

Research

Open Access

Pleural drainage using central venous cathetersKulgit Singh¹, Shi Loo² and Rinaldo Bellomo³¹Consultant, Department of Anaesthesiology, Tan Tock Seng Hospital, Singapore²Senior Consultant, Department of Anaesthesiology, Tan Tock Seng Hospital, Singapore³Professor of Medicine, University of Melbourne, and Director of Intensive Care Research, Department of Intensive Care, Austin & Repatriation Medical Centre, Heidelberg, Melbourne, Victoria, AustraliaCorrespondence: Kulgit Singh, kulgit_singh@ttsh.com.sg

Received: 15 September 2003

Revisions requested: 17 September 2003

Revisions received: 24 September 2003

Accepted: 25 September 2003

Published: 15 October 2003

Critical Care 2003, **7**:R191-R194 (DOI 10.1186/cc2393)This article is online at <http://ccforum.com/content/7/6/R191>© 2003 Singh *et al.*, licensee BioMed Central Ltd (Print ISSN 1364-8535; Online ISSN 1466-609X). This is an Open Access article: verbatim copying and redistribution of this article are permitted in all media for any purpose, provided this notice is preserved along with the article's original URL.**Abstract****Introduction** The objective of the present study was to evaluate the use of a single lumen 16 G central venous catheter for the drainage of uncomplicated pleural effusions in intensive care unit patients.**Methods** A prospective observational study was performed in two intensive care units of university-affiliated hospitals. The study involved 10 intensive care unit patients with non-loculated large effusions. A 16 G central venous catheter was inserted at the bedside without ultrasound guidance using the Seldinger technique. The catheter was left *in situ* until radiological resolution of the effusion.**Results** Fifteen sets of data were obtained. The mean and standard deviation of the volumes drained at 1, 6 and 24 hours post catheter insertion were 454 ± 241 ml, 756 ± 403 ml and 1010 ± 469 ml, respectively. The largest volume drained in a single patient was 6030 ml over 11 days. The longest period for which the catheter remained *in situ* without evidence of infection was 14 days. There were no instances of pneumothorax, hemothorax, re-expansion pulmonary edema and catheter blockage/disconnections.**Conclusions** The use of an indwelling 16 G central venous catheter is efficacious in draining uncomplicated large pleural effusions. It is well tolerated by patients and is associated with minimal complications. It has the potential to avoid repeated thoracentesis or the use of large-bore chest tubes.**Keywords** central venous catheters, drainage, pleural effusion**Introduction**

A recent study confirmed the high incidence of pleural effusions in patients in the intensive care unit (ICU). Using criteria based on the physical examination and evaluation of chest radiographs, an annual incidence of 8.4% was recorded [1]. This incidence would probably be higher if diagnostic modalities such as ultrasound were employed [2]. The presence of a pleural effusion has diagnostic and therapeutic implications [3]. Large effusions can compress the underlying lung, resulting in atelectasis and impaired gas exchange. This may precipitate the need for invasive mechanical ventilation or may delay endotracheal decannulation.

Current common practices to drain uncomplicated pleural effusions include thoracentesis via small gauge needles or trocar/venulae systems, or the use of large-bore chest tubes placed at the bedside or of small-bore pig-tail catheters placed under radiographic guidance [4,5]. Loculated effusions and empyemas may require surgical drainage. Each technique has its advantages and limitations. We hypothesised that by using an indwelling 16 G single lumen central venous catheter in uncomplicated large effusions, we would be able to avoid repeated thoracentesis procedures and to successfully drain large effusions with minimal complications. To test the efficacy of this approach we conducted a prospective observational study.

Materials and methods

This study was conducted in the ICUs of a Singaporean hospital and an Australian hospital. Informed consent was obtained from the patient or a relative. Ten patients were studied prospectively. Patients were included if they had large pleural effusions clinically and on a chest radiograph, which were judged to be contributing significantly to their respiratory impairment. Patients were excluded if there was a suspicion that the effusions were loculated, if they had significant pre-existing coagulation abnormalities or if they had structural chest abnormalities. Ultrasound confirmation of the non-loculated nature of the effusion was obtained in three patients.

Preparation and technique

The procedure was performed with the patient lying in a semi-recumbent manner at an angle of 45° because most of the patients were ventilated and sedated. The ipsilateral arm was raised over the head and held in place by the nurse assistant. The site of insertion was determined by physical examination or had been marked by the ultrasound technician in the three cases where the ultrasound investigation had been performed. The skin was prepared with 0.05% chlorhexidine (Baxter, Old Tongabbie, Australia) and 10% povidine-iodine solution and was then draped in a sterile manner. Local anesthetic (3–5 ml of 1% lidocaine) was infiltrated from the subcutaneous plane down to the parietal pleura with a 21 G needle. Pleural fluid was aspirated via this needle to confirm its free flowing consistency.

The insertion kit used was the ARROW® 16 G central venous catheterisation set (product no ES-04301; Arrow, Reading, Pennsylvania, USA). The 18 G trocar needle attached to the supplied syringe was inserted into the specified intercostal space in the mid-axillary line until it breached the parietal pleura and confirmed that free flowing pleural fluid could be obtained. The Seldinger technique was applied with the flexible guide wire inserted 2 cm beyond the distance of the trocar needle. The tract was subsequently dilated prior to the insertion of the catheter. Care was taken that the dilator should not be inserted more than the expected distance from the chest wall to parietal pleura, in order to decrease the risk of lung injury. The length of the catheter in the pleural space ranged from 5 to 15 cm, the final depth being dependent on the ease of aspiration of the pleural fluid. The catheter was then connected to a urine drainage bag with a non-return valve (Polymedicure, Haryana, India) via a three-way stopcock (B Braun, San Goncalo, Brazil) and a modification from the end of an intravenous drip set (B Braun, Penang, Malaysia). A piece of transparent dressing (Tegaderm™; 3M, St Paul, Minnesota, USA) was applied over the junction of the urine bag tubing and the rubber bung of the intravenous drip set to prevent a disconnection. The central venous catheter was stitched down to the skin and a similar transparent dressing applied over the insertion site.

Parameters

A record of complications (pneumothorax, hemothorax, re-expansion pulmonary edema and equipment failure) was made. A chest radiograph was performed routinely post catheter insertion for pneumothorax detection. Subsequent radiographs made as part of the ICU management of the patient were also reviewed. The catheter site was inspected daily for evidence of redness, swelling or discharge and the duration of the catheter's presence *in situ* was noted. The daily and total volumes of pleural fluid drained were recorded. Recurrence of the effusion after catheter removal and the need for a repeat thoracentesis was noted.

Statistics

The means and standard deviations of the volumes of pleural fluid drained at 1, 6 and 24 hours post catheter insertion are presented.

Results

Fifteen sets of data were obtained from 10 patients. Three patients had catheters inserted for bilateral pleural effusions. One of these patients, who suffered from chronic pancreatitis, subsequently had a unilateral left pleural effusion drained twice during further re-admissions to hospital. Twelve sets of data were obtained when the patients were mechanically ventilated.

Four patients had pancreatitis, with the remaining six patients having a variety of underlying medical conditions including perforated intra-abdominal viscus, liver transplantation and recent cardiac surgery. Three of these patients had pneumonia complicating their primary medical condition.

Table 1 summarises the biochemical profile of the pleural fluid and the cumulative volume of effusion drained at 1, 6 and 24 hours post catheter insertion. The mean volumes drained at 1, 6 and 24 hours were 454 ± 241 ml, 756 ± 403 ml and 1010 ± 469 ml, respectively. As we did not simultaneously determine serum lactate dehydrogenase levels and serum total protein levels, we classified exudates as having pleural fluid lactate dehydrogenase levels ≥ 200 IU [6] or pleural fluid total protein levels ≥ 30 g/l [7]. Twelve samples were classified as exudates and two samples as transudates. The results for one sample were not available.

No patients had a pneumothorax on the first radiograph performed within 8–12 hours after catheter insertion and on review of subsequent radiographs. There were no instances of hemothorax or re-expansion pulmonary edema. None of the catheters slipped out and there were no accidental disconnections of the drainage system.

All ventilated patients were successfully weaned. Mechanical ventilation was avoided in the three instances where the large effusions had caused respiratory distress in these non-intubated patients.

Table 1**Selected patient characteristics, biochemical profile and cumulative volumes of pleural fluid drained**

Pt	Remarks	Indication for drainage	Biochemical profile			Effusion volumes drained (ml)		
			pH	PTP (g/l)	LDH (IU/l)	1 hour	6 hours	24 hours
1	Pancreatitis, intubated, right pleural drain	Facilitate weaning	7.5	26	288	400	530	530
	Left pleural drain		8.0	34	3884	570	690	690
	Second admission 5 months later, intubated, single drain	Facilitate weaning	8.5	22	266	240	430	450
	Third admission 2 months later, non-intubated, single drain	Respiratory compromise	8.5	33	219	370	1170	1270
2	Pancreatitis, non-intubated	Respiratory compromise	7.5	11	98	880	1810	2075
3	Pancreatitis, non-intubated	Respiratory compromise	8.5	28	527	180	550	1200
4	Pneumonia, intubated	Facilitate weaning	8.0	23	395	600	700	1300
5	Pancreatitis, intubated	Facilitate weaning	8.5	52	362	830	980	1380
6	Liver transplant, intubated	Facilitate weaning	NA	NA	NA	300	410	600
7	Trauma, intubated	Facilitate weaning	NA	30	258	400	500	700
8	Cardiac surgery, intubated	Facilitate weaning	NA	33	426	800	1300	1400
9	Perforated sigmoid colon	Facilitate weaning						
	Right pleural drain		8.0	16	216	540	700	970
	Left pleural drain		8.5	16	175	200	780	1430
10	Perforated gastric ulcer	Facilitate weaning						
	Right pleural drain		8.0	20	473	350	400	630
	Left pleural drain		8.5	19	474	150	410	520

LDH, pleural fluid lactate dehydrogenase level; NA, not available; PTP, pleural fluid total protein; Pt, Patient.

The longest duration that a single catheter remained *in situ* was 14 days, and it drained a total of 5050 ml over this period. This same patient had a contralateral catheter inserted, which drained 6030 ml over 11 days. In total, five patients had the catheter *in situ* for between 7 and 9 days. The daily drainage ranged from 70 to 1700 ml/day. There were no instances of catheter blockage despite fibrinous material being seen in the collection bag of two patients.

Discussion

Single puncture thoracentesis has been found to be a safe technique in mechanically ventilated patients [8] although there are still reservations about its use [9,10]. The procedure may need to be repeated frequently, however, and may thus cause some discomfort to the patient and an increased risk of complications associated with repeated puncture. The bedside placement of large-bore chest tubes, 24–32 Fr gauge in diameter, is an alternative technique but its limitations are that the indwelling chest tubes are often associated with much patient discomfort and a relatively higher risk of mechanical complications. This can be overcome using fine pig-tail catheters of 8.0–14.0 Fr [11]. This corresponds approximately to a diameter of 2.66 and 4.66 mm [12],

respectively, and is usually placed under ultrasound guidance by radiologists.

The present technique describes the use of a similar flexible tube, but smaller in diameter (1.7 mm), which can be kept *in situ* to facilitate continuous drainage and thus avoid patient discomfort and potential complications from repeated thoracentesis. Our patients reported minimal, if any, discomfort from the indwelling catheter and were able to cooperate with our physiotherapists and respiratory therapists to facilitate alveolar recruitment.

Ultrasound-guided techniques have been advocated for use in ICU patients [9,10]. Thoracentesis under ultrasound guidance is not complication free, however [13]. We ourselves seek the help of our radiological colleagues to insert pig-tail catheters in patients with difficult chest wall anatomy, with significant coagulation abnormalities or with possible loculated effusions. In these instances, however, insertion is frequently delayed as arrangements have to be made with the radiologists and patients may need to be transported to the radiology department for the procedure. Our complication rate is no worse than those rates reported by Lichtenstein

and colleagues [10], and it compares favorably with other series [5,13]. We do, however, acknowledge that because our number of patients is small the true incidence of complications with this technique must await a larger study.

The first reported use of a central venous catheter to aspirate a pleural effusion might be attributed to Cooper who used it in a single patient to aspirate an effusion, after which it was removed [14]. We have been unable to trace any other published material on this technique except for the follow-up correspondence [15]. We therefore believe that the present paper is the first to document in detail the indwelling nature of this technique in a larger group of patients. Grodzin and Balk have described a similar technique of leaving a 7 Fr indwelling pleural catheter (Turkel thoracentesis systems) for intermittent pleural drainage [5]. We are unable to determine the widespread availability or use of this system. Our small study has also shown the feasibility and safety of using a urine drainage bag system instead of a water seal system in mechanically ventilated patients. The bag is always placed below the level of the patient's chest. We do not routinely flush the drainage system. The catheter is removed if pleural drainage is less than 100 ml for two consecutive days and there is resolution of the effusion on the chest radiograph.

There are several potential advantages of this technique over repeated thoracentesis, use of pig-tail catheters and use of conventional large-bore chest drains. This single lumen catheter is well tolerated with minimal patient discomfort and, in our small series, is not associated with catheter blockage, problems with the drainage system and with infection. The technique thus avoids the need for repeated punctures, which are painful. In our two hospitals, the advantage over the pig-tail catheters can be viewed from the point of logistics and cost. Once the decision is taken to insert the single lumen catheter, this can be accomplished rapidly by the intensivist with the assistance of the bedside nurse. For pig-tail catheter insertion, either the radiology team comes to the intensive care unit or the patient needs to be transported to the radiological suite. We are also able to avoid the procedural charges of the radiology team. The cost in our institution of the catheter and disposable preparation set is less than US\$15.00. In comparison with conventional large-bore chest drains, the catheter is associated with less discomfort during insertion and when it is *in situ*. This facilitates nursing and physiotherapy care. We are able to avoid the use of conventional chest drainage bottles which are expensive. Demands on nursing care are minimal as the catheter entry site is small and not associated with pleural fluid leaks around it and because we have not needed to regularly flush the catheter while it is *in situ*.

In summary, the present article provides preliminary data on the use of a 16 G indwelling central venous catheter to drain large non-loculated pleural effusions in the ICU. Although our case series is small, it appears that this technique is useful and safe in selected individuals.

Key messages

- A number of techniques have been described to drain pleural effusions
- Each technique has its advantages and disadvantages
- In selected individuals, non-ultrasound guided placement of small bore catheters such as central lines provide effective and safe drainage of pleural effusions with minimal discomfort

Competing interests

None declared.

References

1. Fartoukh M, Azoulay E, Galliot R, Le Gall JR, Baud F, Chevret S, Schlemmer B: **Clinically documented pleural effusions in medical ICU patients. How useful is routine thoracentesis?** *Chest* 2002, **121**:178-184.
2. Mattison LE, Coppage L, Alderman DF, Herlong JO, Sahn SA: **Pleural effusions in the medical ICU. Prevalence, causes and clinical implications.** *Chest* 1997, **111**:1018-1023.
3. Light RW: **Pleural effusion (clinical practice).** *N Engl J Med* 2002, **346**:1971-1977.
4. Colice GL, Rubins JB: **Practical management of pleural effusions. When and how should fluid accumulation be drained?** *Postgrad Med* 1999, **105**:67-77.
5. Grodzin CJ, Balk RA: **Indwelling small pleural catheter needle thoracentesis in the management of large pleural effusions.** *Chest* 1997, **111**:981-988.
6. Light RW, Macgregor MI, Luchsinger PC, Ball WC Jr: **Pleural effusions: the diagnostic separation of transudates and exudates.** *Ann Intern Med* 1972, **77**:507-513.
7. Peek GJ, Morcos S, Cooper G: **The pleural cavity.** *BMJ* 2000, **320**:1318-1321.
8. Godwin JE, Sahn SA: **Thoracentesis: a safe procedure in mechanically ventilated patients.** *Ann Int Med* 1999, **113**:800-802.
9. Keske U: **Ultrasound-aided thoracentesis in intensive care patients.** *Intensive Care Med* 1999, **25**:896-897.
10. Lichtenstein D, Hulot JS, Rabiller A, Tostivint I, Meziere G: **Feasibility and safety of ultrasound-aided thoracentesis in mechanically ventilated patients.** *Intensive Care Med* 1999, **25**:955-958.
11. Reinhold C, Illescas FF, Atri M, Bret PM: **Treatment of pleural effusions and pneumothorax with catheters placed percutaneously under image guidance.** *Am J Roentgenol* 1989, **152**:1189-1191.
12. Poll JS: **The story of the gauge.** *Anaesthesia* 1999, **54**:575-581.
13. Petersen S, Freitag M, Albert W, Temple S, Ludwig K: **Ultrasound guided thoracentesis in surgical intensive care patients [letter].** *Intensive Care Med* 1999, **25**:1029.
14. Cooper CMS: **Pleural aspiration with a central venous catheter [letter].** *Anaesthesia* 1987, **42**:217.
15. Thorp JM: **Pleural aspiration with a central venous catheter.** *Anaesthesia* 1987, **42**:896-897.