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Interventional study to compare the effectiveness of large and small-bore intercostal tubes in the management of large pneumothorax at IRD, SMS Medical College, Jaipur.

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Abstract

Introduction- Pneumothorax is defined as the presence of air or gas in the pleural cavity. Chest drains provide a method of removing air & fluid substances from the pleural space. Chest tubes have been classified into small bore (<20Fr) and large bore(>20Fr) based on their sizes. The British Thoracic Society (BTS) prefers to group pneumothorax into "small" or "large" depending on the presence of a visible rim of <2 cm or ≥2 cm between the lung margin and the chest wall.

Aim- To compare the effectiveness, tolerability, and complications of large-bore and small-bore intercostal tubes in the management of large pneumothorax.

Material and Methods-A hospital-based cross-sectional study were conducted in patients having large pneumothorax at the Institute of respiratory diseases, SMS Medical College, Jaipur, Rajasthan, India. Sixty patients were included and divided into 2 groups using simple randomization. Patients in the first group underwent chest tube insertion with large-bore tubes while patients in the second group underwent chest tube insertion with small-bore tubes. Patients in both groups were assessed and compared for the duration of chest tube drainage, length of hospital stay, Complications, Tolerability, and Outcome in the form of drainage success and failure. The data analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0.

Results- Mean age (years) in our study was 43.17 ± 14.41 ranging between 22-77. Amongst sixty patients

65% were males and 46.67% were smokers. Majority of patients were diagnosed as spontaneous pneumothorax secondary to COPD (18.33%) followed by Tuberculosis, Silicosis, and Silico-tuberculosis. The success rate of the intercostal drainage tube (ICDT) was comparable between large (86.67%) and small-bore (73.33%) intercostal chest tubes. We found the proportion of patients with adequate lung expansion was higher in large-bore chest tubes. i. e, 80%. (p-value-0.0009) Duration of ICD and duration of hospitalization was significantly higher in small bore chest tubes. (p-value-0.045) The pain was significantly higher in large-bore intercostal chest tubes (p value=0.001), followed by blocking and kinking of the tube in both groups and the majority of complications occur after insertion of the large bore i.e., Surgical site infection, subcutaneous emphysema, bronchopleural fistula. Blocking of the tube was seen more in the small-bore chest tube (SBCT) group (20%).

Conclusion-A small-bore chest tube was as effective as large-bore chest tube drainage. Large bore chest tubes can be used for emergent scenarios. SBCT offers a tolerable method with lesser complication rates as compared to that of the large-bore chest tube.

Keywords:

Introduction

Pneumothorax is defined as the presence of air or gas in the pleural cavity. According to etiology pneumothorax is classified into spontaneous and traumatic. Spontaneous pneumothorax is further classified into primary and secondary. Traumatic pneumothorax may result from either blunt trauma or penetrating injury to the chest wall. It can also be caused by iatrogenic injuries. Primary spontaneous pneumothorax occurs in patients without predisposing lung disease. Secondary spontaneous pneumothorax occurs in patients with predisposing lung disease, most commonly chronic obstructive pulmonary disease (COPD) [1]

Chest drains are also referred to as chest tubes, underwater sealed drainage (UWSD), tube thoracostomy, or intercostal drain. Chest drains provide a method of removing air & fluid substances from the pleural space. [2]

Chest tubes have been classified into small bore (<20Fr) and large bore(>20Fr) based on their sizes. Operative tube thoracostomy with a large bore intercostal chest tube has been conventionally used. More recently, small-bore bore catheters have become an alternative to large-bore intercostal chest tubes (ICT).[3]

Small-bore chest drains are likely related to ease of insertion, reduced trauma, and the perception of diminished patient discomfort, despite potentially improved drainage from a large drain.

British Thoracic Society pleural disease guidelines 2010 recommend the use of small-bore chest drains in the management of pneumothorax.[4] The British Thoracic Society (BTS) prefers to group pneumothorax into"small" or "large" depending on the presence of a visible rim of <2 cm or ≥2 cm between the lung margin and the chest wall.[5]

The present study was aimed at comparing the effectiveness, tolerability, and complication of large and small-bore intercostal tubes in the management of large pneumothorax.

Material And Methods

This was a hospital-based cross-sectional interventional study carried out on large pneumothorax patients admitted to the Department of Respiratory medicine, Institute of Respiratory Diseases, SMS Medical College, Jaipur, Rajasthan during the year 2020–2021. The study was initiated after approval from the Research Review Board (RRB) and Institutional Ethics Committee (EC).

This hospital-based interventional study enrolled 60 patients with large pneumothorax. After giving a full explanation regarding the study, written consent was obtained from all enrolled patients.

Inclusion and exclusion criteria- Sixty patients with large pneumothorax were recruited after excluding the patients on conservative management, mechanical ventilation, those who have a history of recurrent pneumothorax and history of pleurodesis, those with bleeding disorders/on anticoagulant, those with other pleural diseases like pyo-pneumothorax, hydropneumothorax, etc. Patients having the first episode of pneumothorax, requiring intercostal drainage were enrolled.

All selected patients were subjected to clinical history, physical examination, chest x-ray, and relevant blood investigations. USG chest and CECT chest were also done. Arterial blood gas analysis, if needed. Then, the etiology of pneumothorax was established.

The selected patients were divided into 2 groups using simple randomization. Patients in the first group underwent insertion with large-bore chest tubes while patients in the second group underwent insertion with small-bore chest tubes. Post-ICDT chest X-ray done after 2 hours. We assessed patients for adequate lung expansion after 24 hours of tube insertion and it was assessed by the absence of a rim of pneumothorax on chest x-ray.

We also assessed the following parameters -

- Duration of chest drainage (days).
- Length of hospital stay.
- Complications: Pain, subcutaneous emphysema, surgical site infection, tube displacement, bronchopleural fistula, tube blocking, and kinking.
- Patient discomfort- Pain by VPIS (Verbal pain intensity scale), Dyspnea by MMRC scale (Modified Medical Research Council).

The outcome was assessed by drainage success and failure

- Drainage success was considered with full lung re-expansion and extubation with hospital discharge.
- Drainage failure was defined as the need for a second intervention.

Follow-up was done till discharge. Repeat Chest-x-ray done as and when required. Tube extubated after lung expansion. The patient was kept under observation for 24 hours and assessed for recurrence of pneumothorax.

Statistical Analysis

Collected data were entered into Microsoft Excel data sheet which was tabulated for further interpretation. This was then subjected to appropriate statistical tests. The Categorical variables were presented in the form of numbers and percentages (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). The following statistical tests were applied to the results. The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0. For statistical significance, a p-value of less than 0.05 was consideredstatistically significant.

Results

The Mean age (years) in our study was 43.17 ± 14.41 ranging between 22-77, and amongst 60 study subjects, most of the patients were males. 46.67% of patients in our study were smokers. (Table no.1)

Majority of patients were diagnosed as spontaneous pneumothorax i.e., 89.90%. The most common etiology was COPD followed by Tuberculosis, Silicosis, and silico-tuberculosis. The distribution of etiology was comparable between large and small-bore intercoastal tubes. (Table no.2)

The success rate of ICDT was comparable between large (86.67%) and small-bore (73.33%) intercostal chest tubes (p value=0.333). (Table no.3)

We found relief of dyspnea was more in large bore (93.33%) as compared with small bore intercostal chest tube. (73.33%) (p-value=0.08). The proportion of patients with adequate lung expansion was significantly higher in large-bore (80%) intercostal chest tubes as compared to small-bore intercostal chest tubes (53.33%), (p value=0.0009). (Table no.4)

Duration of ICD (days) is less in large bore intercostal chest tubes (6.4 ± 5.96) as compared to small bore intercostal chest tubes (8.77 ± 7.04). Duration of hospitalization (days) in small bore intercostal chest tube was (13.97 ± 8.12) which was significantly higher as compared to large bore intercostal chest tube (10.03 ± 6.67) (p value=0.045) (Table no.5)

The most common complication was pain followed by blocking and kinking of tubes in both groups. The pain was significantly higher in large-bore intercostal chest tubes. (p value=0.001). The majority of complications occur after insertion of the large bore as compared to small bore tube i.e., Surgical site infection: - 16.67% vs 3.33% respectively, Subcutaneous emphysema: - 16.67% vs 0% respectively, Bronchopleural fistula: - 13.33% vs 10% respectively. Blocking of the tube was seen more in the small-bore chest tube group (20%). (Table no.6)

The recurrence rate was comparable between large and small-bore chest tubes (13.33% vs 6.67% respectively). (Table no.7)

Patients with post covid fibrosis had a significantly high failure rate (16.67%) as compared to a success rate (0%) (p value=0.037). Distribution of other etiologies was comparable between the outcome of drainage (failure vs success). (Table no.8)

Table 1: Distribution of age (years), gender and smoking status between large and small-bore intercostal chest tubes.

	Large boreintercostal chest tube(n=30)	Small boreintercostalchest tube(n=30)	Total
Age (in years)			
Mean± SD	43.6 ± 12.9	42.73 ±15.99	43.17 ±14.41
Gender			
Female	8 (26.67%)	13 (43.33%)	21(35%)
Male	22 (73.33%)	17 (56.67%)	39(65%)
Smoking status			
Non-smoker	18 (60%)	14 (46.67%)	32(53.33%)
Smoker	12 (40%)	16 (53.33%)	28(46.67%)

Table 2: Comparison of etiology between large and small-bore intercostal chest tube.

Etiology	Large boreintercostal chest tube (n=30)	Small bore intercostal chest tube(n=30)	Total	P-Value
Unknown (PSP)	2 (6.67%)	3 (10%)	5(8.33%)	1*
COPD	5(16.67%)	6(20%)	11(18.33%)	0.739†
Tuberculosis	5(16.67%)	5(16.67%)	10(16.67%)	1†
COPD with tuberculosis	1(3.33%)	1(3.33%)	2(3.33%)	1*
Silicosis	6 (20%)	1 (3.33%)	7(11.67%)	0.103*
Silico-tuberculosis	2 (6.67%)	3 (10%)	5(8.33%)	1*
Traumatic	2 (6.67%)	1 (3.33%)	3 (5%)	1*
Post covid fibrosis	0 (0%)	2 (6.67%)	2 (3.33%)	0.492*
Idiopathic pulmonary Fibrosis	0 (0%)	2 (6.67%)	2 (3.33%)	0.492*
Lung cancer	2 (6.67%)	1 (3.33%)	3 (5%)	1*
Post TB OAD	3(10%)	1 (3.33%)	4 (6.67%)	0.612*
Lymphangioliomyomatosis	0(0%)	2(6.67%)	2(3.33%)	0.492*
Iatrogenic	2 (6.67%)	1 (3.33%)	3 (5%)	1*
HIV with pneumonia	0 (0%)	1 (3.33%)	1(1.67%)	1*

* Fisher's exact test, † Chi-square test

Table 3: Comparison of outcome of ICDT between large and small-bore intercostal chest tube.

Outcomeof ICDT	Large bore intercostal chest tube(n=30)	Small bore intercostal chest tube(n=30)	Total	P value
Failure	4 (13.33%)	8 (26.67%)	12 (20%)	0.333*
Success	26 (86.67%)	22 (73.33%)	48 (80%)	
Total	30 (100%)	30 (100%)	60 (100%)	

* Fisher's exact test

Table 4: Comparison of relief of dyspnoea and adequate lung expansion after 24 hours of chest tube insertion between large and small-bore intercostal chest tubes.

	Large boreintercostal chest tube(n=30)	Small bore intercostal chest tube(n=30)	Total	P value
Relief of dyspnea				
No	2 (6.67%)	8 (26.67%)	10 (16.67%)	0.08*
Yes	28 (93.33%)	22 (73.33%)	50 (83.33%)	
Adequate lung expansion				

No	6 (20%)	14 (46.67%)	20 (33.33%)	0.0009*
Yes	24 (80%)	16 (53.33%)	40 (66.66%)	
Total	30 (100%)	30 (100%)	60 (100%)	

* Fisher's exact test

Table 5: Comparison of duration of ICD (days) and duration of hospitalization(days) between large and small-bore intercostal chest tubes.

	Large bore intercostal chest tube(n=30)	Small boreintercostalchest tube(n=30)	Total	P value
Duration of ICD (days)				
Mean ± SD	6.4 ± 5.96	8.77 ± 7.04	7.58 ± 6.57	0.165‡
Duration of hospitalization (days)				
Mean ± SD	10.03 ±6.67	13.97 ±8.12	12 ± 7.63	0.045‡

‡ Independent t-test

Table 6: Comparison of complications between large and small-boreintercostal chest tube.

Complications	Large boreintercostal chest tube(n=30)	Small bore intercostal chest tube (n=30)	Total	P value
Blocking of Tube	4 (13.33%)	6 (20%)	10 (16.67%)	0.731*
Kinking of tube	3 (10%)	4 (13.33%)	7 (11.67%)	1*
Surgical site Infection	5 (16.67%)	1 (3.33%)	6 (10%)	0.195*
Subcutaneous Emphysema	5 (16.67%)	0 (0%)	5 (8.33%)	0.052*
Bronchopleural Fistula	4 (13.33%)	3 (10%)	7 (11.67%)	1*
Pain scale				
Mild pain	5 (16.67%)	18 (60%)	23 (38.33%)	0.001*
Moderate pain	12 (40%)	9 (30%)	21 (35%)	
Severe pain	11 (36.67%)	3 (10%)	14 (23.33%)	
Very Severe Pain	2 (6.67%)	0 (0%)	2 (3.33%)	

* Fisher's exact test, † Chi-square test

Table 7:Comparison of recurrence of pneumothorax 24 hours after extubation between large and small-bore intercostal chest tube.

Recurrence of pneumothorax 24 hour after extubation	Large bore intercostal chest tube(n=30)	Small boreintercostalchest tube (n=30)	Total	P value
No	26 (86.67%)	28 (93.33%)	54 (90%)	0.671*
Yes	4 (13.33%)	2 (6.67%)	6 (10%)	
Total	30 (100%)	30 (100%)	60 (100%)	

* Fisher's exact test

Table 8: Association of etiology with the outcome of drainage.

Etiology	Failure (n=12)	Success (n =48)	Total	P value
Unknown	0 (0%)	5 (10.42%)	5 (8.33%)	0.572*
COPD	3(25%)	8 (16.67%)	11(18.33%)	0.677*
Tuberculosis	0 (0%)	10 (20.83%)	10(16.67%)	0.188*
COPD with tuberculosis	1(8.33%)	1(2.08%)	2(3.33%)	0.363*
Silicosis	0 (0%)	7 (14.58%)	7 (11.67%)	0.326*
Silico-tuberculosis	3 (25%)	2 (4.17%)	5 (8.33%)	0.05*
Traumatic	0 (0%)	3 (6.25%)	3 (5%)	1*
Post covid fibrosis	2 (16.67%)	0 (0%)	2 (3.33%)	0.037*
Idiopathic pulmonary Fibrosis	1 (8.33%)	1 (2.08%)	2 (3.33%)	0.363*
Lung cancer	0 (0%)	3 (6.25%)	3 5%)	1*
Post TB OAD	1 (8.33%)	3 (6.25%)	4 (6.67%)	1*
Lymphangioliomyomatosis	0 (0%)	2 (4.17%)	2 (3.33%)	1*
Iatrogenic	0 (0%)	3 (6.25%)	3 (5%)	1*
HIV with pneumonia	1(8.33%)	0 (0%)	1(1.67%)	0.2*

* Fisher's exact test

Discussion

In our study, the majority of cases were males i.e., 65%. The higher incidence in males has been attributed to higher rates of smoking, outdoor activities, body habitus, and different mechanical properties of the lung. Smoking is a major risk factor for COPD as well as for pneumothorax. 28 (46.67%) patients in our study were smokers. Smoking causes bronchiolar inflammation, leading to alveolar overdistension and rupture, and may cause pneumothorax. Similarly, a study conducted by **Manish Kumar Meena et al.** [6] in Rajasthan found that 76% of patients were smokers while 24% of patients were nonsmokers.

The most common etiology of pneumothorax in our study was COPD: - followed by Tuberculosis, Silicosis, and Silico-tuberculosis. Whereas **Y. Gayatri Devi**.[7] in Andhra Pradesh India and **Shivaji V. Patil et al.** [8] found the most common etiology for SSP as TB followed by COPD. Both of these studies did not find Silicosis and silico-tuberculosis as major aetiological factors for pneumothorax but we found that along with COPD and TB, silicosis and silico-tuberculosis were also major aetiological factors. This is due to more prevalence of silicosis in the western part (Rajasthan) of India. Silica's toxic particles directly damage the lungs and lead to the formation of inflammatory products which in turn damage the alveolar wall's elastic fibre, which contributes to bleb formation. The silica's chemical and physical properties could have an association with pneumothorax, as silicon dioxide content is found high in the silica dust of Rajasthan.

The outcome of ICDT was comparable between large and small-bore intercostal chest tubes. We also found that relief of dyspnea was more in large-bore chest tubes, this observation was found may be due to the fact that LBCT has a higher flow rate. Relief of dyspnea was assessed by the MMRC scale. Most of the patients who were in MMRC grades- 3 and 4 prior to ICD insertion were found in MMRC grades -1 and 2 after the large bore tube insertion.

The proportion of patients with adequate lung expansion was significantly higher in the large bore intercostal chest tube.

The mean ± SD of the duration of ICD (days) and hospitalization in our study is significantly higher in small-bore intercostal chest tubes. This observation of our study somewhat differs from previously available studies. A study by **Murat Ersin Çardak et al.** [9] showed the period of termination of the drain was 3.3±1.2 days for the small-bore chest tube group and 4.0±1.7 days for the large-bore chest tube group. SBCT group patients had a longer duration of ICD and hospital stay as compared with the large bore chest tube group probably due to lower flow rate in SBCT.

In our study, the most common complication was pain followed by blocking and kinking of the tubes in both groups. The majority of complications occur after the insertion of the large bore as compared to a small-bore tube. Only a few complications were found more in small bore tubes (Blocking and Kinking of the tube). Similar data were also found in a study by **Su-Huan Chang et al.** [10] that the Pigtail catheter (PC) group had significantly lower complication rates than the LBCT group in both spontaneous (six studies) and secondary (two studies) subtypes.

The advantages of a SBCT are smaller size, small incision, better patient comfort, and outpatient management, these are the contributing factors for less complication rate in the SBCT group.

Conclusion

A small-bore chest tube was as effective as large-bore chest tube drainage irrespective of the subtypes. Furthermore, compared with small-bore chest tubes, the large-bore chest group had a shorter duration of drainage and hospital stay in patients with large pneumothorax probably due to the lower flow rate in a small-bore chest tube. Large bore chest tubes can be used for emergent scenarios (Tension pneumothorax) due to the higher flow rate which in turn leads to rapid relief of dyspnea. SBCT offers a tolerable method with lesser complication rates as compared to that of the large-bore chest tube.

Limitations

We used rubber malecot catheters for the majority of patients because most of the patients were belonging to poor socio-economic status in our hospital (government setup). They had affordability issues. This may lead to biasness in our study. Quantification among large pneumothorax was not done.

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