Original Article

Video-assisted thoracoscopic surgery management of primary spontaneous pneumothorax: Results in 110 consecutive cases

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ABSTRACT

Background: Primary spontaneous pneumothorax (PSP) results from the rupture of small blebs or bullae in a patient without any pre-existing lung disease. Last decade witnessed a paradigm shift in the surgical management of pneumothorax from open to video-assisted thoracoscopic surgery (VATS) method. In this study, we aim to report our single center experience of surgical management of PSP along with surgical outcomes in 110 consecutive cases of PSP. **Materials and Methods:** This is a retrospective study of 110 operated cases of PSP over 5 years. Demography, computed tomography findings, operative technique, endoscopic classification (Vanderschueren), surgical duration, intraoperative and postoperative complications, duration of Intercostal Drain (ICD), hospital stay, and recurrence in follow-up were recorded. **Results:** The average age of patients was 27.59 years (range 9–68 years). The average number of episodes before the presentation was 2 (range 1–5). The average number of loss of working days because of symptoms, conservative management, or long-term intercostal drainage was 13.33 days (range 5–60 days). As per intra-operative findings, patients were categorized as per Vanderschueren's classification and managed accordingly. Conversion rate was in 1.8% ($n = 2$). Mean time to removal of chest tubes was 4 days (2–12 days). Mean hospital stay was 3.83 days (2–9 days). There were no postoperative deaths. The mean follow-up was 25.05 months (6–60 months). Overall complication rate was 3.6% ($n = 4$) and recurrence happened in 2.7% ($n = 3$) cases. **Conclusions:** VATS is an efficient and safe treatment modality for PSP with low recurrence rates and high level of patient satisfaction.

KEY WORDS: Video-assisted Thoracoscopic Surgery (VATS), Primary Spontaneous Pneumothorax, Surgical Outcomes

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Submitted: 29-Sep-2019 **Revised:** 02-Jun-2020 **Accepted:** 15-Oct-2020 **Published:** 31-Dec-2020

INTRODUCTION

Spontaneous pneumothorax (SP) is the accumulation of air within the pleural space leading to collapse of lung. It is classified as primary spontaneous pneumothorax (PSP) when it results from the rupture of small blebs or bullae in a patient without any pre-existing lung disease and secondary SP where pneumothorax is related to the presence of an underlying lung disease. The main goals of treatment are to achieve re-expansion of the lung and to prevent further recurrences. Chest tube drainage alone achieves same in around 50% of patients;[1] however, remaining patients require surgery based on standard indications. For decades, open surgery has been practiced

Access this article online

Quick Response Code:

Website: www.lungindia.com

DOI: 10.4103/lungindia.lungindia_453_19

How to cite this article: Puri HV, Asaf BB, Pulle MV, Bishnoi S, Kumar A. Video-assisted thoracoscopic surgery management of primary spontaneous pneumothorax: Results in 110 consecutive cases. Lung India 2021;38:36-40.

for such cases with very good results; however, the morbidity associated with thoracotomy has deterred both patients and referring pulmonologists from choosing this modality of management. In the last two decades, video-assisted thoracoscopic surgery (VATS) is now being used more and more commonly for various benign as well as malignant thoracic surgical diseases[2,3] and has been shown to be a low morbidity, efficacious, and cost-effective method.[4-7] In this retrospective study, we aim to report our single center experience of surgical management of PSP along with immediate and long-term results in 110 consecutive cases of PSP.

MATERIALS AND METHODS

The case records of 110 patients who underwent VATS procedure for the treatment of SP between March 2012 and May 2017 were retrospectively reviewed. Demographic details, history, type of pneumothorax, computed tomographic findings, operative technique, endoscopic classification (Vanderschueren), duration of surgery, intraoperative and postoperative complications, duration of intercostal drainage, hospital stay, and any recurrence in immediate or long-term follow-up period were recorded.

The patients were taken up for surgery according to the British Thoracic Society (BTS) 2010 guidelines,[1] i.e., second episode or recurrent ipsilateral pneumothorax, first contralateral pneumothorax, persistent air leak (despite 5–7 days of chest tube drainage) or failure of lung re-expansion, and professionals who are at risk (e.g., pilots and divers). The patients who underwent VATS treatment for PSP and then developed contralateral PSP were considered as new cases.

All patients were operated under general anesthesia with single-lung ventilation. Patients were placed in the lateral decubitus position with the arm held abducted to allow maximum superior displacement of the scapula. The first port was placed in the 9th intercostal space. Five-mm 30° scope was used to inspect the thoracic cavity. Two other ports were made according to the findings of diagnostic thoracoscopy. The pleural cavity was filled with saline. The lung was now gently ventilated to look for any obvious bleb, bullae, and for any air leak by underwater air leak test. The pathologic lung lesions that were diagnosed endoscopically were classified according to Vanderschueren's classification.[8] stage I: no endoscopic abnormalities, Stage II: Pleuro-pulmonary adhesions, Stage III: Blebs <2 cm, and Stage IV: Blebs/bullae more than 2 cm. Our surgical protocol according to Vanderschueren's stage was: stage I: Isolated pleurectomy, Stage II: Lysis of all adhesions and isolated pleurectomy, and Stages III and IV: Addressing the blebs/bullae (stapling with adequate healthy margin) with mechanical pleurodesis.

Stapling of blebs/bullae was achieved by endoscopic linear cutter device with clear healthy margins. Pleurodesis was achieved by endoscopic pleural abrasion with a roll of poly-propylene mesh. In this technique, the parietal pleura was abraded with a rough object like poly propylene mesh from apex to costo-diaphragmatic recess including the diaphragmatic surface to create a rough surface with petechial hemorrhages with the intention to achieve pleurodesis and prevent further recurrences. Postprocedure two chest tubes one apical and other basal in location would be placed and connected to Thopaz™ negative suction device at a pressure of minus 20 cm of H_2O to aid lung expansion and augment pleural symphysis. From the 1st postoperative day, patients were instructed to do deep breathing and breath holding exercises and started on rigorous exercise program consisting of brisk walking on treadmill and stair climbing. By the time of discharge, all were able to climb seven floors at a time several times a day and were instructed to continue same after discharge also, for a minimum of 3 months.

Persistent air leak was defined as any air leak in the chest tube >5 days. Complications were reported as re-exploration, pneumonia, respiratory failure, pulmonary embolism, atrial fibrillation, and wound-related complications. Return to activity was defined as patient returning to his day to day activities as he was doing them before the symptoms of pneumothorax developed.

RESULTS

In our series, 110 patients were managed by VATS technique for PSP as per the BTS guidelines. In the study group, there were 86 (78.18%) males and 24 (21.2%) females. The average age of patients was 27.59 years (range 9–68 years). At presentation, 48 (43.63%) patients had right sided pneumothorax, whereas 58 (52.72%) had left-sided pneumothorax and 4 (3.6%) had bilateral pneumothorax. The average number of episodes before the presentation to our institute were 2 (range 1–5). The average number of loss of working days because of symptoms, conservative management or long-term intercostals drainage was 13.33 days (range 5–60 days) [Table 1].

Intraoperative details are enlisted in Table 2. Thoracoscopic evaluation of the lung was accomplished according to Vanderschueren's classification and revealed: Stage I: 6 (5.4%) cases, Stage II: 2 cases (1.8%), Stage III: 68 cases (61.81%), and Stage IV: 34 cases (30.9%)

Table 1: Demographic details of study group (*n*=110)

Characteristics	Value
Male:female (%)	86 (78.18):24 (21.8)
Mean age years (range)	27.6 (9- 68)
Side of disease (%)	
Right	48 (43.63)
Left	58 (52.72)
Bilateral	4 (3.6)
Median number of episodes before surgery (range)	2 (1- 5)
Mean number of working days lost before surgery (range)	13.3 (5- 60)

cases. Seventy-one (64.54%) patients were having apical lesions. There were no intra-operative complications. No patient required blood transfusion. Elective conversion to thoracotomy was required in two patients (2.5%) due to extensive pleural adhesions. There was no emergency conversion. Average operative time was 122.95 min.

Details of postoperative outcomes are mentioned in Table 3. Prolonged air leak occurred in six cases (5.4%), and all of them resolved spontaneously with prolonged chest tube drainage and aggressive exercise schedule. There were no postoperative deaths. Mean time to removal of chest tubes was 4.04 (2–12 days). Mean hospital stay was 3.83 days (2–9 days). All patients were included in the follow-up. The mean follow-up was 25.05 (6–60 months) and included clinical history and physical examination. After chest tube removal, a chest X-ray is done to ensure completely expanded lung. Thereafter, chest X-ray was done at 3 months and 6 months after which the patients were told to lead a normal life and further X-rays were ordered only if symptomatic. The average days of return to normal activity were 6.1 days (5–14).

Overall, complication rate was 3.6% (4 cases) with two cases had pleural collection, in which 1 patient required chest drain reinsertion and another managed conservatively. VATS re-exploration was done in another case for bleeding and another patient developed postoperative pulmonary edema which required 1 day of ventilation [Table 4]. In our series, three patients had recurrence of pneumothorax. Recurrence was noticed after 4 months of primary surgery in two patients and another patient developed 13 months later. These recurrences were managed by insertion of intercostal drainage tube and talc poudrage [Table 5].

Table 2: Operative details of study group, (*n*=110)

Characteristics	Value
Vanderschueren's stage (%)	
Stage 1	6 (5.4)
Stage 2	2 (1.8)
Stage 3	68 (61.8)
Stage 4	34 (30.9)
Mean operative time (min)	122.9
Mean operative blood loss (ml)	152
Conversion to thoracotomy	2

Table 3: Postoperative details of study group (*n*=110)

Characteristics	Value
Prolonged air leak (>5 days)	6
Mean postoperative ICD duration in days (range)	4.04 (2- 12)
Mean hospital stay in days (range)	3.83 (2- 9)
Mean time to return to full work (days)	6.1 (5- 14)

ICD: Intercostal Drain

Table 4: Complication details of study group, (*n*=110)

Characteristics	Value
Complications (overall)	4
Bleeding	1
Postoperative pleural collection	2
Re-expansion pulmonary edema	1
Perioperative mortality (<30 days)	Nil

An attempt was made to correlate the preoperative variables and surgical methods with postoperative events such as prolonged air leak, postoperative complications, and postoperative recurrence. However, in view of very small number of these events, none of the statistical methods could find any significant correlation between them.

DISCUSSION

The term pneumothorax was coined by Itard and then by Laennec in 1803 and 1819[9] respectively. Back in those days, the pneumothorax was mostly secondary to tuberculosis although some were seen in healthy individuals which was usually addressed to as "pneumothorax simple." The first modern description of PSP occurring in healthy individuals was given by Kjærgaard.[10] The appropriateness of this term "Primary Spontaneous Pneumothorax" has become questionable in the present era as thoracoscopic exploration has shown that most of the patients with so-called PSP have endoscopically visible lesions.[11] This is also evident in our series wherein 102 of 110 (92.7%) patients had apparent lesions (Vanderschueren Stage III and IV lesion). In 1.8% cases (Stage II), pleuropulmonary adhesions were identified. In only 6 (5.45%) patients, thoracoscopy fail to reveal any abnormality (Stage I). The conventional approach of simple chest drainage has a high recurrence rate of 25%–43%. It becomes even higher for subsequent episodes: approximately 50% after a second episode and 80% after a third episode so that surgery is inevitable in these cases.[12] Surgeons have started exploring the possibility of VATS even for the first episode of SP.[13] In a recent systematic review and meta-analysis specifically aimed at answering the question of use of VATS in the first episode itself, the authors concluded that though VATS appears to be an effective alternative in comparison to conventional chest tube drainage as a first-line treatment for an initial episode of PSP and is associated with significantly reduced recurrence rates and shorter length of hospitalization, there is not enough high quality evidence for its use in the first episode and well-designed randomized controlled trials are necessary to change existing guidelines.[14] More established indications for surgery are first contralateral pneumothorax, persistent air leak (despite 5–7 days of chest tube drainage) or failure of lung re-expansion, and professionals at risk (e.g., pilots, divers) which are less debatable.

In the present series, the average number of episodes before the presentation to our institute was 2 (range 1–5) with average number of loss of working days 13.33 days (range 5–60) days representing the personal, economic, and social burden of inadequate management of this disease or untimely referral to a thoracic surgeon. This is particularly relevant in our country due to lack of availability of surgical

Table 5: Vanderschueren's staging and details of procedure done and recurrence

Stage	Procedure	*n*	Recurrence	Duration happened at
Stage 1	Isolated pleurectomy	6	1	4 months
Stage 2	Adhesiolysis with isolated pleurectomy	2	0	
Stage 3	Stapling of blebs with mechanical pleurodesis	68	1	13 months
Stage 4	Stapling of bullae with mechanical pleurodesis	34	1	4 months

expertise in all the centers which leads to inhibitions on part of chest physicians because of fear of complications related to thoracotomy. After evidence from large-scale controlled studies, VATS has become more popular than thoracotomy, and currently, it probably represents the gold standard of the therapy for PSP.[15-17] If we compare the results of VATS and conventional surgical therapy in the treatment of PSP, the mean recurrence rates of VATS were higher than conventional standard thoracotomy in previous studies,[18-20] which can be attributed to the learning curve of VATS. In our series, the recurrence rate is 2.7%, this can be attributed to careful selection of patients, meticulous preparation, and aggressive postoperative management. One very important difference in our and previous series is the religious use of continuous suction device THOPAZ™ in all our cases immediately postoperatively which helped to maintain and enforce the symphysis between lung and parietal pleura after surgical pleurodesis.[21]

Most of the studies have shown a reduced operation time, duration of chest tube drainage, complication rates, and hospital stay in VATS which is similar to the results achieved by us in the present series.[16,22,23] We have found that classifying our findings based on Vanderschueren's 4-stages is a useful tool giving a better understanding of the disease: it is possible to classify the disease (presence or absence of adhesions, blebs, and bullae) and to stratify the different treatment options.[24] Studies have shown no pathomorphological changes in as high as 45% to as low as 5.1% cases which in our series was 7.27%.[11, 25-26] We do not do blind apical stapling in patients with no evidence of bullae. In our opinion, isolated parietal pleurectomy is the right choice with Stage I and II disease.

We follow a less aggressive approach to pleurodesis with only mechanical rubbing of pleural cavity to achieve pleural symphysis in cases where we find definitive morphological changes. This approach offers the major advantage that a repeat thoracic surgery, if ever required, will be a reasonable undertaking as compared with either poudrage or pleurectomy. In cases where we do not find any morphological changes we chose more aggressive approach of parietal pleurectomy as here pleural symphysis alone will be an important factor in avoiding recurrence. We did not use talc poudrage as there is an increased theoretical risk of respiratory failure in elderly and mesothelioma in the young population.[27] Recent studies also show that if pleural rubbing is done appropriately by a VATS experienced surgeon then results are similar to more aggressive approaches of pleurectomy and talc poudrage.[28]

Another important parameter studied was return to normal activity after VATS surgery which was 6.1 days which represents minimal physical and mental debilitation. All patients undergoing surgery were telephonically contacted 6 months postprocedure and were asked to rate their surgical experience as very satisfactory, satisfactory, not satisfactory, and poor with 104 patients rating it as very satisfactory, 4 rating it as satisfactory, and only two patients who had recurrence rating it as not satisfactory. Thus, majority of the patients exhibited the high level of satisfaction with VATS.

VATS has become our treatment of choice in patients within the first episode of contralateral pneumothorax, in patients whose professions put them at risk (pilots, scuba divers, and sportsmen), in patients with treatment failure of a first episode of PSP, and in patients with recurrent PSP. Video-thoracoscopic examination enables the detection of blebs, bullae and even small leaking areas, provided that the examination is done during gentle ventilation with saline in the pleural cavity. In our opinion, Vanderschueren's 4-stage system provides a chance to classify pneumothorax and to stratify the different treatment options. In early stages (Stages I and II), isolated parietal pleurectomy is our favored treatment; we do not add blind apical stapling to this. In the presence of blebs and bullae (Stages III and IV), stapled wedge resection is strongly advised. Pleurodesis and negative suction must always be added. VATS provide a very high rate of satisfaction among the patients undergoing surgery for pneumothorax.

CONCLUSIONS

VATS is an efficient and safe treatment modality for PSP with low recurrence rates and high level of patient satisfaction.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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