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Single versus Double Chest Tube Drainage after Thoracotomy for Cancer

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Abstract

Background

After pulmonary lobectomy, two chest tubes are traditionally placed: an apical tube for air evacuation and a diaphragmatic tube for fluid drainage. This study investigates whether one apical chest tube is as effective as two chest tubes after lobectomy.

Methods

Between July 2008 and November 2009, 40 consecutive patients with lung cancer underwent thoracotomy and lobectomy. The initial 20 patients had two chest tubes placed while the latter 20 patients had a single chest tube. All 40 patients had epidural catheters placed.

Results

The groups were similar in demographics, comorbidities, lobe resected, and lung pathology. Length of stay, chest tube days, and chest tube drainage were less in the single tube group; however, they did not achieve statistical significance. Similarly, post-operative airleak and residual pneumothorax after tube removal were not significantly different but were less in the single tube group. While the post-operative day to oral pain control was similar in the single and double chest tube groups, postoperative pain as assessed by the VAS pain scale was lower in the single tube group each of the first four PODs with the difference achieving significance on postoperative days 3 (3.6 ± 0.5 versus 5.9 ± 0.5) and 4 (3.2 ± 0.6 versus 5.4 ± 0.6).

Conclusion

Single apical chest tube drainage after thoracotomy for lobectomy is as effective as apical and diaphragmatic double tube drainage. Single tube drainage improves patient's postoperative comfort and may result in less chest tube drainage, fewer chest tube days, and a shorter hospital stay.

Introduction

The classic mantra in thoracic surgery has always included the use of two chest tubes after pulmonary lobectomy. One chest tube is placed in the apex of the chest for air drainage while the other is placed along the diaphragm for fluid drainage [1]. Recently there have been reports, are randomized, substituting the double chest tube approach for a single chest tube after surgery [2–5].

The theoretical advantage of a single chest tube would be less drainage and subsequently earlier chest tube removal as well as decreased pain. Reducing post-operative pain can allow patients to ambulate earlier, which can avoid complications such as pneumonia and deep vein thrombosis. It also encourages the use of incentive spirometry and pulmonary toilet [6]. All of these advantages can lead to shorter hospital stay and decreased cost. Of course, there are potential disadvantages to using a single tube. Due to inadequate drainage of either air or fluid, there is the potential for having a residual pneumothorax or a loculated fluid collection after tube removal.

This study includes patients undergoing thoracotomy for lobectomy with mediastinal lymph node dissection who have a diagnosis of cancer. The aim of the study is to identify if single chest tube placement will result in less chest tube drainage, decreased overall pain, and subsequently shorter hospital stays.

Methods

Setting

Karmanos Cancer Institute/Detroit Medical Center is a large academic, tertiary care center affiliated with Wayne State University School of Medicine. It is located in Detroit, Michigan and has a wide referral base from southeastern Michigan.

Patients

We obtained IRB approval: HIC#035410MP4E, protocol #1003008149. In a retrospective fashion, we identified 40 consecutive patients from July 1, 2008 through November 30, 2009 who had a

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diagnosis of lung cancer and subsequently underwent a standard posteriolateral thoracotomy and lobectomy with mediastinal lymph node dissection by a single surgeon after IRB approval. None of these patients had preoperative chemotherapy or radiation treatment. The first 20 patients had a straight #32 French chest tube (Covidien, Mansfield, MA) as well as a curved #28 French chest tube placed after lobectomy. The second 20 patients had a single straight apical #32 French tube placed. All patients were adults. Preoperatively, all 40 patients had epidural catheters placed for post-operative pain control. These catheters remained in place for 72 hours along with a Foley catheter which was placed after the induction of anesthesia. Preoperative antibiotics were also given approximately one hour prior to skin incision.

Data Collection

Medical records including inpatient charts, electronic medical records, operative reports, laboratory data, and radiographic data and images were reviewed for all 40 patients in a retrospective manner. Data was collected on demographics, associated comorbidities, stage of lung cancer, side of tumor and pre-operative Pulmonary Function Tests (PFTs). We also collected outcome data including total chest tube output, total chest tube days, days of chest tube airleak, total hospital stay, and complications. Post-operative pain information gathered included days to oral pain control and patient reported pain based on the Visual Analogue Scale (VAS) pain scale from 1–10 as collected from a similar pool of nurses. Scores were collected every six hours prior to any bolus pain medication.

Definitions

Comorbidities were defined based on previous diagnosis by primary care physicians. Complications were defined as follows. Smoking was defined as greater than 15 pack-years with the average in our patients being 30 pack-years and the maximum 75. Prolonged airleaks were defined as airleaks lasting longer than 7 days. Residual pneumothorax was defined as a pneumothorax seen on upright chest X-ray after chest tube removal. Pneumonia was defined as either positive sputum cultures or changes on X-ray with appropriate patient symptoms and elevated WBC count. Arrhythmias were recorded when they required treatment. Chest tube management was similar in all patients. Patients were on suction until there was no evidence of airleak with cough or Valsalva. Removal was based on output of less than 200cc per day (currently we use less than 400cc per day).

Data Analysis

Data was entered into a Microsoft Excel spreadsheet for analysis. Categorical variables were compared using chi-square or Fisher's exact test where appropriate while continuous variables were compared using the Student t-test with Bonferroni correction when using multiple comparisons. All statistical tests were 2-tailed and a p value of <0.05 was considered statistically significant.

Results

Patient demographics were identified in our 40 patients and are shown in table 1. There was a predominance of female patients (82%) and white patients (75%), though they were similar in both the single and double chest tube groups. The average age was approximately 65 in both groups with the single chest tube groups having slightly more patients greater than 70 years of age (7 vs 4). Comorbid conditions such as hypertension, diabetes mellitus, Chronic Obstructive Pulmonary Disease (COPD), Coronary Artery Disease (CAD), and a previous diagnosis of cancer were also similar in both groups. While there were slightly more smokers in the double chest tube group (16 vs 19), this was not statistically significant.

Table 1. Preoperative Characteristics.

	Single tube	Double tube	p value
Age	65.4 ± 9.8	65.0 ± 10.0	NS
Sex (M:F)	3:17	3:17	NS
Resection			
Upper	10	10	NS
Middle	1	1	NS
Lower	8	8	NS
Bilobe	1	1	NS
Tumor Side			NS
Right	13	14	NS
Left	7	6	NS
Associated disease (#)			
COPD	3	5	NS
CAD	7	7	NS
Smoker	16	19	NS
PFT (%)			
FEV1	81.7 ± 18.0	80.3 ± 16.9	NS
FVC	87.4 ± 22.1	88.4 ± 10.5	NS
DLCO	65.6 ± 12.2	68.3 ± 19.0	NS

The pre-operative stage of the cancer showed that all patients were either stage I or II while the post-operative stage was similar except that one patient in the single group and two patients in the double group were identified as stage III due to positive mediastinal nodes that were not identified on preoperative scanning. Our lymph node dissections typically yield around 10 lymph nodes. The tumors were predominantly right-sided (65% single chest tube and 70% double chest tube) and mostly in the upper followed by lower lobes. All patients had pre-operative pulmonary function test including a FEV-1, FVC, and D_LCO which were similar in both groups.

Outcomes measured are shown in Table 2. Days of chest tube airleak (2.2 ± 0.7 vs. 2.9 ± 0.7), total chest tube drainage (1971 ± 170 mL vs. 2201 ± 231 mL), and total chest tube days (5.9 ± 0.5 vs. 6.9 ± 0.6) were all less in the single chest tube group versus the double chest tube group. Still, statistical significance was not achieved. Overall patient length of stay was similar (7.8 ± 0.8 vs. 7.9 ± 0.7). In terms

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of complications, arrhythmias, chyle leaks, and pneumonias were similar. Though prolonged airleak and residual pneumothorax after tube removal were not significantly different, they occurred less in the single versus the double tube group (1 vs. 3 and 0 vs. 2 patients, respectively).

Table 2. Comparison of postoperative characteristics, complications, and pain scores.

Variable	Single tube	Double tube	p value
Days of airleak	2.2 ± 0.7	2.9 ± 0.7	0.450
Chest tube days	5.9 ± 0.5	6.9 ± 0.6	0.238
Total chest tube drainage (mL)	1971 ± 170	2202 ± 231	0.418
Length of stay (days)	7.8 ± 0.8	7.9 ± 0.7	0.920
Prolonged airleak	1	3	0.343
Arrythmia	4	2	0.410
Chyle leak	1	0	1.000
Pneumonia	2	3	0.663
Residual airspace	0	2	0.487
Days to oral pain control	3.9 ± 0.3	4.4 ± 0.2	0.164
VAS score			
POD 1	6.2 ± 0.6	7.0 ± 0.6	0.400
POD 2	5.4 ± 0.7	6.7 ± 0.4	0.112
POD 3	3.6 ± 0.5	5.9 ± 0.5	0.009
POD 4	3.2 ± 0.6	5.4 ± 0.6	0.013

Total days to oral pain control again showed a similar pattern with fewer days in the single group (3.9 ± 0.3 vs. 4.4 ± 0.2) but again, statistical significance was not achieved. We then assessed postoperative pain using the VAS pain scale. This analysis showed that on Post-Operative Day (POD) 1 and 2 there was less pain in the single group (6.2 vs. 7.0 and 5.4 vs. 6.7) that was not significant. However, on POD 3 and 4 this pattern achieved significance with the single tube group reporting less pain than the double group (3.6 vs. 5.9 and 3.2 vs. 5.4, $p<0.02$ for each).

Discussion

Double chest tube placement has been the standard in thoracic surgery with one tube placed anterior and apical while the other is placed posterior and basal for fluid drainage. The timing of removing these tubes has more recently been challenged. For example, an output as high has 450 mL/day has been shown to be safe for removal of chest tubes after pulmonary resections [7]. Thus, total chest tube output may not be a useful outcome measure in light of this study. Still, it would be expected that two chest tubes would have more drainage than a single chest tube. Given the high absorptive capacity of the pleura and the lack of complications after early tube removal it is likely that a single tube will suffice in this regard. In fact, continued drainage may simply add to fluid loss that may not be beneficial.

Air leak is another factor that may keep chest tubes in longer than anticipated. We used underwater suction for the first day post-operatively and then as needed based on the presence of an airleak. Suction has the theoretical advantage of promoting lung expansion. Suction via a single tube has been shown to deliver equivalent intrapleural pressure as suction through dual chest tubes [8]. However, suction or waterseal has been shown to be equivalent in terms of post-operative airleak after thoracotomy [9]. Certainly being attached to wall suction limits your ability to ambulate.

Further study has been done looking specifically at the type of tube used. In our study, we used the standard rigid 32 French chest tubes. Others have shown that using more flexible Blake (Ethicon, Somerville, NJ) tubes are equivalent in terms of patient outcome [10] and using these tubes may further increase patient comfort. Further, small tubes such as 24 or 28 French are often used. However, 32 French tubes were used in both groups so no bias was introduced.

Alex et al. first used single chest tubes and found no difference in post-operative outcomes but reported overall less pain in the single tube group [4]. It is not clear in this study if all patients underwent mediastinal lymph node dissection. Another European group showed no difference in outcomes and reported less analgesia use in the single group [2] though this group included patients with sleeve resections and chest wall resections in addition to lobectomy. Two years later it was shown that a single chest tube reduces hospital costs due to a shorter hospital stay as compared to using two chest tubes [5]. Most recently, Okur et al. compared single and double chest tubes in terms of pain scale though their group was not limited to cancer pathologies [3]. Further, this study excluded patients if the surgeon expected increased postoperative output.

Interestingly, these studies all reported their total chest tube drainage to be less than typically seen at our institution leading us to investigate our patient population. This difference could be the result of stapling devices used or a particular sealant used in the operating room. To the author's knowledge, this is the first North American-based study that compares single versus double chest tube placement in patient undergoing thoracotomy for lobectomy and mediastinal lymph node dissection for a diagnosis of cancer. The inclusion of a lymph node dissection has the possibility of resulting in more post-operative drainage. Further, limiting our study to patients with cancer pathologies avoids the variables patients with infectious or traumatic pathologies add.

Pain has been reported as a major issue among patients with chest tubes after surgery [11]. In fact, reduced pain is one of the advantages cited by those who advocate thoracoscopic lung resection [12]. Respiratory rehabilitation with incentive spirometry and ambulation is important in any postoperative patient including those with chest surgery [6]. This can help control sputum secretion and potentially avoid respiratory complications in the early post-operative period [13]. Therefore, keeping patients comfortable is an important part to their post-thoracotomy recovery [14]. We used epidural catheters placed prior to surgery and removed early on post-operative day three.

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This plus the use of a single chest tube allowed patients to experience much less pain which should lead to fewer complications.

The VAS pain scale was used in this study to assess the degree of pain experienced by each patient. Of course, pain is a very subjective finding though its importance cannot be overstated. This method is one of the most common ways to assess pain in a hospital setting [15,16]. This scale ranges from 1 (no pain) to a 10 (worst pain) and patients are asked to report a number as they see fit. This is not a perfect method to assess pain since it is subjective and does not take into account the quality of the pain [7]. Still, using this method we were able to show that after epidural catheter removal, pain was reported to be less in patients with one chest tube than with two after similar operations.

Single chest tube placement after pulmonary lobectomy for cancer is as effective as double tube placement in terms of chest tube days, total chest tube output, complications after surgery, and total hospital stay. Pain, however, is reported to be less intense if a single chest tube is used which could potentially result in earlier ambulation and fewer complications. While this study only incorporates twenty patients treated similarly in each arm, a larger study may show single chest tube use to be superior. Still, perceived pain is clearly less with a single chest tube. Given these data we recommend single chest tube use on all thoracotomies for cancer unless specific circumstances dictate otherwise.

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Christopher Gayer did the chart review and analyzed the data.

Frank Baciewicz was the senior author and oversaw the project.

Abbreviations

CAD: Coronary Artery Disease -Disease of coronary arteries to heart resulting from arthrosclerosis

COPD: Chronic Obstructive Pulmonary Disease - Chronic disease of lungs leading to decreased function

PFT: Pulmonary Function Test - Tests done to assess pulmonary function pre-operatively

POD: Post-Operative Day - Days after operation

VAS: Visual Analogue Scale - A patient-reported pain scale from 1–10

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