Original Article

Small-bore catheter is more than an alternative to the ordinary chest tube for pleural drainage

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ABSTRACT

Background: Pleural collection is a common medical problem. For decades, the chest tube of different designs was the commonly used toll for pleural drainage. Over the past few years, small-bore catheter (SBC) has gained more popularity. We present our experience of using SBCs for the drainage of pleural collection of different etiologies. **Patients and Methods:** A total of 398 small-bore pleural catheters were inserted in 369 patients with pleural collection during the period from January 2013 to October 2019. Data were collected regarding the efficacy of drainage, experienced chest pain, duration of drainage, and the occurrence of complications. **Results:** Malignant associated (59.24%) and parapneumonic (19.57%) effusions constituted the most common causes. The drainage was successful in 382/398 (95.98%) occasions; six cases had incomplete fluid evacuation that required decortications; five cases (1.26%) had nonexpendable lung. Catheter reinsertion was needed due to dislodgment in 2 (0.50%) cases and obstruction in 3 (0.75%) cases. Sixty-two cases (15.58%) experienced chest pain. No patient developed empyema or cellulites at the site of catheter insertion. The duration of drainage ranged from 2 to 7 days, with an average of 3.5 days. **Conclusions:** SBC is equivalent to conventional chest tube for the drainage of pleural collection. Moreover, it has the advantages of less associated pain, versatility of insertion site, and relative safety of the technique in some risky and difficult situations.

KEY WORDS: Chest tube, pleural drainage, pleural effusion, small-bore catheter

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INTRODUCTION

Tube thoracostomy has been used as the primary tool for the evacuation of air or fluid in the pleural space from a myriad of causes, namely pleural effusions of different etiologies, empyema, hemothorax, chylothorax, and pneumothorax. Conventionally, large-bore tubes (24–32 F) were recommended in almost all situations and were inserted using a blunt dissection technique. This procedure usually requires hospitalization, limits patient mobility, and may cause significant patient discomfort.[1-3]

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Over the past few years, small-bore drains have been increasingly used. Several reports suggested the adequacy of small-bore catheter (SBC) in the treatment of pleural effusion and pneumothorax. However, debate continues on its effectiveness in cases of viscid fluids such as empyema or hemothorax.[4,5] Proponents of SBC claim that it is less painful both during insertion and while the tube is *in situ*, and they appear to have a lower risk of complications.

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The aim of this study was to evaluate the outcome of SBC in the management of different types of pleural collection.

PATIENTS AND METHODS

This was a retrospective study of a prospectively collected data that was conducted at the tertiary care thoracic surgery center. The study protocol was approved by the Institutional Ethical Committee. Individual patient consent for inclusion in the study was waived. All SBC pleural drainages for pleural collection performed at our institution during the period from January 2013 to October 2019 were included in the study.

During the period of the study, 368 patients with pleural collection of different etiologies underwent 398 procedures of SBC insertion. Our patients were referred to us from the medical and oncology services after failure (or recurrence) of initial management with diagnostic and when indicated therapeutic thoracentesis. All patients were subjected to a full clinical history; clinical examination focusing on respiratory system; laboratory tests, particularly complete blood count, and coagulation profile. All patients had chest X-ray, and chest computed tomography (CT) was performed when loculated effusion was suspected.

Catheter insertion was performed under local anesthesia with 1% lignocaine and complete aseptic technique. In short, diagnostic thoracentesis was performed to select the proper site for catheter insertion and to reveal the nature of the pleural collection. In case of free-flowing fluid, the selected skin insertion site was the 5th or 6th intercostals space, midaxillary line. When the collection appeared on chest radiographs to be loculated, CT scans were performed, and the insertion site was selected accordingly and sometimes with ultrasound guidance.

All catheters were inserted using the Seldinger technique.[6] An 18G cannula was placed into the pleural space, and the return of pleural fluid was confirmed. A guidewire was advanced well into the fluid collection. Sequential dilators were then used to prepare the tube tract. Catheter (either pig-tail catheter size 8 or 10 F or central-line catheter size 7 F) was advanced over the wire into the pleural space. The pleural catheter was then connected to a drainage bag or underwater seal system. The catheter was removed when the drainage ceased or became <100 ml for 2 consecutive days.

In cases of malignant pleural effusion, pleurodesis was induced by the injection of bleomycin (60 mg diluted in 100 ml of normal saline) through the catheter.

Following catheter insertion, the following data were collected; clearance or improvement of pleural fluid collection, catheter dwell time, pain score according to the Visual Analog Scale (Wong Baker face scale), requirement of analgesia and insertion site infection. Following catheter removal and patient discharge, all patients were seen in the outpatient clinic as part of routine follow-up.

RESULTS

During the period from January 2013 to October 2019, 368 patients, of which 206 (55.98%) women and 162 (44.02%) men, mean age, 53 years (range, 17–92 years) were subjected to small-bore pleural catheter insertion in a total of 398 procedures.

Three cases underwent four procedures; nine cases underwent three procedures; six cases underwent two procedures; and three cases underwent bilateral procedures.

The majority of cases had exudative malignancy-associated pleural effusion 59.24%, followed by parapneumonic effusion 19.57%. The indications of catheter insertion are presented in Table 1.

For malignancy-associated effusion, cytological proof was not documented in all cases. In all patients, a sample was sent for cytological study. However, for patients with known-advanced malignancy under chemotherapy when the result showed the presence of atypical cells without definite diagnosis of malignant cells, no further studies were done to proof malignant nature of the effusion.

Patients with cancer breast represent the majority of cases (51.38%). The underlying primary tumors of malignant pleural effusion are presented in Table 2.

Table 1: The indications of catheter insertion

Etiology	Number of patients, *n* (%)
Malignant effusion	218 (59.24)
Parapneumonic effusion	72 (19.57)
ICU patient*	31 (8.42)
End-stage renal disease	18 (4.89)
Heart failure	13 (3.53)
Hepatic effusion	6 (1.63)
Miscellaneous**	10 (2.72)
Total	368 (100)

*Patients with refractory bilateral transudative pleural effusion interfering with weaning from mechanical ventilation, **Sympathetic effusion, chylothorax, rheumatic disease, and retained hemothorax. ICU: Intensive care unit

Table 2: The underlying primary tumors of malignant pleural effusion

Primary malignancy	Number of cases, *n* (%)
Breast cancer	112 (51.38)
GIT cancer*	47 (21.56)
Bronchogenic carcinoma	24 (11.01)
Lymphoma	7 (3.21)
Miscellaneous**	19 (8.71)
Unknown primary	9 (4.13)
Total	218 (100)

*Colon, stomach, and esophagus, **Ovary, soft-tissue sarcoma, thyroid, and prostate. GIT: Gastrointestinal tract

All procedures were performed successfully without acute clinically significant surgical complications.

The drainage was successful in 382/398 (95.98%) occasions. Five cases (1.26%) developed pneumothorax (four malignant and one chronic benign effusions). In all of them the pneumothorax was considered to be due to nonexpandable lung, the catheter was removed and fluid allowed to refill the space. Another six (1.51%) cases had incomplete fluid evacuation due to organized collection that required subsequent decortications. The catheter was dislodged in two (0.50%) cases that required catheter reinsertion; in both cases, the catheters were partially pulled outside to correct the catheter kink before subsequent complete dislodgment.

In another three (0.75%) patients, the catheter was obstructed and required replacement. The duration of drainage ranged from 2 to 7 days, with an average of 3.5 days.

Sixty-two cases (15.58%) experienced mild chest pain (pain score 3/10) after the insertion of the catheter. In all of them, the pain was relieved with paracetamol intravenous infusion without the need for any narcotics.

No patient developed empyema or cellulites at the site of catheter insertion.

DISCUSSION

In recent years, small-bore pleural catheters have gained increasing popularity. Their safety and efficacy in managing different pleural pathologies have become the scope of several studies. Most of these studies concentrate on the efficacy of the SBC in producing effective drainage with more patient comfort in comparison to conventional chest tube.

For malignant pleural effusion, several clinical studies comparing large-bore chest tubes to small-bore chest tubes demonstrated that both tube sizes were equivalent in terms of both effective drainage and feasibility of inducing pleurodesis.[7-9]

Other authors measured the pain experienced by patients at the time of insertion of SBCs for malignant effusion as well as other conditions; they showed that the pain experienced by the patients was on average very mild, and consequently, SBCs were considered well tolerated by the patients.[10,11] These results seem logic as SBC unlike conventional chest tube does not impinge on the neurovascular bundle or alter the geometry of the intercostal space.[12]

Other studies have addressed the economic aspect and reported a shorter hospital stay and superior cost-effectiveness for SBC over conventional chest tube for the drainage of malignant effusion and subsequent pleurodesis.[13,14] Moreover, SBCs have been used for the management of malignant effusion and for some cases of refractory pleural effusion in the outpatient settings.[15-17]

Few complications were encountered with the use of the SBCs including the pneumothorax. We observed this complication in four of our patients (three malignant and one chronic benign effusions). We as well as other authors suggest that the development of pneumothorax is not related to the procedure itself but may be due to the removal of fluid from a relatively noncompliant lung due to either malignant infiltration or thickened pleura. This complication has been estimated to occur in up to 30% of cases of malignant effusion.[18] These patients do not require further catheter drainage and it is better to allow pleural fluid to reaccumulate in the residual space over time.[19,20] Others recommend the use of indwelling pleural catheter to enable further drainage and possible alleviation of symptoms.[21]

For patients with viscous pleural fluids such as pus or blood, the situation is more controversial. *In vitro* studies demonstrated lower flow rates of viscous secretions through small-bore tubes.[22] On the other hand, several clinical studies demonstrated the efficacy of SBCs in the drainage of infected pleural fluid in 70%–100% of instances.[23-25] However, it is important to take into considerations the recommendations of expertise in this field, especially frequent flushing of the catheter with sterile saline and the use of fibrinolytic agents (urokinase, streptokinase, and recombinant tissue plasminogen activator) to facilitate drainage.[26] In addition, we usually use catheter size 14 F for frank pus drainage. Finally and most importantly is the use of image guidance for proper insertion of the catheter in the most dependent position.[27,28] This is considered of paramount importance for effective drainage of empyema.

Our results are concordant with previous studies. Moreover, in this study, we demonstrated more advantages of SBC the feasibility of insertion in difficult situations. The use of Seldinger technique allowed us to insert the catheter at lower intercostals spaces without injury of the diaphragm or abdominal organs. Localization of the pleural space with a small needle and passage of the guidewire into the pleural space allowed catheter insertion safely. Accordingly, the catheter can be inserted in the most dependent site.

In other circumstances, the classic site of chest tube insertion may be unsuitable for drainage [Figure 1] or is involved by neoplastic or infectious processes [Figure 2] or is very thick requiring major dissection to reach the pleural space as in cases of morbid obesity. In such cases, the catheter can be inserted on the back and tagged to the skin with adhesive tapes without kinking or obstruction. Furthermore, this has been shown to be beneficial when there were some partitions or loculation within the pleural space that communicate together in the lower zone.

The small caliber of the catheter and the use of Seldinger technique during insertion minimize the chance of injury of the intercostals bundle or the intrathoracic organs. This advantage has a great impact in patients with coagulopathy either due

to bone marrow depression (patients under chemotherapy) or impaired liver function and patients with vascular malformations or dilatation of chest wall collaterals [Figure 3].

CONCLUSIONS

We conclude that SBC is equally effective to conventional chest tube for the drainage of pleural collection of different etiologies with more patient comfort. Moreover, it has the advantages of versatility of site of insertion and suitability and safety in dangerous situations of susceptibility to bleeding or injury of vascular structures and very thick chest wall.

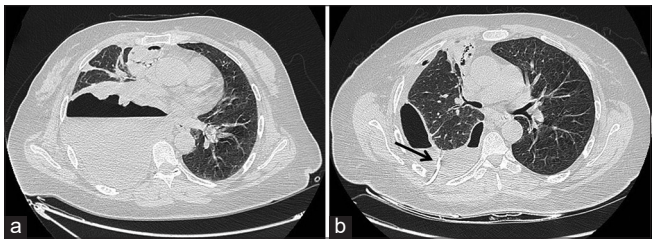

Figure 1: A 58-year-old female had ruptured lung abscess resulting in multilocated collection with air fluid level and mediastinal shift. Catheter was inserted on the back medial to the upper end of the scapula. Drainage of pus allowed relieve of respiratory distress and improvement of toxemia before definitive management. (a) Computed tomography chest showing loculated right side collection with air fluid level; (b) Small-bore catheter in place (arrow) with partial lung inflation

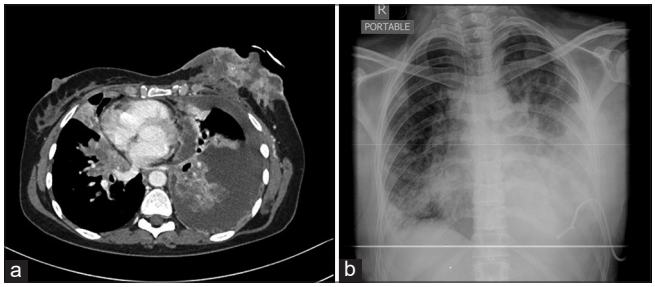

Figure 2: A 37-year-old female had metastatic left side cancer breast, with fungation, ulceration, and infection. She had pleural effusion on the same side and there was no suitable site for ordinary chest tube insertion. A catheter was inserted in the scapular line allowing drainage of the effusion and subsequent chemical pleurodesis. (a) Computed tomography chest axial view showing locally advanced left breast cancer and pleural effusion; (b) Chest X-ray showing left pleural effusion with small-bore catheter in place

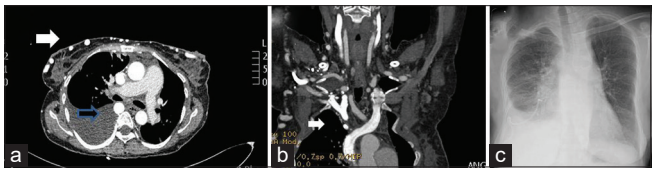

Figure 3: A 45-year-old female with end-stage renal disease has right internal jugular vein obstruction and right pleural effusion. (a) Computed tomography chest (axial view) showing right pleural effusion, dilated azygos vein (arrow), dilated chest wall tributaries (arrow); (b) Computed tomography chest (coronal view) showing right innominate vein obstruction; (c) Chest X ray showing small-bore catheter in place

Limitations

This is an observational and not a comparative study. Inclusion of all cases who underwent small catheter drainage for different diseases, trying to concentrate mainly on the principle of drainage, it is needless to say that each pathology has its own management plane.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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