Is video-assisted thoracoscopic surgery superior to limited axillary thoracotomy in the management of spontaneous pneumothorax?

Meaghen J Hyland MHSc, Ahmad S Ashrafi MD,
André Crépeau MD, Reza J Mehran MD MSc
Division of Thoracic Surgery, Ottawa Hospital – General Campus, University of Ottawa, Ottawa, Ontario

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OBJECTIVE: To evaluate bullectomy and pleurectomy in the treatment of spontaneous pneumothorax (PNO) using video-assisted thoracoscopic surgery (VATS), and to compare the outcome with that of the same procedure performed using limited axillary thoracotomy (LAT).
DESIGN: A retrospective case series with patient follow-up.
SETTING: A Canadian tertiary care hospital.
PATIENTS: The medical records of all patients with a spontaneous PNO treated by either VATS or LAT at the Ottawa Hospital – General Campus, Ottawa, Ontario, between April 1993 and August 1999 were reviewed, and the patients were subsequently interviewed.
MAIN OUTCOME MEASURES: Operative details (length of operation, operative complications); postoperative details (duration of chest tube, length of hospital stay, duration of analgesia, pain, time missed from work, complications, recurrence rate); and cost (hospital and operative, socioeconomic [time missed from work]).
RESULTS: Fifty patients were identified who had had surgical treatment of a spontaneous PNO. Twenty-eight patients were treated by LAT and 22 underwent VATS. The median length of follow-up was 44.6 months (range four to 81.5 months). Three patients developed a recurrent PNO – two patients after LAT and one patient after VATS. No difference was found between the two groups in the operating time or in the amount of pain experienced immediately after surgery. However, patients who underwent VATS had a shorter length of stay (P=0.002) and a shorter requirement for analgesics postoperatively (P=0.03). Overall, the total cost of VATS was no different than that for LAT; however, in terms of socioeconomic costs, patients in the VATS group missed significantly less time from work postoperatively (P=0.02).
CONCLUSIONS: VATS offers a cost effective and better tolerated procedure for the management of spontaneous PNO than the time-honoured open technique.

Key Words: *Emphysema; Pneumothorax; Surgery; Thoracoscopy*

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Correspondence: Dr Reza Mehran, Division of Thoracic Surgery, Ottawa Hospital – General Campus, 501 Smyth Road, Ottawa, Ontario K1H 8L6. Telephone 613-737-8647, fax 613-737-8633, e-mail rmehran@ottawahospital.on.ca

La chirurgie thoracique vidéo-assistée est-elle supérieure à la thoracotomie axillaire restreinte pour le traitement du pneumothorax spontané?

OBJECTIF : Évaluer la bullectomie et la pleurectomie dans le traitement du pneumothorax spontané à l'aide de la chirurgie thoracique vidéo-assistée et comparer les résultats à ceux de la thoracotomie axillaire restreinte.
MODÈLE : Série de cas rétrospectifs avec suivi des patients.
CONTEXTE : Hôpital de soins tertiaires canadien.
PATIENTS : Les dossiers médicaux de tous les patients ayant présenté un pneumothorax spontané traités soit par chirurgie thoracique vidéo-assistée ou par thoracotomie axillaire à l'Hôpital Général d'Ottawa, Ottawa, Ontario, entre avril 1993 et août 1999 ont été passés en revue et les patients ont été interrogés par la suite.
PRINCIPAUX PARAMÈTRES : Les détails de la chirurgie (durée, complications), les détails de la période postopératoire (durée du drainage, durée du séjour hospitalier, durée de l'analgésie, douleur, absentéisme au travail, complications, taux de récurrence) et les coûts (hospitaliers et opératoires, socio-économiques [absentéisme au travail]).
RÉSULTATS : Cinquante patients ayant subi un traitement chirurgical pour pneumothorax spontané ont été recensés. Vingt-huit ont été traités par thoracotomie axillaire et vingt-deux par chirurgie thoracique vidéo-assistée. La durée moyenne du suivi a été de 44,6 mois (de 4 à 81,5 mois). Trois patients ont présenté une récurrence de pneumothorax, deux patients après la thoracotomie axillaire et un patient après la chirurgie thoracique vidéo-assistée. Aucune différence n'a pu être observée entre les deux groupes pour ce qui est de la durée de l'intervention ou de l'intensité de la douleur postopératoire. Par contre, les patients qui ont subi la chirurgie thoracique vidéo-assistée sont restés moins longtemps à l'hôpital (P = 0,002) et ont nécessité moins d'analgésiques après la chirurgie (P = 0,03). Dans l'ensemble, le coût total de la chirurgie thoracique vidéo-assistée n'a pas différé du coût de la thoracotomie axillaire. Par contre, sur le plan des coûts socio-économiques, les patients qui ont subi la chirurgie thoracique vidéo-assistée se sont absentés du travail beaucoup moins longtemps après l'intervention (P = 0,02).
CONCLUSION : La chirurgie thoracique vidéo-assistée constitue une intervention plus économique et mieux tolérée que la technique ouverte pour le traitement du pneumothorax spontané.

Spontaneous pneumothorax (PNO) occurs in more than seven/100,000 men and in more than one/100,000 women/year (1). It can be classified as primary PNO, which results from the rupture of a subpleural bleb when the underlying lung is otherwise normal, or secondary PNO, when there is underlying lung disease, usually bullous emphysema.

Treatment modalities for PNO range from conservative measures, including bed rest, aspiration and chest tube drainage, to more invasive methods, such as chemical pleurodesis, and surgical measures, using video-assisted thoracoscopic surgery (VATS) or limited axillary thoracotomy (LAT). The recurrence rate after conservative treatment has been estimated to be between 30% and 50% after the first PNO, but the rate is higher in patients with secondary PNO and more than one recurrence (2).

The commonly accepted indications for the surgical management of PNO are persistent air leak (for longer than seven days), recurrent PNO, contralateral PNO and first PNO occurring in people with certain high risk occupations (eg, pilots, scuba divers). The goals of treatment are to control the air leak by blebectomy or bullectomy, and to prevent recurrences by provoking pleural adhesions via a pleurectomy.

Traditional surgical therapy for PNO involved bullectomy and pleurectomy using open axillary thoracotomy. The use of VATS in the resection of bullae and partial pleurectomy for the management of PNO was first described in 1991 (3). The efficacy and safety of VATS in the treatment of PNO has been confirmed by numerous studies (4-6). Surgeons using thoracoscopic surgery claim that it is more cost effective (7,8) and that patients have fewer postoperative problems than those operated on using conventional thoracotomy methods (9,10). LAT, while achieving all of the goals of surgical management of PNO, exposes patients to the complications of post-thoracotomy pain, respiratory dysfunction and pneumonia.

Despite the evidence supporting the use of VATS in the management of PNO, some surgeons have their doubts about the therapeutic efficacy of VATS. This procedure has been reported to be associated with a higher recurrence rate of PNO than LAT (11), with which relapses generally do not exceed 0.5% (6). The indications for VATS in cases of PNO are thought to be the same as those for thoracotomy (6). However, some think that this procedure should be used with more caution in cases of secondary PNO due to the presence of adhesions and large multiple bullae (5,8).

The surgical management of PNO using VATS was introduced at the University of Ottawa, Ottawa, Ontario, in 1993 after the arrival of a new thoracic surgeon familiar with this technique. Since that time, VATS and LAT have both been used, depending on the surgeon performing the procedure, with the new surgeon (RJ Mehran) performing all procedures using VATS and the senior surgeon (A Crépeau) continuing to use the open technique. The objective of the present study was to review the treatment of PNO at our centre (Ottawa Hospital – General Campus) with LAT and VATS to evaluate the efficacy, morbidity and costs associated with the two procedures.

PATIENTS AND METHODS

A retrospective review of the medical records of all patients admitted with the diagnosis of spontaneous PNO and undergoing surgical management (VATS or LAT) was undertaken at the Ottawa Hospital – General Campus, a tertiary care institution affiliated with the University of Ottawa. The study period extended over a six-year span between April 1993 and August 1999.

The patient population was identified by the health records department at the Ottawa Hospital – General Campus using the appropriate diagnostic codes for PNO, and the procedure codes for the surgical correction of PNO by LAT or VATS. The duration of surgery, postoperative chest tube drainage and postoperative hospital length of stay were compared between the group of patients treated with LAT and the group treated with VATS. In addition, postsurgical complications were examined. A complication was defined as an event occurring within 30 days of the surgery, and included an air leak for longer than seven days, postoperative infection, bronchoscopy for retained secretions and conversion of a VATS procedure to an LAT procedure.

The recurrence rate of PNO after surgical correction was determined by chart review of patient emergency and outpatient visits to the Ottawa Hospital, and also prospectively. A recurrent PNO was defined as a repeat PNO at any time after corrective surgery using VATS or LAT.

Telephone follow-up of all patients was conducted to review their medical history since discharge and to interview patients on their experiences postoperatively. Patients were asked to estimate the amount of pain they had immediately after the surgery on a scale from 0 (no pain) to 5 (the worst pain that they had ever experienced). Other variables about which patients were asked included the length of time after the surgery that they required analgesia and the number of weeks of work missed. The interviewers were not blinded to the type of surgery before the intervention.

A comparison of the costs of VATS and LAT was based on the actual direct hospital costs of each patient's surgery and postoperative admission. These costs are calculated by the health records department based on expenses incurred that are directly related to patient care, including medical and/or nursing and/or operating personnel, and surgical and pharmacy costs. The cost of the tissue-stapling devices used in each surgery were added to each patient's direct costs, because these expenses are absent from the direct costs tabulated by the health records department. The cost data were available from 1996 onward; thus, this comparative analysis included nine of the 28 patients (32%) who had LAT and 14 of the 22 patients (63%) who underwent VATS.

Statistical methods: Data were entered into SPSS Version 8.0 (SPSS Inc, USA), which was used to calculate the descriptive statistics and to conduct two-tailed Student's *t* tests for equality of means. $P<0.05$ was considered statistically significant. Data are reported as mean (minimum, maximum).

Surgical technique: All patients underwent general anesthesia with a double-lumen endotracheal tube to allow selective ventilation.

VATS: In a full lateral decubitus position, three ports were used: one 12 mm nondisposable port for the camera, a nondisposable 5 mm port posterior to the scapula for a grasping forceps, and a 20 mm disposable Flexipath trocar (Ethicon endosurgery, Johnson & Johnson, USA) for the passage of the EZ 45 mm stapler device (Ethicon endosurgery) and tissue extraction. In all cases, blebs or bullae were stapled away from the apical segments of the upper lobe, followed by an apical pleurectomy. A 28-F chest tube was inserted through the thoracoscope trocar.

LAT: A 10 to 15 cm skin incision was made along the rib orientation in the axillary fossa. The thoracic cavity was entered through the third intercostal space. The intercostal space was enlarged using a Tuffier retractor. Bullae were identified and stapled off with a Proximate 75 mm (Ethicon endosurgery). Dry sponge (mechanical) pleurodesis and a limited apical pleurectomy were performed. One 28-F chest tube was inserted through a separate incision.

At the time of surgery, all patients had an intercostal block with bupivacaine hydrochloride (Marcaine, Abbott Laboratories Limited, Canada) and a patient-controlled analgesia or an intrapleural catheter for continuous delivery of local analgesia, with each method of pain control being divided equally between the two groups of patients. On discharge, all patients were prescribed a similar mixture of acetaminophen 350 mg and codeine 30 mg for postoperative analgesia.

TABLE 1
Demographics of 50 patients who were treated for spontaneous pneumothorax (PNO) with limited axillary thoracotomy (LAT) and video-assisted thoracoscopic surgery (VATS)

	LAT (n=28)	VATS (n=22)
Male to female ratio	21:7	14:8
Mean age (years)	35 (17 to 77)	33 (17 to 71)
Mean number of PNOs	1.7 (1 to 3)	2.4 (1 to 10)
Mean follow-up (months)	44 (4 to 71)	39 (11 to 81)

Numbers in parentheses are ranges

RESULTS

Fifty patients were identified who had had surgical treatment of spontaneous PNO with bullectomy and apical pleurectomy during the study period (Table 1). Twenty-eight patients (56%) were treated by LAT between February 1994 and August 1999, while 22 patients (44%) were treated by VATS between April 1993 and January 1999. No cases were converted from VATS to LAT, and no patients died from complications related to the procedure.

All 50 charts were available for review in the health records department. Forty-eight of 50 patients were contacted by telephone during the study for follow-up and completion of a retrospective questionnaire. Two of 50 patients (4%) were lost to follow-up (unable to be located by telephone).

The demographics of patients undergoing LAT and VATS were similar (Table 1). Overall, the mean age of all patients was 34 years (range 17 to 77 years), 70% of patients were male and 71% of patients had a history of smoking. The indications for surgery included recurrent PNO and persistent air leak after a first PNO. Treatment

TABLE 2
The comparison of variables among patients who received video-assisted thoracoscopic surgery (VATS) and limited axillary thoracotomy (LAT) for the treatment of spontaneous pneumothorax

Variable	LAT	VATS	P
Mean operating room time (min)	49 (35 to 100)	47 (30 to 80)	NS
Number of complications (%)	4 (14.3)	2 (9.1)	S
Number of recurrences (%)	2 (7.1)	1 (4.5)	NS
Mean total cost*	3007 (1952 to 5110)	2533 (1303 to 6258)	NS
Mean pain score†	3	3	NS
Mean use of analgesia (days)	35 (0 to 180)	10 (2 to 30)	0.05
Mean length of stay postoperatively (days)	6 (3 to 14)	4 (2 to 13)	0.002
Mean duration chest tube postoperatively (days)	12 (2 to 195)	3 (1 to 10)	>0.05‡
Time off of work (weeks)	7 (1 to 24)	3 (1 to 8)	0.05

**The total direct hospital costs since 1996 are expenses incurred from direct patient care (eg, physician, nursing, pharmacy and operating costs); †The pain scale ranges from 0 (no pain) to 5 (most severe pain); ‡If one outliner with 195 days of chest tube drainage postoperatively is omitted from the calculations, P=0.001*

before surgery included a chest tube in 38 patients (78%) for an average of three days in the VATS group and five days in the LAT group.

The variables for each study group are reported in Table 2. Immediately after surgery, patients in the two groups reported similar amounts of pain on a pain scale ranging from 0 (no pain) to 5 (most severe pain). Despite similar pain scores initially, analgesia was required for a greater period of time among patients who underwent LAT. Patients who underwent LAT required significantly longer hospitalizations. Finally, patients with LAT missed more time from work than patients with VATS (Table 2).

Four patients with LAT and two patients with VATS had postoperative complications. Among the complications after LAT was a residual PNO in one patient that resolved on its own. Another patient had a persistent air leak requiring chest tube drainage for more than seven days. A third patient required bronchoscopy on days 3 and 4 postoperatively for retained secretions. A postoperative infection occurred in a fourth patient, who developed pneumonia two weeks after LAT. Among the two patients with surgical complications after VATS, one patient developed an empyema requiring intravenous antibiotics and chest drainage, and the second patient had a persistent air leak that required a chest tube for nine days.

A recurrent PNO occurred in one patient (4.5%) who had had VATS almost two years after the surgery, and in two patients (7.1%) who had had LAT at eight months and two years after the surgery. All three of these recurrences were identified on chest x-ray, which was prescribed for the sudden onset of chest pain; two cases resolved spontaneously, while one LAT case resolved after treatment with a chest tube.

DISCUSSION

VATS is an alternative technique that enables good access to the chest, similar to open thoracotomy. The main difference is in the amount of tissue injury necessary to obtain the access. VATS requires no rib distraction, and minimal or no muscular and chest wall dissection. Whether this makes any difference in the final outcome of the patient is a matter of contention, similar to that which existed between laparoscopic cholecystectomy and the open technique a decade ago (12). At our centre, the senior thoracic surgeon maintains the superiority of the time-honoured technique, while the younger specialists trained in laparoscopic surgery may be more adventurous and looking for a niche in a specialty that has seen very little technical advancement in the past 40 years.

Despite the less invasive exposure technique of VATS, we noted no difference in the amount of pain between the two groups in the immediate postoperative period. The reason for the similar amount of discomfort in the VATS group is undoubtedly related to the number of trocars that are necessary to gain exposure and with each, the risk of irritation, if not injury, to the intercostal pedicle (13).

However, when patients who have had VATS are followed up over weeks and months, they have a faster recovery as shown by the amount of analgesia and the time off of work that were required until full recovery was achieved. It is well understood that VATS results in a reduced inflammatory response as shown by a decrease in the release of mediators of inflammation (14). The diminished effect of these mediators locally and systemically results in faster healing and a more rapid feeling of well-being.

We found no difference in the recurrence rate of PNO after either procedure. We found, however, that VATS allows a better overall exposure of the intrathoracic structures, which could be useful in cases where the culprit blebs are not located at the apex of the lung.

The overall cost for VATS was similar to that for LAT, because the shorter hospital stay offset the greater cost of the disposable equipment used with the VATS procedure.

CONCLUSIONS

Despite the bias in the study introduced by the retrospective design and the follow-up questionnaire, we conclude that VATS appears to be a very safe, elegant and better tolerated procedure than the time-honoured LAT procedure. VATS should be taught in all thoracic training programs, because the procedure will gain more popularity in the years to come.

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