Research Article

Trocar thoracostomy or blunt dissection thoracostomy - Which is safe?

Pankaj Kumar Omar[1], Amit K Asati[2], Anikta Borkar[1], Shipra Surin[1]

[1]Department of Critical Care, Shree Narayana Hospital, Raipur, Chhattisgarh, India, [2]Department of TB and Chest Diseases, Shree Narayana Hospital, Raipur, Chhattisgarh, India

Correspondence to: Pankaj Kumar Omar, E-mail: pankajomar@rediffmail.com

Received: February 08, 2018; **Accepted:** February 24, 2018

ABSTRACT

Background: Thoracostomy is done frequently in cases of chest trauma, pneumothorax, hydrothorax, or after cardiothoracic surgeries to drain the collected fluid, blood, or air. Thoracostomy most often is a bedside procedure done by general surgeons, intensivists, emergency room physicians, or respiratory physicians either electively or in emergency. There are two common types of chest tubes one is with trocar and other is without trocar. It is an invasive procedure and complications may result from inadequate training, inadequate experience or lack knowledge of anatomy. However, trocar thoracostomy is by far associated with a higher rate of complication. **Objectives:** The aim of the stud0y was to assess the safety profile of trocar thoracostomy versus blunt thoracostomy, in terms of the injury to various structures in and around the lung. The nature of the study was prospective and randomized. **Materials and Methods:** We selected patients of blunt chest trauma with hemothorax, pneumothorax or both in the age group of 18–67 years, male or female, with or without other associated injuries during January 2017–December 2017. Complications of thoracostomy were recorded as insertional (for example, lung or other organ laceration or perforation, and hemorrhage), positional (for example, extrathoracic placement, persistent hemothoraces, or pneumothoraces), or infective (for example, minor wound infection and empyema thoracis). All chest drains were placed between anterior and posterior axillary lines using the recommendation by advanced trauma life support and another expert. **Results:** The overall complication rate related to trocar chest tube placement was 48% as against blunt chest tubes (12%). Malpositioned chest tubes constituted the major bulk of these complications; they were replaced on the basis of clinical and radiological grounds. Infectious complications were noted in 6 (13.33%) patients in both the groups. Insertional complications were noted in one patient in this series with trocar tube. 38 patients (76%) with isolated chest injuries had a mean duration of stay of 9 days (range 7–26 days). 12 patients (24%) whose chest injury was part of multiple trauma had a mean duration of stay of 28 days (range 20–46 days). Significant associations were observed while comparing complications of trocar thoracostomy with blunt thoracostomy. There was also a propensity of more positional complications with trocar thoracostomy $P < 0.001$. **Conclusions:** Blunt tube thoracostomy is an effective measure in managing patients with chest trauma but associated with significant morbidity. Most of the complications were the consequence of trocar insertion technique rather than blunt method. Hence, it is recommended that trocar insertional technique is not safe and preference should be given to the blunt methods. With the increasing frequency of traumatic chest injuries, a large number of patients are dealt with by doctors in the emergency department. Tube thoracostomy is an essential lifesaving measure for the management of pneumothorax, hemothorax, and hemopneumothorax developed as a consequence of chest trauma.

KEY WORDS: Thoracostomy; Trocar Thoracostomy; Bronchopleural Fistula; Subcutaneous Emphysema; Empyema

Access this article online	
Website: http://www.ijmsph.com	**Quick** Response code
DOI: 10.5455/ijmsph.2018.02058240022018	

INTRODUCTION

Thoracostomy is done frequently in cases of chest trauma, pneumothorax, and hydrothorax or after cardiothoracic surgeries to drain the collected fluid, blood, or air. Thoracostomy most often is a bedside procedure done by general surgeons, intensivists, emergency room (ER)

physicians or respiratory physicians either electively or in emergency. In chest trauma, the primary aim is to maintain ventilation of lungs for proper oxygenation of body tissues, and this cannot be achieved without chest decompression to decrease intra-pleural pressure and allow lungs to expand fully. Various therapeutic options have been reported in literature for management of chest injuries such as clinical observation, thoracocentesis, tube thoracostomy, and open thoracotomy. Among these chest tube decompression remains the most efficacious with the complication rate up to 30%.

In a study conducted by Bailey., the most common indications for tube thoracostomy are pneumothorax (54%) and hemothorax (20%); 90% tubes are placed as a result of blunt chest trauma. Fewer than 10% of blunt chest injuries and 15–30% of penetrating chest injuries require thoracotomy.[1] Initially, the majority of these injuries can be effectively managed by careful assessment of the airway, breathing, and circulation making appropriate interventions as indicated according to advanced trauma life support (ATLS) principles. The insertion of an appropriately sized chest drain has played a pivotal role in this process. Recently, the necessity of chest drain insertion for a proportion of traumatic pneumothoraces has been challenged.[2] The justification for this proposed change is the high complication rate some authors associate with tube thoracostomy.[3-6]

There are two common types of chest tubes one is with trocar and other is without trocar. As it is an invasive procedure, complications may result with inadequate training, inadequate experience or inadequate knowledge of anatomy. However, trocar thoracostomy is by far associated with a higher rate of complication.

Despite many benefits of tube thoracostomy drainage, the potential for significant morbidity and mortality exists. Injury to lung parenchyma, lung vessels, aorta, thoracic duct, and mediastinal structures including heart, esophagus, diaphragm, vagus nerve, and solid abdominal organs such as liver, spleen, bowel, and formation of bronchopleural fistula does exist. Mechanical injuries may lead to cardiac dysrhythmias, Horner's syndrome, and phrenic nerve palsy. Infectious complications may include empyema, pyothorax or surgical site infections. Non-functioning and malfunctioning thoracostomy tubes also represent a significant source of morbidity.

Although in injured patients tube thoracostomy may be lifesaving, it facilitates the evacuation of hemothorax, prevents tension pneumothorax, promotes respiratory function and helps in re-expansion of lungs while temponading low-pressure pulmonary bleeding. In patients with malignancy and hydrothorax, it confirms a significant symptomatic relief. Performing tube thoracostomy needs knowledge of thorough thoracic wall anatomy to avoid injury to neuromuscular bundles, lung parenchyma, solid organs, and major blood vessels. To avoid injury to neuromuscular bundles which are lying just inferior to the lower border of the rib, tube thoracostomy should be placed 50–70% of the way down the interspace.

British thoracic society has recommended the triangle of safety as the side for insertion for intercostals drain. This area is bordered by the anterior border of the latissimus dorsi, the lateral border of pectoralis major muscle and a line superior to the horizontal level of the nipple, and an apex below the axilla. Midaxillary line is the most commonly advocated position for tube thoracostomy. Right lung consists of three lobes-upper, middle, and lower-separated by horizontal and oblique fissures, while the left consists of two lobes-upper and lower-separated by an oblique fissure.

In full expiration the diaphragm rises as high as the fourth dorsal inter-vertebral space in the right and fifth space on the left, hence, when chest tube is placed too low, there is a high probability of abdominal placement. Inferiorly placed chest tube will not only perforate the diaphragm but may also damage intra-abdominal organs. The same will also apply to other conditions that elevate the diaphragm such as pregnancy, ascites, and splenomegaly.

Many physicians still prefer trocar thoracostomy in India, for the ease of insertion. However, due to the high rate of complications in developed countries trocar thoracostomy is no more recommended. As in our country studies comparing these two techniques are not available, and physicians still use trocar chest tubes; therefore, we planned to do a comparative study to see which technique carries higher rate of complications and how we can reduce these complications.

Aims of the Study

The aim of the study was to assess the safety profile of trocar thoracostomy versus blunt thoracostomy, in terms of the injury to various structures in and around the lung. The nature of the study was prospective and randomized.

MATERIALS AND METHODS

We selected patients of blunt chest trauma with hemothorax, pneumothorax or both in the age group of 18–67 years, male or female, with or without other associated injuries during January 2017–December 2017.

Complications were categorized as insertional (for example, lung or other organ laceration or perforation, hemorrhage), positional (for example, extrathoracic placement, persistent hemothoraces, or pneumothoraces), or infective (for example, minor wound infection and empyema thoracic). All chest drains were placed between anterior and posterior axillary lines using the recommendation of ATLS and another expert.

Once inserted, the tube was connected to an underwater-seal drainage system, and its working was affirmed by movement of water column in chest tube. Later, supine anteroposterior chest X-ray was performed to confirm its position. Patients were then subsequently managed and followed in surgical ward and/or intensive care unit. Eventually, tubes were removed as indicated by the rate of drainage (i.e., <50 ml/day), clinical status of the patient, i.e., bilaterally equal intensity of breath sounds and chest radiograph with evidence of lung expansion. Patients were then kept under observation for at least 24 h to rule out post-extubation pneumothorax. A predesigned pro forma was used for collecting the data. Outcomes of interest included duration of hospital stay (in days) and chest tube-related complications. The Software Program SPSS for mean ± standard deviation was used to compute quantitative variables, whereas qualitative variables were expressed as percentages and frequencies. $P < 0.05$ was considered statistically significant. The null hypothesis was rejected when the two-sided significance level was below 5%.

RESULTS

The overall complication rate related to trocar chest tube placement was 48% as against blunt chest tubes (12%). Malpositioned chest tubes constituted the major bulk of these complications; they were replaced on the basis of clinical and radiological grounds. Infectious complications were noted in 6 (13.33%) patients in both the groups. Insertional complications were noted in one patient in this series with trocar tube. 38 patients (76%) with isolated chest injuries had a mean duration of stay of 9 days (range 7–26 days). 12 patients (24%) whose chest injury was part of multiple trauma had a mean duration of stay of 28 days (range 20–46 days).

A total of 50 patients, fulfilling the inclusion and exclusion criteria, were enrolled in this study with mean age of 30.5 ± 12.01 years (range 18–67 years) from January 2017 to December 2017. Of these, 49 (88%) were males whereas 11 (12%) were females. The most common indication was hemothorax followed by pneumothorax and hemopneumothorax [Table 1]. All the chest tubes were placed by senior consultants. The overall complication rate related to trocar chest tube placement was 48% as against blunt chest tubes (12%) [Table 2].

Malpositioned chest tubes constituted the major bulk of these complications; they were replaced on the basis of clinical and radiological grounds. Infectious complications were noted in 6 (13.33%) patients in both the groups. Insertional complications were noted in one patient in this series with trocar tube. This patient was with severe abdominal injury with hemoperitoneum, lung, and liver lacerations which lifted the diaphragm quite high. Post-extubation pneumothorax was not observed in our study. The duration of drain placement ranged from 5 to 12 days with a mean of 6 days. 80% chest drains were placed as a result of blunt trauma, 15% as a result of penetrating trauma, and 5% as a result of barotraumas. 38 patients (76%) with isolated chest injuries had a mean duration of stay of 9 days (range 7–26 days). 12 patients (24%) whose chest injury was part of multiple trauma had a mean duration of stay of 28 days (range 20–46 days), significant associations were, however, observed when comparing complications of trocar thoracostomy with tube thoracostomy $P < 0.05$. There was also a propensity of more positional complications with trocar thoracostomy.

Table 1: Indications for thoracostomy in groups

Injury	Trochar ICD C*n*=25 (%)	Blunt ICD *n*=25 (%)
Hemothorax	14 (56)	13 (52)
Pneumothorax	9 (26)	10 (40)
Tension pneumothorax	2 (8)	1 (4)
Flail chest	4 (16)	5 (20)

Table 2: Complications

Complications	Trochar thoracostomy *n*=25 (%)	Blunt thoracostomy (*n*=25)
Vascular injury	1 (6.66)	0
Diaphragm injury	1 (6.66)	0
Splenic injury	1 (6.66)	0
Liver injury	0	0
Bowel injury	1 (6.66)	0
Bronchopleural fistula	1 (6.66)	0
Heart injury	0	0
Subcutaneous placement	3 (20)	0
Intraparenchymal placement	1 (6.66)	0
Re-expansion pulmonary edema	0	0
Phrenic nerve injury	0	0
Esophageal perforation	0	0
Chylothorax	0	0
Cardiac dysrhythmias	0	0
Infectious complications	2 (13.33)	2 (13.33)

DISCUSSION

In this series, the majority of the patients presented to ER with hemothorax and fewer patients presented with pneumothorax, which is not similar to other studies.[7-10] Published complications in literature include lacerations of lung, intercostals artery,

esophagus, diaphragm, stomach, right atrium, subclavian vein as well as pulmonary artery.[8,11,12] 48% complication rate for tube thoracostomy in trocar group as compared to 12% in blunt dissection seems unacceptably high, however, the type of complication encountered merits further analysis. The positional complications resulted in greater morbidity in this series, as also reported by others.[13] Ball *et al.*[8] observed[14] complications in 76 tube thoracostomies (22.4%); most of these were positional (53%). Critical review of malpositioned chest tubes in this series revealed blunt (0%) versus trocar (20%) group had extrathoracic location of tube. Leading to subcutaneous emphysema and one (6.6%) had intrathoracic malposition resulting in tube failure in trocar group. All were successfully replaced without further complications. There is a high prevalence of chest tube malposition in emergency thoracostomies, as previously mentioned by Baldt *et al.* in their retrospective series.[15] None of the patients in this study developed post-extubation pneumothorax. Only one complication was insertional (lung laceration). Chan *et al.* encountered 64 complications in 352 tube thoracostomies (18.2% complication rate), but no insertional complications.[6] In this series, 13.33% infective complications seen in both groups. These were drain site infections one of them responded well to a course of antibiotics and repeated dressings. Gonzalez and Holevar evaluated the efficacy of antibiotics in reducing the infective complication rate after tube thoracostomy for isolated chest trauma.[17] The remaining one (6.6%) infective complication in this series was empyema thoracis. Its rate is nearly consistent with a study conducted by Bailey.[18] Contamination of blood in pleural space during tube thoracostomy insertion is the key factor in developing post-traumatic empyema, as mentioned by Hoth *et al.*[19,20] Apart from aseptic techniques, prophylactic administration of antibiotics significantly lowers the incidence of this complication, as suggested by LoCurto *et al.* in their prospective randomized study.[20]

Nichols *et al.* evaluated the safety and efficacy of antibiotics in reducing the infectious complication rate after tube thoracostomy for isolated chest trauma.[21] They concluded those patients receiving prophylactic antibiotics had a significantly reduced infection rate compared with those given placebo. No significant adverse effects were seen in either group. Grover *et al.* noted a 2.6% rate of empyema in patients randomized to receive prophylactic antibiotics after tube thoracostomy for penetrating chest trauma and a slightly higher rate in those receiving placebo[22] in his meta-analysis.

It is now, generally, accepted that the trocar has no part to play in the safe insertion of a chest drain, the preferred method being blunt and open.[23,24] By employing this technique, particularly the correct site of insertion, blunt dissection above the rib, and the finger sweep to ensure the lung is not adherent to the chest wall will minimize the complications.

Westa by recommends a sustained Valsalva maneuver to forcibly inflate the lung against the chest wall with breathing suspended until the purse string suture is tied.[23] He goes on to suggest that auscultation of breath sounds after drain removal yields the same information as a check chest radiograph, and redrainage is unnecessary for "small" residual pneumothoraces. Another area of potential complication is dislodgement of the drain after insertion. The ATLS manual does not emphasize the importance of meticulously securing the drain in place with a combination of sutures and adherent dressings.[1] This is emphasized by Westa by in his a User's Guide to Thoracic Drainage[23] and is a point well worth making. The policy in our department with regard to drain size is in line with ATLS recommendations - that is, a #36–40 French (F) drain. Westa by recommends #26 F or larger drain for hemothoraces and a #20 F or larger for simple pneumothoraces.[8] The use of a large bore (#36 F or greater) drain is likely to reduce the complications associated with the drain becoming kinked or clotted off.

In this study, the tube placement was done in all the cases by senior consultants thereby omitting the chances of technical error.

The size of the study was small and also very few patients with abdominal injury could be studied.

Large multicentric studies are further required. Moreover, ultrasound-guided chest tube placement may further increase the chances of success and lessen the complications.

CONCLUSION

The rationale for using tube thoracostomy in the treatment of many chest injuries, including simple pneumothorax, and hemothorax, is well established. In particular, ATLS recommends that all traumatic pneumothoraces be treated by tube thoracostomy on the basis that any simple pneumothorax left untreated could convert into a life-threatening tension pneumothorax.[1] ATLS also recommends that acute hemothorax, sufficiently large to appear on chest radiography, is best treated with a large caliber chest drain. The drain evacuates blood, reduces the risk of a clotted hemothorax, and provides a means of continuously monitoring blood loss. The most serious complications encountered are those associated with incorrect drain insertion, in particular, the use of a closed technique and a trocar. Insertion of the drain using an open technique as described in the ATLS manual should eliminate these complications; none were encountered in this study. The next important group of complications is infective, particularly empyema thoracic. Tube thoracostomy is a surgical procedure and as such full aseptic technique should be employed with appropriate wound care. The role of prophylactic antibiotics in reducing the incidence of empyema is still unclear. A prospective trial of antibiotic prophylaxis versus placebo would be useful to assess this question. The final group of complications analyzed was the "positional" group. As stated

previously meticulous care in drain anchorage and possibly a different technique of drain removal could have reduced these complications. There is a difference in opinion in the literature regarding which technique is best at preventing pneumothoraces after drain removal; this needs further investigation. None of this group of complications resulted in significant medium to long-term morbidity, although the patients had to undergo repeated procedure that elongated their length of admission. A larger study to confirm or refute these findings needs to be undertaken.

REFERENCES

1. Advanced Trauma Life Support. Committee on Trauma, American College of Surgeons. Chicago: American College of Surgeons; 1997.
2. Johnson G. Traumatic pneumothorax: Is a chest drain always necessary? J Accid Emerg Med 1996;13:173-4.
3. Etoch SW, Bar-Natan MF, Miller FB, Richardson JD. Tube thoracostomy. Factors related to complications. Arch Surg 1995;130:521-5.
4. Helling TS, Gyles NR 3rd, Eisenstein CL, Soracco CA. Complications following blunt and penetrating injuries in 216 victims of chest trauma requiring tube thoracostomy. J Trauma 1989;29:1367-70.
5. Eddy AC, Luna GK, Copass M. Empyema thoracis in patients undergoing emergent closed tube thoracostomy for thoracic trauma. Am J Surg 1989;157:494-7.
6. Chan L, Reilly KM, Henderson C, Kahn F, Salluzzo RF. Complication rates of tube thoracostomy. Am J Emerg Med 1997;15:368-70.
7. Adegboye VO, Ladipo JK, Brimmo IA, Adebo AO. Blunt chest trauma. Afr J Med Med Sci 2002;31:315-20.
8. Ball CG, Lord J, Laupland KB, Gmora S, Mulloy RH, Ng AK, *et al.* Chest tube complications: How well are we training our residents? Can J Surg 2007;50:450-8.
9. Spanjersberg WR, Ringburg AN, Bergs EA, Krijen P, Schipper IB. Prehospital chest tube thoracostomy: Effective treatment or additional trauma? J Trauma 2005;59:96-101.
10. Leone M, Brégeon F, Antonini F, Chaumoître K, Charvet A, Ban LH, *et al.* Long-term outcome in chest trauma. Anesthesiology 2008;109:864-71.
11. Yuncu G, Aykanli D, Yaldiz S, Ulgan M, Alper H. An unusual pulmonary perforation case after chest tube placement. Acta Chir Hung 1999;38:231-3.
12. Shapira OM, Aldea GS, Kupferschmid J, Shemin RJ. Delayed perforation of the esophagus by a closed thoracostomy tube. Chest 1993;104:1897-8.
13. Khanzada TW, Samad A. Indications and complications of tube thoracostomy performed by general surgeons. J Pak Med Assoc 2008;58:39-40.
14. Martino K, Merrit S, Boyakye K, Sernas T, Koller C, Hauser CJ, *et al.* Prospective randomized trial of thoracostomy removal algorithms. J Trauma 1999;46:369-71.
15. Baldt MM, Bankier AA, Germann PS, Pöschl GP, Skrbensky GT, Herold CJ, *et al.* Complications after emergency tube thoracostomy: Assessment with CT. Radiology 1995;195:539-43.
16. Singh JK, Newman MA. Pulmonary artery catheterisation-an unusual complication of chest drain insertion. Aust N Z J Surg 1994;64:513-14.
17. Gonzalez RP, Holevar MR. Role of prophylactic antibiotics for tube thoracostomy in chest trauma. Am Surg 1998;64:617-20.
18. Bailey RC. Complications of tube thoracostomy in trauma. J Accid Emerg Med 2000;17:111-4.
19. Hoth JJ, Burch PT, Bullock TK, Cheadle WG, Richardson JD. Pathogenesis of posttraumatic empyema: The impact of pneumonia on pleural space infections. Surg Infect (Larchmt) 2003;4:29-35.
20. LoCurto JJ Jr., Tischler CD, Swan KG, Rocko JM, Blackwood JM, Griffin CC, *et al.* Tube thoracostomy and trauma-antibiotics or not? J Trauma 1986;26:1067-72.
21. Nichols RL, Smith JW, Muzik AC, Love EJ, McSwain NE, Timberlake G, *et al.* Preventive antibiotic usage in traumatic thoracic injuries requiring closed tube thoracostomy. Chest 1994;106:1493-8.
22. Grover FL, Richardson JD, Fewel JG, Arom KV, Webb GE, Trinkle JK, *et al.* Prophylactic antibiotics in the treatment of penetrating chest wounds. A prospective double-blind study. J Thorac Cardiovasc Surg 1977;74:528-36.
23. Westaby S. A User's Guide to Thoracic Drainage. Gosport: Sherwood Medical; 1992.
24. Hyde J, Sykes T, Graham T. Reducing morbidity from chest drains. BMJ 1997;314:914-5.

How to cite this article: Omar PK, Asit AK, Borkar A, Surin S. Trocar thoracostomy or blunt dissection thoracostomy - Which is safe? Int J Med Sci Public Health 2018;7(5):403-407.

Source of Support: Nil, **Conflict of Interest:** None declared.