Videothoracoscopic Bleb Excision and Pleural Abrasion for the Treatment of Primary Spontaneous Pneumothorax: Long-Term Results

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Background. **The goal of this study was to evaluate the long-term efficiency of videothoracoscopic bleb excision and pleural abrasion for the treatment of primary spontaneous pneumothorax.**

Methods. **From July 1991 to December 1997, 182 patients with primary spontaneous pneumothorax were treated by a single technique at our institution. Seven patients had single-stage bilateral procedures and 11 other patients had staged bilateral procedures. Indications for operation were first episode with prolonged air leak, incomplete lung reexpansion, or job restrictions (n = 59), first ipsilateral recurrence (n = 57), second or third ipsilateral recurrence (n = 34), contralateral recurrence (n = 25), synchronous bilateral pneumothorax (n = 3), hemopneumothorax (n = 3), and tension pneumothorax (n = 1). All patient data were reviewed retrospectively, and 167 patients were available for late follow-up (92%).**

Results. **Mean operative time was 57 ± 19 minutes Conversion to thoracotomy was required in 1 patient (0.6%). Mean duration of pleural drainage was 5.8 ± 1.2 days (range, 4 to 26 days), and mean postoperative stay was 7.7 ± 1.6 days (range, 6 to 31 days). Postoperative complications occurred in 50 patients (27.4%), the most frequent being prolonged air leak (14.8%), and in-hospital mortality was 0%. After a mean follow-up of 93 ± 22 months (range, 57 to 134 months; median, 84 months), five ipsilateral recurrences were noted (3%). Three recurrences occurred within 12 months of videothoracoscopy and required reoperation. Two patients had partial pneumothorax recurrence at 39 and 58 months, and were treated conservatively with chest tube insertion and tale slurry. After 1 year, 10.7% of patients complained of chronic chest pain or discomfort, although none was taking pain medication after 3 months. Most patients (89.8%) were satisfied or very satisfied of their operation. All patients had returned to sport activities within 2 years.**

Conclusions. **Videothoracoscopic bullectomy and pleural abrasion is a reliable and safe method to treat primary spontaneous pneumothorax. Long-term recurrences occur with an acceptable rate that compares with results after limited thoracotomy. Chronic chest pain or discomfort is unpredictable and may represent a problem in a few patients.**

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In 1941, Tyson and Crandall reported excision of subpleural blebs and gauze abrasion of the pleura as a method to prevent recurrence of spontaneous pneumothorax [1]. In 1956, Gaensler reported the first series of patients with recurrent spontaneous pneumothorax treated by pleurectomy [2]. In 1968, Clagett called attention to this somewhat too-radical procedure and suggested the use of abrasion instead of pleurectomy [3]. In 1980, Deslauriers and colleagues reported their results in 362 patients who had resection of apical blebs associated with limited apical pleurectomy through a transaxillary approach [4]. Postoperative morbidity was minimal and recurrences occured in 2 patients (0.6%).

Since then, numerous studies have recommended various surgical techniques with different surgical approaches (posterolateral thoracotomy, limited lateral thoracotomy, thoracoscopy, or video-assisted thoracic surgery [VATS]) [5–19]. Some surgeons have reported favorable immediate and intermediate results with VATS approaches in patients with primary spontaneous pneumothorax (PSP) and secondary spontaneous pneumothorax (SSP) [6–11]. Although some colleagues demonstrated the postoperative impairment in pulmonary function was significantly reduced with VATS compared with limited posterolateral or transaxillary thoracotomy, mean operative time, analgesic requirement, hospital stay, and recurrences did not differ significantly between the different approaches [6, 13, 20]. However, those prospective studies enrolled limited numbers of patients with both PSP and SSP and had limited follow-up [6, 13, 20]. Therefore, it remains impossible to formally conclude the superiority of one approach over the other one.

At the present time, it is clear that videothoracoscopy represents the preferred approach in patients with PSP [6, 14]. However, in the absence of an appropriately

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Table 1. Indications for Operation

Indications	No. (%)
First episode[a]	59 (32.4)
First ipsilateral recurrence	57 (31.3)
Second or third ipsilateral recurrence	34 (18.7)
First contralateral recurrence	25 (13.7)
Synchronous bilateral pneumothorax	3 (1.6)
Hemopneumothorax	3 (1.6)
Tension pneumothorax	1 (0.5)

[a] Associated with persistent air leak (>7 days), incomplete lung reexpansion, or job restrictions.

conducted prospective study, it is yet impossible to conclude the superiority of thoracotomy over VATS approaches in patients operated on for PSP, in terms of late recurrences and chronic chest pain. In addition, it is also impossible to formally conclude the superiority of video-assisted pleurectomy over pleurabrasion, although large retrospective studies involving thoracotomy have demonstrated lower rates of recurrence with pleurectomy [4, 15–19].

We have performed the first videothoracoscopic procedure for the treatment of PSP in July 1991. Since that year, all surgeons in our department have been using a highly standardized videothoracoscopic technique that is reproducible (blebs stapling combined with pleural abrasion). This allows us to analyze retrospectively our long-term results with this technique in the subgroup of patients with PSP.

Material and Methods

Patient Characteristics

Between July 1991 and December 1997, 182 patients with primary spontaneous pneumothorax have been treated by videothoracoscopy at our institution. Twelve patients were female (7%) and 170 were male (93%). All patients had a preoperative chest computed tomography (CT) to determine the number and location of blebs or bullae. The indications for operation are reported in Table 1. The mean age at operation was 25.1 $\pm$ 4.9 years (range, 16 to 37 years). Seventy-eight patients (43%) had a history of smoking, with a mean of five pack-years among those who smoked. All patient were seen in our outpatient clinic at 1 month postoperatively. Most of them were also seen at 3 months, and then followed up by their referring physicians or pulmonologists. Fifteen patients were lost to late follow-up, but information was available regarding the first 2 postoperative years in all of them. Thus, mid-term follow-up is 100% and long-term follow-up is 92%. Data were collected retrospectively for each patient, including detailed medical history, number of episodes of pneumothorax and their treatment modalities, existence of blebs or bullae diagnosed on chest CT or at operation, existence of pleural adhesions, operative time, number of staple cartridges used, duration of pleural drainage, hospital stay, complications, recurrences, and long-term satisfaction. Information regarding late complications, recurrences, chronic chest pain, and late satisfaction was obtained directly from the patients by phone contact or by mail. We used a standard pain questionnaire to assess chronic chest pain [21]. Pain was graded on a 0 to 5 scale as follows: 0, no pain, 1, mild pain; 2, discomfort; 3, distressing; 4, horrible; and 5, excruciating.

Operative Technique

All operations were performed by senior surgeons (RJ and FP) before 1993. After that time, operations were performed either by senior surgeons, or by surgical residents under the supervision of a senior surgeon. Surgical residents were on a 1-year basis rotation in our department, and all were enrolled in an accredited thoracic and cardiovascular surgery residency program.

With the patient under general anesthesia, ventilation was commenced with double-lumen intubation. The patient was placed and prepared as for postero-lateral thoracotomy. Single-lung ventilation was begun before the 1.5-cm skin incision was made below the tip of the scapula in the sixth intercostal space. A 0-degree, 10-mm videothoracoscope was introduced through a thoracoport and the pleural cavity was inspected. Two other thoracoports were then placed under direct endoscopic visualization in the fourth anterior and eighth anterior intercostal spaces. The apex of the lung was grasped with an Endograsp (Autosuture; USCC, Norwalk, CT) and all aspects of the lung were carefully inspected. Blebs or bullae were excised with an endoscopic linear stapler (according to surgeon's preference, either EndoGIA; Auto Suture Company Division, USCC; or Endopath; Ethicon Endo-Surgery, Inc., Cincinatti, OH). If no bleb or bulla was visible, saline solution was instilled into the pleural cavity and the lung ventilated to identify the site of the air leak. If no air leak was found, we performed a blind stapling of the pulmonary apex.

Pleurodesis was performed by vigorous pleural abrasion using a pledget of wide-mesh polyglycolic acid gauze (Davis & Geck Division, American Home Products, Danbury, CT) attached to the tip of a standard endoscopic grasper. The entire parietal pleura and diaphragmatic pleura were abrated by inserting the grasper successively through the three thoracoports. Abrasion was stopped when a uniform aspect of bloody pleura was obtained. Two chest tubes (28F; Sherwood Medical, Tullamore, Ireland) were placed through the anterior incisions, and adequate lung reexpansion was verified. The tubes were connected to an underwater seal suction with a negative pressure of 25 cm H_2O.

The surgical specimens were systematically sent to the histopathology laboratory.

Postoperative Care

The patients were extubated in the operating room and observed for 3 to 6 hours in the intermediate care unit. Patients were transferred to the thoracic surgical unit the day of operation and were ambulated the next day. Pulse oxymeter and electrocardiogram were routinely monitored during the first 24 hours. Daily chest roentgeno-

gram was obtained for each patient. Chest tubes were usually removed after 4 to 5 days, when any parenchymal air leak that may have been present had resolved, when the lung was fully expanded, and when pleural drainage was less than 100 mL per 24 hours. Active and passive physiotherapy was started on postoperative day 1 and maintained for 1 month. Subcutaneous low–molecular weight heparin was injected daily while patients had chest tubes.

Postoperative Analgesia

We used either epidural analgesia or patient-controlled anagesia (PCA) during the 1991 to 1997 period. Most patients operated on before May 1995, or patients undergoing single-stage bilateral procedures, received epidural analgesia (n = 119). An epidural catheter was placed just before surgery, while patient received general anesthesia. This catheter was left in place for 4 days. Bupivacaine 0.125% was continuously infused, and morphine (2 to 4 mg) was injected twice daily. Most patients operated on after May 1995 received PCA (n = 63). Oral therapy was started on postoperative day 5 with paracetamol, codeine, or dextropropoxyphene, and was adapted to individual requirements.

Results

All patients had preoperative chest CT allowing for preventive surgical procedures on the contralateral lung in selected patients. All patients but 19 had blebs or bullae diagnosed on chest CT. Indications for operation are reported in Table 1. Ninety-three procedures were performed on the right side and 71 on the left side; 7 patients had a single-stage bilateral procedure and 11 patients had a staged bilateral procedure. All patients but 8 had at least one bullous area excised. The mean number of staple cartridges used for wedge resections was three per patient (range, one to eight). The mean operative time was 57 ± 19 minutes. We had three peroperative incidents: pulmonary laceration due to thoracoport insertion in an adherent lung, loss of a metallic piece of staple cartridge in the pleural cavity, and hemorrhage due to electrocauterization of an adhesion on the left subclavian artery. One patient required conversion to posterolateral thoracotomy because of hemorrhage from adhesion on the left subclavian artery. Postoperative complications are summarized in Table 2. One patient required reoperation by videothoracoscopy for clotted hemothorax. Mean duration of pleural drainage was 5.8 ± 1.2 days (range, 4 to 26 days). Postoperative hospital stay was 7.7 ± 1.6 days (range, 5 to 31 days). Fifteen patients had pleural detachment (recurrent pneumothorax after removal of chest tubes) while hospitalized and required insertion of a new chest tube for adequate lung reexpansion. Most of them were operated over the 1991 to 1992 period (8/15), and this complication significantly decreased with time and experience. In-hospital mortality and 30-day mortality were 0%. Twenty-eight patients were discharged from our department with an isolated apical incomplete lung reexpansion (< 2 cm). All of them had complete reexpansion after 1 month of physiotherapy. Mean follow-up was 93 + 22 months (range, 134 to 57 months; median, 84 months).

Table 2. Postoperative Complications

Complications	No. (%)
Prolonged air leak (>7 days)	27 (14.8)
Insertion of a new chest tube	15 (8.2)
Transient Horner's syndrome	2 (1)
Pneumopathy	2 (1)
Clotted hemothorax	1 (0.6)
Chylothorax[a]	1 (0.6)
Pleural effusion[b]	1 (0.6)
Incomplete brachial cutaneous nerve palsy[c]	1 (0.6)
Acute renal failure	1 (0.6)

[a] Regressed spontaneously; [b] regressed with physiotherapy; [c] regressed spontaneously.

Recurrences

One patient suffered an ipsilateral recurrence within 1 month of operation. He was reoperated on by videothoracoscopy and had apical pleurectomy performed. No bleb or bulla could be identified at reoperation. Two patients suffered an ipsilateral recurrence during the first postoperative year and were reoperated on. One had a pleurectomy performed by videothoracoscopy and the other 1 was reoperated on at another hospital through a limited lateral thoracotomy. The intermediate recurrence rate (24 months) was 1.6% (3/182). Two patients suffered late recurrences at 39 and 58 months, respectively. Those were apico-lateral and diaphragmatic partial recurrences. Both patients were treated conservatively with chest tube insertion and talc slurry. Thus, the global recurrence rate is 3% (5/167), assuming that 8% of patients were not available for follow-up longer than 2 years.

Chronic Chest Pain or Discomfort

Forty-eight patients (26.4%) complained of chronic chest pain or discomfort persisting after the second postoperative month. Twenty-five patients complained of intermittent pain or dysesthesia located on the trocar incisions and quoted 1 (n = 14) or 2 (n = 11). Four patients suffered chronic intercostal neuralgia quoted 2 and persisting up to 12 months (n = 3) or 24 months (n = 1). Two patients reported intermittent burning on the trocar incisions persisting up to 6 months, postoperatively. None of those patients was taken pain medication after 3 months, postoperatively. Some patients complained of recurrent sudden onset of chest pain mimicking pneumothorax that prompted them or their physicians to obtain a chest roentgenogram to eliminate a recurrence. Those symptoms dissapeared with time and with anxiolytic therapy (3 patients). After 1 year, 14 patients reported recurrent chest discomfort at exercise associated with dyspnea, but no recurrence could be documented in those patients. Three patients reported mild pain on the trocar incisions triggered by changes in the weather.

Return to occupational activity was within 30 days of operation for most patients (mean, 31 days; range, 5 to 90 days), and all patients returned to sport activities after 2 years, postoperatively. At long-term, 17 patients (10.2%) are not fully satisfied with the VATS procedure, mainly because of cheloids on the trocar incisions, dysesthesias, or fear of recurrence. All other patients were either very satisfied (31.1%) or satisfied (58.7%) with their operation.

Comment

There is now compelling evidence that VATS is a viable alternative to limited lateral thoracotomy (LLT) for the treatment of primary spontaneous pneumothorax [6–14]. Videothoracoscopic procedures result in short hospital stay, low morbidity, high patient acceptance, and mid-term rates of recurrence slightly higher than those reported after open procedures [6–14]. Moreover, VATS has been reported to reduce postoperative pain, reduce shoulder dysfunction, and reduce pulmonary impairment when compared with LLT [6, 21]. However, initial enthusiasm with VATS techniques has been tempered by reports of high rates of recurrence, or absence of evident benefit over LLT in some series [7, 13]. Moreover, VATS has been reported to increase the cost of treatment because of the use of endostaplers, double-lumen endotracheal tubes, disposable material, and video equipment [14].

Most reports have focused on immediate and intermediate results and have neglected the problems of chronic chest pain and late recurrence. Although most recurrences occur within 18 months of operation, some can occur after 5 years and can be missed if only intermediate follow-up is obtained [9–12]. Most reported series have mixed cases of primary and secondary spontaneous pneumothorax [6–8, 10–13]. Moreover, most of those series have limited follow-up varying from 13 to 53 months, and reported different techniques for both pleurodesis (pleurectomy or abrasion) and management of bullae (stapling, laser ablation, ligature) (Table 3) [6–13]. Therefore, valid conclusions cannot be taken from those studies, in our opinion. Thus, data are lacking to compare the long-term results of VATS with those obtained with the transaxillary approach and apical pleurectomy in patients with primary spontaneous pneumothorax [4, 19].

This series represents a single-center experience, with all four senior surgeons using the same surgical technique over a 7-year period. Follow-up was available for 100% of patients at 2 years and 92% of patients at 93 ± 22 months. Our series is informative, because it is very homogenous. Thus, we have studied exclusively patients with PSP who had videothoracoscopic blebs/bullae excision and pleural abrasion. Most patients were men (93%) due to our status of military national referral center. All patients had preoperative chest CT to rule out underlying lung disease and to assess blebs or bullae. Although not routinely performed at first episode of PSP in other institutions, we have adopted a policy of performing chest CT in all patients, guided by the high rate of military personnel with job restrictions treated at our institution. In this series, 17 patients (9%) were operated on after their first episode of PSP on the basis of chest CT demonstrating multiple blebs or bullae.

Table 3. Outcome After Video-Assisted Thoracic Surgery Operation for Primary Spontaneous Pneumothorax

Author/Year	No. of patients	Reoperation Within 15 Days	Mean Follow-up (Months)	Recurrences (%)
Inderbitzi, 1994 (PSP and SSP)	79	4	19.6	8.3
Naunheim, 1995 (PSP and SSP)	113	1.7	13.1	4.1
Bertrand, 1996 (PSP)	163	3	24.5	6
Mouroux, 1996 (PSP and SSP)	97	0	30	3
Passlick, 1998 (PSP and SSP)	99	5	29	4
Hatz, 2000 (PSP and SSP)	118	2.5	53	4.6
Present series (PSP)	182	0.5	93	3

PSP = primary spontaneous pneumothorax; SSP = secondary spontaneous pneumothorax.

There was clearly a learning curve with the VATS technique used in this study, with a higher rate of pleural detachment after removal of tubes over the 1991 to 1992 period, probably due to suboptimal pleural abrasion or persistence of blebs. However, the surgical technique became standardized after 1992, and most procedures have been performed by surgical residents under the supervision of a senior surgeon after 1993. Our chest tube removal policy has also slightly varied over this period. We used to pull out 5 cm of the tubes after 3 days and remove them after 5 days, a practice that is current in France, but not standard in North America. Starting in 1996, we simply removed the chest tubes after 4 days, when any parenchymal air leak had resolved, when lung was totally reexpanded, and when pleural drainage was less than 100 mL per 24 hours. The position of thoracoports, materials, and surgical technique have not varied much over the 1991 to 1997 period. In our experience, pleural abrasion took 15 minutes to be performed appropriately. The parietal pleura was vigorously abraded, especially at the apex, resulting virtually into an apical pleurectomy in some patients. We also used to abrade the diaphragmatic pleura, to prevent partial recurrence on this site. At the end of the procedure, we used to verify that all areas except the mediastinal pleura had been appropriately abraded. Blind stapling of the pulmonary apex was systematically performed if no air leak could be found at videothoracoscopy. Thus, most patients without evidence of air leak at operation had apical dystrophy diagnosed at histopathologic examination, in our experience. Failure to localize air leaks and to adequately

perform pleural abrasion is probably the main cause of recurrence in most series [7, 8, 14]. Although the primum movens of spontaneous pneumothorax is an air leak that should be identified and treated by wedge resection, pleurodesis appears mandatory in order to achieve rates of recurrences less than 5% [18]. Failure to perform vigorous abrasion is also; in our opinion, a major cause of recurrence. Thus, VATS results in a lower degree of tissue trauma and in a less intense biologic reaction compared with thoracotomy [22]. Regarding recurrences after videothoracoscopy, most cases occur within 18 months [9, 23]. Redo videothoracoscopy is feasible in most patients with early recurrences [23]. Late recurrences are often partial pneumothorax and can be managed conservatively, as in the present series.

Long-term pain remains a distressing problem after thoracotomy. However, long-term pain also exists after VATS procedures, although less frequently reported [24, 25]. Pain is probably related to intercostal bundle injury due to trocart insertion and manipulation in most patients [21, 24]. Although most surgeons tried to minimize injury to the intercostal nerves, this problem has remained the most frustrating because no dramatic reduction in chronic chest pain has been observed as surgeons gained experience in VATS techniques. Placing the incisions more anteriorly (where the intercostal space is larger) and reducing the diameter of instruments and chest tubes still results in significant pain in most patients. Bertrand and colleagues reported residual pain in 63% of patients operated on by VATS for spontaneous pneumothorax [9]. Although 58% of their patients had minimal pain, and pain was described as intermittent in 87% of patients, 19% required analgesic drugs for pain relief. Passlick and associates reported that 31.7% of patients suffered chronic chest pain at late follow-up and that 3.3% had high pain intensity [25]. The high rate of chest pain in Bertrand and associates' study is probably related to the shorter follow-up in this study compared with Passlick and associates' study and ours. Passlick and associates' results and ours are in a similar range to those reported by Mouroux and colleagues: 3% at a mean follow-up of 30 months [10]. Although no patient required pain medication after 3 months in our series, the potential for chronic pain after videothoracoscopy should be kept in mind and discussed with patients preoperatively. Although no legal suit has been recorded in the present series, chronic chest pain may represent a real problem in otherwise young, healthy, and sportive patients.

Considering the safety and reliability of videothoracoscopic excision of blebs/bullae associated with pleural abrasion, and the low rate of recurrences and chronic chest pain, we advocate this technique in all patients with primary spontaneous pneumothorax with first ipsilateral recurrence, first contralateral recurrence, prolonged air leak (>5 days), nonreexpansion of the lung, hemopneumothorax, synchronous bilateral pneumothorax, tension pneumothorax, and associated large bulla(e) diagnosed on chest CT. However, considering the morbidity associated with this procedure and considering the fact that only 50% of patients suffering a first episode of pneumothorax will ever require any type of operation, we do not advocate routine videothoracoscopic treatment at first episode, unless the patient asked for definitive therapy, had professional restrictions, or lived in an area with no medical facilities.

Table 4. Outcome After Open Operation for Spontaneous Pneumothorax (Transaxillary Approach and Posterolateral Thoracotomy)

Author/Year	No. of patients	Reoperation Within 15 Days (%)	Mean Follow-up (Months)	Recurrences (%)
Deslauriers, 1980 (pleurectomy)	362	0.8	4.5	0.6
Weeden, 1983 (pleurectomy)	233		56	0.4
Thevenet, 1992 (pleurectomy)	278	2.1	84	1
Nakata, 1993 (pleurabrasion)	100		52	3
Thomas, 1993 (pleurabrasion)	107		27	0
Bertrand, 1996 (pleurabrasion)	87		33	1.3
Körner, 1996 (no pleurodesis)	120	2	84	5

Because the VATS technique described in the present study carries a 3% to 6% rate of recurrence, we do not recommend its use in patients with a targeted 0% recurrence rate, such as aviators, scuba divers, crew members of nuclear-powered submarines, or other military personnel with special professional requirements. We currently use videothoracoscopic apical pleurectomy as the method of pleurodesis in those few patients with special requirements, and our current rate of recurrence is 0% in those patients. As stated by others, only pleurectomy resulted in less than 1% recurrence rates in most series involving long-term follow-up (Table 4) [4, 17].

In conclusion, videothoracoscopic blebs/bullae stapling combined with pleural abrasion represents a safe and reliable method for the treatment of patients with PSP. The long-term recurrence rate is grossly similar to that observed after identical operation performed by thoracotomy. Although chronic chest pain is observed in a minority of patients, it is unpredictable and may represent a real problem in young and sportive patients.

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