common indication of VATS in chest injury; in about 40-60% patients. The basic principle is to assess the extent of intra-thoracic injury, arrest bleeding and drain the haemothorax. Blood within the pleural space is a good medium for bacterial growth and delayed drainage increases the risk of intrapleural infections. Chou *et al.*[20] showed that VATS is superior to tube thoracostomy alone with lesser post-injury infection rate (17.8% vs. 46.5%; p=0.004), overall hospital stay and duration of ventilator dependency.[21] In patients with lung lacerations where there is ongoing blood loss VATS is a useful method because it allowed for closure of lacerations using stapling devices.[21]

Our study had certain limitations. VATS was performed by different surgical specialists and the operation methods and skills may be different in each case. Moreover, hospital acquired pneumonia is difficult to differentiate from post-injurytic chest infection in injury patients and might be responsible for poor clinical outcome in some patients.

CONCLUSION

Early VATS in chest injury is associated with better clinical outcome in terms of shorter length of hospital stay, duration of chest tube drainage, duration of ventilatory support and lower infection rate.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

AA & YI: Conception, study design, data acquisition, critical review, approval of the final version to be published.

SA & MA: Data analysis, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Breugel JM., Niemeyer MJ, Houwert RM. Global changes in mortality rates in polytrauma patients admitted to the ICU—a systematic review. World J Emerg Surg 2020; 15(1): 55.
2. Mahoozi HR, Volmerig J, Hecker E. Modern management of traumatic hemothorax. J Trauma Treat 2016; 5(1): 326.
3. Lecky FE, Bouamra O, Woodford M, Alexandrescu R, Brien SJ. Epidemiology of polytrauma. InDamage control management in the polytrauma patient 2010; (1): 13-24.
4. Branco JMC. Thoracoscopy as a method of exploration in penetrating injuries of the thorax. Dis Chest 1946; 12: 330-335.
5. Jackson AM, Ferreira AA. Thoracoscopy as an aid to the diagnosis of diaphragmatic trauma in penetrating wounds of the left lower chest: A preliminary report. trauma 1976; 7(1): 213–217.
6. Jones JW, Kitahama A, Webb WR, McSwain N. Emergency thoracoscopy: A logical approach to chest trauma management. J Trauma 1981; 21(1): 280–284.
7. Yuh DD, Doty JR, Vricella LA, et al. Thoracic Trauma. In: Yuh DD, Vricella LA, editors. John Hopkins textbook of cardiothoracic surgery. Second Edi. New York, NY: McGraw Hill Education; 2014; (1): 9-24.
8. Alwatari Y, Simmonds A, Ayalew D, Khoraki J, Wolfe L, Leichtle SW, et al. Early video-assisted thoracoscopic surgery (VATS) for non-emergent thoracic trauma remains underutilized in trauma accredited centers despite evidence of improved patient outcomes. Eur J Trauma Emerg Surg 2022; 48(4): 3211-3219.
9. Lodhia JV, Konstantinidis K, Papagiannopoulos K. Video-assisted thoracoscopic surgery in trauma: pros and cons. J Thorac Dis 2019; 11(4): 1662-1667.
10. Lin HL, Huang WY, Yang C, Chou SM, Chiang HI, Kuo LC, et al. How early should VATS be performed for retained haemothorax in blunt chest trauma? 2014; 45(9): 1359-1364.
11. Eren S, Esme H, Sehitogullari A, Durkan A. The risk factors and management of posttraumatic empyema in trauma patients. Injury 2008; 39(1): 44–49.
12. DuBose J, Inaba K, Okoye O, Demetriades D, Scalea T, O'Connor J, et al. Development of posttraumatic empyema in patients with retained hemothorax: results of a prospective, observational AAST study. J Trauma Acute Care Surg 2012; 73: 752–757.
13. 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): 102-105.
14. Landreneau RJ, Keenan RJ, Hazelrigg SR, Mack MJ, Naunheim KS. Thoracoscopy for empyema and hemothorax. Chest 1996; 109(1): 18–24.
15. Heniford BT, Carrillo EH, Spain DA, Richardson JD. The role of thoracoscopy in the management of retained thoracic collections after trauma. Ann Thorac Surg 1997; 63(1): 940–943.

16. 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(1): 1396–1400.
17. Morales Uribe CH, Villegas Lanau MI, Petro Sanchez RD. Best timing for thoracoscopic evacuation of retained post-traumatic hemothorax. Surg Endosc 2008; 22(1): 91–95.
18. DuBose J, Inaba K, Okoye O, Demetriades D, Scalea T, O'Connor J, et al. Development of posttraumatic empyema in patients with retained hemothorax: results of a prospective, observational AAST study. J Trauma Acute Care Surg 2012; 73(1): 752–757.
19. Goodman M, Lewis J, Guitron J, Reed M, Pritts T, Starnes S, et al. Video-assisted thoracoscopic surgery for acute thoracic trauma. J Emerg Trauma Shock 2013; 6(2): 106-109.
20. Chou YP, Kuo LC, Soo KM. The role of repairing lung lacerations during video-assisted thoracoscopic surgery evacuations for retained haemothorax caused by blunt chest trauma. Eur J Cardiothorac Surg 2014; 46(1): 107-111.
21. Thoongsuwan N, Kanne JP, Stern EJ. Spectrum of blunt chest injuries. J Thorac Imaging 2005; 20(1): 89-97.

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