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ORIGINAL RESEARCH

Evaluating efficiency of tube thoracostomy in triangle of safety versus outside the triangle of safety: A comparative study

[1]Dr. Santsevi Prasad, [2]Dr. Apurva Agarwal, [3]Dr. Sushant Kumar Sharma

[1]Assistant Professor, [3]Professor, Department of Surgery, SKMC, Muzaffarpur, Bihar, India
[2]Specialist Medical Officer, Sub Divisional Hospital, Sitamarhi, Bihar, India

Corresponding Author
Dr. Sushant Kumar Sharma
Professor, Department of Surgery, SKMC, Muzaffarpur, Bihar, India
Email: dr.sushant@ymail.com

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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 comparision 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 lifesaving 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

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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 classify 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, tube thoracostomy in safe triangle (n=35) and tube thoracostomy outside safe triangle (n=34). The patients were studied from 2021 to 2024. Patients were selected from those attending outpatient and emergency at various hospitals. The age of patient varied from 13 years 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, Prothrombin time, International normalization ratio, activated partial thromboplastin time. Radiological imaging included chest x ray and/or CT chest. All patients empirically received Injection ceftriaxone and sulbactum 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 comlications and noted it carefully. Comlications were treated accordingly on the basis of individual cases.

Follow up

The patients were followed up weekly for a month and monthly for three months. 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 forrecover 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

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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 thoracostomyin triangle of safety.

Table 2: Frequency of complications in two groups.

Complication of tubethoracostomy	Frequecy 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 insertionsite	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 drainbe 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 comparision 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 thoracostomyin 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]

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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 comparision to tube thoracostomy done outside triangle of safety.

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