# MINIMALLY-INVASIVE TUBE THORACOSTOMY MADE EASY WITH A COMBINATION OF THORACIC ULTRASOUND AND SMALL BORE CHEST DRAIN KITS (12F TO 16F) USING GUIDEWIRE TECHNIQUE

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**ABSTRACT**

**BACKGROUND**

Minimally-invasive tube thoracostomy made easy with a combination of thoracic ultrasound and small bore chest drain kits (12F to16F) using guidewire technique.

The present study is aimed at easy and safe insertion of small bore chest drains (12F to 16F) using Seldinger technique under ultrasound guidance with least discomfort to the patient. Large bore chest drains of size >20F using blunt dissection technique is painful, difficult to place in thick chest walls and technically more demanding. Placing the drains blindly basing on chest x-ray image may sometimes injure the underlying lung.

**MATERIALS AND METHODS**

Present study included 21 cases, of which 12 cases (57.1%) were of pleural effusion and 9 cases (42.8%) were of pneumothorax. Thoracic ultrasound was utilised by the operator for all pleural effusions and for those cases of pneumothorax who were on ventilator before tube insertion. Small bore chest drains (12F to 16F) designed for guidewire technique were used in the present study.

**RESULTS**

Complete and sustainable lung expansion was seen in 19 of 21 cases (90.4%). It failed in remaining 2 cases (9.5%) who had complex empyemas and hepatic hydrothorax. Pleurodesis was attempted in 6 cases (28.5%) using tetracycline injectable form with success rate of 90%. Patient tolerance was good with numeric pain rating score of 1 to 3 (range 0 to 10; 0 = no pain; 5 = moderate pain; 10 = worst possible pain).

**CONCLUSION**

Using small bore chest tubes of sizes 12F to 16F designed for guidewire technique of insertion and utilising thoracic ultrasound, while insertion made the procedure easy and safe, less painful and good tolerance from patient's point of view. Complete and sustainable lung expansion was seen in 90.4% of cases and highly efficacious for spontaneous and iatrogenic pneumothorax and in noncomplex and malignant pleural effusions. The technique is less demanding and thoracic ultrasound knowledge can be easily learnt and a combination of this will make the procedure easy, safe and less painful with good efficacy. Many can attempt this procedure with confidence. The present study was done after obtaining permission from Hospital's Ethics Committee and no financial aid was received from any individual or organisation and the study has no commercial interest.

**KEYWORDS**

Small Bore Chest Drain (SBCD), Guidewire Technique, Thoracic Ultrasound, Tube Thoracostomy, Seldinger Technique.

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## BACKGROUND

Traditionally, large bore chest tubes using blunt dissection technique are in vogue for pleural drainage. This involves larger incision, blunt tissue dissection, pain and discomfort to patient, while inserting the tube and complications sometimes. Nowadays, more and more institutions are using small bore chest tubes because of ease of insertion, less pain, minimal complications with comparable efficacy to large bore drains. The British Thoracic Society Guidelines strongly advocate Small Bore Chest Tubes (SBCT) for most cases of pleural drainage.[1,2,3]

**Aim**- The present study is aimed at easy insertion of small bore chest tubes of sizes 12F to 16F using the Seldinger technique with guidewire and utilising thoracic ultrasound and chest x-ray in combination and the outcome in terms of sustainable lung expansion and patient safety and comfort and the study period was for two years till September 2017.

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## MATERIALS AND METHODS

The study population included 21 patients of pleural effusions to pneumothorax of various aetiologies. Haemothorax and postoperative cases were excluded from present study due to limited access to this population of patients in our institution.[4] Out of 21 cases, there are 3 cases of empyema (14.28%), 4 cases of massive tuberculous pleural effusion (19.04%), 3 cases of malignant pleural effusion (14.28%), 2 cases of massive transudative effusion (9.52%), 4 cases of iatrogenic pneumothorax (19.04%),[5] 2 cases of barotrauma (9.52%), 2 cases of secondary spontaneous pneumothorax (9.52%) with tension and 1 case of primary spontaneous pneumothorax (4.76%). A 40% of study population were on mechanical ventilation at time of tube insertion. The age of patients range from 15 to 81 years and male-to-female ratio was 2:1 and the study period was for 2 years till September 2017.

Small bore chest tube kits used in the present study range from 12F to 16F, which are made for insertion by Seldinger technique using guidewire, which can be connected to underwater seal drain. Area of tube insertion was limited to triangle of safety (triangular area in mid axillary region bounded anteriorly by lateral border of pectoralis major, laterally by anterior border of latissimus dorsi, inferiorly by a horizontal line at level of nipple or fifth intercostal space, the apex is at axilla) except for loculated collections where tubes were inserted at identified point of location. After making diagnosis by chest x-ray, thoracic ultrasound was utilised in all cases of pleural effusions and some cases of pneumothorax. Ultrasound is very helpful in identifying the extent of pleural effusion, the nature of effusion, the distance of visceral pleura from insertion site and in case of loculated effusions for precise location. The patient position used was semi-prone with affected side upwards, which facilitates fall of lung and mediastinum to opposite side by virtue of gravity allowing enough space for safe tube insertion. No attempt is made to direct the chest tube upwards or downwards, while inserting the tube with the assumption that it is difficult to retain the tube in the said position and with the fact that the suction force exerted by underwater seal drain would be helpful in expansion of the lung irrespective of tube position. Type of anaesthesia used was 1% lignocaine local infiltration.

Tube removal was done at point of sustainable lung expansion. Pleurodesis was done for 6 cases (2 cases of malignant pleural effusion, 2 cases of secondary spontaneous pneumothorax with tension, 2 cases of transudative effusion, 1 each for LVF and 1 for hepatic hydrothorax, total of 28.5%).

## RESULTS

Complete and sustainable lung expansion was seen in 90% of cases. In 10% of cases, tube drainage was done for loculated empyema as a bridge before decortication. Tube removal could be done in less than 1 week in 90% of cases. Pleurodesis was successful in 90% of cases. It failed in hepatic hydrothorax.

| Total No. of Cases | Empyema | Massive TB pleural effusion | Malignant pleural effusion | Iatrogenic Pneumothorax | Barotrauma | Spontaneous Pneumothorax | Transudate pleural effusion |
|---|---|---|---|---|---|---|---|
| 21 | 14.28% | 19.04% | 14.28% | 19.04% | 9.52% | 14.28% | 9.52% |

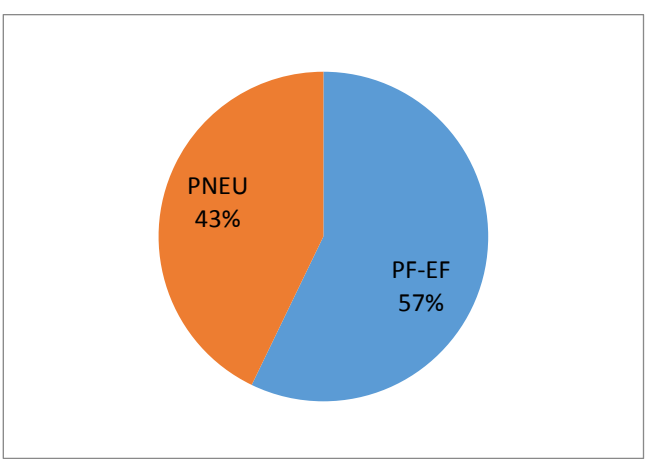


***Figure 1. Percentage of Pneumothoraces vs. Pleural Effusions***

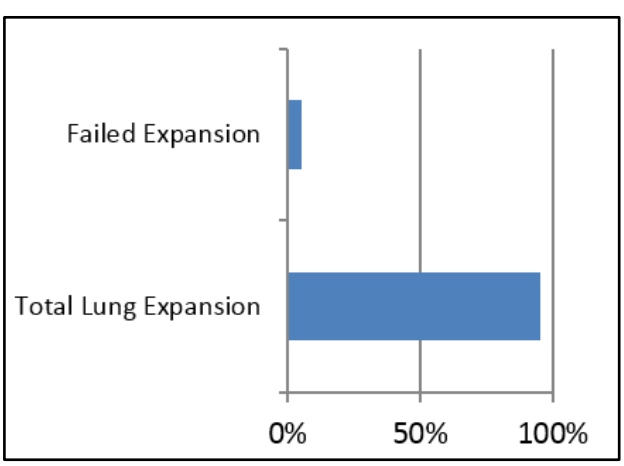


***Figure 2. Lung Expansion after Tube Drainage***

Complications- No major complications were noted. Tube blockage was seen in 10% of cases and could be manageable with periodic flushing of tube with the three-way adapter. No malposition, no organ injury was seen unlike in other studies as the procedure was done under guidance. Pain score was 1 to 3 (numeric pain score of 0 to 10) due to small size of tube.

Kinking of tube was noted in 15% of cases with 12F tube. No suturing was done and post procedure scar was inconspicuous.

## DISCUSSION

Pleural effusions and pneumothoraces are the common pleural disorders necessitating tube thoracostomy for evacuation of air or fluid allowing expansion of the lung for

pleurodesis, for pneumothorax and for malignant pleural effusions when indicated.[6,7,5]

Chest tubes vary in size from 9F to 40F made of synthetic non-irritant, non-allergic material hollow with side holes to facilitate drainage and by convention, tubes less than 14F are considered small bore tubes and more than 14F are large bore tube,[8,9,4,3,10] but there is no uniform consensus regarding size.

As the difference in size is not significant among tubes of less than 16F (one French is equal to one third of a millimetre), the difference in size between 12F and 18F chest tube is only 2 mm, which is not significant in terms of insertion as it is the insertion technique that is more important than the marginal difference in size and sizes below 20F tubes can be inserted with ease using guidewire technique.[8]

**Methods of Insertion**

1. Blunt Dissection- Traditional method where after local infiltration anaesthesia, a horizontal incision is made in the skin over the upper border of the lower rib and after separating the intercostal muscles with artery forceps, a dent is made in the pleural cavity, the distal end of the selected tube held with artery forceps is introduced into the pleural cavity and a stay suture is done with the skin and connected to underwater seal drain. Since the tube is large, it needs larger incision, needs tissue dissection, which causes more pain and difficult to carry out in obese people and in women with breast tissue interposing. It causes discomfort to patient and a larger scar after healing.[11]
2. Seldinger technique using guidewire- Of late, small bore chest drain kits are available, which can be placed by Seldinger technique using guidewire.[8] The kit consists of a needle, guidewire, series of dilators and the chest tube, which varies in size from 9F to 20F. After selecting the site of insertion, local infiltration anaesthesia is given a syringe half filled with saline solution is attached to the needle provided and inserted into pleural cavity and after ascertaining it's proper position by drawing fluid or air, guidewire is passed into pleural cavity and needle removed, then series of dilators are introduced into pleural cavity to the point of loss of resistance and finally the tube over stylette is introduced into pleural cavity and the stylette along with guidewire is removed, stay suture applied and connected to underwater seal drain. Here, because, small drain is used, it entails smaller incision, minimal tissue dissection, less painful, tube can be snugly fit into pleural cavity preventing seepage of fluid or air from outside of chest drain and whole procedure can be done quickly and as the tube is small, it does not require suturing, when it is removed and it leaves small scar.[8,12,13] Operator's thoracic ultrasound knowledge is very useful as one can see the visceral pleural border of the collapsed lung and can have idea of safe depth of insertion of dilators and tubes.[8,9,1,14,2] In the present study, ultrasound is utilised in all cases of pleural effusion and in some cases of pneumothorax. In case of pneumothorax, collapsed lung border is visible on chest x-ray. Ultrasound utility can substantially reduce the incidence of complications, which in the present study, did not notice any tube misplacements or underlying organ injury. British Thoracic Society Guidelines strongly recommend ultrasound utilisation and use of small bore chest drains.[1,2,3] Many studies conducted so far reaffirmed the safety, efficacy and ease of small bore chest tube placements by Seldinger technique using guidewire.[8,3,15,13]

***Figure 3. Small Bore Chest Drainage Kit***

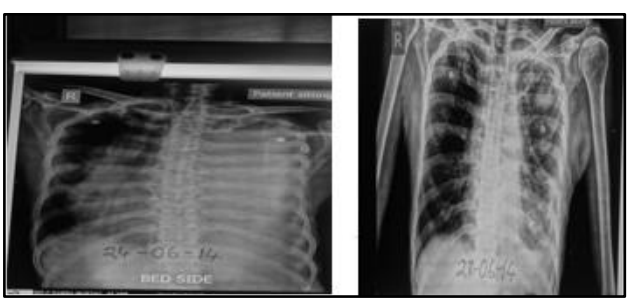

***Figure 4. CXR Before and After Tube Thoracostomy***

3. Trocar technique is not recommended as per current guidelines in view of complications.[3]

**CONCLUSION**

The present study is in accordance with the earlier studies.[8] Tube thoracostomy is made easy, safe, less painful with a combination of operator's thoracic ultrasound knowledge and small bore chest drains of 12 to 16F size using guidewire technique and good tolerability from patient's point of view.[8,9,3,10]

Following are the observations-

1. Small bore tubes of sizes 12F to 16F meet all needs and at the same time limit tube kinking and better drainage.[12,16,5,4,15]
2. Keeping patient in semi-prone position and limiting to area of triangle of safety helps ease of insertion for fluid or air.
3. Whatever maybe the attempt at direction of insertion of chest drain, the final outcome of lung expansion is

same, which could be due to constant suction force exerted by underwater seal drain.

4. Thoracic ultrasound knowledge is highly essential for pulmonary and ICU intensivists, the art of which can be acquired easily within a short span of time.8,9,1
5. Procedural pain and complications are substantially less with SBCTS.11,15
6. The commercially available kits are small, available in sterile packing and portable, hence can be used in wide settings in the hospital and in emergency services.13
7. Many physicians and residents can attempt tube thoracostomy, which is made easy with small bore chest tubes with Seldinger technique.[6] An extension of the Seldinger technique with guidewire can be considered for trocar placement for flexi-rigid thoracoscopy placement of which facilitates easy insertion of flexi-rigid thoracoscope into pleural cavity and the subsequent procedure would be similar to fiberoptic bronchoscopy. Manufacturers may consider that.

The disadvantages could be cost of the set, but can be mitigated by ease of procedure and comfort to patient. Long and straight guidewires may sometimes slip into pleural cavity if one is inattentive and sometimes long guidewires may be touched accidentally, while insertion making procedure unsterile.[11,14,15] Tube clogging can be prevented with frequent flushing of the tube with the adapter available.

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