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How emergency physicians choose chest tube size for traumatic pneumothorax or hemothorax: a comparison between 28Fr and smaller tube

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ABSTRACT

Most traumatic pneumothoraxes and hemothoraxes can be managed non-operatively by means of chest tube thoracostomy. This study aimed to investigate how emergency physicians choose chest tube size and whether chest tube size affects patient outcome. We reviewed medical charts of patients who underwent chest tube insertion for chest trauma within 24 hours of admission in this retrospective, single-institution study. Patient characteristics, inserted tube size, risk of additional tube, and complications were evaluated. Eighty-six chest tubes were placed in 64 patients. Sixty-seven tubes were placed initially, and 19 additionally, which was significantly smaller than the initial tube. Initial tube size was 28 Fr in 38 and <28 Fr in 28 patients. Indications were pneumothorax (n=24), hemothorax (n=7), and hemopneumothorax (n=36). Initial tube size was not related to sex, BMI, BSA, indication, ISS, RTS, chest AIS, or respiratory status. An additional tube was placed in the same thoracic cavity for residual pneumothorax (n=13), hemothorax (n=1), hemopneumothorax (n=1), and inappropriate extrapleural placement (n=3). Risk of additional tube placement was not significantly different depending on tube size. No additional tube was placed for tube occlusion or surgical intervention for residual clotted hemothorax. Emergency physicians did not choose tube size depending on patient sex, body size, or situation. Even with a <28 Fr tube placed in chest trauma patients, the risk of residual hemo/pneumothorax and tube occlusion did not increase, and drainage was effective.

Keywords: chest tube size, thoracic trauma, tube thoracotomy

Abbreviations and acronyms:
AIS: Abbreviated Injury Scale score
ATLS: Advanced Trauma Life Support
BMI: body mass index
BSA: body surface area
HPTX: hemopneumothorax
HTX: hemothorax
ISS: Injury Severity Score
JATEC: Japan Advanced Trauma Evaluation and Care
PTX: pneumothorax
RTS: Revised Trauma Score

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INTRODUCTION

Most occurrences of traumatic pneumothorax (PTX) and hemothorax (HTX) can be managed non-operatively by means of chest tube thoracostomy. Although most guidelines for chest trauma recommend a large-bore chest tube, e.g., the 9th edition of the ATLS™ (Advanced Trauma Life Support) program recommends a 36 or 40 Fr tube,[1] and the JATEC™ (Japan Advanced Trauma Evaluation and Care) course recommends a 28 Fr or larger tube and choosing the tube size based on the patient's physique,[2] these recommendations are mainly based on traditional clinical habits. These large-bore chest tubes may cause pain related to the insertion site and discomfort, especially in conscious patients. Smaller tubes were reported to reduce the pain associated with the tube insertion site in patients with pleural infection.[3]

Inaba et al reported in their recent study that smaller chest tubes (28–32 Fr) were as effective as larger (36–40 Fr) tubes to manage thoracic trauma.[4] Although the effectiveness of smaller tubes was proven in their study, the pain felt by patients at the insertion site was not reduced in the smaller-bore group. Although 28 Fr was categorized in the smaller-bore group in this report, some physician feel 28 Fr is still too large for patients.

The aims of this study were to investigate how emergency physicians choose chest tube size and whether chest tube size, including the recommended size of 28 Fr or smaller, affects patient outcome.

MATERIALS AND METHODS

We reviewed the clinical charts of patients who were transferred to our department due to chest trauma and underwent chest tube placement within the first 24 hours of admission for traumatic PTX, HTX, or hemopneumothorax (HPTX) between January 2012 and December 2015.

Argyle trocar catheters (Covidien Japan, Tokyo; 18,20,22,24 and28Fr) were inserted with an open technique by emergency medicine physicians or residents supervised by an attending emergency medicine physician. The size of the chest tube placed was at the discretion of the attending emergency medicine physician.

The patients' clinical data including demographic characteristics, injury mechanism, Revised Trauma Score (RTS), Injury Severity Score (ISS), chest Abbreviated Injury Scale score (AIS), patient condition at tube placement, indication for drainage, insertion-related complications, requirement for an additional tube, tube insertion duration, and hospital stay were retrospectively collected.

Continuous values were compared using the Student *t*-test, Welch's *t*-test, or Mann-Whitney *U* test, and categorical values were compared by means of the chi-square test or two-sided Fisher's exact test. The relations between two values were examined by Pearson's correlation coefficient test. Differences were considered significant at a P value < 0.05.

RESULTS

In total, 86 chest tubes were placed in 64 patients during the study period. Sixty-seven tubes were placed as an initial drain (bilateral drainage was needed in 3 patients), and 19 were additional placements.

Patient characteristics are shown in Table 1. The size of all chest tubes placed was 28 Fr in 42 and <28 Fr in 41 patients. Sixty-seven tubes were placed as an initial drain and 19 were additionally placed. The size and number of placed chest tubes and relation of initial and additional tube are shown in Table 2. A clear description of the inserted tube size could not be confirmed in 3 out of 86 cases who underwent chest drainage. The tube size of the additional drains was significantly smaller than that of the initial tubes (25.5 ± 3.16 vs 22.2 ± 3.75; P<0.01, 95%CI: 1.49–5.07).

The size of the initial tubes placed was 28 Fr in 38 and <28 Fr in 28 patients. The indications for initial tube thoracostomy were PTX in 24, HTX in 7, and HPTX in 36 patients. The size of the initially placed chest tube was not significantly different depending on the patient's sex, indication, respiratory status (intubated or not), or mechanism of injury (Table 3). In addition, the size of the placed tube was not related to the patient's age, BMI, BSA, RTS, ISS, or chest AIS score (Table 4, Figure 1A-F).

To investigate whether tube size affects the patient outcome, we divided the patients to two groups, group L (placed tube ≥28 Fr) and group S (placed tube <28 Fr). Except for the patients in group L being younger (P = 0.049, 95% confidence interval: 0.19–18.4), the patient backgrounds

Table 1 Patient characteristics (n = 64)

Age (years old)	65.0 ± 18.5
Sex	
Male	49 (75.6)
Female	15 (23.4)
BSA (m^2)	1.62 ± 0.15
BMI (kg/m^2)	22.1± 3.11
Mechanism	
Blunt	61 (95)
Penetrating	3 (5)
RTS	6.35 ± 2.39
ISS	29.0 ± 13.9
Chest AIS	3.87 ± 0.64
Intubated at tube placement	34 (53)

BSA: body surface area, BMI: body mass index, RTS: Revised Trauma Score, ISS: Injury Severity Score, AIS: Abbreviated Injury Scale.
Values are shown as mean ± SD or number (%).

Table 2 The size and number of chest tube placed

	Initial tube (n=67)	**Additional tube (n=19)**
28Fr	38	n=11: 28Fr:3,22Fr:1, 20Fr:5, 18Fr:1, unknown:1
24Fr	13	n=5: 24Fr:2, 18Fr:3
22Fr	4	n=0
20Fr	11	n=3: 28Fr:1, 24Fr:1, unknown:1
Unknown	1	n=0

Table 3 Chest tube size and patient condition

Tubes (n = 67)	n	Drain size, Fr (mean ± SD)	*P* value	95% CI
Sex				
Male	51	25.3 ± 3.21	0.39	-1.06–2.66
Female	16	26.1 ± 2.78		
Indication				
Pneumothorax	24	24.8 ± 3.46		-3.29–4.22 (PTX-HTX)
Hemothorax	7	24.3 ± 3.45	} 0.1	-1.62–5.62 (HTX-HPTH)
Hemopneumothorax	36	26.3 ± 2.58		-2.08–5.16 (PTX-HPTX)
Respiratory status				
Intubated	37	25.8 ± 3.0	0.46	-0.99–2.14
Not-intubated	30	25.2 ± 3.2		
Mechanism				
Blunt	64	25.5 ± 3.17	0.52	-2.54–4.95
Penetrating	3	26.7 ± 1.89		

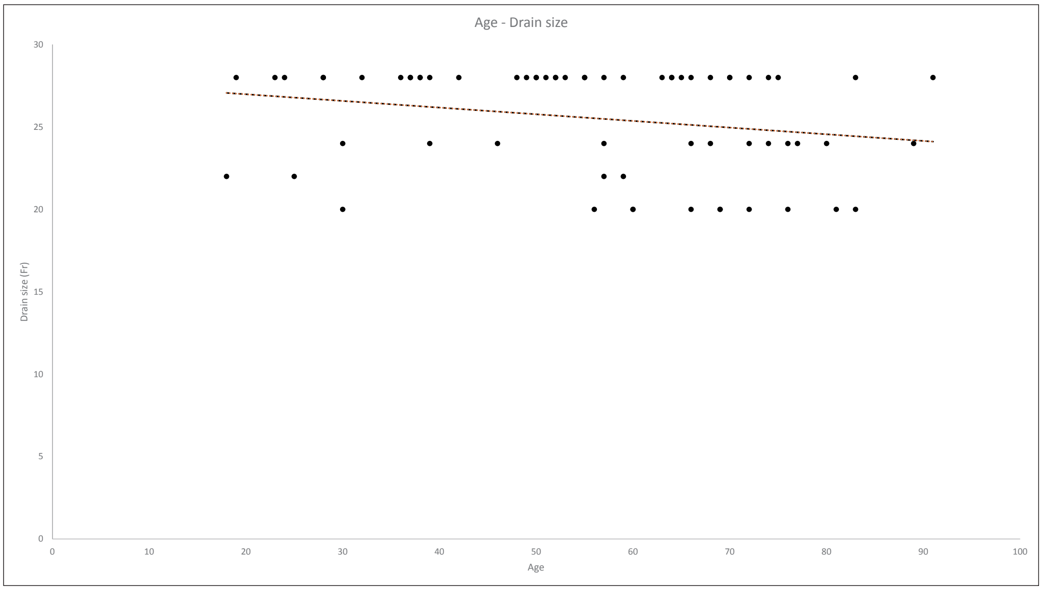
SD: standard deviation, CI: confidence interval, PTX: pneumothorax, HTX: hemothorax, HPTX: hemopneumothorax.

Table 4 Correlation between tube size and patient characteristics

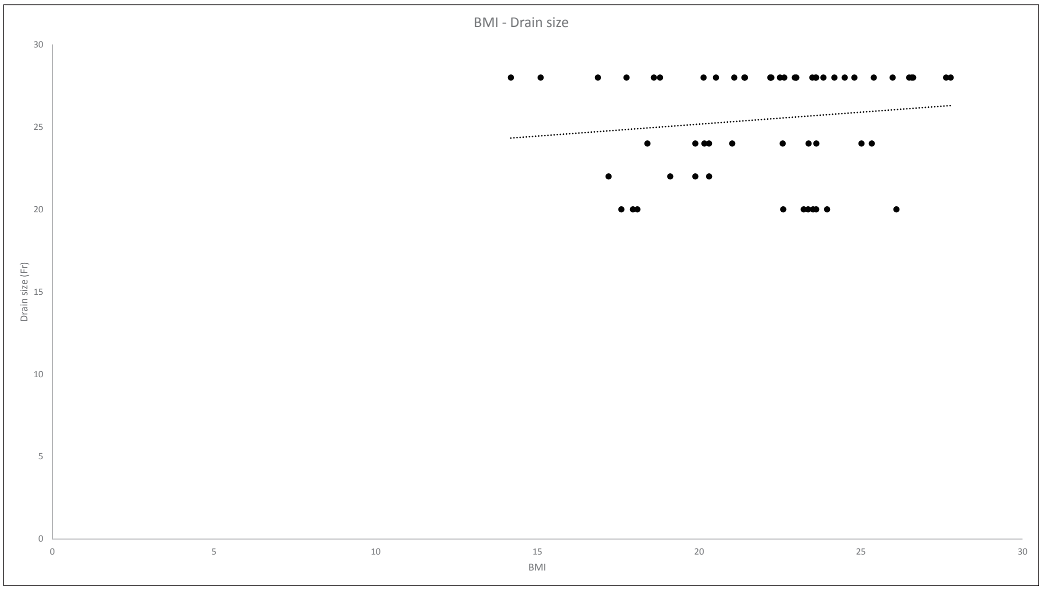
Relation to drain size	r (Pearson's correlation coefficient test)	*P* value
Age	-0.00011	0.99
BSA	0.23	0.06
BMI	0.23	0.07
RTS	0.22	0.07
ISS	0.009	0.95
Chest AIS	0.076	0.54

BSA: body surface area, BMI: body mass index, RTS: Revised Trauma Score, ISS: Injury Severity Score, AIS: Abbreviated Injury Scale.

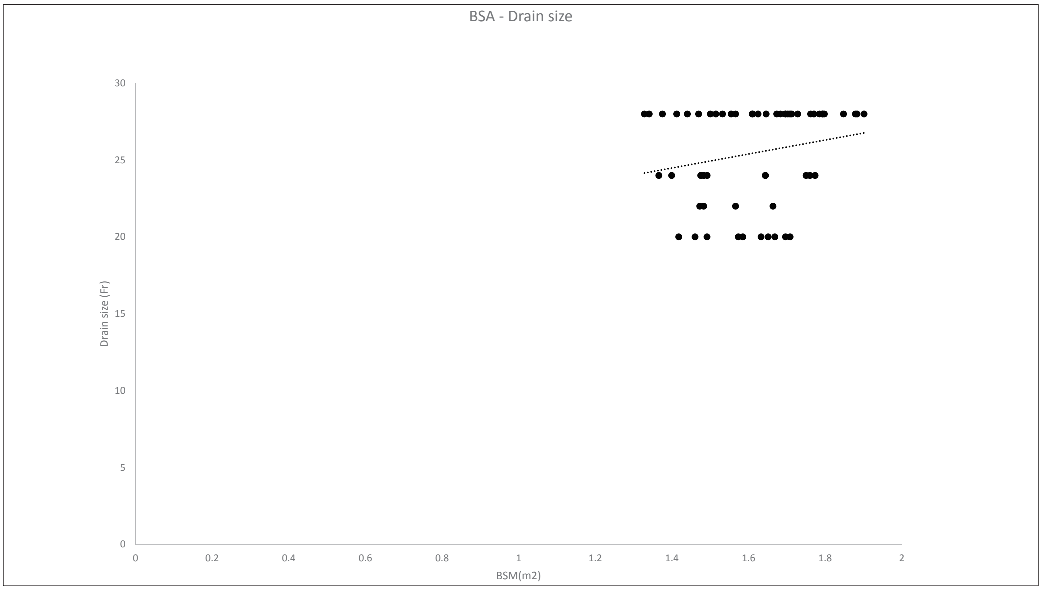
were similar between the two groups (Table 5). Additional tubes for the same thoracic cavity were required in 19 patients, and the reasons for an additional tube were residual PTX in 13, residual HTX in 1, residual HPTX in 1, and inappropriate extra-pleural placement in 3 patients. The risks of requiring an additional tube, residual hemo/pneumothorax, and inadequate placement into the extra-pleural layer were not significantly different between the two groups. There was no requirement for an additional tube or surgical intervention for tube occlusion or residual clotted hemothorax during the mean placement duration of 6.5 days in this patient series.


Age - Drain size
30
25
20
15
10
5
0
Drain size (Fr)
0
10
20
30
40
50
60
70
80
90
100
Age

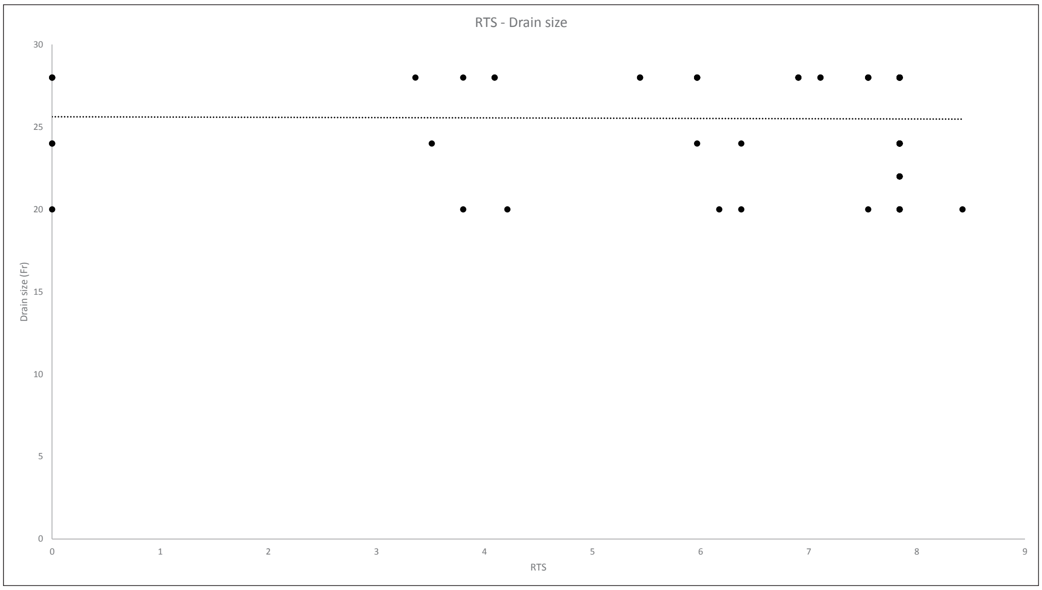
A


BMI - Drain size
30
25
20
15
10
5
0
Drain size (Fr)
0
5
10
15
20
25
30
BMI

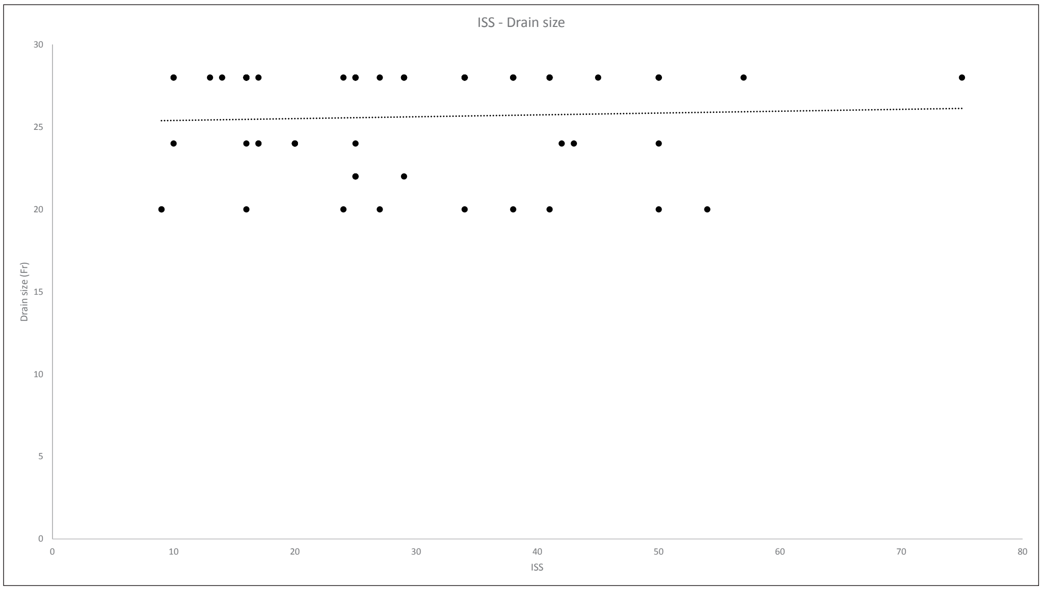
B


BSA - Drain size
Drain size (Fr)
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
BSM(m2)

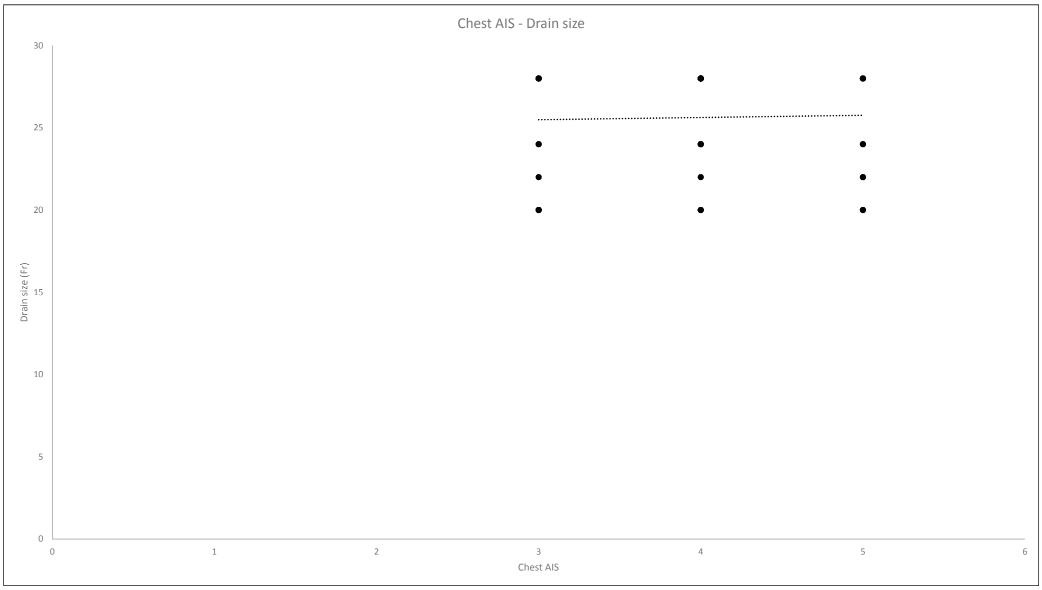
C


RTS - Drain size
Drain size (Fr)
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
RTS

D



E



F

Fig. 1 Correlation between tube size and patient background
(A, age; B, BMI; C, BSA; D, RTS; E, ISS; F, chest AIS). BSA, body surface area; BMI, body mass index; RTS, revised trauma score; ISS, injury severity score; AIS, abbreviated injury scale

Table 5 Patient characteristics and complication rates of groups L and S

	Total (n = 67)	Group L ≥28 Fr (n = 38)	Group S <28 Fr (n = 28)	P value	95% CI
Age (years old)	55.5 ± 18.5	52.0 ± 17.2	61.4 ± 18.3	0.049	0.19–18.4
Sex					
Male	51	28 (54.9)	23 (45.1)	} 0.42	
Female	16	10 (62.5)	5 (31.3)		
BSA (m2)	1.62 ± 0.15	1.65 ± 0.16	1.58 ± 0.12	0.063	-0.009–0.15
BMI	22.1 ± 3.08	22.5 ± 3.32	21.5 ± 2.61	0.24	-0.72–2.61
RTS	6.24 ± 2.48	6.33 ± 2.24	6.35 ± 2.55	0.97	-1.18–1.23
ISS	29.2 ± 14.0	30.1 ± 14.6	27.4 ± 12.9	0.47	-4.66–1
Chest AIS	3.90 ± 0.66	3.89 ± 0.61	3.92 ± 0.74	0.88	-0.32–0.38
Initial indication for chest tube					
Pneumothorax	24	12 (50)	12 (50)		
Hemothorax	7	3 (42.9)	4 (57.1)	} 0.36	
Hemopneumothorax	36	23 (63.9)	12 (33.3)		
Respiratory status					
Intubated	37	22 (59.5)	14 (37.8)	} 0.52	
Not-intubated	30	16 (53.3)	14 (46.7)		
Mechanism of injury					
Blunt	64	36 (56.3)	27 (42.2)	} 0.79	
Penetrating	3	2 (66.7)	1 (33.3)		
Duration of tube placement (days)	6.5±3.48	7.2 ± 4.09	5.55 ± 2.06	0.067	-0.28–3.60
Need for additional drain	18 (26.9)	10 (26.3)	8 (28.6)	0.88	
Cause of additional drainage					
Residual HTX/PTX/HPTX	15 (22.4)	8 (21.1)	7 (25)	0.76	
Inadequate placement	3 (4.48)	2 (5.26)	1 (3.57)	1	
Hospital stay (days)	19.3 ± 23.0	22.8 ± 28.4	15.2 ± 11.4	0.15	-4.15–19.3

CI, confidence interval; *BSA*, body surface area; *BMI*, body mass index; *RTS*, Revised Trauma Score; *ISS*, Injury Severity Score; *AIS*, Abbreviated Injury Scale; *PTX*, pneumothorax; *HTX*, hemothorax; HPTX, hemopneumothorax.
Values are shown as mean ± S.D. or number (%).

DISCUSSION

Tube thoracotomy is one of the essential treatments for traumatic HTX and PTX. Traditionally, large-bore drainage tubes have been recommended because smaller-bore tubes were believed to be less effective and have a tendency to become blocked. Both American and Japanese trauma care guidelines recommend large-bore (36–40 Fr in the ATLS and 28 Fr in the JATEC) chest tubes. However, these recommendations have never been subjected to evidence-based evaluation.

Although large-bore tubes are believed to have better drainage capacity, this traditional belief was contradicted in some studies. In the report of Niinami et al, although the drainage capacity of the conventional large-bore (28 Fr) chest tube was 9-times higher than that of the smaller (19 Fr) silicone drain (103.8 vs. 11.6 L/h) in the experimental setting, there was no difference in drainage capacity between the two different-sized tubes in the in vivo study.[5]

A recent prospective study of trauma patients proved that the small-bore (28–32 Fr) chest tube was as effective as the traditional large-bore (36–40 Fr) tube, but the pain at the site of insertion did not differ between the two groups.[4] In a study of pleural infection, smaller tube size (<15 Fr) reduced pain related to tube insertion and the tube insertion site.[3] These two results may indicate that a 28 Fr tube is adequately effective for trauma patients but is not small enough to reduce patient pain.

Because a small-bore tube is used for pediatric patients, the JATEC program recommends choosing the chest tube size based on the patient's body size. In the emergency clinical situation, we have to choose the tube size immediately according to the patient's presentation. In our experience, except for additionally placed drains that were smaller than the initial one, the inserted tube size was not related to the patient's sex, age, BMI, or BSA. Furthermore, the patient's condition, such as respiratory status (ventilator dependent or not), indication for the chest tube (PTH, HTX, or HPTX), mechanism of injury, ISS, or chest AIS score did not affect the tube size selected. Nevertheless, the chosen tube sizes ranged from 18 to 28 Fr. This may be due to physician preference.

We compared effectiveness and safety in the two groups and found that the patient characteristics were similar, except for the group L patients being younger, and the risks of additional drainage and complications were not significantly different between the two groups. Although the difference was not statistically significant, large bore tubes tended to be chosen for patients of hemopneumothorax and patients intubated at the time of tube placement. In addition, although there was no significant difference in ISS and chest AIS, hospital stay was more than 7 days longer in group L. There may be a tendency to increase the length of hospital stay in the case of insertion of large size chest tube.

As mentioned above, smaller-bore chest tubes have been evaluated for both their effectiveness and reduction of tube-related pain. Small-bore (28–32 Fr) tubes, apart from whether these sizes are really "small" for patients, were proven to be as effective as traditional large-bore (36–40 Fr) tubes.[4] In our series, the effectiveness was similar between the group L (28 Fr) and group S (<28 Fr) patients.

Furthermore, to reduce patient pain and discomfort, we should investigate how small the tube size can be while still maintaining its drainage ability. Kulvatunyou et al introduced 14 Fr pigtail catheters to manage traumatic pneumothorax and proved their effectiveness and reduction in pain in patients with uncomplicated traumatic PTX.[6,7] They expanded their target to physiologically stable patients with blunt traumatic HTX and suggested that 14 Fr pigtail catheters seemed to be able to drain blood as well as traditional large-bore chest tubes.[8]. Although very small drainage catheters such as 14 Fr can be considered in stable patients, further research is necessary to apply these drainage tubes to critically ill patients. In our experience, chest tube size of 20–24Fr could drainage adequately but whether these size can reduce pain or discomfort of inserted site is unknown because pain or discomfort were not evaluated in this study.

LIMITATIONS

This study was single-institution, retrospective, observational study of small number of trauma patients. The pain related to tube insertion and the effects of the duration of tube placement were not assessed in this study.

CONCLUSION

In our experience, emergency physicians did not choose chest tube size based on patient age, sex, body size, physiological status, or injury severity. An additional drain placed on the same side was smaller than the initially placed tube. Although tubes of smaller than the recommended tube size (28 Fr) were placed in about one half of the patients, the drainage effect and complication rate were not statistically significantly different according to the placed tube size.

The patients' condition in two group may not be equal in this study, randomized controlled trial is needed to determine whether smaller than 28 Fr chest tube is adequate for trauma patients.

DISCLOSURE

Approval of the research protocol: This retrospective study was confirmed by the Ethics Committee of Osaka City University Graduate School of Medicine.

Informed consent: All participants gave their written informed consent.

Conflicts of interest: Authors declare no Conflict of Interests for this article.

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