

ORIGINAL RESEARCH

Comparative evaluation of tube thoracostomy in triangle of safety versus outside the triangle of safety

¹Dr. Santsevi Prasad, ²Dr. Apurva Agarwal, ³Dr. Manas Ranjan Deo,
⁴Dr. Bhartendu Kumar

¹Assistant Professor, ^{2,3}Senior Resident, ⁴Associate Professor, Department of Surgery, SKMCH, Muzaffarpur, Bihar, India

Correspondence:

Dr. Apurva Agarwal

Senior Resident, Department of Surgery, SKMCH, Muzaffarpur, Bihar, India

Email: apurvaagarwal10@gmail.com

ABSTRACT

Background: Tube thoracostomy is defined as insertion of a tube (chest tube) into the pleural cavity to drain air, blood, bile, pus, chyle or other fluids. The present study was conducted to compare tube thoracostomy in triangle of safety versus outside the triangle of safety.

Material and methods: This study was multiple centre prospective comparative study conducted in department of Surgery. A total of 69 patients were included in study, randomized into two groups, tube thoracostomy in safe triangle (n=35) and tube thoracostomy outside safe triangle (n=34). All cases were carefully worked up in terms of detailed history and clinical examination. Lab and imaging intervention included.

Results: It was observed that major lung conditions for which the tube thoracostomy done in triangle of safety, improved rapidly and earlier in comparison to tube thoracostomy done outside the triangle of safety. Pneumothorax, Hemothorax, Hemopneumothorax, Empyema, Chylothorax, Hydrothorax and Pleural effusion improved rapidly and earlier when tube thoracostomy was done in triangle of safety. However, group of patients having similar indications for tube thoracostomy but done outside safety triangle, improved slowly and delayed. It was observed that major complications of tube thoracostomy as either technical or infective. Technical complications include –Tube malposition, Blocked tube, Chest drain dislodgement, Reexpansion pulmonary oedema, Subcutaneous emphysema, Nerve injury, Cardiac and vascular injuries, Oesophageal injuries, Fistula, Tumor recurrence at insertion site, Herniation through the site, Chylothorax and cardiac dysrhythmia. Infective complications include Empyema and Surgical site infection including cellulitis and necrotizing fasciitis. All above mentioned complications except few one were more frequent when tube thoracostomy was done outside safety triangle in comparison to tube thoracostomy in triangle of safety. Tube malposition is the commonest complication of tube thoracostomy. Intraparenchymal tube placement occurs more likely in the presence of pleural adhesion. Blocked tube may be due to kinking, angulation or clot formation. Subcutaneous emphysema associated with trauma, bronchopleural fistula, large and bilateral pneumothoraces, prolonged drainage and tube blockage.

Conclusion: Tube thoracostomy, though commonly performed is not without risk. It has been seen that, there is not only rapid recovery but least chance of complications, when tube thoracostomy done in triangle of safety in comparison to tube thoracostomy done outside triangle of safety.

Keywords: Tube thoracostomy, thoracic, Trocar technique.

INTRODUCTION

Tube thoracostomy is the most commonly performed surgical procedure in thoracic surgery. As a life saving procedure Surgeons and Intensivists may at one time or the other is required to perform tube thoracostomy. The first documented description of a closed tube drainage system for the drainage of empyema was by Hewett in 1867.¹ in 1992, Lilienthal reported the postoperative use of chest tube following lung resection for suppurative disease of lung.² Tube thoracostomy is an invasive procedure and complications can result due to inadequate knowledge of thoracic anatomy or inadequate training and experience. These complications can simply be classified as technical or infective. Trocar technique is by far associated with a higher rate of complications.^{3,4} Current recommendations from both the BTS and Advanced Trauma Life Support (ATLS)⁵ provide minimal information for procedural performance and lack data for insertion angle relative to chest wall and surface anatomy. Angle of insertion may be of importance given that TTs are a semi-rigid tube and placement perpendicularly to the thoracic wall may allow for increased force on the TT. This may lead to subsequent injury from this force during placement on underlying structures, kinking of the TT leading to obstruction, or a TT position leading to poor drainage. We recently have developed a TT complication classification method which is robust, validated, successfully categorize, and classifies complications of TT.⁶ The present study was conducted to Compare tube thoracostomy in triangle of safety versus outside the triangle of safety.

MATERIAL AND METHODS

This study was multiple centre prospective comparative study conducted in department of Surgery. A total of 69 patients were included in study, randomized into two groups, tubethoracostomy in safe triangle (n=35) and tube thoracostomy outside safe triangle (n=34). The patients were studied from 2019 to 2021. Patients were selected from those attending outpatient and emergency at various hospitals. The age of patient varied from 13 year to 82 years. Patients having indication for Tube Thoracostomy (open/tension pneumothorax, hemothorax, empyema, chylothorax, hydrothorax, pleural effusion and patients having penetrating chest wall injury who are intubated/about to be intubated) were diagnosed clinically and radiologically (X ray chest and/or CT chest) were included in the study. Patients diagnosed having coagulopathy, pulmonary bullae, pulmonary/pleural/thoracic adhesion, pulmonary abscess, loculated pleural effusion/ empyema and diaphragmatic hernia were excluded from study. All cases were carefully worked up in terms of detailed history and clinical examination. Lab and imaging intervention included complete hemogram, Liver function test, renal function test, Prothrombintime, International normalization ratio, activated partial thromboplastintime. Radiological imaging included chest x ray and/or CT chest. All patients empirically received Injection ceftriaxone and sulbactam 1.5 gram iv stat, Injection Atropine 1 ample imstat, Injection Rabeprazole 20 iv stat and Injection ondem 1 ample iv stat before tube thoracostomy. There are two principle methods of tube thoracostomy: the blunt dissection technique and the trocar technique. The Trocar technique is associated with a higher rate of intrathoracic organ injury. The intercostal spaces are filled with intercostal muscles, with vein artery and nerve lying in the costal groove along the inferior margin of the superior rib from above downwards and situated between the second and third layers of muscles. To avoid the neurovascular bundles it is normally advocated that the drain be located in the intercostal space just superior to the rib. The midaxillary line is the most commonly advocated position for tube thoracostomy; the innermost layer of intercostal muscle being poorly developed at this point and comprising thin intercostals which blend with the internal intercostal layers except where separated by neurovascular bundles.

TUBE THORACOSTOMY IN THE TRIANGLE OF SAFETY

Here the intercostal drain was inserted in midaxillary line in the area bordered by the anterior border of latissimusdorsi, the lateral border of pectoralis major muscle, a line superior to the horizontal level of the nipple and an apex below the axilla.

TUBE THORACOSTOMY OUTSIDE THE TRIANGLE OF SAFETY

Here the intercostal drain was inserted in mid axillary line outside the area of triangle of safety in fifth, sixth and seventh intercostal space.

EVALUATION OF RESPONSE TO INTERVENTION

Both groups of patients were evaluated in terms of clinical response and laboratory parameters on daily basis. Daily chest x-ray and tidaling (water level fluctuating in the water seal chamber) was most important monitoring methods applied. After 5 to 12 days intercostal drain were removed after achieving desired improvement in chest /pleural disease. Before removal of intercostal drain, all cases of both groups were evaluated in terms of complications and noted it carefully. Complications were treated accordingly on the basis of individual cases.

FOLLOW UP

The patients were followed up weekly for a month and monthly for three month. Apart from clinical response, laboratory parameters and radiological finding were evaluated until complete resolution of chest/pleural disease and tube thoracostomy related complications.

RESULTS

It was observed that major lung conditions for which the tube thoracostomy done in triangle of safety, improved rapidly and earlier in comparison to tube thoracostomy done outside the triangle of safety. Pneumothorax, Hemothorax, Hemopneumothorax, Empyema, Chylothorax, Hydrothorax and Pleural effusion improved rapidly and earlier when tube thoracostomy was done in triangle of safety. However, group of patients having similar indications for tube thoracostomy but done outside safety triangle, improved slowly and delayed.

Table 1: Average time required for recovery from similar indication of tube thoracostomy in both groups.

Indication of tube thoracostomy	Average time required for recover in triangle of safety(in days) (n=35)	Average time required for recovery outside the triangle of safety(in days) (n=34)
Pneumothorax	2-3	5-6
Hemothorax	4-5	6-7
Hemopneumothorax	5-6	8-9
Empyema	6-7	8-10
Chylothorax	5-7	5-7
Hydrothorax	6-7	7-8
Pleural effusion	8-10	9-11

It was observed that major complications of tube thoracostomy as either technical or infective. Technical complications include–Tube malposition, Blocked tube, Chest drain dislodgement, Reexpansion pulmonary oedema, Subcutaneous emphysema, Nerve injury, Cardiac and vascular injuries, Oesophageal injuries, Fistula, Tumor recurrence at insertion site, Herniation through the site, Chylothorax and cardiac dysrhythmia. Infective complications include Empyema and Surgical site infection including cellulitis and necrotizing fasciitis. All above mentioned complications except few one were more frequent

when tube thoracostomy was done outside safety triangle in comparison to tube thoracostomy in triangle of safety.

Table 2: frequency of complications in two groups.

Complication of tube thoracostomy	Frequency in triangle of safety (n=35)	Frequency in outside triangle of safety (n=34)
Tube malposition	1	3
Blocked tube	2	3
Chest drain dislodgement	2	4
Reexpansion pulmonary edema	1	2
Subcutaneous emphysema	1	3
Fistula	0	0
Tumor recurrence at insertion site	0	1
Herniation through the insertion site	1	1
Surgical site infection	1	2

Tube malposition is the commonest complication of tube thoracostomy. Intraparenchymal tube placement occurs more likely in the presence of pleural adhesion. Blocked tube may be due to kinking, angulation or clot formation. Subcutaneous emphysema associated with trauma, bronchopleural fistula, large and bilateral pneumothoraces, prolonged drainage and tube blockage.

DISCUSSION

British Thoracic Society (BTS) has recommended the “Triange of safety” as the site for insertion for intercostal drain.⁷ this area is bordered by the anterior border of the latissimus dorsi, the lateral border of the pectoralis major muscle, a line superior to the horizontal level of the nipple, and an apex below the axilla. Most surgeons insert the chest tube via an incision at the 4th or 5th intercostals space in the anterior axillary or mid-axillary line, as the innermost layer of intercostals muscle being poorly developed at this point, and comprising thin intercostals, which blend with the internal intercostals layer except where separated by neurovascular bundles. To avoid neurovascular bundle, it is normally advocated that the drain be located in the interspace just too superior margin to the lower rib.⁸

It was observed that major lung conditions for which the tube thoracostomy done in triangle of safety, improved rapidly and earlier in comparison to tube thoracostomy done outside the triangle of safety. Pneumothorax, Hemothorax, Hemopneumothorax, Empyema, Chylothorax, Hydrothorax and Pleural effusion improved rapidly and earlier when tube thoracostomy was done in triangle of safety. However, group of patients having similar indications for tube thoracostomy but done outside safety triangle, improved slowly and delayed. It was observed that major complications of tube thoracostomy as either technical or infective. Technical complications include –Tube malposition, Blockedtube, Chest drain dislodgement, Reexpansion pulmonary oedema, Subcutaneous emphysema, Nerveinjury, Cardiac and vascular injuries, Oesophageal injuries, Fistula, Tumor recurrence at insertion site, Herniation through the site, Chylothorax and cardiac dysrhythmia. Infective complications include Empyema and Surgical site infection including cellulitis and necrotizing fasciitis. All above mentioned complications except few one were more frequent when tube thoracostomy was done outside safety triangle in comparison to tube thoracostomy in triangle of safety. Tube malposition is the commonest complication of tube thoracostomy. Intraparenchymal tube placement occurs more likely in the presence of pleural adhesion. Blocked tube may be due to kinking, angulation or clot formation. Subcutaneous emphysema associated with trauma, bronchopleural fistula, large and bilateral pneumothoraces, prolonged drainage and tube blockage.

Complication of the tube thoracostomy is the misplacement of the drain. Such occurrence is highly variable, ranging from 1.1% to 30%.⁹⁻¹¹

Capizzi *et al* found that pneumothorax was present in five of 54 chest x-rays performed after pleural aspiration for fluid as outpatients and no symptomatic complications were found in a further 50 cases who did not have a chest x-ray.¹²

CONCLUSION

Tube thoracostomy, though commonly performed is not without risk. It has been seen that, there is not only rapid recovery but least chance of complications, when tube thoracostomy done in triangle of safety in comparison to tube thoracostomy done outside triangle of safety.

REFERENCES

1. K.Dural et al “ A novel and safe technique in closed tube thoracostomy”*Journal of cardiothoracic Surgery*,vol 5,no1 article 21,2010
2. M.M. Baldt et al, “Copmlication after emergency tube thoracostomy:assessment with CT,”*Radiology*,vol.195,no.pp539-543,1995
3. D.Laws,e.Neville,andJ.Duffy, “BTS guidelines for the insertion of a chest drain”,*Thorax*,vol.58,supplement2,pp.ii55-ii59,2003
4. H.Ellis, “The applied anatomy of chest drain insertion,”*Thebritish journal of Hospital Medicine*, vol.68,no3,pp.M44-M45,2007.
5. *Advanced Trauma Life Support: Student Course Manual*. 9. Chicago, IL: American College of Surgeons; 2012.
6. Aho JM, Ruparel RK, Rowse PG, Brahmhatt RD, Jenkins D, Rivera M. Tube Thoracostomy: A Structured Review of Case Reports and a Standardized Format for Reporting Complications. *World J Surg*. 2015 doi: 10.1007/s00268-015-3158-6.
7. Ellis H.The applied anatomy of chest drain insertion. *Br J Hosp Med (Lond)* 2007;68:M44-5.
8. Dural K, Gulbahar G, Kocer B, et al. A novel and safe technique in closed tube thoracostomy. *J Cardiothorac Surg* 2010;5:21.
9. M. Deneuille. Morbidity of percutaneous tube thoracostomy in trauma patients. *Eur. J. Cardio. Thorac. Surg.*, 22 (2002), pp. 673-678.
10. S. Huber-Wagner, M. Körner, A. Ehrh, M.V. Kay, K.J. Pfeifer, W. Mutschler, *et al*. Emergency chest tube placement in trauma care-Which approach is preferable? *Resuscitation*, 72 (2007), pp. 226-233.
11. F. Remérand, V. Luce, Y. Badachi, Q. Lu, B. Bouhemad, J.J. Rouby. Incidence of chest tube malposition in the critically ill: a prospective computed tomography study. *Anesthesiology*, 106 (2007), pp. 1112-1119.
12. Capizzi SA, Prakash UB. Chest roentgenography after outpatient thoracentesis. *Mayo Clin Proc* 1998;73:948–50. (3).