Review Article

Outpatient chest tube management

Cecilia Menna[1], Mohsen Ibrahim[1], Camilla Poggi[2], Camilla Vanni[1], Giulio Maurizi[1], Antonio D'Andrilli[1], Anna Maria Ciccone[1], Federico Venuta[2,3], Erino Angelo Rendina[1,3], Claudio Andreetti[1]

[1]Division of Thoracic Surgery, Sant'Andrea Hospital, Faculty of Medicine and Psychology, [2]Division of Surgery "Paride Stefanini", Thoracic Surgery Unit, Policlinico Umberto I, University of Rome 'Sapienza', Rome, Italy; [3]Fondazione Cenci-Lorillard, Rome, Italy

Contributions: (I) Conception and design: C Andreetti, C Menna; (II) Administrative support: C Andreetti; (III) Provision of study materials or patients: C Andreetti, M Ibrahim; (IV) Collection and assembly of data: C Menna, C Andreetti; (V) Data analysis and interpretation: C Menna, C Poggi; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Claudio Andreetti. Division of Thoracic Surgery, Sant'Andrea Hospital, Faculty of Medicine and Psychology, University of Rome 'Sapienza', Via di Grottarossa 1035, 00189 Rome, Italy. Email: claudio.andreetti@uniroma1.it.

Abstract: The pleural space is an air-tight closed space with a sub-atmospheric inside pressure variable during the breathing cycle. Also, the pleural cavity contains a small amount of pleural fluid that as a lubricant ensures lung coupling to the chest wall. This system is under a constant dynamic equilibrium not simple to control after a lung major resection: a chest drainage system has to guarantee an adequate drains of fluid and air allowing a complete lung expansion. Excessive fluid drainage or air leak will prevent timely hospital discharge after thoracic surgery, increasing length of stay (LOS) and the healthcare costs. In the era of "fast track surgery" to standardize an outpatient chest tube management is necessary. This review tries to reach a conclusion by comparing all recent studies reporting a management of chest drains following thoracic surgery. We will explore through this article the tips and tricks to register the best outcomes dealing with an outpatient pleural drainage.

Keywords: Chest tube; pleural cavity; air leak; water seal; technologies

Received: 01 January 2018; Accepted: 09 March 2018; Published: 13 April 2018.
doi: 10.21037/jxym.2018.03.03
View this article at: http://dx.doi.org/10.21037/jxym.2018.03.03

Introduction

Although the pleural drainage placement is the standard surgical step at the end of almost every pleural or pulmonary intervention, the management of chest tube remains controversial. The most frequent issues to be addressed are: how many tubes are necessary after a lobectomy? When it is correct to remove the tube? Is it the outpatient management of the chest tube safe?

After pulmonary resection, the air spreads towards the retrosternal part of the chest wall; instead fluids are collected in its lower part. For this reason the placement of two drains is usually recommended after lung resection. The use of outpatient chest drains to preserve the post-operative pleural space represents the gold standard for thoracic surgeons. Nevertheless a non-recovery drain management for pneumothorax have been reported (1,2), the majority of surgeons remains reluctant to consider the opportunity of outpatient catheters in order to ensure a complete lung expansion in case of hemothorax to avoid some clinical complications due to pulmonary atelectasis, prolongation of air leak because of pleural apposition failure, and risk of empyema. The possibility to shorten the hospital stay after chest surgery using particular devices can reduce the medical care cost providing an increased comfort for the patient and better clinical outcomes. This review explores the major causes of a prolonged use of the pleural catheters identifying the strategy for their correct management particularly focusing on the experience of the single centres.

Chest tube after major lung resections

Cerfolio *et al.* in 2010 (3) wrote the first review article on the management of chest tubes after pulmonary resection. He analysed two important factors that slow or prevent the chest drain removal: air leaks and high volume of pleural drainage. He reports that from 1997 to 2009 there were only 11 publications on the management of chest tube and air leaks. The authors concluded that the use of Heimlich valve system is an optimal device to check the air leak evolution permitting to the patient to go home safely. About the high-volume drainage, the authors concluded that the chest tubes can be removed with up to 450 mL/day of non-chylous drainage after pulmonary resection.

The incomplete lung expansion and air leaks after major lung resection represent an Achille's heel for all thoracic surgeons that request a not simple management of chest drain. Conservative approaches include prolonged period of drains permanence with the use of Heimlich valve, implantation of endobronchial valves or pleurodesis. Korasidis *et al.* in 2010 (4) proposed an original technique to management residual pleural space and severe air leaks after major lung resection in oncological patients. All patients underwent to combined pneumoperitoneum and autologous blood patch. Obliteration of pleural space was obtained in 100% of patients. The chest tube was removed after 8 days (range, 6–10 days), three patients were discharged with Heimlich valve.

The systematic review and meta-analysis by Coughlin and colleagues in 2012 (5) perhaps represented the first rigorous study about the management of pleural drain after pulmonary resection. Using MEDLINE, EMBASE, the Cochrane Central Register of Controlled Trials, the reference lists of all articles obtained as well as bibliographies of two major textbooks in thoracic surgery and the database of registered trials at www.clinicaltrials.gov, the Authors identified 1,061 articles. Of these 1,051 were excluded. Of the 10 articles only 7 (published between 2001 and 2008) were considered eligible and included in their analysis. Sample sizes ranged from 31 to 254 patients. The majority of studies included operations for lung cancer, only one study for spontaneous pneumothorax. In particular, they investigated a possible association between air leak and intrapleural suction by chest drain. Six studies used −20 cm of water for the strength of intrapleural suction, and one used between −10 and −18 cm of suction. The authors concluded that a different setting of intrapleural suction does not influence duration of air leak, duration of chest tubes and length of hospital stay.

Andreetti *et al.* in 2007 (6) demonstrated that the use of the autologous blood can quickly stop the air leaks and permitting a fast discharge of patients without the chest drain. The authors enrolled in their study 25 patients with air leaks after lobectomy. The study was organized with two random groups: group A (12 patients), 50 mL of autologous blood was infused in the pleural cavity, group B (13 patients), 100 mL of blood infused. Group A and B were retrospectively compared with the group C (15 patients with air leaks for at least 6 days). In group A air leaks stopped 2.3±0.6 days after the infusion of autologous blood, in group B after 1.5±0.6 days, and in group C after 6.3±3.7 days. A complete resolution of the air leaks was registered within 72 hours in groups A and B with a statistically significant difference in the length of stay (LOS) of the drainage between groups A and B (P=0.005), groups A and C (P=0.0009), and groups B and C (P=0.0001).

There are clinical conditions where the management of chest tube requests a great experience. Post-pneumonectomy bronchopleural fistula is one of these (7). It represents a severe complication, with a reported incidence varying from 1.5% to 28% and consequent mortality rates ranging between 18% and 50%. The most frequent cause of mortality is pneumonia developing from the contamination of healthy lung tissue by empyema material via fistula, with consequent adult respiratory distress syndrome. Andreetti *et al.* in 2012 (8) proposed an excellent surgical strategy to treat fistulas with a diameter >5 mm. The authors treated six patients with post-pneumonectomy fistula by the introduction of a tracheobronchial conical fully covered self-expandable nitinol stent. According to the modified classification of Le Brigand, all fistulas were considered "early", since they occurred within 7 days after lung resection. The pleural space was drained in all cases by a chest tube to exclude the presence of empyema and to observe the gravity and the evolution after treatment of air leaks. A successful covering of dehiscence was achieved in all cases, as shown by the immediate cessation of bubbling in the chest drain system.

Chest tube and technology

Technologies can help in the management of chest tube facilitating lung expansion. An efficient chest drainage system has to drain fluid and air respecting the natural negative pleural pressure. Conventional underwater seal chest drainage systems do not permit an accurate data and they are often no simple to use for patients and hospital staff.

George *et al.* in 2016 (9) observed the modern digital chest drain system and evaluated their specific features. All digital drainage systems (DDS) are very comfortable to use: they are portable and equipped with a rechargeable battery for a long run time. These devices permit to manage the pressure in the pleural cavity. If the devise register any air leak, it is able to maintain the desired negative intrapleural pressure, initially preset by the user, producing an additional suction effect. Furthermore, these devices reduced inter-observer variability displaying on a screen the objective measurement of air leaks recorded in system (mL/min). The Authors reported the first multicentre international randomised controlled trial comparing the conventional system and the DDS. The paper conclusion were that DDS was associated with significant reduction in air leak duration, in duration of chest tube placement and post-operative LOS (1.0 *vs.* 2.2 days, 3.6 *vs.* 4.7 days, and 4.6 *vs.* 5.6 days, respectively).

Moreover, could surgery technique influence the removal of chest drain? McKenna *et al.* in 2007 (10) reported their experience in fast-tracking protocol after video-assisted thoracoscopic surgery (VATS) lobectomy. The paper analysed the LOS according to morbidity and mortality or leading to readmission to the hospital. The protocol was to perform VATS lobectomies with no routine postoperative laboratory work or chest roentgenograms if not clinically indicated. The chest tubes were discontinued once the output was less than 300 mL in a 24-hour period and there was no air leak present. If the chest tube output was low, but there was an air leak, the patient was discharged home with a Heimlich valve. The authors reported 282 consecutive VATS lobectomies performed by a single surgeon, with a mean LOS of 3.26 days, and a median of 3 days. Seven of 282 patients (2.5%) were discharged with a Heimlich valve. The authors presented only one postoperative death due to pneumonia and no complications in 251 patients (89%). Only two patients were readmitted to the hospital and any patient needed the reinsertion of a chest tube drainage. The paper underlined that the hospital LOS bore on the hospital's gross margin for a patient with Medicare coverage. Indeed the much larger impact for this margin per room for the year if the hospital LOS is reduced from 7 to 2 days. If the LOS was 2 or 7 days the same amount, approximately $24,000 for a lobectomy, is refund from the Medicare diagnosis-related group (DRG). Each additional day in the hospital minimally raised the hospital cost for the stay. That reduced the gross margin slightly for each additional day in the hospital. Although over 1 year, this makes a large difference in gross margin the unitary gross margin for one patient was better if the LOS was shorter. Considering a LOS of 2 days, in each room 3.5 lobectomy patients can be admitted in the hospital instead of 1 patient, as if the LOS was 7 days. The shorter LOS made an enormous difference in the gross margin for that hospital room with a huge difference in the financial net profits for hospitals.

Thus, it is clear that the management of chest tubes after pulmonary resection is still influenced by the surgeons' personal experience and the possibility to access to advance technologies. Moreover, chest tube duration is one of the most important factors influencing the overall hospital LOS, hospitalization costs, as well as morbidity in general. In a recent review article Filosso (11) analysed features and advantages of a correct used of a chest drainage system. After pulmonary resection air moves to the retrosternal part of the chest wall and fluids are located in its lower part. This condition needs of two large-bore drains (24–32 Fr) with to permit an adequate lung re-expansion avoiding possible severe complications such as atelectasis, hemothorax, or persistent air leak. However, a single small-bore drain can be used to treat spontaneous pneumothorax or malignant pleural effusions. The review shows that, after the explosion of the mini-invasive technique to perform wedge resection or lobectomy, several papers demonstrated that a single chest drain is effective as using the conventional two. Also, a single chest drain causes less pain and discomfort to the patient compared with two tubes. Filosso reports that in a recent meta-analysis pooling data from large number of patients treated and published in the previous studies confirmed that one chest tube after lobectomy is less painful than 2 [95% confidence interval (CI): 0.52–0.68, P<0.00001] and the patients with a single chest tube had a shorter hospitalization (95% CI: 0.12–0.91, P=0.01). These data demonstrated that one tube can drain air and fluid from chest cavity after pulmonary resection. Further randomized trials are needed before concluding that a single chest tube should be considered the standard after an uncomplicated lobectomy.

Suction or not suction

Paraphrasing one of the best poets ever Sir William Shakespeare, Rocco *et al.* (12) in a review article published in 2016 have set the focus on a relevant theme: suction or nonsuction. The authors reported that since the early 2000s, several randomized controlled trials (RCTs) have been designed to compare suction with water seal. Interestingly enough, the results did not support suction, showing either no difference or a definitive benefit only from no suction/water seal. The institutional policy was to apply suction for the first night after surgery in all trials but one in which the suction was not applied at all in postoperative period. Based on the described physiology of suction applied to chest drain, the results from these RCTs are consistent with the idea that no additional suction is needed for routine postoperative air leaks.

Recently, The Society for Translational Medicine and The Chinese Society for Thoracic and Cardiovascular Surgery conducted a systematic review (13) of the literature to analyse the better management of chest tube in patients subdued to pulmonary lobectomy. Gao *et al.* produced a series of recommendations. With a daily pleural non-chylous and non-sanguineous fluid of up to 450 mL the chest tube can be safely removed, this practice may reduce chest tube duration and hospital LOS. If persistent abundant fluid production can be useful to test pleural fluid-to-blood protein ratio ($PrR_{P/B}$), if <0.5, chest tube can be removed. The authors reported that after a pulmonary lobectomy only one chest tube is necessary, except in case of hemorrhage and space problems and no need of chest tube clearance by milking and stripping is recommended. Speaking of suction the authors assumed that chest tube suction is necessary only the first postoperative day and that regulated chest tube suction [–11 (–1.08 kPa) to –20 (1.96 kPa) cmH_2O depending upon the type of lobectomy] is not superior to regulated seal [–2 (0.196 kPa) cmH_2O] when electronic drainage system are used after lobectomy by thoracotomy. The Authors concluded that chest tube removal is recommended at the end of expiration and may be slightly superior to removal at the end of inspiration and when possible electronic drainage systems are recommended in the management of chest tube in patients undergoing lobectomy.

Conclusions

In conclusion, the empirical approach to chest tube management in the postoperative period has been a distinctive feature of the mastery of the art possessed by the senior thoracic surgeons. Many of us can narrate anecdotes of old mentors removing chest drains while there was some bubbling on coughing in the glass reservoir and the lung was not fully re-expanded on chest radiograph. Others may remember the times when no chest drain was removed before a 24-hour trial of provocative clamping. Nowadays, the ever increasing knowledge of the pathophysiology beyond postoperative air leakage and the use of digital drain system have made chest tube management progressively more a science and less an art.

Acknowledgments

The authors acknowledge Dr. Marta Silvi, Data Manager, Division of Thoracic Surgery, Sant'Andrea Hospital, Faculty of Medicine and Psychology, University of Rome "Sapienza".
Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Marco Anile, Daniele Diso) for the series "Management of Air Leaks After Thoracic Surgery" published in *Journal of Xiangya Medicine*. The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jxym.2018.03.03). The series "Management of Air Leaks After Thoracic Surgery" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Ponn RB, Silverman HJ, Federico JA. Outpatient Chest

Tube Management. Ann Thorac Surg 1997;64:1437-40.
2. Woo WG, Joo S, Lee GD, et al. Outpatient Treatment for Pneumothorax Using a Portable Small-Bore Chest Tube: A Clinical Report. Korean J Thorac Cardiovasc Surg 2016;49:185-9.
3. Cerfolio RJ, Bryant AS. The management of chest tubes after pulmonary resection. Thorac Surg Clin 2010;20:399-405.
4. Korasidis S, Andreetti C, D'Andrilli A, et al. Management of residual pleural space and air leaks after major pulmonary resection. Interact Cardiovasc Thorac Surg 2010;10:923-5.
5. Coughlin SM, Emmerton-Coughlin HM, Malthaner R. Management of chest tubes after pulmonary resection: a systematic review and meta-analysis. Can J Surg 2012;55:264-70.
6. Andreetti C, Venuta F, Anile M, et al. Pleurodesis with an autologous blood patch to prevent persistent air leaks after lobectomy. J Thorac Cardiovasc Surg 2007;133:759-62.
7. Menna C, Poggi C, Ibrahim M, et al. Coated expandable metal stents are effective irrespective of airway pathology. J Thorac Dis 2017;9:4574-83.
8. Andreetti C, D'Andrilli A, Ibrahim M, et al. Effective treatment of post-pneumonectomy bronchopleural fistula by conical fully covered self-expandable stent. Interact Cardiovasc Thorac Surg 2012;14:420-3.
9. George RS, Papagiannopoulos K. Advances in chest drain management in thoracic disease. J Thorac Dis 2016;8:S55-64.
10. McKenna RJ Jr, Mahtabifard A, Pickens A, et al. Fast-tracking after video-assisted thoracoscopic surgery lobectomy, segmentectomy, and pneumonectomy. Ann Thorac Surg 2007;84:1663-7; discussion 1667-8.
11. Filosso PL. Chest Drainage Management: Where Are We Now? Thorac Surg Clin 2017;27:ix.
12. Rocco G, Brunelli A, Rocco R. Suction or Nonsuction: How to Manage a Chest Tube After Pulmonary Resection. Thorac Surg Clin 2017;27:35-40.
13. Gao S, Zhang Z, Aragón J, et al. The Society for Translational Medicine: clinical practice guidelines for the postoperative management of chest tube for patients undergoing lobectomy. J Thorac Dis 2017;9:3255-64.

doi: 10.21037/jxym.2018.03.03
Cite this article as: Menna C, Ibrahim M, Poggi C, Vanni C, Maurizi G, D'Andrilli A, Ciccone AM, Venuta F, Rendina EA, Andreetti C. Outpatient chest tube management. J Xiangya Med 2018;3:12.