Original Article

Access this article online
Quick Response Code:

Website:
https://eurasianjpulmonol.org
DOI:
10.14744/ejp.2026.77677

Impact of chest tube size on patient comfort and outcomes in malignant pleural effusion: A prospective comparative non-randomized study

Ragdah Arif

ORCID:
Ragdah Arif: 0009-0006-6862-9085

Department of Internal Medicine, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

Address for correspondence:
Dr. Ragdah Arif, Department of Internal Medicine, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia.
E-mail: ragdah.arif@hotmail.com, Rarif@kau.edu.sa

Received: 18-11-2025
Revised: 09-01-2026
Accepted: 26-01-2026
Published: 09-04-2026

Abstract:

BACKGROUND AND AIM: Malignant pleural effusion (MPE) is a common complication of advanced cancer. Both large-bore chest tubes (≥20 Fr) and small-bore catheters (≤14 Fr) are used for drainage and pleurodesis; however, their effects on patient comfort and clinical outcomes remain unclear. This study compared comfort, efficacy, pleurodesis success, and complication rates between these methods.

METHODS: This prospective comparative study enrolled 146 patients with MPE who underwent physician-directed allocation to receive either a large-bore (n=73) or small-bore (n=73) intercostal catheter (ICC) under local anesthesia, followed by talc pleurodesis after lung re-expansion. Outcomes included procedure duration, pain scores, drainage parameters, pleurodesis success, complications, and four-week follow-up.

RESULTS: Baseline characteristics were comparable between groups. Large-bore tubes required a longer insertion time (23.6±2.6 vs. 11.0±1.8 min, $p<0.001$) and were associated with higher pain scores immediately post-insertion (6.9±1.4 vs. 4.9±1.3, $p<0.001$), at 6 hours (5.1±1.3 vs. 3.7±1.1, $p<0.001$), and at 24 hours (3.3±1.2 vs. 2.4±1.0, $p<0.001$). Drainage volume was higher (1594±340 vs. 1331±415 mL, $p<0.001$), and time to complete drainage was shorter (34.9±8.8 vs. 39.5±10.5 h, $p=0.005$) in the large-bore group. Pleurodesis success was comparable (71.2% vs. 68.5%, $p=0.686$), as was drainage efficacy (80.8% vs. 76.7%, $p=0.544$). Blockage occurred more frequently in small-bore catheters (5.5% vs. 1.4%, $p=0.366$), whereas infection (6.8% vs. 1.4%, $p=0.209$) and dislodgement (5.5% vs. 2.7%, $p=0.681$) were more common with large-bore tubes.

CONCLUSIONS: Both large- and small-bore chest tubes were effective for pleurodesis in MPE. Large-bore tubes enabled faster and higher-volume drainage but were associated with greater pain and longer procedure times, whereas small-bore tubes provided better patient comfort with comparable efficacy. Small-bore tubes are preferable in most cases, while large-bore tubes may be suitable when rapid, high-volume drainage is required.

Keywords:

Chest tube insertion, large-bore chest tube, malignant pleural effusion, patient comfort, pleurodesis, small-bore catheter

How to cite this article: Arif R. Impact of chest tube size on patient comfort and outcomes in malignant pleural effusion: a prospective comparative non-randomized study. Eurasian J Pulmonol 0000;00:1-7.

Introduction

Malignant pleural effusion (MPE) is a common complication in patients with advanced malignancies, particularly lung and breast tumors and lymphomas.[1,2] Although MPE usually signifies advanced disease with a limited prognosis, patients with chemosensitive tumors, such as breast cancer or lymphoma, may experience relatively prolonged survival.[2] In such cases, palliative interventions to relieve symptoms, including dyspnea, orthopnea, cough, and pleuritic pain, are justified to improve quality of life.[1,2] Systemic therapy, either alone or in combination with local measures, may benefit selected patients with chemosensitive tumors. However, systemic therapy alone is often insufficient to control pleural fluid accumulation, necessitating local interventions.[2–4]

Traditional local approaches include repeated thoracentesis and tube thoracotomy; however, both are associated with high recurrence rates, and simple drainage rarely achieves durable control.[1] This limitation has led to the widespread use of chemical pleurodesis employing sclerosing agents such as tetracycline, bleomycin, and talc.[5–8] Over time, talc has become established as the most effective agent, while advancements in catheter design and placement techniques, such as the Seldinger guidewire approach and image-guided insertion, have enhanced both safety and precision.[7–12] These developments have supported the increasing adoption of small-bore intercostal catheters (SB ICCs; ≤14 Fr) as less invasive alternatives to conventional large-bore intercostal tubes (LB ICTs; ≥20 Fr). SB ICCs have been reported to be effective, safe, and well tolerated in the management of pleural effusions, empyema, and pneumothorax.[11,12] Ultrasound-guided placement offers further benefits, including optimal positioning above the diaphragm and the ability to identify insertion sites.[10] Despite these advantages, concerns persist that smaller tubes may result in slower drainage rates or a higher risk of blockage,[4,13,14] even though experimental studies contradict this view. Pass et al.[2] previously observed no significant variation in drainage time with catheters larger than 8 Fr, irrespective of fluid viscosity. Similarly, Laws et al.[3] demonstrated comparable *in vivo* drainage efficiencies of 19 Fr and 28 Fr tubes.

Clinical studies have reported mixed results. Observational studies generally highlight the advantages of SB ICCs; however, comparative trials have been less consistent.[15–17] Vedam and Barnes[13] observed increased complication and recurrence rates with SB ICCs, whereas Parulekar et al.[15] reported no significant differences in pleurodesis success. Furthermore, the Thoracic Interventional Procedures (TIME1) randomized trial demonstrated that 24 Fr tubes achieved higher pleurodesis efficacy than 12 Fr catheters, although at the cost of greater pain.[18] Nevertheless, reviews and guideline statements have consistently highlighted that the ideal tube size remains a subject of ongoing debate.[3,4,19–20]

Thus, the optimal tube size for MPE remains unclear. LB ICCs are still favored in many centers owing to their perceived drainage efficiency, whereas SB ICCs are increasingly preferred because of their superior tolerability and procedural ease. Against this backdrop of uncertainty, the present study was conducted to prospectively compare LB and SB chest tubes in patients with MPE, with a focus on patient comfort, drainage efficacy, pleurodesis success, and complication profiles.

Materials and Methods

Patients

This prospective comparative study was approved by the Ethical Review Board of Government Mozang Teaching Hospital (Approval Number: 5170 /GMTH, Date: 15/03/2024) and conducted between March and December 2024. The study adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained after providing a comprehensive explanation of the study, including its objectives, methodology, potential risks, and benefits. The required sample size was calculated to achieve a power of 80% with a significance level of 5%. Based on the expected difference in drainage efficacy between large- and small-bore tubes (47.3% vs. 23.6%) and allowing for a 20% dropout rate, a total of 146 patients (73 in each group) were required. Convenience sampling was applied. Eligible participants were adults (≥18 years) with a confirmed diagnosis of MPE established by pleural fluid cytology and/or pleural biopsy and who required chest tube insertion. In some patients, malignant pleural effusion was confirmed by cytology and/or pleural biopsy, but the primary tumor site had not yet been identified at the time of enrollment. Exclusion criteria included trapped lung, prior pleurodesis, severe coagulopathy, and refusal to participate. Participants were divided into two groups according to chest tube size:

- Group A (Large-bore): chest tube size ≥20 French,
- Group B (Small-bore): chest tube size ≤14 French.

This study was designed as a prospective comparative study. Formal randomization was not performed; therefore, allocation concealment methods (e.g., computer-generated sequences or sealed envelopes) were not applicable. Tube size selection was based on the treating physician's clinical judgment and the patient's condition.

Procedure, patient assessment, and follow-up

Chest tube insertion was performed under local anesthesia using 2% lignocaine, following strict aseptic precautions. Tubes were inserted at the mid-axillary line in the fifth or sixth intercostal space and connected to an underwater seal drainage system. After radiographic confirmation of complete lung expansion, pleurodesis was performed using sterile talc (4 g). Baseline demographic and clinical data, including age, sex, comorbidities, and underlying malignancies, were recorded. Pain was assessed using a standardized visual analogue scale (VAS; 0=no pain and 10=worst pain imaginable) at three time points: immediately post-insertion, 6 hours, and 24 hours post-procedure. Drainage efficacy was assessed using the total volume of fluid drained within 24–48 hours and the time required for complete drainage. Non-effective drainage was defined as incomplete lung re-expansion and/or significant residual pleural fluid on post-procedural imaging despite an adequate drainage duration. Pleurodesis success was defined as the absence of recurrent effusion on follow-up imaging. Additional outcomes included procedure duration and complications, such as tube dislodgement, blockage, infection, or re-accumulation.

Indications for chest tube insertion included symptomatic dyspnea, recurrent malignant pleural effusion requiring pleurodesis, radiological evidence of significant effusion causing lung compression, and reduced oxygen saturation attributable to pleural fluid. Patients were monitored for four weeks post-discharge to evaluate recurrence, late complications, and pleurodesis outcomes. Follow-up was conducted during outpatient visits and, when required, through telephone interviews.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables (e.g., age, VAS scores, and procedure duration) were expressed as mean±standard deviation (SD) and compared using Student's t-test. Categorical variables (e.g., sex, drainage efficacy, pleurodesis success, and complications) were expressed as frequencies and percentages and analyzed using the chi-squared test. A p-value <0.05 was considered statistically significant.

Table 1: Baseline demographic and clinical characteristics of the study population (n=146)

Variable	Large-bore (n=73)	Small-bore (n=73)	Total (n=146)	p*
Age (years), mean±SD	59.6±9.6	58.0±11.0	58.8±10.3	0.38
Sex, n (%)				
Male	39 (53.4)	44 (60.3)	83 (56.8)	0.41
Female	34 (46.6)	29 (39.7)	63 (43.2)	
Side of effusion, n (%)				
Right	35 (47.9)	45 (61.6)	80 (54.7)	1.00
Left	38 (52.1)	28 (38.5)	66 (45.2)	
Comorbidities, n (%)				
Hypertension	20 (27.4)	18 (24.7)	38 (26.0)	0.97
Diabetes	17 (23.3)	17 (23.3)	34 (23.3)	
COPD	11 (15.1)	11 (15.1)	22 (15.1)	
Diabetes + hypertension	7 (9.6)	8 (11.0)	15 (10.3)	
None	18 (24.7)	19 (26.0)	37 (25.3)	
Underlying malignancy, n (%)				
None	55 (75.3)	61 (83.6)	116 (79.5)	0.42
Breast cancer	3 (4.1)	3 (4.1)	6 (4.1)	
Colon cancer	3 (4.1)	3 (4.1)	6 (4.1)	
Lung cancer	9 (12.3)	5 (6.8)	14 (9.6)	
Prostate cancer	3 (4.1)	1 (1.4)	4 (2.7)	

*: Chi-square test. "None" indicates an unknown primary malignancy despite confirmed malignant pleural effusion. SD: Standard deviation, COPD: Chronic obstructive pulmonary disease.

Results

Baseline and demographic characteristics

A total of 146 patients with MPE were enrolled, with 73 patients in each group. Baseline demographic and clinical characteristics were comparable between the large- and small-bore groups. The mean age was 59.2±9.6 years in the large-bore group and 58.5±11years in the small-bore group. Males comprised 58.9% of the large-bore group and 54.8% of the small-bore group (p=0.41) (Table 1). Although right-sided effusion was slightly more common in the small-bore group (61.6% vs. 47.9%), this difference was not statistically significant. Comorbidities were evenly distributed, with hypertension (27.4% vs. 24.7%), diabetes mellitus (23.3% in both groups), and chronic obstructive pulmonary disease (COPD) (15.1% in both groups) showing no statistically significant differences. The distribution of underlying malignancies was also balanced. Lung cancer was the most frequent primary tumor (12.3% vs. 6.8%), followed by breast cancer

Table 2: Procedural outcomes and patient comfort according to chest tube size

Variable	Large-bore (n=73)	Small-bore (n=73)	Mean difference	95% CI of difference	p
Procedure duration (min)	23.62±2.57	11.03±1.81	12.59	11.86–13.32	<0.001
VAS (immediate)	6.85±1.40	4.88±1.25	1.97	1.54–2.40	<0.001
VAS (6 h)	5.13±1.33	3.70±1.14	1.43	1.02–1.84	<0.001
VAS (24 h)	3.29±1.16	2.37±1.01	0.92	0.56–1.27	<0.001
Drainage volume (mL)	1594.33±340.12	1331.03±414.92	263.30	139.18–387.42	<0.001
Time to complete drainage (h)	34.90±8.82	39.48±10.53	-4.58	-7.75–1.40	0.005

CI: Confidence interval,VAS: Visual analogue scale.

(4.1% vs. 4.1%), colon cancer (4.1% vs. 4.1%), and prostate cancer (4.1% vs. 1.4%). These differences were not statistically significant, indicating that the groups were well matched at baseline (Table 1). Baseline characteristics are presented to demonstrate group comparability.

Procedural outcomes and patient comfort

Statistically significant differences were observed in procedure duration and pain scores. Large-bore tubes required a longer insertion time (23.6±2.6 min vs. 11.0±1.8 min, p<0.001) and were associated with consistently higher pain scores at all measured time points: immediately post-insertion (6.9±1.4 vs. 4.9±1.3, p<0.001), at 6 hours (5.1±1.3 vs. 3.7±1.1, p<0.001), and at 24 hours (3.3±1.2 vs. 2.4±1.0, p<0.001) (Table 2) [Fig. 1].

Drainage efficacy, pleurodesis success, and complications

Drainage efficiency was superior in the large-bore group, with a greater mean volume of fluid removed (1594±340 mL vs. 1331±415 mL, p<0.001) and a shorter time to achieve complete drainage (34.9±8.8 h vs. 39.5±10.5 h, p=0.005) (Table 2). Despite these differences, both groups achieved comparable clinical outcomes. Adequate drainage was achieved in 80.8% of patients in the large-bore group and 76.7% in the small-bore group (p=0.544). Pleurodesis success rates were also similar, at 71.2% in the large-bore group and 68.5% in the small-bore group (p=0.686) (Table 3). The complication profiles differed modestly between groups. Small-bore tubes were more frequently associated with blockage (5.5% vs. 1.4%, p=0.366), whereas large-bore tubes showed higher rates of infection (6.8% vs. 1.4%, p=0.209) and dislodgement (5.5% vs. 2.7%, p=0.681). Re-accumulation of pleural effusion occurred at comparable frequencies in both groups (4.1% vs. 5.5%, p=1.00). Although patients with non-effective drainage were managed according to standard clinical practice, details of subsequent interventions were not systematically recorded in the study dataset. Overall, complication rates were low in both groups, with all individual complications occurring in fewer than 7% of patients [Fig. 2].

Table 3: Clinical outcomes and pleurodesis success by chest tube group

Outcome/ variable	Large-bore (n=73)	Small-bore (n=73)	Total (n=146)	p
Drainage efficacy, n (%)				
Effective	59 (80.8)	56 (76.7)	115 (78.8)	0.544
Non-effective	14 (19.2)	17 (23.3)	31 (21.2)	
Pleurodesis success, n (%)				
Yes	52 (71.2)	50 (68.5)	102 (69.9)	0.686
No	21 (28.8)	23 (31.5)	44 (30.1)	

*Chi-square test.

Discussion

This prospective comparative study demonstrated that chest tube size had a greater impact on patient experience than on clinical outcomes in the management of MPE. Large-bore ICCs achieved faster and higher-volume drainage but were consistently associated with longer procedure duration and greater pain. In contrast, small-bore tubes offered superior comfort and procedural tolerability, with only a modest increase in the risk of blockage. Notably, both tube sizes achieved comparable drainage efficacy and pleurodesis success, suggesting that tube selection should be guided primarily by patient-centered considerations rather than assumptions of superior efficacy with larger drains. These findings align with those of Parulekar et al.,[15] who reported no significant difference in pleurodesis success between small- and large-bore tubes in MPE. Similarly, Hafiza et al.[20] reported better patient comfort and fewer complications with small-bore tubes, although their study included mixed clinical indications. In contrast, the TIME1 randomized trial demonstrated higher pleurodesis efficacy with larger tubes, albeit at the cost of increased pain.[18] Methodological differences, including the standardized use of talc pleurodesis in the present study, which is considered the most effective sclerosing agent, may partly explain

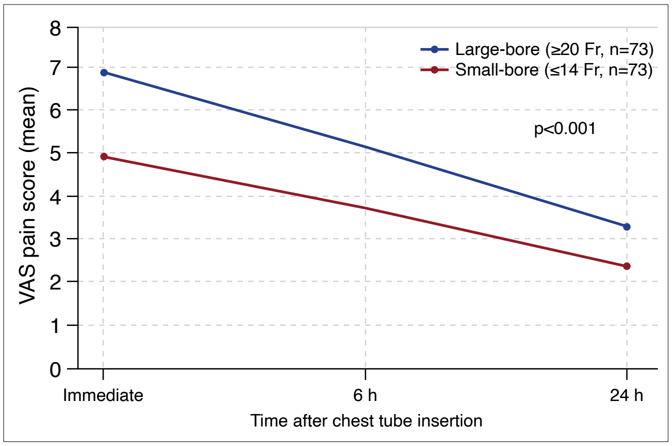

Figure 1: Comparison of mean pain scores assessed using the Visual Analogue Scale (VAS) between large-bore and small-bore chest tube groups immediately after insertion, at 6 hours, and at 24 hours. Pain scores were significantly higher in the large-bore group at all time points (immediate: $p<0.001$; 6 h: $p<0.001$; 24 h: $p<0.001$)

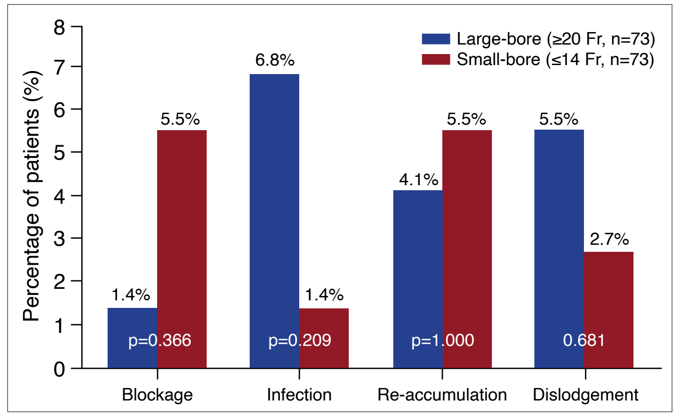

Figure 2: Comparison of complication profiles between large-bore and small-bore chest tubes in patients with malignant pleural effusion (n=146). Percentages are calculated based on group size (n=73 per group). Blockage occurred more frequently in the small-bore group (5.5% vs. 1.4%), whereas infection (6.8% vs. 1.4%) and tube dislodgement (5.5% vs. 2.7%) were more common in the large-bore group. None of these differences were statistically significant ($p>0.05$ for all comparisons)

these discrepancies.[7,8] In their reviews, McCracken et al.[19] and Light[4] emphasized that the ideal tube size is still a subject of debate and highlighted the importance of prioritizing patient comfort in clinical decision-making. It is also possible that the observed differences in drainage volume and time to complete drainage partly reflect selection bias, as patients with larger or more symptomatic effusions may have been preferentially assigned to large-bore tubes. This should be considered when interpreting drainage-related outcomes.

The complication profile observed in this study was consistent with that reported in the literature. Infections were limited to localized insertion-site infections and were managed conservatively. Horsley et al.[14] and Davies et al.[21] have highlighted the increased risk of blockage associated with small-bore drains, whereas larger drains have been more frequently associated with infection and dislodgement.[14,21–23] These findings are consistent with our observations, highlighting that each tube size has its own complication profile. In recent years, indwelling and tunneled pleural catheters have emerged as effective alternatives for outpatient management, with fewer inpatient days and favorable safety profiles for malignant effusions, including those associated with hematologic malignancies.[24–27]

Overall, these results highlight the importance of prioritizing patient comfort during tube selection. We believe these findings suggest that small-bore catheters may be considered the first choice for most patients with MPE, especially in palliative settings where quality of life is paramount. However, large-bore tubes remain valuable in selected scenarios requiring rapid, high-volume drainage, such as massive effusions or acute respiratory distress. Tailoring tube size to the clinical context allows physicians to balance procedural efficiency with patient-centered care.

Strengths and limitations

This study has several notable strengths, including its prospective design, relatively large cohort, and systematic assessment of both objective outcomes (drainage efficacy and pleurodesis success) and subjective outcomes (pain scores). The standardized use of talc pleurodesis further enhances the consistency and relevance of the findings in contemporary clinical practice. However, subsequent interventions following non-effective drainage were not uniformly documented, which represents a limitation of the study.

This study was conducted at a single center, which may limit the generalizability of the findings. The four-week follow-up period primarily reflects early pleurodesis success and short-term recurrence. Although this duration is commonly used in clinical practice to assess initial outcomes, it may not capture late recurrence or long-term pleurodesis durability. Future studies with longer follow-up periods are needed to confirm sustained efficacy. Detailed radiological stratification of effusion volume, pleural thickening, or septations was not uniformly available for all patients and therefore could not be analyzed. As these features may influence drainage efficiency, their absence represents a limitation of this study.

Conclusion

Overall, this study demonstrated that both large- and small-bore chest tubes/intercostal catheters are effective for drainage and pleurodesis in patients with MPE. Large-bore tubes enabled faster, higher-volume drainage but were associated with greater procedural pain and longer insertion times. Conversely, small-bore tubes offered better patient comfort, with only a slightly increased risk of blockage. Based on these findings, small-bore tubes may be considered a preferred option in most cases, particularly when patient comfort and quality of life are priorities. Nevertheless, large-bore tubes remain useful in situations requiring rapid, high-volume evacuation.

Ethics Committee Approval

The study was approved by the Ethical Review Board of Government Mozang Teaching Hospital (No: 5170/GMTH, Date: 15/03/2024) in collaboration with Ragdah Arif from King Abdulaziz University, Jeddah Saudi Arabia.

Informed Consent

Written informed consent was obtained from the patients.

Conflicts of Interest

The author have no conflicts of interest to declare.

Funding

The author declared that this study received no financial support.

Use of AI for Writing Assistance

No use of AI-assisted technologies was declared by the author.

Acknowledgments

Thanks to Humaira Waseem for assisting in ethical consideration, data acquisition process and the data analysis.

Peer-review

Externally peer-reviewed.

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