Transitioning from multiple ports to a single port in video-assisted thoracic surgery: early results

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Abstract: Single-port video-assisted thoracic surgery (SPVATS) is a relatively new minimally invasive thoracic approach and is rapidly being adopted around the world. SPVATS is not merely a variation of the established multi-portal VATS, because it requires specific skills. We here describe our transition from 2-port VATS to SPVATS. From January 2017 to May 2018, we performed SPVATS in 54 patients. The procedures performed included 21 anatomic lung resections and 23 decortications for empyema. Perioperative outcomes were good with few complications and low postoperative pain scores. Despite some challenges due to our location and public health system, we successfully integrated SPVATS into our operative repertoire in a relatively short time.

Keywords: Video-assisted thoracic surgery (VATS); uniportal surgery; lobectomy

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Introduction

Video-assisted thoracic surgery (VATS) is continuously evolving (1) and according to current guidelines from the National Comprehensive Cancer Network (NCCN) and European Society of Thoracic Surgeons (ESTS) is now considered the standard approach to manage lung cancer. A VATS lobectomy has several advantages over lobectomy via thoracotomy including a shorter hospital stay, shorter duration of chest tube drainage, less postoperative loss of respiratory function, and fewer surgical complications (2). In the early 1990s, VATS operations were done through 3 to 4 surgical ports, but gradually surgeons began to use only 2 ports (3). The development of articulated staplers and other purposely designed instruments for VATS has greatly facilitated minimally invasive surgery for major pulmonary resections to the point where many can be performed through a single incision (4).

In 2014, I finished my residency at Holy House of Mercy Hospital Porto Alegre, a major center for thoracic surgery and lung transplantation in Latin America, where I had been exposed to VATS procedures and returned to my hometown. I started working with my father, a thoracic surgeon with a large experience in open lung resections. The combination of a motivated young surgeon fully trained in VATS and an experienced senior surgeon was perfect to start performing our first video-assisted resections at Doctor Beda General Hospital, in Rio de Janeiro, Brazil. In the beginning, we performed the VATS procedures with conventional thoracic surgery supplies and used 2 or more ports. We became more efficient and our learning curve was accelerated after the acquisition of specific instruments for VATS. I began to perform single-port VATS (SPVATS) for main pulmonary resections (lobectomy and anatomic segmentectomy) in December 2017.

Once we acquired VATS-specific tools and sufficient experience, we began transitioning other surgeons in our department to VATS as a preferred approach for lung resections. Our department began performing SPVATS in January 2017 for treatment of pleural diseases and some wedge resections. In recent years, our staff received further training on more advanced VATS procedures by attending international courses and exchanging experience with leaders in the field. Our department the referral center for

Figure 1 Uniportal approach: preemptive intercostal nerve block (6). Available online: http://www.asvide.com/article/view/27818

in a region of approximately 1 million inhabitants and has a large percentage of the population that depends on the public health system. Our objective here is to describe our experience of transitioning from multiple-port VATS to SPVATS in a developing country.

Materials and methods

We performed retrospective analysis of patients who underwent uniportal VATS procedures for treatment of pulmonary and pleural disease by our department, between January 2017 and June 2018. The study was approved by the Institutional Review Board of Doctor Beda General Hospital, and all patients consented to participation in the study. The patients were divided into two groups for analysis: one group included only patients who had undergone lung anatomic resection via SPVATS, and the other group was composed of patients who had undergone other procedures using SPVATS including pulmonary wedge resection, pulmonary biopsy and treatment of pleural effusions (neoplastic and empyemic). For the main pulmonary resections, the preoperative workup included pulmonary function tests and a chest computed tomography (CT) scan. Mediastinoscopy was performed unless the tumor was staged as 1A by the CT scans. In most patients, the diagnosis was achieved only upon examination of the histological specimen.

The variables examined for this study were number of days to discharge after their procedure, postoperative pain, and complications. Clinical features, including age, sex, disease location, tumor stage, tumor histology, operation duration, and complications, were recorded. We used the visual analogue scale (VAS) [0–10] to classify the postoperative pain (5).

Surgical technique

All surgical procedures were performed under general anesthesia with double-lumen endotracheal tube placement for one-lung ventilation. The patients were placed in a lateral decubitus position with an axillary cushion and lower chest cushion. A preemptive intercostal nerve block was routinely done in the 3rd, 4th and 5th intercostal spaces. The surgical incision (3.5–4.5 cm in length) was created in the 4th intercostal space for upper lobe resection or 5th intercostal space for lower lobe resection or decortication and placed between the anterior and middle axillary line at the diseased side. After transecting the serratus anterior muscle, I tunnel with my finger using the rib as a rail under the serratus, which allows extended transection of the intercostal muscle (*Figure 1*). This maneuver promoted better exposure, more comfort during the procedure, and easier removal of the specimen from the cavity especially for larger tumors. An incision protector was applied in the port, but the ribs were not retracted. A 10-mm 30-degree camera and Scanlan® VATS-specific equipment was used for all procedures.

Most patients in our referral zone depend on Brazil's public health system, which does not allow the use of disposables for VATS due to their high cost. So, we had to develop a technique for doing uniportal VATS resections without endoscopic staplers. In these cases, we used anatomic information from the CT scan to select patients with a favorable, easy-to-dissect fissure and confirmed suitability at the beginning of the procedure with a thoracoscopy. Hemostasis was obtained using only a hook tool, and the vessels and bronchi were controlled using stiches and a Duval clamp as a knot pusher (*Figure 2*). In patients who paid privately, endoscopic staplers and other disposables, including ultrasonic devices such as the Ligasure® vessel sealing device and the Ultracision® harmonic scalpel, were used.

The uniportal approach demands a systematic way to dissect the hilar structures. In contrast to multiportal procedures, where the surgeon can angulate the staplers from different positions, during SPVATS all the instruments must go through the same incision, so the dissection of the vessels needs to be more extensive and systematic, especially of the pulmonary vein, allowing a greater mobility to apply traction to the thoracic structures. This makes the stapler angulation more comfortable and safe and prevents vascular

Figure 2 Manual suture of vascular and bronchial stumps (7).
Available online: http://www.asvide.com/article/view/27819

injury. Specific VATS instruments allow up to 5 or more instruments at the same incision without a problem. We were unable to convert to SPVATS until we had acquired these instruments.

When the lobectomy was completed, the lobe was removed in a protective bag, and a systematic lymph node dissection was accomplished. The intercostal spaces were infiltrated with bupivacaine at the end of the surgery under thoracoscopic view (4), and a 22–26 Fr chest tube was placed for drainage.

Postoperative course

Patients with comorbidities went to a 1-night stay in the intensive care unit. All patients were submitted to early mobilization and respiratory exercises in the first 6 hours after the procedure. Intravenous analgesics and anti-inflammatory medication were given until hospital discharge.

Results

During the study period, our department performed SPVATS in 54 patients. All procedures were completed by SPVATS; there were no conversions to multiport VATS or thoracotomy. The median age of the 26 women (48.2%) and 28 men (51.8%) was 56, 18 (range, 1–86) years (*Table 1*). The incidence of inflammatory diseases in our country is very high. Tuberculosis and bronchiectasis are very common and are frequently accompanied by complicated pleural effusions. Because of these patient demographics, the most frequent SPVATS procedure was decortication for treatment of empyema (23 patients). Eighteen patients underwent to anatomic pulmonary resections.

Table 1 Patient characteristics

Characteristic	N (%)[1]
Age (in years, mean ± SD)	56.2±10.3
Sex	
Male	28 (51.8)
Female	26 (48.2)
Payer	
Public health system	30 (55.6)
Private	24 (44.4)
Diagnosis (all patients)	
Cancer	
NSCLC	12 (22.2)
Secondary lung cancer	13 (24.3)
Benign	
Bronchiectasis	2 (3.7)
Pneumothorax	1 (1.8)
Empyema	23 (42.6)
Arteriovenous malformation	1 (1.8)
Chylothorax	1 (1.8)
Necrotising pneumonia	1 (1.8)
Diagnosis (patients who underwent lung anatomic resection)	
Cancer	
NSCLC	12 (66.7)
Secondary lung cancer	2 (11.1)
Benign	4 (22.2)

[1], unless otherwise noted. NSCLC, non-small cell lung cancer; SD, standard deviation.

SPVATS for anatomic lung resection

We performed 21 lung anatomic resection using SPVATS in 18 patients—12 men (66.7%) and 6 women (33.3%) ranging in age from 17 to 87 years, primarily for non-small cell lung cancer (NSCLC). Other indications for anatomic resection were bilateral pulmonary arteriovenous malformation (1 patient), bronchiectasis (2 patients), and necrotizing pneumonia due to methicillin-resistant *Staphylococcus aureus* (1 patient).

Table 2 Surgical characteristics

Surgery	N (%)
Lung anatomic resections, N=21	
Lobectomy	14 (66.7)
Right upper lobe	3
Right middle lobe	2
Right lower lobe	0
Bilobectomy (right upper + middle lobe)	1
Left upper lobe	4
Left lower lobe	5
Segmentectomy	6 (28.6)
Bilobectomy	1 (4.8)
Other thoracic surgeries, N=36	
Wedge resection	11 (30.5)
Decortication	23 (63.9)
Ligation of thoracic duct	1 (2.8)
Bullectomy	1 (2.8)

Table 3 Complications after single-port thoracic surgery

Complication[1]	SPVATS lung anatomic resections (N=21)	Other SPVATS thoracic surgeries (N=36)
Minor complications		
Prolonged air leak	1 (4.8%)	1 (2.8%)
Heart rhythm disorders	1 (4.8%)	0 (0%)
Pulmonary tract infection	1 (4.8%)	0 (0%)
Major complications		
ARDS	2 (9.5%)	1 (2.8%)
Pneumonia requiring ICU	0	0 (0%)
Bronchopleural fistulae	1 (4.8%)	0 (0%)
Chylothorax[2]	0 (0%)	0 (0%)
Hemothorax	0 (0%)	2 (5.6%)
Cardiogenic shock	1 (4.8%)	0 (0%)
Postoperative pain[3]	3-0	4-0
Hospital length of stay, median (IQR)	3 (1 to 8) days	4 (2 to 6) days after decortication 2 (1 to 3) days after wedge resection

[1], some patients experienced more than 1 complication; [2], requiring surgical repair; [3], as measured by visual analog scale. SOVATS, single-port video-assisted thoracic surgery; ARDS, acute respiratory distress syndrome; ICU, intensive care unit; IQR, interquartile range.

Most of the lung anatomic resections were lobectomies (15 procedures, 71.4%). We also performed 6 anatomic segmentectomies (28.6%) including 1 trisegmentectomy, 1 lingulectomy, 2 basal segmentectomies, 1 left lower lobe superior segment resection, and 1 left lower lobe anteromedial segment resection (*Table 2*). Anatomic lung resection was successfully performed with SPVATS in all patients. Most of the patients had a final diagnosis of NSCLC (12 patients 66.7%). We resected 2 metastases with a hilar component (*Table 1*).

Three patients had more than one procedure. Of these patients, one had a bilateral pulmonary arteriovenous malformation in the right middle lobe and the apical-posterior segment of the left upper lobe, which we treated with sequential middle lobe lobectomy and trisegmentectomy. The second patient had a necrotizing pneumonia due to methicillin-resistant *Staphylococcus aureus* and initially underwent a right middle lobe lobectomy, but developed a bronchopleural fistula caused by necrosis of the right upper lobe, which was then treated with a second SPVATS lobectomy. The third patient had a postoperative bronchopleural fistula because of a large bulla that formed in the upper segment of left lower lobe after a left upper lobectomy. A SPVATS anatomic segmentectomy was then performed to resect the bulla.

The median length of hospitalization for patients who underwent lung anatomic resection with an intended SPVATS approach was 3 days (1–8 days). Most patients were cared for in the regular hospital wards after SPVATS. Patients with comorbidities, such as hypertension and cardiovascular disease, diabetes, or SPVATS over 4 hours in duration, spent the first postoperative day in the intensive care unit. The main complications we observed after SPVATS were a 5-day air leak in patient who underwent inferior lower lobe lobectomy and the death of a patient with a postoperative arrhythmia on the third day after upper left lobe resection (*Table 3*). There was no postoperative pain graded >4 on a 10-point visual analogue scale after the adoption of the SPVATS approach. After the removal of the chest tube, all patients were discharged following confirmation of lung re-expansion by chest X-rays.

Other SPVATS procedures

During the study period, our department performed 36 SPVATS procedures that were not lung anatomic resections. SPVATS was used for decortication for empyema, wedge resection, ligation of thoracic duct for chylothorax, and bullectomy (*Table 2*). If palpation was needed to locate the nodule during wedge resection, the operative time was longer, because the finger inserted for palpation competed for space in the single incision and did not allow good angulation of the camera and lung grasper. The median length of hospital stay was 4 days (IQR, 2–6 days) after decortication and 2 days (1–3 days) after wedge resection. We had to re-intervene using 2-port VATS in 1 patient who developed a hemothorax the second day after decortication. The wedge resections were performed to treat lung metastasis in 12 patients. There were no postoperative air leaks or empyema in this group (*Table 3*). No mortality was recorded in the patients who underwent SPVATS for procedures other than anatomic lung resection.

Discussion

In this study, we report the results of our first SPVATS series. Notably, even though our department is not located in a large center, we migrated to single-port techniques over a very short time with excellent results. This was possible through the acquisition of specific supplies for SPVATS, continuing education, and the systematization of all our approaches. Although there are some limitations in the present study, such as the small number of patients and the short follow-up period, our experience should be valuable to other surgeons adopting SPVATS under similar working conditions.

During our transition to SPVATS, we noticed that the vision provided using SPVATS was similar to that provided by open surgery, thus facilitating visualization during the surgery as well as the accomplishment of the maneuvers of dissection in the cavity. On the other hand, the aid of the camera assistant became less ergonomic because of competition for space in the single incision, which required a more difficult adaptation. Yang and colleagues made a similar observation, that the SPVATS is geometrically favorable when compared with multiport techniques (8). Liu and colleagues reported that a single-port VATS lobectomy has many advantages, including shorter surgery time and more resected lymph nodes as compared with multiple-port VATS (9), which is also consistent with our results.

Postoperative pain was low in the single-port VATS, which may be attributed to reduced intercostal nerve injury and the presence of only one incision after the SPVATS procedure. This result is in accordance with previous studies. For example, Wang and colleague compared the results of a single-incision thoracoscopy and three-incision thoracoscopy and demonstrated that the single-incision group had a lower pain score (10). The patients who underwent SPVATS also had significantly higher satisfaction scores than those who underwent multi-port VATS. This was probably because the SPVATS is cosmetically appealing with less postoperative pain.

In conclusion, single-port VATS lobectomy is suggested to be safe and feasible for treating NSCLC. Compared with 2-port VATS, single-port VATS has many advantages including less blood loss, less postoperative pain and higher patient satisfaction (2). We were successful in adopting SPVATS at a regional hospital in Brazil, despite the need to adapt some technical aspects from those typical in wealthier countries.

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Footnote

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