The Heart Surgery Forum #2006-1040
9 (4), 2006 [Epub June 2006]
doi:10.1532/HSF98.20061040

Online address: http://cardenjennings.metapress.com/link.asp?id=112496

Comparative Analysis of the Bonanno Catheter and Tube Thorocostomy in Effective Aspiration of Pleural Effusion

Govind K. Chetty, Narrinder R. Battula, Radhika Govindaswamy, Maqsood M. Elahi

Department of Cardiac Surgery, Northern General Hospital, Sheffield, United Kingdom; Faculty of Medicine and Surgery, University of Lahore, Pakistan

ABSTRACT

Background and Methods. In our earlier report, we suggested the Bonanno catheter (a 14-gauge suprapubic catheter) as a less traumatic but equally effective alternative for drainage of a variety of fluid collections, including pleural effusion. This study aims to evaluate the efficacy of the Bonanno catheter compared with closed-tube thoracostomy in draining pleural effusion in 38 patients following routine cardiac surgery between 2003 and 2004. Twenty patients were managed using the Bonanno catheter and 18 were treated with standard tube thoracostomy. Data were collected retrospectively and statistical analysis was performed using the SPSS software. $P < .05$ was considered significant.

Results. There were 20 (53%) male and 18 (47%) female patients with a mean age of 63.5 years (range, 31-83 years). Significant differences were observed with regards to the amount of lignocaine administered locally, intra-procedure pain score, post-procedure pain score after 15 minutes, and amount of analgesia used on a regular basis ($P < .05$ in each case). Statistically, significant differences were also noted during 2 to 3 weeks follow-up between the 2 groups with regards to pain score. In the the tube thoracostomy group, 22.2% developed infection of the procedure site, requiring antibiotic treatment, whereas no infection was reported in the Bonanno group ($P < .001$).

Conclusion. This study provided evidence that small-bore drains such as the Bonanno catheter are safe and better tolerated than standard chest drains. This is consistent with the British Thoracic Society guidelines that strongly recommend small-bore drains for the drainage of pleural effusions as they are more comfortable than larger-bore tubes.

INTRODUCTION

Pleural effusion is a common condition in both medical and surgical specialties [van Sonnenberg 1982]. Large pleural effusions pose several potential problems—restricted ventilatory capacity, problems with chemotherapeutic drugs delivery and distribution, and an increased risk of infection—whether of the pleural space itself or of the collapsed lung because of the displacement by fluid [Barkan 2004]. Some of these difficulties can be overcome by pleural drainage, a method regularly used to remove a collection of air, fluid, pus, or blood from the pleural space to restore normal lung expansion and function [Miller 1987].

Over the years, large-bore drains have been the mainstay of treatment for drainage of pleural collections and they remain in use for postoperative thoracic drainage. Traditional surgical teaching dictates that viscous fluid collections require large tubes for successful drainage [Miller 1987; Park 1993]. However, it has been reported that a variety of collections within the abdomen and pelvis can be adequately drained using small-bore catheters [Gobien 1985; Rothlin 1998] and it is likely that this evidence supporting the use of small-bore drains can be applicable for pleural collections. It is also possible, but perhaps less likely, that dissemination of this evidence may end the frequent assertion by clinicians that "patients would have been better treated with the bigger drain."

In this context, we suggested the Bonanno catheter as a less traumatic but equally effective alternative [Chetty 2005]. The Bonanno catheter was first designed for suprapubic bladder drainage [Bonanno 1970]. Its design is therefore well suited for drainage of a variety of fluid collections including pleural effusion. Hence, we aim to evaluate the use of the Bonanno catheter in comparison to closed tube thoracostomy for the drainage of pleural effusion with respect to insertion technique, complication rate, and pain.

PATIENTS AND METHODS

Recruitment

Indications, technique, and complications in 20 consecutive adult postcardiotomy patients with pleural effusion treated with the Bonanno catheter were compared retrospectively with 18 consecutive postcardiotomy patients treated with tube thoracostomy between 2003 and 2004 at the regional cardiothoracic center. Their base-line demographics were available from their respective case notes. Effusions were identified on chest x-ray and confirmed by ultrasound

Received April 13, 2006; received in revised form May 1, 2006; accepted May 12, 2006.

Address correspondence and reprint requests to: Maqsood M. Elahi (e-mail: manzoor_elahi@hotmail.com).

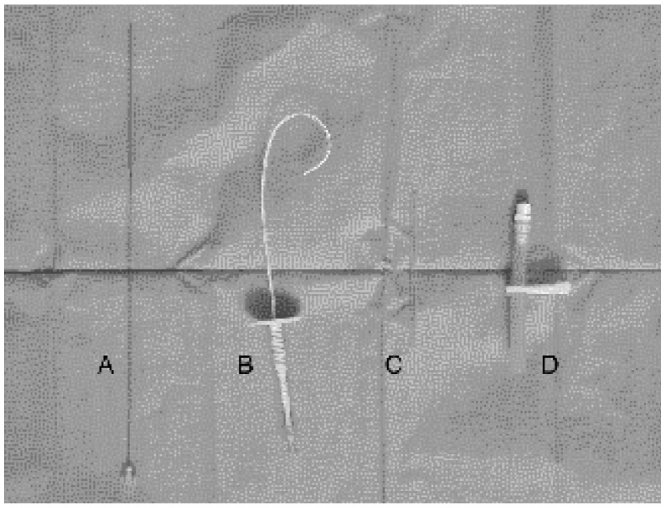

Figure 1. The Bonanno catheter components: trocar needle (A), catheter (B), catheter sleeve (C), and tubing for attachment to the underwater drainage system (D).

findings. Complications were defined as empyema, unresolved pneumothorax (persistent air leak or residual pneumothorax), persistent effusion, or incorrect placement.

Pain Scale

Commonly used pain scores were used to help patients describe their pain [Van Tubergen 2002]. On the numerical rating scale, the patient was asked to identify how much pain he/she was having by choosing a number from 0 (no pain) to 10 (the worst pain imaginable).

Technique for Bonanno Catheter

The Bonanno catheter (Figure 1) was assembled and inserted as described previously [Chetty 2005]. The patient was preferably positioned at 45° or sitting up leaning slightly forward. The entry site was clinically identified by percussion of the chest to elicit an area of stony dullness around the midaxillary line. After preparing the skin and draping the chest, local anesthetic (5 mL) was infiltrated up to the parietal pleura. Presence of effusion was confirmed by aspiration via the same syringe as a guide. A 3- to 4-mm incision was made in the skin to avoid damaging the catheter tip and the catheter was inserted gradually while applying constant suction on the syringe. As soon as serous fluid was aspirated, the trocar was held in a static position and the cannula was advanced into the pleural cavity. The trocar was removed and, with serous fluid flowing freely from the catheter, the catheter was attached via the rubber tubing to a conventional underwater drainage system. The catheter was sutured to the skin and a chest x-ray was performed to confirm the position of the catheter.

Technique for Tube Thoracostomy

The skin over the fifth or sixth intercostal space at the level of the midaxillary line was cleaned with chlorhexidine in alcohol. Local anesthethic (10 mL) was injected into the skin and deeper tissues (intercostals muscle and parietal pleura) along the proposed insertion site. A tract was then created through to the pleura by blunt dissection. The drain was then placed into the pleural space using digital manipulation.

Clinical and Demographic Characteristics of Patients, N = 38

Variables	Tube Thoracostomy, n = 18	Bonanno Catheter, n = 20	*P*
Age, y (range)	59.5 (31-76)	66.6 (45-83)	
Sex, M/F	9/9	11/9	
Lignocaine, mL	5.0 ± 3.1	5.0 ± 1.0	
Additional lignocaine, mL	6.2 ± 2.0	0	.001
Intraprocedure pain score	5.9 ± 1.5	0.55 ± 0.2	.01
Pain score 4 h post-procedure	4.1 ± 1.0	1.0 ± 0.3	.023
Drainage volume, mL	1727.7 ± 154	1298 ± 302	.001
Paracetamol, g	4.0 ± 1.2	2.5 ± 0.5	.05
Dihydrocodeine, mg	118 ± 12	13.5 ± 1.8	.001
Tramadol, mg	13.8 ± 5.0	0	.001
Morphine/pethidine usage, %	22.2	0	.001
Duration of drain stay, h	21.5 ± 3.2	18 ± 3.4	.05
Follow-up, 2-3 wk			
Pain score in outpatient department	0.8 ± 0.3	0.3 ± 0.1	.02
Intercostal neuralgia usage, %	16.6	0	.001
Analgesia usage, %	50	0	.001
Infection rate, %	22.2	0	.001
Antibiotic usage, %	16.6	0	.001
Acceptance of procedure, %	66.6	100	.01

Statistical Analysis

Data were variably expressed as mean with or without range and either standard deviation or range. Statistical analysis was performed using the SPSS software, version 9.05 (SPSS, Chicago, IL, USA), and *P* less than .05 was considered significant.

RESULTS

There were 20 (53%) male and 18 (47%) female patients with a mean age of 63.5 years (range, 31-83 years). The surgical procedures performed were: 20 (53%) coronary artery bypass grafts, 10 (26%) coronary artery bypass grafts with valve repair or replacement, 5 (13%) valve repairs/replacements with others, and 3 (8%) surgeries involving the thoracic aorta.

Clinical and demographic characteristics are described in the Table. There were no significant differences observed in age, volume of lignocaine used initially, or drainage volume and duration of drain stay between the 2 groups (*P* was not significant). However, there were significant differences observed in the amount of additional lignocaine administered, intra-procedure pain score, post-procedure pain score, and amount of analgesia used (<.05 in each case). Significant differences were also noted between the 2 groups in terms of pain score and analgesia usage ($P < .05$ in each case) in 2 to 3 weeks follow-up. In the tube thoracostomy group, 22.2% of the patients had slight infection of the procedure site and required a course of antibiotics, whereas in the Bonanno

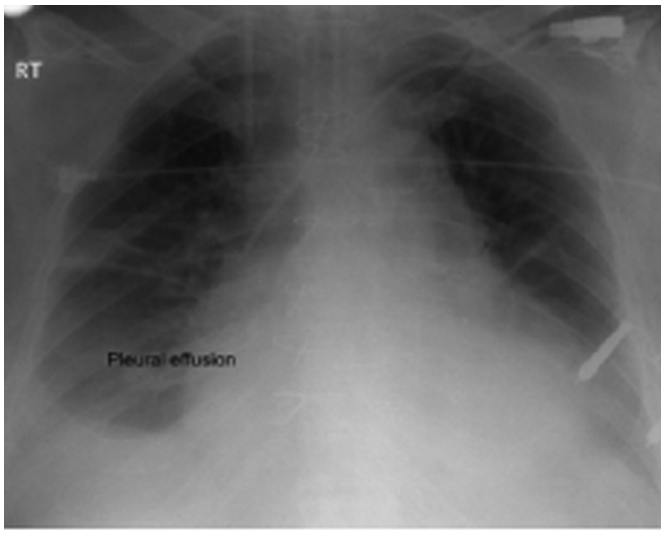

Figure 2. Chest radiograph showing the right-sided pleural effusion.

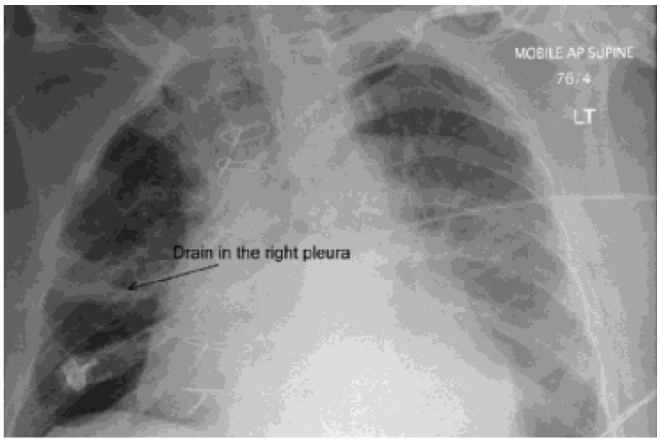

Figure 3. Chest radiograph showing the inserted Bonanno catheter at the base of the right-sided lung-to-drain pleural effusion.

catheter group no infection was reported ($P < .001$). All the patients (100%) accepted the Bonanno catheter insertion for drainage of pleural effusion, and there was not a single case in the whole cohort that required reinsertion of the drain.

CONCLUSION

For a fluid or air collection to be drained successfully, the draining catheter needs to be of sufficient bore to allow adequate flow, to remain patent, and for all or the majority of the collection being drained to be in communication with the catheter. It is also desirable to use the catheter that is the safest and most comfortable for the patient. A large-bore catheter would appear to fulfill the first 2 criteria best. However, review of the published evidence [van Sonnenberg 1984; Park 1993] suggests that small-bore catheters are at least as effective as large-bore tubes, implying that other factors need to be considered. Our study has clearly shown that small-bore drains such as the Bonanno catheter are safe and better tolerated than standard chest drains. This is also coherent with the British Thoracic Society guidelines that strongly recommend small-bore drains for the drainage of pleural effusions, as they are more comfortable than larger bore tubes.

Generally, a small increase in the drainage tube size results in substantial improvement in flow rates. However, an earlier in vitro study has reported that for catheter sizes above 6 to 7 F differences in the flow rates are small [Park 1993]. If drain patency can be maintained, the maximum flow rate of the catheter is unlikely to be the limiting factor for most pleural collections. Although no comparative studies for pleural collections have been performed to date with regard to the use of the Bonanno catheter, 2 series have compared the effectiveness of the different-sized catheters for draining intra-abdominal abscesses [Gobien 1985; Rothlin 1998] and demonstrated no significant difference in drainage success rates or drainage times. Further support for the use of small-bore chest drains is found in the extensive body of literature using small-bore catheters to drain abdomino-pelvic abscesses, both as a primary treatment and as a temporizing measure prior to definitive surgery.

Pleurocentesis can be achieved with needle aspiration; however, this method does not permit complete drainage and is associated with a high incidence of pneumothorax [Mitri 2002]. The Bonnano catheter seems to avoid this problem and enables complete drainage. Our early observations [Chetty 2005] reveal that insertion of this catheter does not cause much pain. Therefore, insertion of the Bonanno catheter can be safely performed by junior medical or surgical staff without the need for extensive dissection that is inevitably required during standard tube thoracostomy. This seems to be supported by the present study as well. A flexible small-bore Bonanno catheter can change configuration in a collection as it decreases in size, thereby avoiding erosion in to the expanding lung (Figures 2 and 3), unlike conventional chest tubes that are less flexible. If contact with the pleura does occur, a small-bore Bonanno catheter has holes on the inside curve of the distal "J" that allow drainage to continue. Moreover, the catheter is made of proprietary polymers of high tensile strength, which allows extrusion into a tube with a relatively high internal diameter relative to the outside diameter.

No infection and no tube misplacement were noted in our series. Although this is still a relatively new technique and patient numbers are significantly smaller, even first principles suggest that the use of the Bonanno catheter appears to be safe, offers reliable drainage of pleural effusion, and provides a less invasive and more comfortable alternative to the standard tube thoracostomy. Importantly, the removal of the Bonanno catheter does not require any purse-string sutures and therefore can be removed by individuals without the need of additional assistance.

This study presents a cogent reason for the use of smaller tubes, yet there is no study available to justify that the Bonanno catheter is also applicable in draining other thick fluids such as blood, malignant fluids, or where there is a lot of fibrin present. Moreover, there are a few authors who have suggested the clogging of thin and small-bore tubes while

draining thick bloody fluids. We have been able to demonstrate its effectiveness only in the treatment of post-cardiotomy thin, serous effusions and report that this technique is safe and better tolerated than their larger counterparts. Furthermore, we recommend that when one encounters a thick, especially bloody effusion, extreme care should be taken to place a proper size tube, avoiding inappropriate use of the Bonanno catheter. Nonetheless, more prospective randomized clinical studies are required to provide substantial evidence of its application in drainage of other fluids such as malignant ones for the continued advocacy of its therapeutic superiority over large-bore drains.

ACKNOWLEDGMENT

Special thanks to Mr. Jeff Chandler for the medical illustration.

REFERENCES

Barkan D, Nusair S, Resnick IB, et al. 2004. Tube thoracostomy during allogeneic stem cell transplantation does not carry an increased risk for infections or bleeding. Clin Transplant 18:85-8.

Bonanno PJ, Landers DE, Rock DE. 1970. Bladder drainage with the suprapubic catheter needle. Obstet Gynecol 35:807-12.

Chetty GK, Elahi MM, Siddagangaiah V, Leverment JN. 2005. Bonanno's catheter: a less invasive alternative for drainage of pleural effusion. J Thorac Cardiovasc Surg 129:219-20.

Gobien RP, Stanley JH, Schabel SI, et al. 1985. The effect of drainage tube size on adequacy of percutaneous abscess drainage. Cardiovasc Intervent Radiol 8:100-2.

Miller KS, Sahn SA. 1987. Chest tubes. Indications, technique, management and complications. Chest 91:258-64.

Mitri RK, Brown SD, Zurakowski D, et al. 2002. Outcomes of primary image-guided drainage of parapneumonic effusions in children. Pediatrics 110:e37.

Park JK, Kraus FC, Haaga JR. 1993. Fluid flow during percutaneous drainage procedures: an in vitro study of the effects of fluid viscosity, catheter size, and adjunctive urokinase. Am J Roentgenol 160:165-9.

Rothlin MA, Schob O, Klotz H, Candinas D, Largiader F. 1998. Percutaneous drainage of abdominal abscesses: are large-bore catheters necessary? Eur J Surg 164:419-24.

van Sonnenberg E, Ferrucci JT, Mueller PR. 1984. Percutaneous drainage of 250 abdominal abscesses and fluid collections. Part I: results, failures and complications. Radiology 151:337-341.

van Sonnenberg E, Ferrucci JT, Mueller PR. 1982. Percutaneous drainage of abscesses and fluid collections. Technique, results and applications. Radiology 142:1-10.

Van Tubergen A, Debats I, Ryser L, et al. 2002. Use of a numerical rating scale as an answer modality in ankylosing spondylitis-specific questionnaires. Arthritis Rheum 47:242-8.