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ORIGINAL SCIENTIFIC REPORT

Video-Assisted Thoracic Surgery (VATS) Talc Pleurodesis Versus Pleurectomy for Primary Spontaneous Pneumothorax: A Large Single-Centre Study with No Conversion

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Abstract

Background Primary spontaneous pneumothorax (PSP) is a relatively common clinical entity with high incidence in the young population. Video-Assisted Thoracic Surgery (VATS) bullectomy and chemical or mechanical pleurodesis are two primary modalities of treatment. There has been much debate on the ideal mode of pleurodesis, but the literature on surgical outcomes comparing VATS pleurectomy with talc pleurodesis has been inconclusive.

Methods We performed a single-centre 5-year observational retrospective study of 202 patients who underwent VATS bullectomy with talc pleurodesis or parietal pleurectomy.

Results There were no significant differences in the demographics, pre-operative and intra-operative characteristics in both groups. Recurrence of pneumothorax, chest tube duration and hospital stay were similar in both groups. However, talc pleurodesis had a shorter operative time compared to pleurectomy.

Conclusion Our study demonstrated comparable outcomes between talc pleurodesis and pleurectomy following VATS bullectomy for patients with PSP.

Introduction

Primary spontaneous pneumothorax (PSP) predominately affects young patients without a history of parenchymal lung disease. It is a relatively common clinical entity with an annual incidence of 18–28/100,000 and 1.2–6/100,000 in males and females, respectively [1]. The consensus for indications of surgical intervention in patients with PSP includes recurrent pneumothorax, prolonged air leak, haemopneumothorax, bilateral pneumothorax, contralateral occurring pneumothorax and patients with specific occupations such as pilots, flight attendants and deep-sea divers [2–6].

Video-Assisted Thoracic Surgery (VATS) approach is regarded as safe and reproducible. VATS bullectomy and chemical or mechanical pleurodesis are the two primary modalities of treatment. Studies have demonstrated recurrence rates between 10 and 20% for bullectomy alone [7–10]. When combined with mechanical or chemical pleurodesis, the risk of recurrence was reduced to 1–6% [11, 12]. There is much debate on the ideal mode of pleurodesis with conflicting evidence over the last 20 years between various large studies which compared pleurectomy, pleural abrasion and chemical pleurodesis [13]. Traditionally, talc pleurodesis was favoured due to its ease of application. Advancements in surgical techniques now permit pleurectomy to be performed with relative ease

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through VATS. The up-to-date literature on surgical outcomes comparing VATS pleurectomy with talc pleurodesis is inconclusive. The aim of this study is to do a direct comparison of thoracoscopic bullectomy with pleurectomy versus thoracoscopic bullectomy with talc pleurodesis and directly compare outcomes of these two methods of pleurodesis.

Materials and methods

Study design

The National University Hospital Singapore is a large tertiary centre that performs an average of 400 thoracic procedures per year with roughly 70% of the procedures done thoracoscopically. A 5-year observational retrospective study of 202 patients who underwent VATS bullectomy with talc pleurodesis or parietal pleurectomy for primary spontaneous pneumothorax between December 2009 and December 2014 was reviewed. Indications for surgery included persistent air leak > 5 days for first presentation of pneumothorax, second ipsilateral pneumothorax, first contralateral pneumothorax, synchronous bilateral spontaneous pneumothorax, spontaneous haemopneumothorax and professions at risk (e.g. pilots and divers) as advised by the British Thoracic Society guidelines [1]. All patients meeting the above indications for surgery were offered surgery immediately and were taken to the operating theatre within 24 h. All patients that were reviewed up to 12 months in the outpatient setting were included in the study.

Clinical variables collected were patient demographics, operative time, intra-operative Vanderschueren's classification [14], post-operative chest tube duration, post-operative hospital stay, post-operative complications, recurrence of pneumothorax and need for repeat intervention.

Post-operative complications were defined as events which occurred within the first 30 days of surgery. Recurrence was defined as pneumothorax found on chest X-ray post-operatively within 30 days to 1 year on the operated side. Patients who underwent procedures to address recurrence were listed as those who required repeat intervention. Patient demographic and clinical characteristics were analysed descriptively. Categorical variables were compared between the two study groups by either Chi-square test or Fisher's exact test. Numerical variables were compared using two-sample T test. Other variables where the normality assumption was not satisfied were compared using the Mann–Whitney U test, with a p value of < 0.05 considered as statistically significant. Our institutional Domain-Specific Review Board approved this study.

Operative technique

Prior to surgery, all patients had routine blood investigations (full blood count, renal panel and coagulation profile) and chest X-ray done. CT thorax was not performed in these patients. All patients were operated under general anaesthesia with a double-lumen tube intubation and single lung ventilation. Three consultant thoracic surgeons with a minimum of 5 years experience each performing VATS procedures were involved in the management of the patients. Both conventional 3-port VATS and uniportal VATS approaches were utilized. The surgical procedure and choice of pleurodesis were surgeon dependent except for patients with haemopneumothorax who underwent talc pleurodesis to minimize bleeding risk. Staple bullectomy was performed in patients with blebs, bullae or apical pleuropulmonary adhesions. Those without visible bullae or blebs underwent an underwater air leak test, and if the leak was apparent, wedge excision of the leaking lung parenchyma was performed. Patients without visible bullae or blebs and a negative air leak test underwent wedge excision of the apex of the upper lobe.

Talc pleurodesis was performed using five grams of asbestos-free, hydrated magnesium silicate, which was administered by a hand-driven powder blower. The talc powder was evenly distributed over the viscera, parietal, mediastinal pleura and the diaphragm.

Parietal pleurectomy was performed by separating the parietal pleura from the endothoracic fascia. A curved ring tip sponge holder was used to peel the parietal pleura away from costal surfaces between the sympathetic chain posteriorly and internal mammary artery anteriorly, superiorly from the apex of the hemithorax to the costophrenic recess inferiorly. The parietal pleura over the mediastinum, diaphragm and near great vessels were not stripped. Careful haemostasis using electrocautery was performed over the post-pleurectomy surface at the end of the procedure to minimize the risk of haemothorax.

All patients received a multilevel intercostal block with 0.5% of Marcaine at the end of the procedure. One apically directed chest drain was inserted and connected to an underwater seal system (Medela or Thopaz), with suction at 15 cmH_2O.

Post-operative care

All the patients were extubated in the operating room and transferred to the recovery area where they were monitored for 2 h. Chest radiograph confirming the chest tube position and full lung re-expansion was performed in the

recovery area before being transferred to the general ward. Subsequently, the chest tubes were removed when no air leak was observed and chest drain output was < 100 ml over 24 h. All patients had a repeat CXR immediately after chest drain removal and were either discharged on the same day or day after.

Results

Demographics and pre-operative characteristics

A total of 202 patients were recruited in this study. All patients had a bullectomy. Seventy-five underwent talc pleurodesis, and 127 underwent parietal pleurectomy. There was no statistically significant difference in the demographics and pre-operative characteristics in both groups, apart from the female gender. There were significantly more females who underwent talc pleurodesis as compared to pleurectomy (18.7% vs. 7.9%, $p = 0.022$). The results of the patient demographics, pre-operative characteristic and indications for surgery are summarized in Tables 1 and 2.

Intra-operative characteristics

There was no statistically significant difference in the intra-operative variables such as the side of pneumothorax and Vanderschueren's classification. However, operative time was significantly longer in the pleurectomy group (55.9 ± 27.8 vs. 81.2 ± 34.8 min, $p < 0.001$). The results of the intra-operative characteristic are summarized in Table 3.

Post-operative outcomes

None of the 202 patients who underwent VATS bullectomy with either pleurectomy or talc pleurodesis required conversion to open thoracotomy. There was no significant difference in post-operative outcomes in both groups (talc pleurodesis vs pleurectomy) in terms of hospital stay (5.27 ± 2.02 vs. 5.28 ± 3.05 days, $p = 0.33$), chest tube duration (4.07 ± 1.30 vs. 4.47 ± 2.30 days, $p = 0.37$) and recurrence ($n = 5$ vs. $n = 10$, 6.7% vs. 7.9%, $p = 0.74$). These results are summarized in Table 4. Post-operative complications occurred in 2.7% ($n = 2$) vs 3.9% ($n = 5$) in talc pleurodesis and pleurectomy groups, respectively.

With regards to the post-operative complications, two patients in the talc pleurodesis group and four patients in the pleurectomy group developed pneumothorax post-chest tube removal. One patient in the pleurectomy group developed haemothorax on the post-operative day two which required a repeat VATS evacuation of haematoma and haemostasis. The acute development of pneumothorax post-chest tube removal was due to technical introduction of air from the atmosphere into the pleural cavity during the removal process and was unrelated to the quality of the pleurodesis performed. All such patients did not require a reintroduction of a new chest tube to drain the pneumothorax.

During the follow-up post-discharge, five patients in the talc pleurodesis group developed recurrence of pneumothorax but only two required reintervention. Ten patients in the pleurectomy group developed recurrence of which five required reintervention. Recurrences which were small and did not cause significant symptoms were conservatively managed. Reintervention included repeated VATS or a bedside chest tube insertion with talc slurry pleurodesis.

Table 1 Demographic characteristics

	Talc ($n = 75$)	Pleurectomy ($n = 127$)	p value
Age	27.83 (± 10.36)	25.03 (± 7.97)	0.123
Female gender	14 (18.7%)	10 (7.9%)	0.022
Height	1.73 (± 0.08)	1.73 (± 0.08)	0.621
Weight	57.8 (± 10.4)	60.4 (± 10.0)	0.11
BMI	19.4 (± 3.1)	20.1 (± 2.9)	0.153
BSA	1.66 (± 0.17)	1.70 (± 0.16)	0.165
Smoking			0.756
Smoker	33 (44.0%)	48 (37.8%)	
Non-smoker	42 (56.0%)	79 (62.2%)	

Discussion

VATS along with bullectomy has become the standard of care for patients with PSP who require surgical intervention. The objective of surgical repair is first to resect the blebs or bullae which are the sources of the air leaks followed by pleurodesis. Mechanical or chemical pleurodesis incites an acute pleural inflammation process causing bridging pleural fibrosis with the lung parenchyma and chest wall which creates adhesions and obliteration of the pleural space. These adhesions prevent the entire lung from collapsing if new bullae are to rupture at a later time.

Pleurodesis can be classified into mechanical and chemical. Standard methods of mechanical pleurodesis include pleural abrasion and pleurectomy, while talc and tetracycline are well-documented forms of chemical pleurodesis [1]. There is much debate on the optimal method of pleurodesis for the treatment of PSP [15, 16]. Both pleurectomy and talc pleurodesis are highly effective in preventing recurrence in patients with PSP and are widely

Table 2 Indication for surgery

	Talc (n = 75)	Pleurectomy (n = 127)
Prolonged air leak (> 5 days)	45 (60%)	69 (54%)
Recurrent PSP	29 (38.7%)	53 (42%)
Bilateral pneumothorax	1 (1.3%)	5 (4%)

Table 3 Perioperative characteristics

	Talc (n = 75)	Pleurectomy (n = 127)	p value
Side			0.543
Left	37 (49.3%)	64 (50.4%)	
Right	37 (49.3%)	58 (45.7%)	
Left + right	1 (1.3%)	5 (3.9%)	
Vanderschueren's classification			0.188
1	2 (2.7%)	2 (1.6%)	
2	9 (12.0%)	9 (7.1%)	
3	56 (74.7%)	110 (86.6%)	
4	8 (10.7%)	6 (4.7%)	
Op duration (min)	55.97 (± 27.827)	81.20 (± 34.739)	< 0.01

Table 4 Post-operative outcomes

	Talc (n = 75)	Pleurectomy (n = 127)	p value
Chest tube duration	4.07 (± 1.298)	4.47 (± 2.300)	0.368
Hospital stay (days)	5.267 (± 2.0157)	5.276 (± 3.0490)	0.33
Recurrence (30 days to 1 year)	5 (6.7%)	10 (7.9%)	0.74
Recurrence requiring reintervention	2 (2.7%)	5 (3.9%)	0.71
Complications			
Pneumothorax post-chest tube removal	2	4	
Hemothorax	0	1	
Atrial fibrillation	0	0	
Renal failure	0	0	
Reintubation	0	0	

used as methods for pleurodesis. [6, 17–19]. However, there is paucity of head-to-head comparison studies in the existing scientific literature. Sudduth et al. [20] reviewed and reported large variability and heterogeneity in 51 studies comparing techniques for PSP thus far. In our series, staple bullectomy is part of the primary operation. Our zero conversion rate also allows for better head-to-head comparison of VATS approaches for these two pleurodesis techniques.

In our review of 202 patients who underwent VATS bullectomy and pleurodesis, 75 underwent talc pleurodesis and 127 underwent pleurectomy. The recurrence of pneumothorax in the talc pleurodesis group was 6.7% (n = 5) versus 7.9% (n = 10) in the pleurectomy group. This was not statistically significant (p = 0.74). Of these recurrences, only 2.7% (n = 2) versus 3.9% (n = 5) were significant enough to require repeated intervention. Most recurrences were treated conservatively with close observation and serial chest X-rays. The rates of recurrence published in other studies were 2.5–8.8% for pleurectomy and 0–7.4% for talc pleurodesis during VATS, which was similar to our recurrence rates [21–23].

Similar to other studies worldwide, our study also showed that talc pleurodesis has shorter operation duration as compared to pleurectomy [16, 19]. Pleurectomy is known to be more technically challenging and time-consuming compared to talc pleurodesis as it involves stripping of the parietal pleura from the endothoracic fascia. There is also the need for meticulous haemostasis post-pleurectomy which prolongs the operative time. Despite this discrepancy, the outcomes for both operative techniques had similar length of high-dependency stay, hospital stay, re-intervention, recurrence and post-operative chest tube drainage duration. The benefits of talc pleurodesis is that it can be delivered rapidly via an insufflator and can be distributed evenly throughout the hemithorax covering most of the pleural space including the diaphragm and mediastinal surface. There is also no risk of bleeding from the pleura as it is not removed or abraded.

There are however several controversies surrounding talc pleurodesis which may cause some surgeons to stray away from it. In the acute setting, various studies have documented fever and pain in approximately a quarter of their patients. Talc pleurodesis potentially also has a rare, but severe, complication of talc induced pneumonitis leading to ARDS [24, 25]. In the chronic setting, the association between topical perineal talc usage and ovarian cancer is documented [26]; hence, there is concern of lung cancer development with talc pleurodesis. Observational studies suggest that non-asbestos form talc exposure that may increase the risk of lung cancer [27], but epidemiological studies show that talc exposure alone does not increase lung cancer mortality [28]. Long-term clinical studies of patients who underwent talc pleurodesis also do not show any increase in incidence of mesothelioma or lung cancer [29–31]. This reassuring finding has also been reproduced in animal and pathological studies [32, 33].

The other known chronic implication of talc instillation is restriction of pulmonary function as described by Lange

et al. [29]. However, in more recent studies, Cardillo et al. [34] compared patients who underwent VATS with talc poudrage with patients who did not undergo pleurage for pneumothorax and noted there was no significant deterioration in lung function of patients who had talc poudrage at 5 years. Another study by Tschopp et al. [35] reported mild lung restriction in the early months that improved at 12 months post-procedure and Dubois et al. [36] reported reduction in lung volumes and capacity at 12 months post VATS bullectomy and talc pleurodesis but preservation of flow rates and diffusion capacities. In addition, talc pleurodesis creates chronic inflammatory reactions and thickened pleura which have been reported to increase FDG uptake during PET scans causing high rate of false positive results, making it difficult to distinguish between benign inflammatory processes and potential malignancies [37]. Since the majority of patients with PSP are young, this may create unnecessary diagnostic challenges in the future if any lung pathology develops in their later years of life.

Mechanical pleurodesis is achieved by pleural abrasion which is physical irritation of the parietal pleura or by complete stripping of the parietal pleura from the endothoracic fascia. The benefits of mechanical pleurodesis are that there is no cost involved by stripping or abrading the pleura, and it avoids foreign material or a chemically induced inflammatory response. Some are concerned that the pleurodesis achieved may be incomplete as pleurectomy does not encompass full coverage of the thorax, especially over the diaphragm, mediastinum and great vessels; however, this did not influence the rate of recurrence in our study.

Bleeding rates of as high as 3.8% also have been reported in the case series of patients who underwent mechanical pleurodesis [21, 38]. This risk of bleeding can be reduced by meticulous intra-operative haemostasis to decrease major post-operative bleeding events [39, 40]. We observed $< 1\%$ ($n = 1$) incidence of post-operative bleeding in our VATS pleurectomy subjects.

While most centres advocate VATS bullectomy and either a mechanical or chemical pleurodesis for PSP, a centre in Korea described an additional covering of staple lines with absorbable polyglycolic acid along with pleural abrasion [35]. They concluded that the coverage with polyglycolic sheet and pleural abrasion after thoracoscopic bullectomy was effective in preventing prolonged post-operative air leaks and reducing post-operative recurrence rates. Muramatsu et al. [8] described reinforcing the staple line with fleece-coated fibrin glue, or sprayed with fibrin glue solution without any pleurodesis and concluded that the recurrence rate after thoracoscopic bullectomy with fleece-coated fibrin glue was significantly lowered compared to bullectomy alone. Min, Xianjun et al. [41] compared staple bullectomy with or without mechanical pleurodesis and demonstrated no difference in the rate of recurrence of pneumothorax. In our institution, given the low rates of complications encountered with mechanical or chemical pleurodesis as well as the low recurrence rates, we continue to practice regular pleurodesis post-staple bullectomy with either talc pleurodesis or parietal pleurectomy.

There have also been concerns regarding re-VATS or thoracotomy post-pleurodesis in the young patients with PSP due to dense bridging fibrosis obliterating the pleural space to prevent recurrence. Cardillo et al. [42] and Doddli et al. [43] described their experience with re-VATS and re-thoracotomy post-pleurodesis and concluded that re-VATS was feasible in this population of patients stating that re-operation for talc pleurodesis was more demanding than mechanical abrasion with an increased rate of conversion to thoracotomy.

This study represents a cohort of patients from a single centre of expertise that was an observational retrospective study although the demographics between both groups were shown to be similar. Our results show there were no significant differences in outcomes between talc pleurodesis and pleurectomy, which may be due to the relatively small cohort size. We did not evaluate pain post-operatively and do not routinely perform a post-operative lung function test for our patients unless they present with shortness of breath without a recurrent pneumothorax or decrease effort tolerance. Our follow-up period was only for 1 year as patients were discharged after. We are unable to comment on the outcomes for a longer follow-up period which may yield a different result. Further, multi-centre randomized controlled studies are warranted in elucidating significant differences between these two methods.

Conclusion

Our study demonstrates comparable outcomes between talc pleurodesis and pleurectomy following VATS bullectomy for patients with PSP. Recurrence of pneumothorax, length of a chest tube duration and length of hospital stay were similar for both procedures. Talc pleurodesis has a shorter operative time compared to pleurectomy.

Compliance with ethical standards

Conflict of interest All authors have no conflicts of interest to disclose.

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