Use of a small bore pleural catheter in the management of patients with malignant pleural effusion

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Background Malignant pleural effusions (MPEs) can produce significant respiratory symptoms and decreased quality of life in patients with terminal malignancies; palliation of respiratory symptoms can be performed by several different approaches, but a minimally invasive procedure to provide relief of respiratory symptoms would be optimal.

Objective This study aimed to evaluate the usage of a small bore catheter in outpatients as an alternative, effective, and safe method to the traditionally large bore chest tube in the management of MPE.

Patients and methods Fifty patients with MPE were grouped randomly into two groups according to the method of drainage.

Results The results showed that there were significant statistical differences in the results of both groups as the duration of catheter was 4 (3–5) days to 11 (10–10.25) days in the chest tube group; the cost of hospital and medication was 780±1400 LE in the pleural catheter group, whereas in the chest tube group, it was 11 520±1895.61 LE and the total cost was 5520±17 600 in the pleural catheter group and 14 020.00 ±1895.61 LE in the chest tube group. The modified Borg scale for dyspnea after insertion showed a 43% improvement in dyspnea in the small bore pleural catheter group compared with 41% in the chest tube group.

Conclusion On the basis of the results of this study and other studies, we conclude that a small bore catheter is as effective and safe as a large bore chest tube in the treatment of MPEs and use in the outpatient clinic led to few complications.

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Introduction

Malignant pleural effusion (MPE) is a common complication of advanced malignancy; it represents a frequent clinical problem in these patients, and is associated with a poor prognosis and decreased quality of life [1,2].

Epidemiological information is limited, but an estimated 50 000 new diagnoses of MPE are made in the UK each year; the incidence and associated healthcare costs of MPE are expected to increased because of an increase in the global cancer rate and advances in systemic therapy, the latter of which allow many patients to live longer [3,4].

Despite treatment of the underlying malignancy with chemotherapy or radiation therapy, MPEs often recur or do not resolve [5]. Various palliative techniques for the improvement of MPE have been developed to alleviate these respiratory symptoms such as repeated thoracocentesis, which is a simple and widely used technique, but it is insufficient for the treatment of recurring MPE; this is because of the fast and symptomatic reaccumulation of liquid that can occur 4 days after the thoracocentesis [6].

Another frequently used technique is pleurodesis through tube thoracostomy and with this technique, longer-lasting effects are gained, provided that adequate drainage of the pleural liquid is achieved, as well as subsequent symphysis of both pleural sheets, but this procedure can be painful and requires prolonged hospitalization [7,8]. In addition, there has also been interest in the use of less invasive techniques of fluid drainage and sclerosis, including the use of small bore catheters in lieu of larger, standard bore chest tubes [9].

An ideal treatment method for MPE should offer a rapid and complete relief of associated symptoms and this improvement should be long-lasting and without the need for repeat procedures for the duration of the patient's life time. Minimally invasive procedures should be favored, and discomfort or side effects of the treatment should be minimal or nonexistent and, if possible, treatment should be offered on an ambulatory basis, minimizing the hospitalization time for those patients who may have only a few months to live [8].

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The aim of this work was to compare the clinical outcomes of symptomatic MPE who were treated with small bore pleural catheter insertion with those with chest tube thoracostomy in terms of complications, duration of hospital stay, and relief from dyspnea.

Patients and methods

Study design

This was a prospective randomized study; recruitment was performed at Ain Shams University Hospitals between February 2014 and February 2017. The study was approved by the institutional ethical committee. After written informed consent was obtained, patients with a biopsy-proven diagnosis of symptomatic MPE (either primary or secondary) were enrolled in the current study.

Consecutive patients with symptomatic MPE without previous attempted pleurodesis were included and randomized in a 1 : 1 ratio to either small bore pleural catheter insertion (group A – chest tube) or chest tube thoracostomy (group B – small bore pleural catheter). Patients with hydropneumothorax, pleural infection, encysted pleural effusion, coagulation abnormalities, and deformities in the chest cavity were excluded from the study.

All patients were subjected to the following: full assessment of history and a thorough clinical examination, relevant laboratory investigations whenever needed (complete blood picture, liver function tests, renal function tests, coagulation profile), radiological assessment including plain chest radiography posteroanterior view before the pleural intervention (to assess the size of the pleural effusion, which was categorized as moderate when extending from the diaphragm to the pulmonary hilum and as massive when exceeding the hilar region) and after 4 weeks of pleural intervention. In addition, chest computed tomography was performed whenever needed. The degree of breathlessness was assessed using the modified Borg scale score for dyspnea through a visual analog scale with a 10 cm line anchored with no breathlessness at 0 cm and maximum possible breathlessness at 10 cm [10]. This occurred before and 4 weeks after the pleural intervention.

Information collected for each patient included demographics, type of malignancy, length of hospital stay, length of the small bore pleural catheter or chest tube insertion, complications encountered, and costs including the total costs, medication costs, and pleural intervention maneuver costs.

Pleural interventions

A total of 25 patients with the chest tube who were admitted to hospital and managed with a traditional large bore chest tube (24–30 Fr) (GMS, straight chest tube with trocar) were randomized into group A; the blunt dissection technique was used and the patient was connected to an underwater seal drainage system and tetracycline pleurodesis with 2 g of tetracycline mixed with 100 cm^3 of sterile saline was used. If the lung expanded and the drainage was less than 100 ml/24 h, the chest tube was removed [11].

Group B included patients with small bore pleural catheters (a 8.5–14.5 Fr silicone rubber catheter, 66 cm in length, with fenestrations along the proximal 24 cm) (Fleixma, Boston Scientific, MA, USA) in whom small bore pleural catheters were inserted using the Seldinger technique as an outpatient procedure and initial large volume drainage was performed and as before discharge, the patients and/or their care givers were provided with detailed oral and written instructions for draining the pleural fluid [12,13].

Pleurodesis was performed in the same manner as in chest tube group; both groups were reassessed after 4 weeks from pleurodesis to assess responses, which were classified as follows: (a) complete (no clinical or radiological recurrence of pleural effusion); (b) partial (small amount of fluid reaccumulation in the chest radiograph, but no symptoms); and (c) failure (reaccumulation of fluid causing symptoms or requiring thoracentesis) [14].

Statistical analysis

Data were analyzed using SPSS Statistics (version 20; SPSS Corp., Armonk, New York, USA) as the mean and SD; the Student *t*-test (unpaired), paired *t*-test, analysis of variance tests, χ^2-tests, the Mann–Whitney test, and Fisher's exact test were also used.

Results

Fifty patients were randomized at Ain Shams University Hospital: 25 in-patients with tube thoracostomy (group A) and 25 outpatients with a pleural catheter (group B); both groups were followed up 4 weeks after pleurodesis. Baseline demographic variables in both groups are shown in Table 1.

The modified Borg scale for dyspnea was performed before and after insertion of chest tube in group A and small bore pleural catheter in group B. There was a

statistically significant difference between both groups in the degree of dyspnea, which improved 43% in the small bore pleural catheter group and to 41% in the chest tube group as shown in Table 2.

The length of hospital stay

All patients with chest tube were admitted to hospital and all patients with a small bore catheter were discharged to home, except one patient only who required admission because of complications. There was a statistically significant difference between both groups as regards the need for hospitalization, length of hospital stay, and duration of tube/catheter insertion all in favor of a small bore catheter as shown in Table 3.

The cost of medications and maneuvers and hospitalization was calculated on the basis of Ain Shams University specialized hospital prices and there was a statistically significant difference between both groups in cost as shown in Table 4; the cost was higher in the chest tube group as patients were admitted in hospital for a longer duration and the tube remained for longer duration than catheter.

Follow-up after 4 weeks of pleurodesis that was performed with tetracycline for both groups showed that in terms of the outcome of pleurodesis in the small bore catheter group, a success ratio of 92–80% was achieved in the chest tube group; there was no significant statistical difference in both groups as shown in Table 5.

Adverse events

The frequencies of adverse events are summarized in Table 6. Pain at the site of insertion was 100% in patients with a chest tube and 0% in the small bore catheter group; this was statistically significant in the chest tube group than the small bore catheter group. The other adverse events were not statistically significant between both the groups.

Discussion

MPEs lead to complications in many advanced malignancies and can cause significant dyspnea, cough, and chest pain; therefore, palliative therapy for MPEs has focused not only on draining the pleural fluid but also on achieving sclerosis of

Table 1 Baseline demographic data for 50 patients with malignant pleural effusion

Baseline demographics	Group A	Group B
Number of patients	25	25
Mean age	55.72	58.12
Male : female [% (no.)]	32 (8) : 68 (17)	36 (9) : 64 (16)
Type of malignancy [% (no.)]		
Metastatic adenocarcinoma of unknown origin	24 (6)	44 (11)
Breast cancer	28 (7)	24 (6)
Malignant mesothelioma	24 (6)	4 (1)
Lung cancer	20 (5)	16 (4)
Colon cancer	4 (1)	4 (1)
Cancer ovary	0 (0)	8 (2)
Adjuvant therapy [% (no.)]		
Chemotherapy	28 (7)	24 (6)
Radiotherapy	8 (2)	16 (4)
Hormonal therapy	4 (1)	20 (5)
Size of effusion on chest radiography (moderate : severe)	24 (6) : 76 (19)	44 (11) : 56 (14)
Site of effusion on chest radiography (right : left)	48 (12) : 52 (13)	68 (17) : 32 (8)
Inpatient : outpatient at enrollment	100 (25) : 0 (0)	0 (0) : 100 (25)
Trapped lung	16 (4)	4 (1)

Table 2 Comparison of the modified Borg dyspnea scale in groups A and B before and insertion of a tube and a catheter

Borg scale	Groups				*t*-Test	*P*-value
	Group A (mean±SD)	Change (%)	Group B (mean±SD)	Change (%)		
Before insertion	8.84±0.55	41.2	8.44±0.92	43.6	1.868	0.068
After insertion	5.20±0.71		4.76±0.44		2.648	0.011
Paired *t*-test						
Before and after						
t	21.157		18.618			
P-value	<0.001		<0.001			

Table 3 Need for hospitalization, length of hospital stay, and duration of tube insertion in groups A and B

Variables	Group A (*n*=25)	Group B (*n*=25)	Mann–Whitney *U*	*Z* statistic	*P*-value
Need for hospitalization	25 (100)	1 (4)	–	–	<0.001
Hospital length of stay (days)	9 (8–12.25)	4 (0–4)	1.00	6.371	<0.0001
Duration of tube insertion (days)	11 (10–10.25)	4 (3–5)	5.50	5.979	<0.0001

Table 4 Comparison of cost of hospital and medication, maneuver, and total cost in groups A and B

	Groups		*t*-Test	*P*-value
	Group A (mean±SD)	Group B (mean±SD)		
Cost of hospitalization and medications (LE)	11 520.00±1895.61	780.00±1400.00	22.788	<0.001
Cost of maneuvers (LE)	2500.00±0.00	1500.00±1760.0	–	–
Total cost (LE)	14 020.00±1895.61	5520.00±0.00	2.401	0.020

the pleural space to prevent reaccumulation of symptomatic MPE [15–17].

As many patients with MPEs have already experienced significant morbidity from chemotherapy and/or radiation therapy, it would be ideal to minimize hospitalization and patient discomfort; thus, for these reasons, the utilization of small bore catheters for prolonged outpatient drainage of MPEs has been advocated in a number of case reports [18].

These catheters may significantly alter the management of MPEs as they can be inserted on an outpatient basis with minimal post procedure discomfort; thus, there is no need for hospitalization and patients can drain the effusion at home on the basis of their symptoms and potentially achieve pleurodesis without significant pain or hospitalization [19].

The present study was carried out on 50 patients randomized at Ain Shams University Hospital as follows: 25 in-patients who underwent tube thoracostomy (group A) and 25 outpatients with a pleural catheter (group B); both groups were followed up 4 weeks after pleurodesis.

The result of our study showed that when comparing both groups in terms of tube and catheter duration, there was a statistically significant difference between both groups as tube duration was 11.52±1.90 days while the pleural catheter duration was 4.48±1.73 days. This was in agreement with several studies as in Abdel Maguid *et al.* [20], in which the mean time from tube removal was 3.53±1.41 days for the group with a chest tube and 1.93±1.79 days for the group with a pleural catheter, and the difference in the time of tube removal in the two groups was statistically significant in favor of the group with a pleural catheter. Parker *et al.* [21] reported that pigtail catheters remained in place for 1–9 days (mean: 5 days) and large bore chest tubes were in place for 3–24 days (mean: 5 days).

Table 5 Rate of successful pleurodesis and recurrence of effusion in groups A and B

Variable s	Group A (*n*=25) [*n* (%)]	Group B (*n*=25) [*n* (%)]	*P*-value
Pleurodesis	20 (80.0)	23 (92.0)	0.417
Recurrence	5 (25.0)	2 (8.0)	0.104

The results of the current study showed that when comparing both groups in terms of the cost of hospitalization and medications and maneuvers on the basis of the prices of Ain Shams University, there was a statistically significant difference between both groups, and this can be attributed to the fact that the catheter duration was shorter than chest tube and patients with catheters were outpatients; however, Parker *et al.* [21] obtained results that were not in agreement with our study as they reported that in their institution, the difference in the cost between the two procedures is less than $50 and they did not report the total cost, whereas Grodzin and Balk [18] reported that the cost of the catheter and insertion kit is ~$80 and the cost of a single-use thoracentesis kit is also $80, whereas the cost associated with the insertion of a closed tube thoracostomy is $284. This is in agreement with our study, where the cost of a small bore pleural catheter was less than that of a chest tube, but they also did not report the total cost and this may be because all patients in their study were in-patients.

The results of the current study also showed that when comparing both groups in terms of the modified Borg scale for dyspnea, there was a statistically significant difference between both groups as there was a 43% improvement in dyspnea in the pleural catheter group compared with 41% in the chest tube group; Putnam *et al.* [12] did not find a significant difference in the Borg dyspnea score between the chest tube and pleural

Table 6 Summary of adverse events among groups A and B at baseline

	Groups [*n* (%)]			χ^2	*P*-value
	Group A	Group B	Total		
Complications					
Pain at the site of insertion	25 (100.0)	0 (0.0)	25 (50.0)	50.000	<0.001
Cellutis	4 (16.0)	0 (0.0)	4 (8.0)	4.348	0.037
Pneumothorax	1 (4.0)	1 (4.0)	2 (4.0)	0.000	1.000
Empyma	2 (8.0)	0 (0.0)	2 (4.0)	2.083	0.149
Blocked catheter	1 (4.0)	1 (4.0)	2 (4.0)	0.000	1.000
Dislodged catheter	0 (0.0)	0 (0.0)	0 (0.0)	–	–
Catheter tract metastases	0 (0.0)	0 (0.0)	0 (0.0)	–	–
Symptomatic fluid loculation	0 (0.0)	0 (0.0)	0 (0.0)	–	–
Fever	0 (0.0)	1 (4.0)	1 (2.0)	1.020	0.312

catheter groups, which was not in agreement with our study, whereas Davis *et al.* [13] used a visual analog scale for comparison of dyspnea between the chest tube and the pleural catheter groups and they did not find a difference in its primary outcome measure of improvement in dyspnea at 42 days, although symptoms improved significantly at the 6-month time point in favor of the catheter group, which was in agreement with our study, but the improvement in dyspnea occurred late in their study.

Follow-up after 4 weeks of pleurodesis that was performed with tetracycline for both groups showed that the outcome of pleurodesis in the small bore catheter group showed a 92% success rate compared with 80% in the chest tube group and there was no statistically significant difference in both groups, which is in agreement with Abdel Maguid *et al.* [20], who performed a 30-day follow-up and no statistically significant differences were detected in both groups.

In our study, we compared the adverse events in both groups and found that pain at the site of insertion was statistically significant in the chest tube group than the small bore catheter group, which is in agreement with Seaton *et al.* [22] as no patient reported significant pain during catheter placement, but three (14%) patients complained of mild discomfort at the chest tube site during drainage. Clementsen *et al.* [23] described small bore catheter insertion as no more unpleasant than thoracocentesis and the presence of the tube as somewhat or very unpleasant, which is in agreement with our study, although it was different from our study because in their study, the tube was inserted during diagnostic thoracoscopy, whereas in our study, it was inserted using the Seldinger technique.

The other complications were not statistically significant between both groups, which is in agreement with Parker *et al.* [21] and Walsh *et al.* [24] and Abdel Maguid *et al.* [20].

On the basis of the results of this study and other studies carried out by others, we conclude that a small bore catheter is as effective and safe as a large bore chest tube in the treatment of MPEs and the use of a pleural catheter in the outpatient clinic led to few complications; also, the costs associated with hospitalization were decreased and patients are allowed to remain in the comfort of their home with their family and friends without comprising their comfort and with symptom control.

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Conflicts of interest
There are no conflicts of interest.

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