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Video-assisted thoracoscopic surgery management of spontaneous pneumothorax — long-term results

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Abstract

Objective: Although widely adopted, there is lack of immediate and long-term follow-up data for patients undergoing video-assisted thoracoscopic surgery (VATS) management of pneumothorax. Therefore, we have reviewed our experience with both primary (PSP) and secondary (SSP) spontaneous pneumothorax to assess the perioperative outcomes and long-term efficacy associated with different VATS operative strategies. **Methods:** A retrospective case series review was undertaken on all patients undergoing VATS procedures for PSP or SSP over a 17-year period. **Results:** A total of 644 VATS pneumothorax procedures were performed between 1992 and 2008 on 569 patients, of which 550 procedures were performed for PSP and 94 for SSP. Mean age for PSP and SSP groups were 28.4 ± 10.4 and 58.2 ± 14.2 years, respectively. Surgical technique used bullectomy in combination with abrasion (273), poudrage (246) and pleurectomy (46). Isolated poudrage was used in 72 cases. Median postoperative stay was 3 and 4 days, respectively. Major complications occurred in 25 (4.6%) PSP and 18 (19.2%) SSP patients. Two patients in the SSP group died (2.1%). Median follow-up was 73 months. Freedom from further surgery for the two populations was PSP: 98.1% at 5 years (confidence interval (C.I.): 96.9—99.4) and 97.8% at 10 years (C.I.: 96.5—99.2); SSP: 96.1% at 5 years (C.I.: 91.5—1.006) and 96.1% at 10 years (C.I.: 91.5—1.006). Freedom from further operation at 10 years was independent of the pleurodesis technique employed: abrasion 96.4%, poudrage 98.9% and pleurectomy 97.5% ($p = 0.22$). **Conclusions:** VATS management of both PSP and SSP offers good short-term results and excellent long-term freedom from repeat surgery. In combination with bullectomy, results of abrasion and poudrage do not significantly differ from pleurectomy. We recommend abrasion for pleurodesis in young patients reserving poudrage for the elderly. Pleurectomy may not be necessary.

Keywords: Spontaneous pneumothorax; Video-assisted thoracoscopic surgery; Pleurodesis

1. Introduction

Primary spontaneous pneumothorax (PSP) is relatively common with an incidence of 24.0 per 100 000 in men and 9.8 per 100 000 in women [1]. Affected patients may demonstrate small bullae, blebs or microbullous disease. Secondary spontaneous pneumothorax (SSP) is by definition related to the presence of underlying lung disease commonly chronic obstructive pulmonary disease (COPD) with histopathology of bullous emphysema [2]. These patients usually suffer from respiratory impairment, necessitating rapid and effective treatment [3].

Surgical treatment of primary pneumothorax is offered when the second episode of ipsilateral spontaneous pneumothorax (SP) occurs. Although the number of procedures carried out to treat SP has risen steadily, since the introduction of video-assisted thoracoscopic surgery (VATS) in the mid-1990s, 27% of pneumothorax operations are still performed via open surgery in the United Kingdom [4].

Prior to the advent of VATS techniques, studies of open pleurectomy, often considered the 'gold standard' procedure for pneumothorax, had shown a 1—5% risk of recurrent pneumothorax at variable follow-ups [5,6]. Reported follow-up of VATS techniques is generally limited to medium-term results. Pleurodesis is usually associated with stapled bullectomy using poudrage, abrasion or pleurectomy. Poudrage involves insufflation of medical-grade talc or kaolin as well as spraying silver nitrate solution [7]. Adult respiratory distress syndrome (ARDS) has been described in association with poudrage [8]. Open pleurectomy is usually performed by peeling the parietal pleura from the costal surfaces between the sympathetic chain and internal mammary artery, and from the apical pleura to the costophrenic recess.

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2. Methods

The case notes of 569 patients who underwent 644 VATS procedures for the treatment of SP between January 1992 and December 2008 were retrospectively reviewed. Demographic and type of pneumothorax, operative technique, postoperative hospital stay, pathology report, complications and long-term outcome were recorded and entered into a database.

Recurrence was defined as a further ipsilateral pneumothorax requiring any intervention. Patients without any identified underlying lung disease were categorised as PSP and patients with or without COPD accompanied by an underlying lung disease were allocated to the SSP group. We excluded from analysis patients with cystic fibrosis and α-1-antitrypsin deficiency. The patients who underwent VATS treatment for SP and then developed contralateral SP were considered as new cases.

All patients were operated under general anaesthesia and with single-lung ventilation. Pleural abrasion was performed with a role of polypropylene mesh or a piece of cautery scratch pad. In this technique, the parietal pleura was roughened and disrupted in a punctuate manner creating a raw inflamed surface to promote pleural symphysis. For poudrage, we used 5 g of medical-grade talc or kaolin, which was insufflated into the pleural cavity aiming to obtain uniform parietal and visceral pleural coverage including the diaphragm. Poudrage was generally performed in elderly patients or those with more extensive bullous disease. Latterly, following a primary audit, which suggested the possibility of lower recurrence rates with poudrage, we extended these indications to include younger patients who might otherwise have undergone pleurectomy or abrasion. Talc consists of a hydrated magnesium sheet silicate of differing fibre lengths mostly less than 50 μm. Current preparations are sterile and asbestos-free. Talc causes an interleukin-8-mediated inflammatory response of the pleura [9]. Kaolin has a similar composition to talc except that the metal ion is aluminium not magnesium.

Apical pleurectomy was performed to the level of the 5th or 6th intercostal space. Bullectomy was performed where blebs or bullae were identified by wedge resection using an endoscopic stapler.

Postoperative complications were classified as major and minor. Major complications were defined as re-exploration, pneumonia, respiratory failure, air leak requiring chest drain re-insertion and pulmonary emboli. Minor complications were defined as atrial fibrillation, pain, wound infection and air leak that resolved after 5 days. We did not routinely obtain post- and preoperative pulmonary function tests (PFTs), arterial blood gas (ABG) as well as dyspnoea index. We believe that PFTs in the presence of intercostal chest drain in pleural cavity may not accurately represent lung function.

Statistical analysis of both continuous and categorical variables was conducted using a computer package (Statview 5) with significance taken at the 5% level. Freedom from recurrent pneumothorax was computed using Kaplan—Meier curves and confidence intervals (C.I.s) computed to 95% limits.

Institutional review board approval was obtained for this study and the informed consent requirement was waived.

3. Results

Between January 1992 and December 2008, 569 patients underwent 644 VATS procedures, out of which 550 procedures were performed for the treatment of PSP and 94 for the treatment of SSP. Pre- and perioperative characteristics are presented in Table 1. One patient (0.2%) underwent bilateral VATS for the treatment of PSP. Staged bilateral VATS procedures for contralateral SP were performed on 70 (12.7%) and five (5.3%) patients for PSP and SSP, respectively.

Postoperative characteristics are summarised in Table 2. There was no mortality in the PSP group, whereas two hospital deaths (2.1%) occurred in the SSP group. A 76-year-old male patient with COPD underwent VATS bullectomy and poudrage. He developed type-2 respiratory failure requiring mechanical ventilation and died of bronchopneumonia on the eighth postoperative day. A 77-year-old man underwent the same operation and on his fourth postoperative day died due to massive pulmonary emboli. One patient (1.1%) in the SSP group, who underwent isolated poudrage pleurodesis, postoperatively developed in-hospital empyema requiring further operation that involved thoracotomy and decortication. There was no incidence of empyema in the PSP population.

Median follow-up was 73.0 months. Freedom from further surgery for the two populations was PSP: 98.1% at 5 years (C.I.: 96.9—99.4) and 97.8% at 10 years (C.I.: 96.5—99.2); SSP: 96.1% at 5 years (C.I.: 91.5—1.006) and 96.1% at 10 years (C.I.: 91.5—1.006); results were not significantly different between the PSP and SSP groups ($p = 0.35$, log rank (Mantel—Cox)). All patients with recurrence ($N = 13$, PSP = 10 and SSP = 3) underwent redo-VATS procedures. Of these, nine patients received pleurodesis with poudrage and the remainder had a partial pleurectomy. Freedom from further surgery for bullectomy associated with abrasion, poudrage or pleurectomy procedures in the whole population at 10 years was 96.4%, 98.9% and 97.5%, respectively ($p = 0.22$, log rank (Mantel—Cox)).

4. Discussion

The current consensus view is that there is no evidence to support surgical intervention in the first episode of PSP [10,11], provided that the pneumothorax resolves with

Table 1. Pre- and perioperative characteristics.

Characteristics	PSP	SSP
Total number of patients ($N = 569$)	480 (84.3%)	89 (15.7%)
Age (years)		
Mean $\pm$ SD	28.4 $\pm$ 10.4	58.2 $\pm$ 14.2
Median	27	61
Gender (male)	318 (66.2%)	62 (69.6%)
Total number of VATS ($N = 644$)	550 (85.4%)	94 (14.6%)
VATS side (right)	295 (53.6%)	52 (55.3%)
Isolated bullectomy	3 (0.5%)	0
Isolated poudrage	58 (10.4%)	14 (14.9%)
Isolated abrasion	2 (0.4%)	0
Isolated pleurectomy	2 (0.4%)	0
Bullectomy + abrasion	255 (46.4%)	18 (19.1%)
Bullectomy + poudrage	189 (34.4%)	57 (60.7%)
Bullectomy + pleurectomy	41 (7.5%)	5 (5.3%)
Conversion to thoracotomy	4 (0.7%)	1 (1.1%)

Table 2. Postoperative characteristics.

Characteristics	PSP	SSP
Hospital stay (days)		
Mean ± SD	4.19 ± 2.86	5.26 ± 3.90
Median	3	4
Total number of VATS (*N* = 644)	550	94
Complications		
Major		
Exploration due to bleeding	2 (0.4%)	0
Exploration due to large air leak	1 (0.2%)	0
Pneumonia	6 (1.1%)	6 (6.4%)
Respiratory failure type-1	3 (0.5%)	2 (2.1%)
Respiratory failure type-2	1 (0.2%)	5 (5.3%)
Air leak requiring chest drain re-insertion	12 (2.2%)	4 (4.3%)
Pulmonary emboli	0	1 (1.1%)
Minor		
Pain	40 (7.3%)	9 (9.6%)
Wound infection	10 (1.8%)	2 (2.1%)
Atrial fibrillation	3 (0.5%)	5 (5.3%)
Air leak (resolved after 5 days)	8 (1.5%)	10 (10.6%)
Mortality	0	2 (2.1%)
Bullectomy pathology report (*N* = 568)	488 (85.9%)	80 (14.1%)
Apical bulla complex	478 (98.0%)	3 (3.7%)
Bullous emphysema	0	66 (82.5%)
Histiocytosis X	0	4 (5.0%)
Lymphangioleiomyomatosis	0	2 (2.5%)
Inconclusive	10 (2.0%)	5 (6.3%)
Recurrence	10 (1.8%)	3 (3.2%)
Isolated bullectomy	0	0
Isolated poudrage	0	0
Isolated abrasion	0	0
Isolated pleurectomy	0	0
Bullectomy + abrasion	8 (1.4%)	0
Bullectomy + poudrage	2 (0.4%)	1 (1.0%)
Bullectomy + pleurectomy	0	2 (2.1%)

simple drainage. However, tube management is associated with a recurrence rate of around 20—25%, consistent with the high proportion of PSP patients who have apparently normal lungs on radiological assessment but visible abnormalities at VATS [12]. This may suggest that simple tube drainage is an unsatisfactory treatment for even a first episode of PSP [12], particularly in the presence of a large pneumothorax, lifestyle or medical factors that would make recurrence especially dangerous.

Medically managed patients with SSP usually require an extended hospital admission related to prolonged air leak, treatment of their underlying lung disorder and management of associated co-morbidities [2]. The mortality rate associated with SSP is of the order of 10%, with many patients even after the pneumothorax has resolved [2,13].

Consistent with these quite different patient groups, surgery for PSP is generally safe with many studies reporting a zero operative mortality [7,14]. However, surgical management of SSP is associated with an operative mortality of 2—10% [11,15].

Comparison between open and VATS surgery for pneumothorax is hampered by the paucity of randomised studies [11]. In addition, the available literature can be confused by a tendency to report series, which do not differentiate between PSP and SSP in the outcome data and, in some instances, without separating open from VATS cases.

Studies concerning SP have mostly reported short- and medium-term results documenting the efficacy of the VATS approach compared with historical results for open surgery [16—20] or the results associated with a VATS approach using different techniques: poudrage, pleurectomy and pleural abrasion [12,14,21—23].

This study has the advantage of large numbers and extended follow-up. We believe that the choice of surgical technique for pneumothorax surgery should be adapted to the patient. In those patients with an obvious culprit bullous complex, excision of the relevant section of lung will be associated with a high degree of confidence that the source of the pneumothorax has been eliminated. In this situation, a less aggressive pleural symphysis strategy is justified and pleural abrasion would seem appropriate. This approach offers the major advantage that repeat thoracic surgery, if ever required, will be a reasonable undertaking as compared with either poudrage or pleurectomy. If, on the other hand, there is no obvious source or multiple potential sources for the pneumothorax, greater reliance must be placed on the symphysis procedure and either pleurectomy or poudrage could be considered. However, it should be noted that pleurectomy does not generally address either the mediastinal or diaphragmatic aspects, whereas poudrage should provide a total intrapleural adhesion effect.

One potential criticism of poudrage is that it may increase the long-term risk of mesothelioma. However, histological examination of the pleura following talc insufflation does not demonstrate mesothelial proliferation [24] and, in a large cohort study, there was no increased incidence of lung cancer or mesothelioma in up to a 40 years' follow-up of patients who had either talc or kaolin pleurodesis [25]. Nonetheless, the use of poudrage requires the permanent insufflation of a foreign material and may therefore be preferable for elderly patients.

In our experience, VATS management of both PSP and SSP offers good short-term results with excellent long-term freedom from re-operation and low recurrence. In combination with bullectomy, the pleurodesis efficacy of abrasion and poudrage is not significantly different from pleurectomy. This would suggest that the least traumatic pleurodesis technique of abrasion might be the best first choice for younger patients in association with bullectomy unless there are pressing reasons to choose a more aggressive pleurodesis approach.

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