Small-Bore Catheter for Draining Most Types of Pleural Effusions: Upper Egypt Experience

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Background and aim of the study **Tube thoracostomy remains the standard of care for the treatment of pneumothorax and simple effusions in most hospitals (2, 8). Placement of a large-bore chest tube is an invasive procedure with potential morbidity and complications and therefore the use of small-bore catheter may be desirable (3). The objective of this study was to evaluate the efficacy and complications of using small-bore catheters (8.3-12 fr.) in drainage of pleural effusion as a less invasive alternative to traditional chest tube insertion.**

Patients and methods**: This prospective study was conducted between January 2010 and september 2012, at Sohag university hospital, El-Helal Inssurance hospital in Sohag, and Qena university hospital (tertiary hospitals in upper Egypt). We evaluated the efficacy and safety of small-bore catheters (8.5–12 French) insertion in cases of pleural effusion of various etiologies. Tow hundred and sixty (260) small-bore catheters were placed in 241 patients. Mean age was 48.4 years (18 to 77 years). There were 152 males and 89 females. The reasons for small-bore catheter drainage were: malignant effusion (n=61), parapneumonic effusion(n=33), transudative effusion(n=46), exudative effusion (hepatic failure and renal failure) (n=68), T.B effusion(n=11),traumatic hemothorax(n=14), and postoperative (n=27).**

Results **Duration of drainage of pleural fluid was 2-15(mean=6.9) days. The Overall success rate was 82.3%. The success rate was highest when the drain was used to treat massive transudate effusions (86.9%) and exudative (post renal and hepatic failure) pleural effusions (83.8%), followed by malignant effusions (82%), T.B. effusion (81.8%),, then post operative effusion (81%), parapneumonic pleural effusion (75.7%), and finally post traumatic hemothorax which yielded the lowerist incidence of success (10 out of 14, 71%). Among the eight cases of empyema, the procedure was successful only in five of them (success rate 37.3%). There were no major complications related to catheter insertion. Complications included pain at the insertion site requiring analgesia in 38 patients (14.6%), pneumothorax in 72 (27.6%) patients, failure to drain properly in 60 patients (23%), fever in 10 cases, and infection in 3 patient (1%). 46 out of 260 catheter placements were not successful, 16 due to loculated effusions, 17 due to obstruction and blockage of the catheter, 5 cases with advanced parenchymatous lung disease, and 5 due to rapid re-accumulation of the fluid after removal of the catheter. If the cases of loculated pleural effusions and advanced lung disease are excluded, the success rate increases to 90% (235 out of 260).**

Conclusion: **Small-bore catheter insertion is an effective and safe method for draining pleural fluid of most etiologies. We recommend its use for all cases of pleural effusion requiring chest drain except for hemothorax, empyema and other loculated pleural effusions that yield low success.**

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Tube thoracostomy remains the standard of care for the treatment of pneumothorax and simple effusions in most hospitals [1, 2]. Placement of a large-bore chest tube is an invasive procedure with potential morbidity and complications, and therefore the use of small-bore catheter may be desirable [3].

The use of small-bore catheters in the treatment of fluid collection in the pleural space has been reported in the radiology literature sporadically for almost 20 years. The therapeutic indications for catheter placement have included treatment of empyema, pneumothorax, and drainage of pleural effusions, with or without sclerotherapy. The experience to date suggests that the use of small-bore catheters is effective, safe, and well-tolerated [4,5,6].

The objective of this study was to evaluate the efficacy and complications of using small-bore catheters (8.3-12 fr.) in drainage of pleural effusion as a less invasive alternative to traditional chest tube insertion.

Materials and methods

We conducted a prospective study of patients treated at Sohag university hospital, El-Helal Inssurance hospital in Sohag, and Qena university hospital (tertiary hospitals in upper Egypt), between January 2010 and september 2012.

In our study all patients with pleural effusions planned to have chest tube insertion were included. Informed signed consent was obtained from all patients. The diagnosis of pleural effusion was based on clinical and chest X-ray findings, and confirmed by a diagnostic thoracocentesis (less than 50mL).

Small sized catheters (central venous catheters: certofix BUO, and dual lumen dialysis catheter) had the size of 8.5–12 French (2.8–4 mm in diameter) were used in the study.

All procedures were done at the bedside under local anesthesia and without radiologic guidance. Insertion of catheters was done using the modified Seldinger technique[7]. Salient technical aspects of catheter insertion include appropriate use of local anesthetic and needle insertion that barely "walks over" the top of the rib to avoid the intercostal bundle. We typically employ a small (22 gauge) "finder needle" before inserting the larger needle provided with the kit. Pleural fluid should be easily withdrawn with the needle, and passage of the guide wire into the pleural space should be virtually effortless. Development of an adequate tract with the dilator and insertion of the catheter so that the sideholes are well within the pleural cavity are important for proper function. The catheter is attached to a standard thoracic drainage system. The catheters were removed as soon as the drainage was less than 100 mL per day for 3 consecutive days.

The therapy was considered successful if the opacity cleared on chest radiograph and confirmed on chest ultrasonography of the thorax and also if there was no need for a second intervention (repeat catheter placement, tube thoracostomy, or operation) within 72 hours after removal of the catheter.

Patients were given, beside catheter insertion, the standard therapy according to the cause of pleural effusion. For malignant pleural effusion, pleurodesis was done using bleomycin (0.75 mg/kg was administered as a single dose), for tuberculous pleural effusion, standard antituberculous chemotherapy and corticosteroids were given, For parapneumonic effusions, antibiotics were given, and For cases of heart failure, antifailure treatment and diuretics were given.

Results

Tow hundred and sixty (260) small-bore catheters were placed in 241 patients over a 33 months period (from January 2010 to september 2012). Mean age was 48.4 years (range 18 to 77 years). There were 152 males and 89 females.

Etiologies of effusions included: 61 was malignant pleural effusion (20 cases secondary to breast cancer, 13 cases secondary to bronchogenic carcinoma, 7 cases secondary to mesothelioma, 12 secondery to gastrointestinal cancer, 7 cases secondary to lymphoma, and tow cases with ovarian malignancy). 11 patients had tuberculous pleural effusion. 33 patients had parapneumonic effusion: 8 of them had empyema. 14 cases had bloody pleural effusion post trauma. 46 patients had transudative effusion (21 secondary to heart failure, and 25 had nutritional). 17 secondary to renal failure. 51 secondery to hepatic failure. and 27 patients post operative serosangunious effusion. Age and sex of the patients are shown in Table (1). Etiologies and clinical data are shown in table (2).

age	19 – 77 yrs	Mean : 48.4 yrs
sex	Male	152 (63%)
	Female	89 (37 %)

Table 1. Age and Sex of patients

Cause of effusion	NO.	%
Malignant effusion:	61	22
Breast cancer	20	
Bronchogenic carcinoma	13	
GIT malignancy	12	
Lymphoma	7	
mesothelioma	7	
Ovarian malignancy	2	
Tuberculous effusion	11	4
Parapneumonic effusion	33	12
Empyema	8	
Blood post traumatic	14	5
Transudative	46	17
heart failure	21	
nutritional	25	
Exudative Hepatic failure	51	20
Exudative renal failure	17	6
Serosangunious post operative	27	10

Table 2. Etiologies and clinical data

The duration of drainage of pleural fluid using the small-bore catheter ranged between 3 and 15 days (mean: 6.9 days). There were no major complications related to the catheter insertion. Complications of the catheter included pain at the insertion site requiring analgesia in 38 patients (14.6%), pneumothorax in 72 (27.6%) patients, failure to drain properly in 60 (23%) patients (due to blockage of the catheter in 17 patients, dislodgement in 18 patients, kinking in 15 patients, disconnection in 10 patients), fever in 10 patients, and infection in 3 patients. Pneumothoraces were resolved spontaneously through the same catheter. In kinked, dislodged, and disconnected catheters, re-insertion was done with good results. Blockage of the catheters and infection were associated with procedure failure.

Small-bore catheter drainage of pleural effusion was successful in 214 out of 260 cases with a success rate (82.3 %). The success rate was highest with transudative pleural effusion (40 out of 46, 86.9%), followed by exudative effusion (secondary to Hepatic and Renal failure) 57 out of 68 (83.8%), malignant pleural effusion (50 out of 61, 82%), tuberculous effusion (9 out of 11, 81.8%), then post operative effusion (22 out of 27, 81%), and finally parapneumonic pleural effusion (25 out of 33, 75.7%), and finally post traumatic hemothorax which yielded the lowerist incidence of success (10 out of 14, 71%). Among the eight cases of empyema, the procedure was successful only in five of them (success rate 37.3%).

Forty six (46) out of 260 catheter placements were not successful. Among the 46 cases of failure,16 of them were due to loculated effusions (7 with parapneumonic effusion, 2 with malignant effusion, 4 with hepatic failure, 2 with renal failure, and one T.B), 17 due to obstruction or blockage of the catheter (4 traumatic hemothorax with frequent clotting, 5 thick purulent discharge, 3 bloody malignant effusion with clotting, and 5 post operative with thick debris), 5 cases with advanced parenchymatous lung disease and entrapment, 5 were due to rapid re-accumulation of the fluid after removal of the catheter, and 3 due to infection at the site of insertion. In both parapneumonic and tuberculous pleural effusion groups, most failures were associated with presence of loculations and diseased lung (Table 3). If the cases of loculated pleural effusions and advanced lung disease are excluded, the success rate increases to 90% (235 out of 260).

Cause of failure	NO.	Clinical data
Blockage (obstruction)	Total :17	
	3 Malignant	Bloody with frequent clotting
	5 Parapneumonic	Thick purulent discharge
	4 post trauma	Clotting
	5 post operative	Thick debries with clotting
Failure to drain properly	Total : 26	
	5 Malignant	2 loculations 3 massive amount >1000 a day
	9 Parapneumonic	7 loculations 2 diseased lung
	4 Hepatic failure	4 loculation
	3 Renal failure	2 loculations 1 entrapped lung
	2 heart failure	2 Massive amount > 1000 a day
	3 T.B	1 loculations 2 entrapped lung
Infection	1 Heart failure 2 Hepatic failure	3 Infection at site with removal of the catheter

Table 3. Clinical data of failure cases

Discussion

Tube thoracostomy remains the standard of care for the treatment of pneumothorax and simple effusions in most hospitals [2,8]. Placement of a large-bore chest tube is an invasive procedure with potential morbidity and complications and therefore the use of small-bore catheter may be desirable [3].

There is a strong believe that the small-bore catheter (8.3 fr) causes substantially less pain than traditional tube thoracostomy, by virtue of its size in relation to the normal intercostal space. The average intercostal space in an adult (measured at the 5th intercostal space in the mix-axillary line) is 8.8 ±1.4 millimeters. A 24 F chest tube (the smallest size commonly used for the described indications) has an outer diameter of 8 mm, while a 32 F chest tube has an outer diameter of just under 11 mm. Chest tubes, with their excessive size, cause pain by compressing the neurovascular bundle at the top of the interspace, as well as by levering open the interspace. In contrast, the 8.3 F small-bore catheter has a diameter of only 2.8 mm and does not impinge on the neurovascular bundle or alter the geometry of the intercostal space [9,10].

In our study, the mean duration of pleural fluid drainage using small bore catheter was 6.9 days (3–15 days). which is more or less similar to the results in other studies, where Bediwy AD and Amer HG [8] reported a mean duration of drainage of 5.8 days (3-14 days). Parulekar et al. [11] reported a mean period of drainage of 6 days (three to 21 days). Liu et al. [12] reported a mean duration of drainage of 6.1 days. Gammie et al. [10] found a mean duration of drainage of 97 hours.

In the present study, there is no recorded serious complications (organ perforation, massive hemothorax….etc), complications of small bore catheter insertion included pain at the insertion site requiring analgesia in 38 cases (15%), pneumothorax in 72 cases (27%), blockage of the catheter in 17 cases (6%),, failure to drain properly in 43 (16.5%%) patients (due to dislodgement, kinking, and disconnection), and infection (1%). Pneumothoraces were resolved spontaneously through the same catheter. In kinked, dislodged, and disconnected catheters, re-insertion was done with good results Blockage of the catheters and infection were associated with procedure failure.

In other studies, it was found that the small bore catherter insertion is usually safe with little chance for complications. Roberts et al. [3] found that five percent of pigtail catheter placements were associated with serious complications (hemothorax, pnuemothorax, and hepatic perforation) and the overall complications of catheter use occurred in 20% of patients and included failure to drain, dislodgement, kinking, empyema, and disconnection.

Walsh et al. [14] found minimal complications with the use of pigtail catheter for pleural effusion drainage. Spontaneously resolving, small, apical pneumothoraces developed in four of the 15 patients. One patient experienced reexpansion pulmonary edema.

Seaton et al. [15] found that the complication rate was low and consisted of symptoms such as pain and fever with using small tube drainage and doxycycline sclerotherapy.

The incidence and significance of pneumothorax after small-bore catheter placement for malignant pleural effusions was examined by Chang et al. [16] in a retrospective review of 88 patients treated over a two-year period. Twenty-seven patients (31%) developed a pneumothorax. Resolution occurred in 22 patients. No complications such as tension pneumothorax or respiratory distress were reported. In another study, Morrison et al. [17] found that pneumothorax occurred in 19% of cases with malignant pleural effusion treated with pigtail catheter insertions. All pneumothoraces were insignificant and authors attribute them to the use of Seldinger technique.

Warren et al. [18] used pigtail catheter in 202 patients with symptomatic malignant pleural effusions on an outpatient basis. Reaccumulation of the pleural effusion occurred in 3.8% of cases. The incidence of infection was 2.2%. The incidence of blockage was 4.8%.

In the present study, the over all success rate of small-bore catheter drainage of pleural effusion was (82%) of cases. The success rate was highest with transudative pleural effusion (86.9%), followed by exudative effusion (post renal and hepatic failure) (84%), malignant pleural effusion (82%), tuberculous effusion (81.8%), then post operative effusion (81%), and finally parapneumonic pleural effusion (77%). Among the eight cases of empyema, the procedure was successful only in five of them (success rate 37.3%).

The success rate in our study were comparable to the Success rates of using small-bore catheter in other studies. Where Bediwy AD and Amer HG [8], in their study found that the success rate 82.35% . The success rate was highest with transudative pleural effusion (85.71%), followed by tuberculous effusion (83.33%), then malignant pleural effusion (81.81%), and finally parapneumonic pleural effusion (80%).

Liu et al. [12], in another study found that the success rate of pigtail catheter insertion was highest when the drain was used to treat massive transudate effusions (81.6%) and malignant pleural effusions (75.5%), followed by parapneumonic effusions/empyemas (72.2%), hemothoraces (66.6%), and pneumothoraces (64.0%).

In another study, Liang et al. [19] found that the success rate of ultrasound-guided pigtail catheter drainage of pleural effusions in the ICU was highest when used to treat traumatic hemothorax (100%) and postoperative pleural effusions (85%); drains inserted for empyema were more likely to fail (overall success rate, 42%). No significant insertion complications, such as hollow organ perforation, were caused by this procedure.

Gammie et al. [10] found that clinical success rates of pigtail catheter insertion for drainage of pleural effusion were 86% with no reported complications.

Grodzin and Balk [20] demonstrated that the use of a small indwelling pleural catheter was more cost-effective when used in place of a closed tube thoracostomy for drainage of large-volume pleural effusions.

In accordance with the results of our study, Sartori et al.[21] reported a success rate of 84.3% with using a nine-French intrapleural catheter insertion under sonographic guidance followed by bleomycin pleurodesis in 160 patients with rapidly recurrent malignant pleural effusion.

Seaton et al. [15] studied the use of small tube drainage and doxycycline sclerotherapy for malignant pleural effusion and reported a success rate of 81%.

In a retrospective study, Parulekar et al. [11] found that small-bore catheter 12 French was as effective as standard chest tube for drainage of malignant pleural effusion and pleurodesis without significant differences in the rate of complications.

In our study, 64 out of 260 catheter placements were not successful. Among the 64 cases of failure, 16 of them were due to loculated effusions, 17 due to obstruction or blockage of the catheter, 5 cases with advanced parenchymatous lung disease, and 5 due to rapid re-accumulation of the fluid after removal of the catheter. In both parapneumonic and tuberculous pleural effusion groups, most failures were associated with presence of loculation. If the cases of loculated pleural effusions and advanced lung disease are excluded, the success rate increases to 90% (235 out of 260).

We found Comparable results In other studies. where Bediwy AD and Amer HG [8], found that among the nine cases of failure, five of them were due to loculated effusions, and four of them were due to rapid reaccumulation of the fluid after removal of the catheter. And with the exclusion of patients with preplacement evidence of loculated effusions, the success rate was 91.3% for effusions treated by pigtail catheter drainage.

And in the study done by Gammie et al. [10], there were eleven out of 77 pigtail catheter placements for pleural effusions were not successful. Four failures were associated with loculated fluid collections that required either operation or radiographically guided drainage for resolution. In two cases, pigtail catheters were removed when they were draining in excess of 1000 mL of fluid per day, and the underlying effusions reaccumulated. They reported that exclusion of patients with preplacement evidence of loculated effusions and postponement of pigtail removal in the face of excess drainage would have yielded a success rate of 94% for effusions treated by pigtail catheter drainage.

Conclusion

Small-bore catheter insertion is an effective and safe method for draining pleural fluid of most etiologies. We recommend its use for all cases of pleural effusion requiring chest drain except for hemothorax, empyema and other loculated pleural effusions that yield low success.

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