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Original Article

Emergency small- vs large-tube thoracostomy in chest trauma patients

Hussein Khairy Abdelaziz Elkhayat[1], Ahmed Mohamed Fathy Ghoneim[1], Moamen Shalkamy Abdelgawaad[2], Amr Mohamed Mamdouh Hussein[1], Amr Ibrahiem Abdelaal Osman[1]

[1] Department of Cardiothoracic Surgery, Assiut University Hospitals, Assiut, Egypt

[2] Department of General Surgery, Assiut University Hospitals, Assiut, Egypt

Abstract

Background: Therapeutic drainage is used to treat pleural disorders such as pneumothorax, hemothorax, empyema, chylothorax, and malignant effusions. This study aimed to conduct a comparative analysis of small (24-26 Fr) versus large (30-32 Fr) tube thoracostomy in terms of the efficacy of drainage due to concerns about obstruction (in the case of hemothorax) or inadequate drainage (in the case of hemothorax, pneumothorax, or hemopneumothorax), pain score, repositioning, and the need for thoracotomy.

Methods: This randomized prospective study included 112 chest trauma patients who experienced significant hemothorax, pneumothorax, or a combination of these conditions in a trauma unit (reception, inpatient, or ICU) between December 2021 and December 2022. Patients were randomly divided into two groups. Group I included 56 patients who underwent small (24–26 Fr) tube thoracostomy and 56 patients in Group II, in which a large (30-32 Fr) tube thoracostomy was performed. We investigated the differences between the two groups in terms of pain score, complication rate, duration of tube insertion, and need for another chest tube or thoracotomy.

Results: There was no statistically significant difference between the two groups concerning the mode of trauma, chest trauma, or effect of trauma ($p= 0.781$, 0.622, >0.99, and >0.99, respectively). The two groups had a highly statistically significant difference regarding the pain score ($p<0.001$). There was no statistically significant difference between the two groups regarding the duration of tube insertion ($P<0.001$). There were no statistically significant differences between the two groups regarding outcomes (drainage efficacy, tube repositioning, tube replacement, or the need for thoracotomy) ($p= 0.315$, 0.344, and 0.814, respectively).

Conclusion: Increasing the tube size might not affect the efficacy of drainage, the duration of tube insertion, the need for another tube, or the need for thoracotomy. Small (24-26 Fr) tube thoracostomies could also have favorable pain score outcomes.

KEYWORDS

Emergency; Large tube thoracostomy; Chest trauma patients

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Corresponding author: Amr Mohamed Mamdouh Hussein amrmamdouh_95@yahoo.com

Introduction

Chest tubes are used for therapeutic drainage of pleural disorders such as pneumothorax, hemothorax, empyema, chylothorax, and two malignant effusions. They are also used for prophylactic drainage of air, blood, and two other fluids following chest surgery [1].

The majority of cases involving traumatic pneumothorax (PTX) and hemothorax (HTX) are amenable to nonoperative management via chest tube thoracostomy. Although the majority of chest trauma guidelines advocate for the use of large-bore chest tubes (as the 9th edition of the Advanced Trauma Life Support (ATLSTM) program [2] suggests employing a 36 or 40 Fr tube, and the Japan Advanced Trauma Evaluation and Care (JATECTM) course [3] suggests utilizing a 28 Fr or larger tube and determining the size of the tube according to the patient's physique), these suggestions primarily stem from conventional clinical practices. These large-bore thoracic tubes may induce discomfort and pain at the insertion site, particularly in conscious patients. It has been reported that patients with pleural infection experience less discomfort at the site of tube insertion when smaller tubes are utilized [4]. Although the 9th edition of the ATLS recommends a 36 or 40-Fr tube, the new recommendation in the 10th edition [5] is a 28-32 Fr tube for acute hemothorax. The ideal size of the tube for an urgent thoracostomy in cases of traumatic pneumothorax or hemothorax remains uncertain. Minimal catheter tube thoracostomy and large-bore chest tube thoracostomy have been demonstrated to be effective in the nonemergent treatment of individuals suffering from traumatic pneumothorax or hemothorax [6]. Small catheter tube thoracostomy is as successful as large catheter tube thoracostomy in addressing chest trauma in stable trauma individuals [7].

The purpose of the present study was to conduct a comparative analysis of small (24-26 Fr) versus large (30-32 Fr) tube thoracostomies in terms of the need for an additional chest tube due to concerns about obstruction (in the case of hemothorax) or inadequate drainage (in the case of hemothorax, pneumothorax, or hemopneumothorax), pain score, repositioning, and the need for thoracotomy.

Patients and Methods

This randomized prospective study (registration number: NCTO483989) was conducted on 112 chest trauma patients with significant hemothorax, pneumothorax, or combined hemopneumothorax in the trauma unit (reception, inpatient, or ICU) from December 2021–December 2022. Patients were randomly divided (by coin tossing) into two groups. Group I included 56 patients who underwent small (24–26 Fr) tube thoracostomy. Fifty-six patients were admitted to Group II, in which a large (30-32 Fr) tube thoracostomy was performed.

The inclusion criteria were as follows: patients who experienced chest trauma and acute hemothorax, pneumothorax, or combination hemopneumothorax and who required tube thoracostomy within the first 2 hours of admission. The exclusion criteria were as follows: chest trauma requiring thoracotomy for reasons such as diaphragmatic rupture, flail chest, or sternal fracture.

Sample Size Calculation

The sample size calculation was performed using G* Power 3 software [8]. To detect significant differences between both techniques with regard to postoperative complications, with an expected frequency of 14.5-16.7% [3], and based on the following parameters, an error probability of 0.05 and eighty percent power on a two-tailed test, a calculated minimum required sample of 112 cases will be needed. Randomization was carried out by sequentially numbered opaque envelopes utilizing a random numbers table (1:1 ratio).

Data collection and definitions

The demographic data included the following: age and sex, intervention data, size of chest tube used, postintervention data (outcomes), efficacy of drainage, re-expansion of the lung, presence or absence of residual collection, pain score and duration of the inserted tube, and pain score assessment. The numerical rating scale NRS, which

Table 1: Comparison of the demographic data and characteristics of trauma patients who had small (Group I) vs. large (Group II) tube thoracostomy

	Group I (n= 56)	Group II (n= 56)	P value
Sex			
Male	52 (92.9%)	49 (87.5%)	0.341
Female	4 (7.1%)	7 (12.5%)	
Mode of trauma			
Blunt	40 (71.4%)	35 (62.5%)	0.315
Penetrating	16 (28.6%)	21 (37.5%)	
Chest trauma			
Isolated chest trauma	24 (42.9%)	29 (51.8%)	0.344
Polytrauma	32 (57.1%)	27 (48.2%)	
Effect of trauma			
Hemothorax	10 (17.9%)	12 (21.4%)	
Pneumothorax	23 (41.1%)	20 (35.7%)	0.814
Combined	23 (41.1%)	24 (42.9%)	
Age (years)			
< 20	14 (25%)	9 (16.1%)	
20 – 40	25 (44.6%)	27 (48.2%)	0.495
> 40	17 (30.4%)	20 (35.7%)	
Mean ± SD	32.46 ± 18.52	36.04 ± 16.67	0.202
Median (Range)	27.0 (4.0-80.0)	34.0 (6.0-80.0)	

is an 11-point numeric scale (NRS 11) with 0 representing one extreme of pain (e.g., “no pain”) and 10 representing the other extreme of pain (e.g., “pain as bad as you can imagine” or “worst pain imaginable”) [9, 10] in which a respondent selects a whole number (0–10 integers) that best reflects the intensity of their pain [10].

Statistical analysis

The data were gathered using a predesigned form and then analyzed utilizing SPSS (Statistical Package for the Social Sciences, version 20, IBM, Armonk, New York). Continuous data are represented as the mean ± standard deviation (SD) or the median (range), whereas nominal data are represented as the frequency (%). The chi-squared test was used to compare the nominal data of various groups, while the Student’s t-test was used to evaluate the means of two separate groups. The confidence level was set at 95%; hence, the two-tailed P value was considered significant if it was < 0.05.

Table 2: Comparison of pain score and duration of tube insertion between patients with small (Group I) vs. large (Group II) thoracostomy tube patients

	Group I (n= 56)	Group II (n= 56)	P value
Pain score			
Mean ± SD	4.32 ± 1.43	6.37 ± 1.27	<0.001
Range	2.0-8.0	4.0-9.0	
Tube duration (days)			
Mean ± SD	4.23 ± 1.85	4.50 ± 1.88	0.449
Range	2.0-11.0	2.0-11.0	

Table 3: Comparison of the outcomes of trauma patients who had small (Group I) vs. large (Group II) tube thoracostomy

	Group I (n= 56)	Group II (n= 56)	P value
Efficacy of drainage			
Full expanded lung	49 (87.5%)	48 (85.7%)	
Complications	7 (12.5%)	8 (14.3%)	
Residual collection	4 (7.1%)	1 (1.8%)	0.781
Clotted hemothorax	3 (5.4%)	4 (7.1%)	
Unresolved pneumothorax	0	3 (5.4%)	
Repositioning of the tube	9 (16.1%)	11 (19.6%)	0.622
Tube replacement	9 (16.1%)	9 (16.1%)	>0.99
Need for thoracotomy	3 (5.4%)	4 (7.1%)	>0.99

Results

The mean age of the patients in Group I was 32.46 years, while that of patients in Group II was 36.04 years (Table 1). The two groups showed male dominance, accounting for 92.9% of the males in Group I and 87.5% of the males in Group II.

There was no statistically significant difference among the groups concerning the mode of trauma, chest trauma or effect of trauma (p= 0.315, 0.344, and 0.814, respectively). (Table 1)

The two groups had a highly statistically significant difference regarding the pain score (p<0.001). There was no statistically significant difference between the two groups regarding the duration of tube insertion (P= 0.449). (Table 2)

There was no statistically significant difference between the two groups regarding outcomes (drainage efficacy, tube repositioning, tube replacement, and the need for thoracotomy) (p= 0.781, 0.622, >0.99, and >0.99, respectively). (Table 3)

Discussion

The main findings of our study favored the use of small-sized chest tubes for treating hemothorax and hemopneumothorax in terms of reduced pain scores and similar complication rates and durations of chest tube placement.

The results of our study showed similar overall rates of complications (25%) and similar rates of need for subsequent procedures in the chest. This 25% complication rate is comparable to that observed in other contexts; for example, a 27% complication rate was reported in a study by Tsai et al., who used echocardiography-guided tube thoracostomy [11]. Another study by Horsley et al. reported a 21% complication rate for small tubes [12].

Complications reported in previous studies included unresolved pneumothorax (the most common complication), residual hemothorax, empyema or clotted hemothorax, or malposition (the least common complication) [7, 12].

Our study revealed complication rates of 12.5 and 14.3% complication rates in patients who underwent small- and large-tube thoracostomy, respectively, comparable to those in other contexts. Additionally, small-tube thoracostomy placement in our study was neither image-assisted nor exclusive in nonemergent patients.

Our complications also varied among unresolved pneumothorax (being the least common in small-sized tubes and the most common in large-sized tubes), residual hemothorax (being the most common in small-sized tubes and the least common in large-sized tubes), tube obstruction, empyema, or clotted hemothorax.

The duration of tube insertion is an important outcome measure in chest trauma patients because it affects pain perception, and the tube itself may be a source of infection; therefore, it is important to identify methods with the shortest duration of tube insertion.

Inaba et al. investigated the difference in duration between small (28-32 Fr) and large (36-

40 Fr) tube thoracostomy, which was not statistically significant (p= 0.427), with a mean duration of 6.3 ±3.9 days vs. large (6.2 ±3.6 days) [3].

In our study, the duration of tube insertion did not significantly differ between small- and large-sized tube thoracostomies (p=0.449), with a mean duration of 4.23±1.85 vs. 4.50 ± 1.88, respectively.

The pain score is a numerical rating scale (NRS). As a subjective method of pain assessment, it is not widely used in clinical practice and is usually not used in many contexts.

Although pain is difficult to assess, the degree of pain perceived by the patient affects the outcome of tube thoracostomy, i.e., the less pain perceived by the patient, the more tolerance to physiotherapy, the better the drainage and the lesser the duration of the inserted tube, and vice versa.

Inaba et al. performed a visual analog pain score on approximately half of patients, and no variance in their perception of pain due to chest tube size was observed [3].

In our study, however, all patients in both groups experienced the same pain control (paracetamol tabs 3 times per day), and the pain score was favorable for small (24-26 Fr) tube thoracostomy, with a mean value of 4.32 ± 1.43 SD, compared to a mean value of 6.37 ± 1.27 SD for large (30, 32 Fr) tube thoracostomy.

Study limitations:

Our research has a limited number of patients, which can be attributed to the short duration of the study; however, we used relatively small tubes in a large number of patients (however, this sample size was calculated before the enrollment of the patients according to our endpoint of outcome). Another limitation is the use of pain scores as a method of patient assessment, which is a subjective method that may differ according to the mode of trauma, local chest trauma or polytrauma, age, and sex of the patients.

Conclusion

Increasing the tube size might not affect drainage efficacy, the duration of tube insertion, or the need for another tube or thoracotomy. Small (24-26 Fr) tube thoracostomies could also have favorable pain score outcomes.

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