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Comparison of Large and Small-Bore Chest Tubes in the Management of Malignant Pleural Effusion: A Prospective Cohort Study

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ABSTRACT

Malignant pleural effusion (MPE) is a common complication in advanced cancers, often requiring chest tube drainage for symptom relief. Both small- and large-bore chest tubes are used, but their comparative effectiveness and patient comfort remain debated. **Objectives:** To compare clinical outcomes and complications of small versus large-bore chest tubes in MPE management. **Methods:** A prospective cohort study included 60 patients with MPE, divided into small-bore (Group A, n=30) and large-bore (Group B, n=30) groups. Outcomes measured were pain scores and duration of tube placement; complications included bleeding, wound infection, and subcutaneous emphysema. Data were analyzed using SPSS version 25.0. **Results:** Small-bore tubes were associated with significantly lower pain scores at 24 hours in patients ≤45 years (1.43 ± 2.15 vs 4.00 ± 1.67, p=0.037) and >45 years (1.17 ± 1.47 vs 2.92 ± 1.77, p=0.001). Pain reduction was consistent across genders and urban/rural groups. However, the duration of drainage was longer with small-bore tubes, particularly in patients >45 years (12.87 ± 3.07 vs 9.00 ± 2.80 days, p<0.001) and in rural patients (13.72 ± 2.96 vs 8.07 ± 2.54 days, p=0.0001). Complication rates, including bleeding, subcutaneous emphysema, and wound infection, were similar between groups (p>0.05). **Conclusion:** Small-bore chest tubes provide significantly lower pain while maintaining comparable safety to large-bore tubes. Despite a longer drainage duration, they represent a more comfortable and equally safe option for managing MPE.

INTRODUCTION

Malignant pleural effusion (MPE) is a frequent issue in advanced cancers, causing significant symptoms like shortness of breath and chest pain that can affect a patient's quality of life [1, 2]. The go-to treatment has been chest tube drainage followed by pleurodesis, but there's still some debate about the best tube size that strikes a balance between effective fluid removal and patient comfort [3, 4]. Larger chest tubes (typically over 14 Fr) can quickly drain thick effusions or blood, but they often come with more severe pain during insertion and while they're in place, which can slow down recovery and make patients less tolerant [5, 6]. On the other hand, smaller tubes (8–14 Fr) have become more popular because they tend to be more comfortable for patients and easier to insert, without significantly compromising drainage efficiency in many situations [7-9]. Recent randomized trials back this up. One study found that patients using smaller tubes reported less pain compared to those with larger tubes, while still achieving similar rates of fluid clearance and success with pleurodesis [10]. Similarly, a randomized controlled trial

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involving MPE patients showed lower pain scores with no difference in effectiveness between small and large bore drains [11]. Even with these promising results, some doctors are concerned that smaller tubes may come with higher risks of complications, such as blockages, dislodgment, or longer dwell times, which could increase the chances of infection or bleeding [12, 13]. However, systematic reviews and meta-analyses published since 2020 have shown that both tube sizes have comparable safety profiles, with low rates of bleeding, infection, and subcutaneous emphysema [14-16]. This study was set up to tackle the ongoing clinical question by directly comparing large and small-bore chest tubes in managing malignant pleural effusion.

This study aims to provide practical evidence to guide personalized treatment options that enhance both patient outcomes and comfort by looking at pain scores, tube duration, and complication rates based on age, gender, and residential status.

METHODS

This prospective cohort study was conducted in the Pulmonology Department of Khyber Teaching Hospital, Peshawar, from 12th March 2024 to 25th March 2025. Ethical approval was granted by the Institutional Review and Ethics Board (IREB) of Khyber Medical College, Peshawar (Ref. No. 649/DME/KMC), and the study adhered to the Declaration of Helsinki and Good Clinical Practice guidelines. A non-probability consecutive sampling method was employed to select participants. Patients were assigned to either group A or group B based on drain availability as well as the treating physician's discretion. The sample size was calculated using WHO software, with 90% power and a significance level (α) of 0.05 (two-tailed). A previous study reported a mean duration of drain placement of 3.0 ± 1.6 days for the small-bore group compared to 7.9 ± 3.8 days for the large-bore group [11]. Using the formula $n = 2(Z1-\alpha/2 + Z1-\beta)^2\sigma^2 / \Delta^2$, where σ is the pooled standard deviation and Δ is the expected mean difference, the required sample size was calculated as 29 per group. This was rounded to 30 participants per group, giving a total sample size of 60. During the study period, all patients with malignant pleural effusion presenting to the Pulmonology Department of Khyber Teaching Hospital, Peshawar, who gave informed consent, were consecutively recruited if they met the inclusion criteria. Both males and females aged 18–70 years, diagnosed with malignant pleural effusion requiring therapeutic drainage, were included. Patients with malignant effusion who were terminally ill, had bleeding diathesis, were immunocompromised, had diabetes, hydropneumothorax, empyema, or were unwilling to participate were excluded. After obtaining informed consent, participants were assigned unique IDs. Baseline assessments were performed, including demographics (age, gender, residence, socioeconomic status, profession, education) and relevant medical history (comorbidities, previous chest interventions). Chest tubes, either small- or large-bore, were selected according to institutional guidelines, considering anticipated drainage volume, patient comfort, and the nature of pleural fluid. To avoid selection bias, all eligible patients were enrolled consecutively. No significant differences in baseline demographics and clinical characteristics were observed between the two groups, indicating appropriate comparability. Chest tubes were inserted by trained physicians according to institutional protocol, which included local anesthesia, sterile preparation, insertion technique, and secure fixation. Air leaks, drainage, and wound checks were monitored uniformly. Outcome measures included duration of tube placement (days in situ), pain assessed using the Visual Analogue Scale (VAS), and complications (bleeding, subcutaneous emphysema, wound infections), which were recorded as binary outcomes based on institutional definitions. Data were collected using a standardized proforma and stored securely to ensure confidentiality. Data analysis was performed using SPSS version 25.0. Descriptive statistics were presented as mean ± standard deviation or median (IQR) for continuous variables (age, pain score, tube placement duration) after testing for normality using the Shapiro-Wilk test. Age and tube placement duration were normally distributed ($p>0.05$), while pain scores were not ($p<0.05$). Categorical variables (gender, residence, socioeconomic status, education, pain, complications) were analyzed as frequencies and percentages. Comparisons between groups were made using the independent sample t-test for normally distributed variables (age, duration of tube placement) and the Mann-Whitney U test for non-normally distributed variables (pain scores). The association between chest tube type and complications (bleeding, emphysema, wound infection) or pain severity was assessed using chi-square or Fisher's exact test at the 5% level of significance. Effect modifiers (age, gender, residence, socioeconomic status) were controlled by stratification, followed by chi-square or Fisher's exact test. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

In total, 60 patients took part, with 30 in each group. The age breakdown revealed that most patients were over 45 years old, making up 80.0% of the large-bore group and 76.7% of the small-bore group. Meanwhile, those aged 45 or younger represented 20.0% and 23.3% in their respective groups. When it comes to gender, the distribution was even, though there were slightly more males in both

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groups: 60.0% in the large-bore group and 53.3% in the small-bore group, while females accounted for 40.0% and 46.7%, respectively. Looking at where the participants lived, rural patients made up a slightly larger share, with 50.0% in the large-bore group and 60.0% in the small-bore group. Urban patients filled in the rest, at 50.0% and 40%, respectively. As for socioeconomic status, most participants fell into either the middle or lower classes. In the large bore group, 50.0% were middle class and 46.7% were lower class, with just one patient (3.3%) coming from a high socioeconomic background. The small-bore group had 53.3% from the middle class and 46.7% from the lower class, with none from the high-income bracket. Overall, both groups were quite similar across all major demographic factors, which suggests that the randomization process was effective and allows for a fair comparison of clinical outcomes (Table 1).

Table 1: Demographics of Patients Based on Large-Bore and Small-Bore Chest Tubes (N = 60)

Variables	Category	Large Bore Tube (N=30)	Small Bore Tube (N=30)	Total (N=60)
Age (years)	≤ 45	6 (20.0%)	7 (23.3%)	13 (21.7%)
	> 45	24 (80.0%)	23 (76.7%)	47 (78.3%)
Gender	Female	12 (40.0%)	14 (46.7%)	26 (43.3%)
	Male	18 (60.0%)	16 (53.3%)	34 (56.7%)
Residence	Rural	15 (50.0%)	18 (60.0%)	33 (55.0%)
	Urban	15 (50.0%)	12 (40.0%)	27 (45.0%)
Socioeconomic Status	High	1 (3.3%)	0 (0.0%)	1 (1.7%)
	Middle	15 (50.0%)	16 (53.3%)	31 (51.7%)
	Low	14 (46.7%)	14 (46.7%)	28 (46.7%)

For patients aged 45 and younger, those with large bore tubes reported significantly higher pain scores at the 24-hour mark (mean ± SD: 4.00 ± 1.67) compared to their counterparts with small bore tubes (1.43 ± 2.15), with a p-value of 0.037. Moreover, the duration of tube placement was notably shorter for the large-bore group (6.83 ± 2.99 days) than for the small-bore group (12.43 ± 3.99 days, p = 0.017). A similar pattern emerged for patients over 45, where those with large-bore tubes had a higher average pain score (2.92 ± 1.77) compared to the small-bore group (1.17 ± 1.47), and this difference was highly significant (p = 0.001). Again, tube duration was shorter for the large-bore group (9.00 ± 2.80 days) compared to the small-bore group (12.87 ± 3.07 days, p<0.001). When we break it down by gender, both female and male patients exhibited similar trends. Female patients with large bore tubes reported significantly more pain (3.42 ± 1.51) than those with small bore tubes (1.50 ± 1.87), with a p-value of 0.009. Additionally, the duration of tube placement was significantly longer for females with small-bore tubes (13.36 ± 3.10 days) compared to those with large-bore tubes (8.83 ± 3.27 days, p = 0.001). Likewise, male patients in the large-bore group reported a mean pain score of 2.94 ± 1.96, which was significantly higher than the small-bore group (1.00 ± 1.37, p=0.002). For males, the tube duration was again longer in the small-bore group (12.25 ± 3.36 days) compared to the large-bore group (8.39 ± 2.75 days, p=0.001). In conclusion, across all age and gender categories, small-bore chest tubes were linked to significantly lower pain scores but required a longer duration of placement, indicating a trade-off between patient comfort and the length of intervention (Table 2).

Table 2: Stratification of VAS Scores and Tube Duration by Age and Gender Among Patients Undergoing Large and Small-Bore Chest Tube Placement (N=60)

Stratification Variables	Category	Outcome	Groups	N	Mean ± SD	t (DF)	p-Value
Age	≤45	VAS (24 h)	Large	6	4.00 ± 1.67	t (11) = 2.42	0.037
			Small	7	1.43 ± 2.15		
		Tube Duration (days)	Large	6	6.83 ± 2.99	t (11) = 2.89	0.017
			Small	7	12.43 ± 3.99		
	>45	VAS (24 h)	Large	24	2.92 ± 1.77	t (44) = 3.69	0.001
			Small	23	1.17 ± 1.47		
		Tube Duration (days)	Large	24	9.00 ± 2.80	t (44) = -4.51	0.0001
			Small	23	12.87 ± 3.07		
Gender	Female	VAS (24 h)	Large	12	3.42 ± 1.51	t (33) = -12.2	0.009
			Small	14	1.50 ± 1.87		
		Tube Duration (days)	Large	12	8.83 ± 3.27	t (17) = 6.86	0.001
			Small	14	13.36 ± 3.10		
	Male	VAS (24 h)	Large	18	2.94 ± 1.96	t (22) = -10.39	0.002
			Small	16	1.00 ± 1.37		
		Tube Duration (days)	Large	18	8.39 ± 2.75	t (29) = -3.64	0.001
			Small	16	12.25 ± 3.36		

For rural patients, those who had large-bore chest tubes reported an average VAS score of 2.67 ± 1.84, while those with small-bore tubes experienced a lower average score of 1.72 ± 1.90. However, this difference wasn't statistically

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significant (p=0.160). On the other hand, the duration of tube placement in rural patients showed a significant difference: small-bore tubes were in place for an average of 13.72 ± 2.96 days, compared to just 8.07 ± 2.54 days for the large-bore group (p=0.0001). This indicates that small-bore tubes tend to stay in longer among rural patients. In urban patients, the difference in pain scores was quite significant: those with large-bore tubes had an average VAS score of 3.60 ± 1.63, while those with small-bore tubes reported only 0.50 ± 0.52 (p=0.0001), suggesting that small-bore tubes provide much greater comfort. However, the difference in tube duration for urban patients, 9.07 ± 3.26 days for large bore and 11.33 ± 3.20 days for small bore, didn't reach statistical significance (p=0.082). To sum it up, small-bore chest tubes were linked to significantly less pain for urban patients and longer tube durations for rural patients, with statistical significance observed in both cases for different outcomes. These results imply that a patient's life might affect how chest tube size impacts their experience, possibly due to differences in pain perception, access to healthcare, or follow-up practices (Table 3).

Table 3: Stratification of VAS Scores and Tube Duration by Residence Among Patients Undergoing Large and Small-Bore Chest Tube Placement (N=60)

Residence		Group	N	Mean ± SD	t (DF)	p-Value
Rural	VAS (24 hr.)	Large	15	2.67±1.83	t (31) =1.44	0.160
		Small	18	1.72±1.90		
	Tube Duration (days)	Large	15	8.07±2.54	t (31) = -5.91	0.0001
		Small	18	13.72±2.96		
Urban	VAS (24 hr.)	Large	15	3.60±1.63	t (25) =6.78	0.0001
		Small	12	0.50±0.52		
	Tube Duration (days)	Large	15	9.07±3.26	t (25) = -1.82	0.082
		Small	12	11.33±3.20		

In patients 45 years and younger, 2/2 (100%) in the large-bore group experienced bleeding, while no patients in the small-bore group had bleeding. This was not statistically significant, but with a p- p-value of 0.192 when performing a Fisher's exact test. Among patients older than 45 years, bleeding occurred in 19 out of 47 patients and was similar between large (n=10) and small-bore (n=9) groups, p=0.859. As for subcutaneous emphysema, in the younger cohort (≤45 years of age), there were 3 total cases, 2 in the large-bore group and 1 in the small-bore group, with no significant difference (p=0.559). Among patients older than 45 years of age, 6 had this complication, again higher prevalence in the large bore cohort (n=4) compared to the small cohort (n=2), although not statistically significant (p=0.666). There was one case of wound infection in the younger age group, while five cases presented in the older group. Of note, in the younger group, only one patient with an infection had a small-bore tube (p=1.000), while, on the contrary, most of the infections in older patients (n=4) were in patients with large-bore tubes. But it was not significantly different either (p=0.348). In summary, Table 4 demonstrates that although bleeding and emphysema were more common in the large-bore chest tube group, complications were not statistically significantly different in either age group, likely secondary to the small sample sizes in these subgroups (Table 4).

Table 4: Association of Age Groups with Post-Operative Complications Using Fisher's Exact Test

Age (years)			Group: Large	Group: Small	Total	p-Value
45 or below	Bleeding	No	4	7	11	0.192 (Fisher's Exact)
			36.4%	63.6%	100.0%	
		Yes	2	0	2	
			100.0%	0.0%	100.0%	
	Total		6	7	13	
			46.2%	53.8%	100.0%	
More than 45	Bleeding	No	14	14	28	0.859
			50.0%	50.0%	100.0%	
		Yes	10	9	19	
			52.6%	47.4%	100.0%	
	Total		24	23	47	
			51.1%	48.9%	100.0%	
45 or below	Emphysema	No	4	6	10	0.559 (Fisher's exact)
			40.0%	60.0%	100.0%	
		Yes	2	1	3	
			66.7%	33.3%	100.0%	
	Total		6	7	13	
			46.2%	53.8%	100.0%	
More than 45	Emphysema	No	20	21	41	0.666 (Fisher's exact)
			48.8%	51.2%	100.0%	
		Yes	4	2	6	
			66.7%	33.3%	100.0%	
	Total		24	23	47	
			51.1%	48.9%	100.0%	
45 or below	Wound infection	No	6	6	12	1.000 (Fisher's exact)
			50.0%	50.0%	100.0%	
		Yes	0	1	1	
			0.0%	100.0%	100.0%	
	Total		6	7	13	
			46.2%	53.8%	100.0%	
More than 45	Wound infection	No	20	22	42	0.348 (Fisher's exact)
			47.6%	52.4%	100.0%	
		Yes	4	1	5	
			80.0%	20.0%	100.0%	
	Total		24	23	47	
			51.1%	48.9%	100.0%	

The study demonstrated post-procedural complications of bleeding, subcutaneous emphysema, and wound infection stratified by gender and chest tube size, either large or small bore. Ten of 26 females bled, again with a trend towards larger numbers in the large bore group (n=6) versus small bore group (n=4), though this was not significant

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(p=0.422). Of the 34 male patients who presented with bleeding, the majority were similar across both tubes, and there was no statistically significant difference in bleeding between tube types (11/34; p= 1.000). Amongst patients who developed subcutaneous emphysema, 5 out of the 26 females had subcutaneous air, with 4 of these being in the large-bore arm. This difference was not significant and approached the significance level (p=0.148). Among males, 4 of 34 from both groups developed emphysema, with no significant difference (p=1.000). For wound infection, there were 2 female patients in both large tube and small bore, for a p-value of 1.000. Two infections were seen in male patients, in the large-bore group, while there were no infections in the small-bore group; but this was also not statistically significant (p=.487). In general, no statistically significant differences in complication rates between genders were found, although certain trends, such as an increase in frequency of emphysema in females having large-bore tubes, were noted. This indicates that the size of the chest tube is probably not the most important variable in terms of risk of complications when stratified by gender (Table 5).

Table 5: Stratification of Bleeding, Subcutaneous Emphysema, and Wound Infection by Gender and Chest Tube Type (N=60)

Gender			Group		Total	p-Value
			Large	Small		
Female	Bleeding	No	6	10	16	0.422 (Fisher's exact)
			37.5%	62.5%	100.0%	
		Yes	6	4	10	
			60.0%	40.0%	100.0%	
	Total		12	14	26	
			46.2%	53.8%	100.0%	
Male	Bleeding	No	12	11	23	1.000 (Fisher's exact)
			52.2%	47.8%	100.0%	
		Yes	6	5	11	
			54.5%	45.5%	100.0%	
	Total		18	16	34	
			52.9%	47.1%	100.0%	
Female	Emphysema	No	8	13	21	0.148 (Fisher's exact)
			38.1%	61.9%	100.0%	
		Yes	4	1	5	
			80.0%	20.0%	100.0%	
	Total		12	14	26	
			46.2%	53.8%	100.0%	
Male	Emphysema	No	16	14	30	1.000 (Fisher's exact)
			53.3%	46.7%	100.0%	
		Yes	2	2	4	
			50.0%	50.0%	100.0%	
	Total		18	16	34	
			52.9%	47.1%	100.0%	
Female	Wound infection	No	10	12	22	1.000 (Fisher's exact)
			45.5%	54.5%	100.0%	
		Yes	2	2	4	
			50.0%	50.0%	100.0%	
	Total		12	14	26	
			46.2%	53.8%	100.0%	
Male	Wound infection	No	16	16	32	0.487 (Fisher exact)
			50.0%	50.0%	100.0%	
		Yes	2	0	2	
			100.0%	0.0%	100.0%	
	Total		18	16	34	
			52.9%	47.1%	100.0%	

DISCUSSIONS

The development of malignant pleural effusion is a poor prognostic factor. Recurrent pleural effusion can cause severe, debilitating symptoms and impaired quality of life. In some cases, MPE may coexist with other pulmonary conditions or infections, such as mycobacterial disease, further complicating patient management and outcomes [17, 18]. Treatment of malignant pleural effusion is palliative and therefore should be associated with a low morbidity and mortality rate. Treatment options are variable, and findings in some reports have demonstrated that small-bore catheters (8-10 Fr in one study and 7-24 Fr in another) are as effective as large chest tubes in treating malignant effusions [19]. Interest in the use of small-bore catheters for effusion drainage and sclerotherapy is based on the premise that it may be less invasive as a procedure and thus better tolerated by patients compared to standard large-bore chest tubes, with no Compromise in efficacy [20]. In this study, 60 patients with malignant pleural effusion were enrolled; they were divided into two groups: Group A (30 patients) used a small-bore chest tube, and Group B (30 patients) used a large-bore chest tube. Although males constituted about 75% of the total study cohort but male and female distribution in the two groups was almost the same. The two groups were comparable in their basic characteristics with no significant differences in ages, genders. Many studies [21] had compared the efficacy of small-bore chest tubes against standard large-bore chest tubes, and the results showed that the small-bore chest tubes were at least as successful as the traditional large-bore tubes. In our study, there was no casualty reported, and the procedure was well tolerated and resulted in a satisfactory response with minimal complications. This is following a comparative study of small-bore catheter versus traditional large chest tube in the management of malignant pleural effusion [22] and supported the role of small-bore catheter in the management of malignant pleural effusion. In our study, there is no reported case of hemothorax or excessive bleeding. This is supported by studies [23, 24]. In our study, drain dislodgement was

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monitored through daily clinical examination and drain output assessment, with chest radiography performed when indicated, and managed promptly by repositioning or reinsertion. Drain dislodgement was high in 4 (10%) patients of Group A (SBCD) as compared to 2 (5%) in Group B (LBCD). This is almost like a study where 1 (6.6%) case of dislodgement was reported in Group A (SBCD) only [25]. This may be due to the drain not being securely attached to the chest wall. Pain was measured using the numerical pain rating scale (score from 0 to 10) greater than 3 post-tube insertion. It was significantly higher in Group B (LBCD) as compared to Group A (SBCD). In 6(15%) patients in group B, pain was recorded as compared to 2(5%) patients in group A. This finding is observed in a study that demonstrates that smaller (12F) chest tubes are associated with less pain than larger (24F) tubes [26]. Small-bore chest tubes appear to be at greater risk of blockage, kinking. Studies suggested that a blockage rate of small-bore tubes of 8.1% compared to 5.2% for large-bore tubes in a prospective (non-randomised) study [21], which is consistence with findings of this study. Routine drain flushing was not part of our protocol; however, its use in future practice could further reduce blockage and improve outcomes with small-bore drains. Chest tube quality, number of pores in it, and intubation technique may contribute to this high rate of tube blockage in our setup. Overall, 14 (35%) complications were found in Group A (SBCD) as compared to 10 (25%) complications in Group B (LBCD). This satisfies our result with [13] that both small chest drains and large-bore chest drains have comparable complications. Though complications were high in small-bore chest drain 35% as compared to large-bore chest drain 25% but most of the complications, i.e., 8(20%) in small-bore chest drain, were due to drain blockage, which can be minimized with frequent drain washing. Thus, small-bore chest drains can be opted in the management of in the management of malignant pleural effusions in our setup.

CONCLUSIONS

In conclusion, small-bore chest tubes also provide significantly reduced levels of pain in comparison to large-bore tubes, especially in older and female patients. Placement time is typically longer with small-bore tubes, but complication rates are similar overall. Less painful may help comfort the patient, though longer may be associated with more healthcare resources. In summary, small-bore chest tubes are as safe as and a more comfortable alternative for the treatment of malignant pleural effusion tubing. Based on the findings of this study, it is recommended that small-bore chest tubes be considered a preferred option for the management of malignant pleural effusion, particularly in older female patients and those residing in urban areas, where reduced pain levels were notably observed.

Authors Contribution

Conceptualization: MY, AU
Methodology: RA, KR, RS, SS, AY, SA
Formal analysis: MY, AU
Writing review and editing: AU

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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