Video-Assisted Thoracic Surgery for Pulmonary Aspergilloma: A Safe and Effective Procedure

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Background. A variety of complications occur in patients with pulmonary aspergilloma. The safety and feasibility of a thoracoscopic approach to therapeutic lung resection for pulmonary aspergilloma have not been well evaluated.

Methods. The medical records of patients who underwent video-assisted thoracic surgery (VATS) or a thoracotomy for therapeutic resection of pulmonary aspergilloma between January 2005 and December 2012 were retrospectively reviewed for age, sex, indications for surgery, approach and procedures, postoperative pain, operative time, blood loss, hospital stay, cost, and complications.

Results. A total of 310 patients underwent thoracotomy, 76 patients underwent attempted VATS lobectomy. Seventy-six patients from 310 patients for thoracotomy were selected and compared with the VATS group. Nine cases (11.8%) in the VATS group were converted to a thoracotomy for the following reasons: bleeding (n = 2); dense fibrous adhesions (n = 3); fused interlobar fissure (n = 2); and hilar lymphadenopathy (n = 2). Lesions treated with pneumonectomy failed to be done using VATS. There was no difference in the blood loss and median operative time between the 2 groups, but the patients with VATS had shorter length of stay in the hospital (p = 0.035) and fewer complications (p = 0.032) than those with thoracotomy.

Conclusions. Video-assisted thoracic surgery is an alternative to open procedures in the management of pulmonary aspergilloma. Simple aspergilloma and complex aspergilloma without infiltration of the hilum are good candidates for VATS resection. Aspergilloma lesions that require a pneumonectomy are still a major challenge for VATS.

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Patients and Methods

We retrospectively reviewed the records of consecutive patients with pulmonary aspergilloma who underwent surgical intervention between January 2005 and December 2012 at the Department of Thoracic Surgery of Shanghai Pulmonary Hospital, affiliated with Tongji University, China. Patients were chosen as candidates for VATS surgical treatment or thoracotomy according to the following criteria: localized pulmonary aspergilloma documented by computed tomography (CT); adequate cardiopulmonary reserve; and obvious symptom failure of medical treatment. The extent of pulmonary resection was determined by the degree of lung function, the amount of involvement by the aspergilloma, the location of the aspergilloma, and the extent of the underlying disease.

The selection of VATS was based mainly on the judgment of surgeons. The following patients were considered to be the candidates for VATS procedure: young patients with aesthetic demands; there was no severe parenchymal and (or) pleural scarring and no calcified lymph nodes near pulmonary arteries and veins based on CT scan; CT scan image findings showed simple aspergilloma (SPA) or localized complex aspergilloma (CPA). According to previous reports [5, 6], SPA has a thin-walled cavity (symptomatic “air-crescent” lesion) with little or no surrounding parenchymal disease. In contrast, CPA has a thick-walled cavity, surrounding parenchymal...
disease, and greater pleural thickening. Patients with evidence for severe parenchymal disease and (or) pleural scarring on CT scan often underwent thoracotomy.

Patients were placed in the lateral decubitus position and one-lung ventilation was established through a double-lumen endotracheal tube. The open procedure was done through a conventional posterolateral serratus-dividing thoracotomy. Video-assisted thoracic surgery was performed through a 3-port access incision. Two entry-port incisions were made to introduce 12-mm trocars; 1 in the seventh or eighth intercostal space (depending on the patient’s thorax configuration) in the midaxillary line, and the second just below the scapular vertex in the sixth or seventh intercostal space. Having confirmed the viability of the technique, an anterior (approximately 3-cm long) incision was placed over the third or fourth intercostal space without rib spreading. There was no difference in our VATS technique for aspergilloma versus for the usually easier cancer cases, and it was unnecessary to change the port locations even if adhesions were expected. Itraconazole was started after surgery and continued for at least 3 months after hospital discharge. Anti-tubercular drugs were given postoperatively as a routine for the patients with preexisting tuberculosis. All specimens had pathologic confirmation of pulmonary aspergilloma. Pain was quantitated by an 11-point pain scale (0 = no pain, 10 = maximal imaginable pain) on postoperative days 0, 1, 2, 3, 7, 14, and 30.[7]

Informed consent was waived because the study was retrospective, and the review of medical records was approved by the Medical College Review Board of Tongji University, Shanghai, China.

Statistical Analysis

Patient data were presented as either median and range for quantitative variables or absolute and relative frequencies for qualitative variables. Patient characteristics and perioperative data were compared using the Student t and χ² tests. Statistical significance was defined as a p value of less than 0.05.

We chose to match VATS and thoracotomy patients in a 1-to-1 fashion by using all available clinical data. This was performed by constructing propensity scores [8] using all preoperative variables that might have an effect on the result of the surgical treatment of pulmonary aspergilloma (shown in Table 1). Pairwise matches were based on the nearest propensity scores.

Results

Between January 2005 and December 2012, 386 patients with pulmonary aspergilloma were diagnosed in our department. Among them, 310 patients underwent thoracotomy and 76 patients underwent attempted VATS procedure. Seventy-six patients from the 310 patients for thoracotomy were selected and were compared with the VATS group. Patient characteristics are shown in Table 1.

In the VATS group, the presenting symptoms included hemoptysis in 32 patients (42.1%), cough in 28 patients (36.8%), sputum in 6 patients (0.8%), chest pain in 6 patients (0.8%), and no symptoms in 4 patients (0.5%). No patients were found for emergency procedures (eg, massive hemorrhage) in either group, and all operations were performed electively. Pleural adhesion was observed in 26 patients (34.2%) in the VATS group. In 9 cases (11.8%), the VATS procedure was converted to a thoracotomy for the following reasons: bleeding (n = 2); dense fibrous adhesions (n = 3); fused interlobar fissure (n = 2); and hilar lymphadenopathy (n = 2). The VATS cases converted to thoracotomy were analyzed as part of the VATS group. We tried to treat patients with a pneumonectomy but failed to be done using VATS (p = 0.152). Intraoperative or postoperative transfusions were not needed.

There was no difference in the blood loss and median operative time between the 2 groups; however, the patients in the VATS group had a shorter length of stay in the hospital (p = 0.035) (as shown in Table 2) and less complications (p = 0.032) as compared with those in the thoracotomy group (as shown in Table 3). The VATS group patients also had significantly less pain than those in the thoracotomy group after procedure, p = 0.018 (Fig 1).

Table 1. Characteristics for VATS and Thoracotomy Patients in Propensity-Matched Group

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>VATS (n = 76)</th>
<th>Thoracotomy (n = 76)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/sex</td>
<td>46</td>
<td>48</td>
<td>0.156</td>
</tr>
<tr>
<td>Age, years (mean)</td>
<td>43.0 ± 6.7</td>
<td>43.0 ± 7.3</td>
<td>0.915</td>
</tr>
<tr>
<td>FEV₁ (%) predicted</td>
<td>86 ± 15</td>
<td>83 ± 20</td>
<td>0.061</td>
</tr>
<tr>
<td>Simple aspergilloma (SPA)</td>
<td>52</td>
<td>48</td>
<td>0.251</td>
</tr>
<tr>
<td>Duration of symptoms (months)</td>
<td>20.3 ± 9.4</td>
<td>23.2 ± 11.5</td>
<td>0.074</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberculosis history</td>
<td>16</td>
<td>18</td>
<td>0.712</td>
</tr>
<tr>
<td>Hypertension</td>
<td>6</td>
<td>5</td>
<td>0.238</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3</td>
<td>4</td>
<td>0.562</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>5</td>
<td>7</td>
<td>0.451</td>
</tr>
<tr>
<td>Bronchogenic cyst</td>
<td>2</td>
<td>4</td>
<td>0.354</td>
</tr>
</tbody>
</table>

FEV₁ = forced expiratory volume in the first second of expiration; VATS = video-assisted thoracoscopic surgery.
No perioperative deaths occurred in either group. In VATS, postoperative complications were found in 8 patients (Table 3). Postoperative fungal relapse was found in 1 patient in the VATS group after a wedge resection. This patient was treated successfully with a second operation of a complete lobectomy. The other 7 patients experienced minor complications, which were cured by conservative therapy. Nine patients converted to thoracotomy recovered well except 1 patient who experienced postoperative cardiac arrhythmia. In thoracotomy, more patients (total 16) experienced postoperative complications as compared with those in the VATS group.

Six patients were lost to follow-up; the rest had follow-up periods ranging from 3 to 80 months with a mean of 38.0 months, after which they were discharged to the referring physician. During follow-up, none of the patients died of pulmonary problems nor had symptoms attributable to aspergilloma.

Comment

In spite of the recent achievements in thoracic surgery, dealing with pulmonary aspergilloma remains a serious challenge for thoracic surgeons. The VATS pulmonary resection, recognized as an equally effective, minimally invasive approach for stage I lung cancer [9, 10], has become an established alternative approach to conventional open surgery for selected patients. Video-assisted thoracoscopic surgery may become a potentially new surgical choice for the treatment of pulmonary aspergilloma. However, there have been only a small number of similar reports published about the role of VATS for aspergilloma [11–14].

The results of our study demonstrate that VATS is a safe alternative to open procedures in the management of selected cases of pulmonary aspergilloma. Young patients or high-risk patients with the following are eligible for VATS: (1) localized pulmonary aspergillum; (2) no severe pulmonary or pleural scaring; and (3) absence of lymph nodes near pulmonary vessels. It should be noted that CT alone is not a reliable guide to the technical difficulty for VATS. In some cases, fewer adhesions were encountered than we had expected, even though the CT showed marked pleural reaction. In our opinion, more liberal use as well as initial attempt of VATS should be advocated as an adjunct for pulmonary aspergilloma patients with localized parenchymal lesions.

Although complicated situations may be encountered during the operation, VATS is also feasible especially when the pleural cavity is not so obliterated with the dense fibrous adhesions. Such cases have therefore become a relative rather than an absolute contraindication for VATS. The amount of blood loss and the risk of complications will be significantly lowered more than usual if dissection of pleural adhesions and control of bleeding are facilitated by the sharp vision of the VATS system. Otherwise, for thoracotomy, a supplementary incision might be employed for the mobilization.

In our series, SPA is the most common indication for VATS, and there were 52 (68.4%) patients with SPA in the VATS group. Considering our experience, VATS can be safely applied to SPA and CPA without infiltration of the hilum, but the application of VATS in the case of CPA close to the hilum or CPA in patients after mediastinal lymph node dissection needs careful consideration.

<table>
<thead>
<tr>
<th>Complications</th>
<th>VATS (n = 76)</th>
<th>Thoracotomy (n = 76)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Atelectasis</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>recurrence</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Persistent air leak more than 2 weeks</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cardiac arrhythmia</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Empyema</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Respiratory insufficiency</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Residual pleural space</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Bronchopleural fistula</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>16</td>
<td>0.032</td>
</tr>
</tbody>
</table>

VATS = video-assisted thoracoscopic surgery.
because dissection of the vessels and bronchi is remarkably difficult. Extensive adhesions to the hilum and calcified lymph nodes near pulmonary arteries are the key limiting factors for a safe VATS major resection. It is obviously wise to quickly convert to a thoracotomy whenever facing intraoperative difficulty [15]. Larger aspergilloma (≥5 cm in diameter) within 1 lobe could also be resected with VATS. However, it often takes a larger incision to facilitate the dissection and extract the specimen.

When the aspergilloma is sufficiently small and is located in the lung periphery, and the underlying lung is healthy, wedge excision can be performed. Shirakusa and colleagues [16] wrote that, because of the saprophytic character of the organism, it is desirable to limit the resection as much as possible so as not to decrease lung function, especially for high-risk patients. In our series, the number of segmentectomies and wedge resections was higher in the VATS group. Based on our experience, wedge resection and segmentectomy are difficult due to the large size and central site of the lesion. In this study, postoperative fungal relapse was found in 1 patient after a wedge resection by VATS. Although the greatest possible amount of healthy parenchyma must be spared, radical resection with enough margin of affected areas most effectively improves patients’ outcomes. We are inclined to choose complete lobectomy to avoid possible complications and recurrence for the patients with the large size of the lesion. Lesions involving the upper lobe and superior segment of the lower lobe usually had dense adhesion in fissures and compromised VATS vessel control, and thus made VATS lobectomy concomitant with segmentectomy difficult. However, this kind of operative procedure still could be done using VATS in selected patients, especially those with right lung lesions [17]. In our experience, pneumonectomy is not suitable for VATS. Different from a pneumonectomy performed for lung cancer patients, in patients with pulmonary aspergilloma, shifted mediastinum, the narrowed intercostal space, severe adhesion, and calcified lymph nodes around the bronchus and vessels that are always combined with distortion of the lobar anatomy hinder a VATS pneumonectomy.

Of the complications, postoperative persistent air leaks resulting from release of pleural adhesions is the most common morbidity after both VATS as well as open lobectomy for inflammatory disease [4]. However, in our series only 1 patient in the VATS group had experienced prolonged air leak. We preferred to suture the lung wounds with 5-0 Prolene (Ethicon, Somerville, NJ) by VATS. This procedure could effectively prevent air leak.

The resection of infected or purulent lesions through minimal access may predispose to contamination of the pleural cavity and wound, leading to empyema and wound infection. However, in our series no patient suffered from postoperative empyema or wound contamination. In our experience VATS should be performed very carefully to avoid the intraoperative dissemination that may lead to empyema, especially for the cases of CPA. It is a routine in our institute that, before closing, around 3,000 mL neomycin sulfate solution was used to clean the cavity and the incision to avoid the contamination [3].

Many vessels supplying the lesion from the bronchial, intercostal, subclavian, and internal thoracic arteries often run through the adhesion site to the thoracic wall [18], and their preoperative embolization leads to the
alleviation of symptoms such as hemoptysis and bloody sputum, and reduces hemorrhage during the adhesiomy. Therefore, we suggest a preoperative embolization to the patients with the symptom of hemoptysis, especially to the patients with dense adhesions based on imaging findings [3].

In previous series, complications of bronchopleural fistula were reported between 1.6% and 15.8% [3, 19, 20]. There was 1 case of postoperative bronchopleural fistulas, but only in the thoracotomy group. Although it has been acknowledged that the bronchial stump should be reinforced with a viable intercostal muscle, pleural flaps, or a pericardial fat pad [19–21], we did reinforcement only in selected cases. If peribronchial lymph nodes and soft tissue needed to be dissected off to facilitate bronchial stump control, we used a pleural or intercostal muscle flap to cover the stump to prevent complications. Because the healing of the bronchial stump is associated with peribronchial lymph node or soft tissue coverage, which has been considered as the most significant cause of bronchopleural fistulas [22], we emphasize that excessive dissection of the peribronchial tissue should be avoided to preserve perfusion. Another important surgical aspect is that bronchoscopy must be performed as a routine preoperatively to make sure that there is no engorgement or edema in the tunica mucosa.

Our results show a decrease in postoperative complications in the VATS group, which supports similar results in the literature from studies comparing thoracoscopic and open pulmonary resections [23, 24]. Some authors pointed out that the thoracoscopic approach resulted in reductions in postoperative chest tube duration and overall hospital length of stay, which in turn led to decreased overall hospital costs [25, 26]. However, our data indicate that the whole cost of VATS was significantly higher than those in the open procedure. We think that the high cost of the consumables is a serious concern and represents a major deterrent to adopt VATS in China, especially for patients living in the rural areas, who prefer the open thoracotomy with less cost. More patients in China will choose the open procedure, even though there is a good indication for thoracoscopic surgery, unless the national medical insurance covers the high cost of VATS.

This study has some limitations because it was retrospective and not randomized. Most of the surgeries were conducted by 3 thoracic surgeons. We started using VATS for anatomic lung resection in 2005. Retrospectively, before the learning curve of VATS was overcome, some suitable patients might have been excluded. With increased experience performing VATS, the surgeon’s tolerance and perseverance for performing dissection over adhesive and chronically inflammatory areas may gradually increase and more patients with pulmonary aspergilloma will benefit from VATS.

In conclusion, in experienced hands, VATS is an alternative to open procedures in the management of pulmonary aspergilloma with respect to safety and efficacy in well-selected patients. The SPA and CPA without infiltration of the hilum are considered to be good candidates for VATS resection. Aspergilloma lesions that require a pneumonectomy is still a major challenge for VATS, and it would be more practical and appropriate to use a thoracotomy.

References

INVITED COMMENTARY

Aspergillosis is a ubiquitous infection caused by the *Aspergillus* species. Pulmonary aspergilloma is the most frequently diagnosed aspergillosis and there has been an increase in the number of cases, especially in developing countries. The most important symptom of pulmonary aspergillosis is hemoptysis, which is why surgical treatment has sometimes been selected as the treatment for pulmonary aspergilloma. Because the surgical treatment for pulmonary aspergilloma is associated with high postoperative morbidity and mortality rates, the procedures used for the surgical treatment of pulmonary aspergilloma remain challenging. The authors demonstrate that video-assisted thoracic surgery (VATS) has evolved in the last decade and is now a new choice for the surgical treatments of pulmonary aspergilloma.

Dr Q-K Chen and colleagues [1] retrospectively reported the results of 76 patients with pulmonary aspergilloma who underwent an attempted VATS lobectomy and compared them to 76 patients selected by propensity score matching from 310 patients with thoracotomy. They showed that the VATS group had a shorter hospital stay and fewer complications compared with those in the thoracotomy group, indicating that the VATS can be an alternative to open procedures that could be used for the management of pulmonary simple aspergilloma (SPA) and localized complex aspergilloma (CPA) without infiltration of the hilum. In this study, the authors selected the candidates for VATS based on the following: young patients with aesthetic demands; no severe parenchymal and pleural scarring, and no calcified lymph nodes near pulmonary arteries and veins based on computed tomographic (CT) scans; and CT scan image findings showing SPA or localized CPA. This indicates not only good indications for VATS but a bias toward the patients who would undergo VATS. To rule out any bias that may be associated with this study, further studies should be prospectively performed.

Pulmonary aspergilloma lesions that require a pneumonectomy still remain a major challenge for VATS. Although the authors note that aspergilloma lesions with infiltration of the hilum require a pneumonectomy, no explanation was made with regard to the conditions of 3 patients for pneumonectomy. In addition, in a case that underwent a simple pneumonectomy, which is sometimes not a sufficient surgical modality to cure aspergilloma, extrapleural pneumonectomy is necessary. We wonder if a patient with extrapleural pneumonectomy was included in the patients with pneumonectomy and if the authors could explain the propriety to use the propensity score which made a control group.

In conclusion, the most important point of the present study is that VATS is safe and effective for the treatment of pulmonary aspergilloma in selected patients, and the VATS procedure may therefore be a useful surgical modality for the treatment of patients with pulmonary aspergilloma who meet the above-mentioned criteria.

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