Review Article

Pneumothorax: observation

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Abstract: Pneumothorax based on the cause, it can be divided into two large categories; primary and secondary. The staging of pneumothorax plays a crucial role for treatment. Currently both thoracic surgeons and pulmonary physicians can handle efficiently treatment. Pulmonary physicians with the minimally medical thoracoscopy while thoracic surgeons with a more extensive intervention. Experience defines the outcome in most situations and not the method. In our current work we will present data regarding the observation of pneumothorax from a panel of experts.

Keywords: Pneumothorax; conservative management; interventional treatment; primary spontaneous pneumothorax (PSP); secondary spontaneous pneumothorax (SSP)

Submitted Aug 15, 2014. Accepted for publication Aug 19, 2014.
doi: 10.3978/j.issn.2072-1439.2014.08.32
View this article at: http://dx.doi.org/10.3978/j.issn.2072-1439.2014.08.32

Introduction

Primary spontaneous pneumothorax (PSP) ranks high on the list of common medical conditions, especially in the emergency department. It is a significant global health problem, with a reported incidence of 18-28/100,000 cases per year for men and 1.2-6/100,000 for women (1). The related cost is high and the treatment strategy is complex due to lack of randomized clinical trials and departmental selfishness from physicians and surgeons.

Observation was the mainstay of therapy for PSP before the 1940s. The rate of resolution/re-absorption of SPS is 1.25-1.8% of the volume of hemithorax every 24 hours and complete re-expansion usually occurred in 7 weeks (2). However, the advent of new medical techniques rather the evidence makes observation an alternative option only for minimal, asymptotic PSP. The situation seems to have changed, the British Thorax Society (BTS) re-updated observation to a well-deserved position in 2010 pneumothorax guideline (3).

Principles

Indications of observation as an initial management for pneumothorax remain controversial. Re-expansion of the lung and prevention of recurrence are two main tasks in the treatment of pneumothorax. Although it is difficult to obtain high quality consensus evidence due to differences in classification systems and management guidelines, conservative treatment with observation has been considered as a more viable option for the treatment of pneumothorax, with a success rate of 79% according to an

Australia report (4). Consideration of the treatment-related cost is the main driving force to this evolvement, though the reliability of the results needs more randomized clinical trials. Obviously, observation can do little to positively prevent recurrence. Follow-up related safety and additional costs are factors that need consideration. Many experts in this field seem to concentrate on treating the chest X-ray appearance rather than the patient (5).

With the three variables (early remission, conversion incidence of invasive pleural and lung intervention, and late recurrence) taken into account, the utilization of observation as the primary therapeutic option should be determined by the size of pneumothorax, the severity of symptoms, whether there is a persistent air leak, and whether pneumothorax is primary or secondary.

Size

In defining a management strategy, the pneumothorax size is a relative indicator of positive intervention. Obviously, conservative management has been shown to be safe in patients with small pneumothorax (6-8). In Kevin Flint's report, 11 patients with 16-100% lung collapse all achieved full re-expansion after a mean of 3.2-week observation (6). Therefore, 6-7-week observation usually works for all minimal symptoms of pneumothorax if lung compliance is good and no bronchial pleural fistula exists. Therefore, in the latest BTS guideline, observation has been recommended for large primary PSP in selected patients with minimal symptoms (3).

The duration of observation depends on the balance between absorption and possible persistent leakage. Up to 80% of small pneumothorax (smaller than 15%) have no persistent air leak (9). Fast progression in size and deterioration of the patient's status are rarely observed in patients with primary pneumothorax. The incidence of observational failure in traumatic occult pneumothorax (OP) is about 6%.

Clinical status

To resume the collapsed pulmonary function, intensive monitoring and interventional treatment should be addressed in unstable patients. Observation is contraindicated for breathless patients. The clinical status is determined by the size of pneumothorax and cardiopulmonary reserve. Old age and secondary spontaneous pneumothorax (SSP) are often associated with breathlessness.

PSP vs. SSP

Observation has been recommended by BTS as the first-line treatment for patients with small closed PSP (<15-20%) with minimal symptoms (10). A 70-80% resolution rate can be achieved in these patients in about 7 weeks (8). Since 2010, this indication has been updated to asymptotic patients with large-size (>20%) PSP (3).

However, observation is contraindicated in SSP patients because of underlying lung pathology with less cardiopulmonary reserve. SSP typically presents as a more acute entity as compared with PSP and requires more urgent drainage, and therefore hospitalization is usually recommended. Breathlessness and unilateral chest pain are common in severe hypoxemia and hypercapnia (>50 mmHg). Physical symptoms may not be obvious and are often clouded by the preexisting disease. Aggressive CT scan is strongly recommended to confirm the diagnosis. Spontaneous resolving is rare in SSP.

On the other hand, morbidity and mortality risks associated with potential recurrences are inherently greater in SSP patients. More positive prevention should be considered. Therefore, observation is not the preferable option for SSP.

Underlying disease & prediction of recurrence

Subpleural bullae are the most common anatomic anomaly in PSP, while chronic obstructive pulmonary disease (COPD) accounts for the major underlying disease in SSP. Subpleural bullae were found in 76-100% of PSP patients during video-assisted thoracic surgery (VATS) or thoracotomy, although no clinical lung disease was diagnosed preoperatively. Furthermore, 79-96% of PSP patients had subpleural bullae in the contralateral lung. Imageologically, chest CT showed ipsilateral bullae in 89% of SPS patients, as compared with 20% of controls matched for age and the smoking status. Even among nonsmokers with a history of pneumothorax, 81% had bullae. In theory, the persistent bullae should be the strange risk factor of later recurrence after mere observation. Actually, this is not always the case. Radiographic evidence of pulmonary fibrosis, asthenic habitus, a history of smoking, and younger age have been reported to be independent risk factors for recurrence, though no visible bullae were detected under thoracoscopic or CT evaluation in many cases (3).

In addition to relieving the symptoms and resuming the expanded functional lung volume, the key to selecting a therapeutic option in PSP is the likelihood of a future

recurrence. The risk of recurrence of PSP is as high as 54% in the first 4 years after observation treatment, which is much higher than definitive recurrence-prevention procedures. With needle aspiration and pure tube intervention included, the mean recurrence rate is 30% (range, 16-52%) (11). Observation with/without oxygen, aspiration, and chest tube placement without pleurodesis alone cannot prevent future recurrence. On the contrary, VATS bullectomy has offered an excellent long-term outcome of 97.8% of freedom from further operation in PSP patients within 10 years (12,13). For the evolvement of more minimally invasive devices and procedures, aggressive treatment has been considered in more conditions to prevent the late recurrence. In the management of the second episode of SP, VATS has offered substantial cost saving with only an insignificant decrease in effectiveness when compared with conservative management (14).

How to exclude the cases with high-risk of recurrence is the important work before the observation therapy is considered. Smoking, height and age >60 years have been evidenced to be isolated risk for recurrence (3). Clearly radiographic evidence of bullae should be surgically excised when above risk factors exist instead of conservative observation.

Occult pneumothorax (OP)

OP is common in ICU cases, especially under traumatic conditions (15). A recent multicenter study of OP identified in mechanically ventilated critical care patients showed that the outcome of observation was comparable with that of tube thoracotomy, and there was no significant difference in episodes of respiratory distress and difficulty in ventilation, and changes in radiographic imaging between the two groups (16). Nor was there significant difference in mortality (22% for drainage *vs.* 15% for observation), length of hospital stay, or median ICU time between the two groups. Although 31% of the patients in the observation group were converted to pleural intervention, none of them had an increased morbidity (16,17). Observation failed only in 6% of the patients In AATS multi-center study with a large pooled volume of 448 patients (15). Therefore, the observation is a feasible initial optimal option for OP management, especially in reliable ICU settings.

Indications of observation for pneumothorax

- Observation is the first-line treatment for small closed PSP in stable patients without shortness of breath at rest (3,18-35).
- Selected asymptomatic patients with large PSP can be treated by observation along. Hospital stay can be enlarged to 48 hours, the high-risk duration of progression.
- Observation is a feasible and functionally optimal initial option for OP management, especially in reliable ICU settings.
- Observation cannot be used as an ultimate treatment strategy for any SSP patient. Observation alone is only recommended in patients with small secondary pneumothorax with less than 1 cm depth or isolated apical pneumothorax in asymptomatic patients. Hospitalization is recommended in these cases.

Modalities of observation

Differential diagnosis between PSP and SSP

A clear distinguishment should be made to exclude SSP before observation is scheduled for PSP. Age older than 50 years and a medical history of COPD are strong indicators of SSP. On the other hand, severe breathlessness with small size pneumothorax is also an indicator of SSP.

Hospital admission

Clinically stable patients with small primary pneumothorax on observation should be monitored in the emergency room for a minimum of 3-6 hours before sending them for repeated chest radiography (3,18). This recommendation has gained general consensus between the American College of Chest Physicians (ACCP) and the BTS. Progression of pneumothorax should be excluded in this duration. Patient discharge can be considered in the presence of improvement and absence of progression provided reliable follow-up is ensured within 48 hours. In-hospital observation is indicated if no reliable help or follow-up can be guaranteed 6-48 hours after onset, which is the most important "observation window" (18).

Simple observation is not recommended in clinically stable patients with large PSP according to the ACCP guideline (18). On the contrary, the BTS advocates observation alone for selected asymptomatic patients with a large PSP (3). However, no detailed strategy for patient selection was defined nor was the duration of hospital stays mentioned in the 2010 BTS guideline. If observation

is employed in patients with large-size PSP, the duration of in-hospital observation could be extended to 48 hours to confirm the stabilization of the clinical status. Careful evaluation including CT scan is recommended to exclude any underlying disease. More attention should be given in old patients.

For clinically stable patients with small-size SSP, observation can be instituted but it must be implemented on an inpatient basis (3,18). In-hospital death is rare, but individual cases of death have been reported (9). Notably, no designed clinical trial has been performed to test observation for SSP.

Oxygen therapy

If a patient with pneumothorax is admitted overnight for observation, high flow (10 L/min) oxygen should be administered. At the same time correcting hypoxia, oxygen therapy can increase the baseline pleural air re-absorption 3-4-fold from 1.5% per day (19). A recent study using CT scan for detection of pneumothorax reported that the re-expansion rate of conservative treatment was 2.2% (20). Oxygen is more readily absorbed in the presence of a continued air leak as compared with naturally existing nitrogen. In addition, a similar effect in pleural capillaries creates a more favorable re-absorption gradient (19). Oxygen supplementation works to ameliorate the accompanying hypoxemia that may persist even after drainage of the pneumothorax (9). Meticulous caution should be taken in COPD patients, knowing that they are highly sensitive to high concentrations of oxygen.

Pain management

In most SP patients, the commonly presenting symptom chest pain can decrease or resolve spontaneously in the first day or so. Adequate management with opiate therapy can relieve the pain and breathlessness altogether. No data report the adverse effect of analgesia on respiratory depression.

Palliative treatment for initial failure or aggression

Emergency intervention for observation failure is rare if the initial strategy is strictly implemented (4). Aspiration is not approved as the alternative for the failure of observation therapy. As persisting leakage is severe at that time (21), intermittent aspiration does not always work well. Continuous drainage must be utilized to relieve the symptoms. SSP is on the other tract, where definitive procedures to prevent recurrence should be considered after early palliation to prevent emergence of this unstable status (4).

Follow-up

To prevent quick progression of a small pneumothorax to a large-size pneumothorax, chest X-rays must be repeated within 3-6 hours after admission in patients on observation. Spontaneous hemopneumothorax must be considered in this period. An incidence of 3.09-5.5% has been reported in PSP patients (22-42). Imaging evaluation should be done within 12-48 hours after discharge. Admission observation is recommended for patients without reliable prior follow-ups so as to prevent the condition from being worsened by delayed care. The rate of resolution or re-absorption of pneumothorax was previously estimated as 1.25-2.2% of the volume of hemithorax every 24 hours (6,8). For the stable expanded lung, the last imaging follow-up should be given 6 weeks after onset. Frequent X-ray checkups at a 2-week interval are not pretty reasonable for young asymptomatic patients.

Discharge education

Clear written advice to return is needed with the discharge documents together in the event of worsening breathlessness. Pneumothorax is not usually associated with physical exertion. Avoiding exercise, therefore, should not be recommended to prevent recurrences. However, for the high rate of recurrence, special professional consultation should be advised, such as avoidance of distant traveling activities, air traveling, and any condition staying without timely medical service. Smoking cessation is mandatory, because it is the independent risk factor for ipsilateral recurrence and contralateral onset (35-45).

Results

A 79% successful rate was achieved in Kelly's study using observation only in simple PSP patients, where the largest size of pneumothorax reached 60%. No tension pneumothorax and emergency status occurred in patients who were converted to intervention (4). Stradling *et al.* (8) reported a comparable result with a low relapse of 11% after 4-year follow-up.

Summary

PSP is a benign condition that resolves spontaneously in most patients who can be treated by observation on the outpatient basis. Adequate analgesia and high concentration oxygen therapy without any interventional therapy are enough to relieve the symptoms during the onset period. Large pneumothorax with minimal symptoms may be treated with observation safely. The indication of observation for recurrent PSP needs future clinical trials. The indication of observation for SSP is minimal. The high recurrence rate should be an important consideration in planning conservative treatment. The recurrence-related morbidity, mortality, and cost should be weighted carefully.

Acknowledgements

Disclosure: The authors declare no conflict of interest.

References

1. Melton LJ 3rd, Hepper NG, Offord KP. Incidence of spontaneous pneumothorax in Olmsted County, Minnesota: 1950 to 1974. Am Rev Respir Dis 1979;120:1379-82.
2. Kircher LT Jr, Swartzel RL. Spontaneous pneumothorax and its treatment. J Am Med Assoc 1954;155:24-9.
3. MacDuff A, Arnold A, Harvey J, et al. Management of spontaneous pneumothorax: British Thoracic Society Pleural Disease Guideline 2010. Thorax 2010;65 Suppl 2:ii18-31.
4. Kelly AM, Kerr D, Clooney M. Outcomes of emergency department patients treated for primary spontaneous pneumothorax. Chest 2008;134:1033-6.
5. Simpson G. Spontaneous pneumothorax: time for some fresh air. Intern Med J 2010;40:231-4.
6. Conservative management of spontaneous pneumothorax. Lancet 1984;1:687-9.
7. Hart GJ, Stokes TC, Couch AH. Spontaneous pneumothorax in Norfolk. Br J Dis Chest 1983;77:164-70.
8. Stradling P, Poole G. Conservative management of spontaneous pneumothorax. Thorax 1966;21:145-9.
9. O'Rourke JP, Yee ES. Civilian spontaneous pneumothorax. Treatment options and long-term results. Chest 1989;96:1302-6.
10. Henry M, Arnold T, Harvey J, et al. BTS guidelines for the management of spontaneous pneumothorax. Thorax 2003;58 Suppl 2:ii39-52.
11. Schramel FM, Postmus PE, Vanderschueren RG. Current aspects of spontaneous pneumothorax. Eur Respir J 1997;10:1372-9.
12. Parlak M, Uil SM, van den Berg JW. A prospective, randomised trial of pneumothorax therapy: manual aspiration versus conventional chest tube drainage. Respir Med 2012;106:1600-5.
13. Shaikhrezai K, Thompson AI, Parkin C, et al. Video-assisted thoracoscopic surgery management of spontaneous pneumothorax--long-term results. Eur J Cardiothorac Surg 2011;40:120-3.
14. Falcoz PE, Binquet C, Clement F, et al. Management of the second episode of spontaneous pneumothorax: a decision analysis. Ann Thorac Surg 2003;76:1843-8.
15. Moore FO, Goslar PW, Coimbra R, et al. Blunt traumatic occult pneumothorax: is observation safe?--results of a prospective, AAST multicenter study. J Trauma 2011;70:1019-23; discussion 1023-5.
16. Ouellet JF, Trottier V, Kmet L, et al. The OPTICC trial: a multi-institutional study of occult pneumothoraces in critical care. Am J Surg 2009;197:581-6.
17. Ball CG, Kirkpatrick AW, Feliciano DV. The occult pneumothorax: what have we learned? Can J Surg 2009;52:E173-9.
18. Baumann MH, Strange C, Heffner JE, et al. Management of spontaneous pneumothorax: an American College of Chest Physicians Delphi consensus statement. Chest 2001;119:590-602.
19. Northfield TC. Oxygen therapy for spontaneous pneumothorax. Br Med J 1971;4:86-8.
20. Kelly AM, Loy J, Tsang AY, et al. Estimating the rate of re-expansion of spontaneous pneumothorax by a formula derived from computed tomography volumetry studies. Emerg Med J 2006;23:780-2.
21. Sahn SA, Heffner JE. Spontaneous pneumothorax. N Engl J Med 2000;342:868-74.
22. Hsu NY, Shih CS, Hsu CP, et al. Spontaneous hemopneumothorax revisited: clinical approach and systemic review of the literature. Ann Thorac Surg 2005;80:1859-63.
23. Haciibrahimoglu G, Cansever L, Kocaturk CI, et al. Spontaneous hemopneumothorax: is conservative treatment enough? Thorac Cardiovasc Surg 2005;53:240-2.
24. Tsakiridis K, Mpakas A, Kesisis G, et al. Lung inflammatory response syndrome after cardiac-operations and treatment of lornoxicam. J Thorac Dis 2014;6:S78-98.
25. Tsakiridis K, Zarogoulidis P, Vretzkakis G, et al. Effect of lornoxicam in lung inflammatory response syndrome

after operations for cardiac surgery with cardiopulmonary bypass. J Thorac Dis 2014;6:S7-20.
26. Argiriou M, Kolokotron SM, Sakellaridis T, et al. Right heart failure post left ventricular assist device implantation. J Thorac Dis 2014;6:S52-9.
27. Madesis A, Tsakiridis K, Zarogoulidis P, et al. Review of mitral valve insufficiency: repair or replacement. J Thorac Dis 2014;6:S39-51.
28. Siminelakis S, Kakourou A, Batistatou A, et al. Thirteen years follow-up of heart myxoma operated patients: what is the appropriate surgical technique? J Thorac Dis 2014;6:S32-8.
29. Foroulis CN, Kleontas A, Karatzopoulos A, et al. Early reoperation performed for the management of complications in patients undergoing general thoracic surgical procedures. J Thorac Dis 2014;6:S21-31.
30. Nikolaos P, Vasilios L, Efstratios K, et al. Therapeutic modalities for Pancoast tumors. J Thorac Dis 2014;6:S180-93.
31. Koutentakis M, Siminelakis S, Korantzopoulos P, et al. Surgical management of cardiac implantable electronic device infections. J Thorac Dis 2014;6:S173-9.
32. Spyratos D, Zarogoulidis P, Porpodis K, et al. Preoperative evaluation for lung cancer resection. J Thorac Dis 2014;6:S162-6.
33. Porpodis K, Zarogoulidis P, Spyratos D, et al. Pneumothorax and asthma. J Thorac Dis 2014;6:S152-61.
34. Panagopoulos N, Leivaditis V, Koletsis E, et al. Pancoast tumors: characteristics and preoperative assessment. J Thorac Dis 2014;6:S108-15.
35. Visouli AN, Darwiche K, Mpakas A, et al. Catamenial pneumothorax: a rare entity? Report of 5 cases and review of the literature. J Thorac Dis 2012;4:17-31.
36. Zarogoulidis P, Chatzaki E, Hohenforst-Schmidt W, et al. Management of malignant pleural effusion by suicide gene therapy in advanced stage lung cancer: a case series and literature review. Cancer Gene Ther 2012;19:593-600.
37. Papaioannou M, Pitsiou G, Manika K, et al. COPD Assessment Test: A Simple Tool to Evaluate Disease Severity and Response to Treatment. COPD 2014;11:489-95.
38. Boskovic T, Stanic J, Pena-Karan S, et al. Pneumothorax after transthoracic needle biopsy of lung lesions under CT guidance. J Thorac Dis 2014;6:S99-107.
39. Papaiwannou A, Zarogoulidis P, Porpodis K, et al. Asthma-chronic obstructive pulmonary disease overlap syndrome (ACOS): current literature review. J Thorac Dis 2014;6:S146-51.
40. Zarogoulidis P, Porpodis K, Kioumis I, et al. Experimentation with inhaled bronchodilators and corticosteroids. Int J Pharm 2014;461:411-8.
41. Bai C, Huang H, Yao X, et al. Application of flexible bronchoscopy in inhalation lung injury. Diagn Pathol 2013;8:174.
42. Zarogoulidis P, Kioumis I, Porpodis K, et al. Clinical experimentation with aerosol antibiotics: current and future methods of administration. Drug Des Devel Ther 2013;7:1115-34.
43. Zarogoulidis P, Pataka A, Terzi E, et al. Intensive care unit and lung cancer: when should we intubate? J Thorac Dis 2013;5:S407-12.
44. Hohenforst-Schmidt W, Petermann A, Visouli A, et al. Successful application of extracorporeal membrane oxygenation due to pulmonary hemorrhage secondary to granulomatosis with polyangiitis. Drug Des Devel Ther 2013;7:627-33.
45. Zarogoulidis P, Kontakiotis T, Tsakiridis K, et al. Difficult airway and difficult intubation in postintubation tracheal stenosis: a case report and literature review. Ther Clin Risk Manag 2012;8:279-86.

Cite this article as: Li Z, Huang H, Li Q, Zarogoulidis K, Kougioumtzi I, Dryllis G, Kioumis I, Pitsiou G, Machairiotis N, Katsikogiannis N, Papaiwannou A, Madesis A, Diplaris K, Karaiskos T, Zaric B, Branislav P, Zarogoulidis P. Pneumothorax: observation. J Thorac Dis 2014;6(S4):S421-S426. doi: 10.3978/j.issn.2072-1439.2014.08.32

