Initial Experience of Single-Incision Thoracoscopic Surgery for 100 Patients with Primary Spontaneous Pneumothorax

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Purpose: The aim of this retrospective study was to evaluate single-incision thoracoscopic surgery (SITS) for primary spontaneous pneumothorax (PSP).

Methods: Among 141 patients who underwent surgery for PSP from July 2009 to December 2013, a total of 100 patients underwent SITS. Their data were examined for clinical characteristics and surgical results.

Results: More patients with younger age, female sex, and who had social indications were treated by SITS than by three-port video-assisted thoracic surgery (VATS). The mean operative time for SITS was 48.8 min. There were no conversions from SITS to three-port VATS or thoracotomy. After SITS, the median duration of chest drainage was 1 day, and the median hospital stay was 2 days. Early complications included one surgical-site infection and one case of air leakage. Four patients (4.0%) had ipsilateral recurrence of PSP.

Conclusion: SITS is feasible when performed for selected patients with PSP. Long-term follow-up and further examinations are required to evaluate patient selection, efficacy, and comparability of SITS with conventional open and three-port VATS approaches.

Keywords: VATS, pneumothorax

Introduction

Video-assisted thoracoscopic surgery (VATS) for treating primary spontaneous pneumothorax (PSP) has been accepted during recent decades. Potential advantages of VATS are decreased pain and improved cosmesis because of small incisions. A two- or three-port technique is most commonly performed.

In addition to the conventional video-assisted technique, single-incision thoracic surgery (SITS) has emerged since Rocco et al.1 reported a technique for VATS wedge pulmonary resection through a single port. Outcomes of the technique for diagnosing 10 interstitial lung diseases and treatment of five patients with PSP indicated that it was safe and effective. The authors concluded that it was a better choice for pulmonary wedge resection with specific indications. Jutley et al.2 published a retrospective review of postoperative pain in patients with PSP who underwent SITS or three-port VATS. SITS was associated with less postoperative pain than was seen with three-port VATS in that series. Since then, some authors have reported SITS for PSP, and the adequacy of the technique has been discussed.3-9

We have also established an original SITS procedure with a single incision 2.0 cm in length and have been
using it in PSP patients since 2009. We herein describe the clinical characteristics and surgical results for the first 100 patients who underwent SITS for PSP.

Patients and Methods

A total of 141 patients with PSP have been treated surgically at two medical institutions (Saiseikai General Hospital, July 2009 to April 2013; Kyushu Medical Center, May 2013 to December 2013). Among them, 100 patients treated by SITS were retrospectively analyzed in this study.

The surgical indications for PSP and the operative procedures for treating it are almost the same at these two institutions. All operations were performed by a single physician: KY. Surgical indications for PSP were persistent air leakage, ipsilateral recurrence, contralateral recurrence, and social demands (such as needing to return to school or work as quickly as possible). The indication for SITS was based on both radiographic and thoracoscopic evaluations. Blebs and bullae located at the apex, lateral side, and pulmonary edge made the patient eligible for SITS. When these lesions were located on the mediastinal side, were adjacent to large vessels, and were difficult to find, a conventional three-port VATS approach was indicated. Each patient was fully informed about the three approaches—SITS, conventional three-port technique, open thoracotomy—and their surgical risks and potential complications. Written informed consents were obtained. Data collection and report were approved by the ethical regulations of the clinical research committee at both hospitals.

The operation was performed with the patient under general anesthesia and placed in a lateral position. After one-lung ventilation, an initial 5-mm skin incision was made through the seventh intercostal space on the mid-axillary line or through the wound of a previous chest tube placement. Thoracoscopic examination using a 5-mm flexible fiberscope (ENDOEYE FLEX; Olympus, Tokyo, Japan) was performed through a 5-mm thoracoport. If the bullae and blebs known by the radiographical examination were found with a thoracoscopic exploration, SITS was indicated. For SITS, the skin incision was expanded to 2 cm, and a wound edge protector (LAP PROTECTOR, type: mini-mini; Hakko Co., Ltd, Nagano, Japan) was inserted. Mechanical staplers (Endo GIA Universal Stapling System, Covidien, Minnesota, USA) and endoscopic grasping forceps were inserted through the incision for pulmonary wedge resection (Fig. 1A). If necessary, another puncture was added for insertion of a supporting device (Mini Loop Retractor II; Covidien, Minnesota, USA) through the chest wall to lift the lesion (Fig. 1B). After resection of the blebs and bullae, the area was checked for air leakage and hemostasis. One chest tube was placed through the incision and connected to a water-sealing drainage system. Reinforcement of a staple line or pleurodesis was performed only as needed. A Fibrin glue spray was used to reinforce the staple line through the same incision. The chest tube was removed after confirming the absence of air leakage. All patients were followed for at least a month after surgery. Patients were surveyed for recurrence by direct phone communication 12 months after surgery. From then on, whenever the patients visit our hospital with symptoms, they were evaluated by chest radiography or computed tomography. A recurrence was defined as an ipsilateral pneumothorax demonstrated by radiological examinations.

We examined the database for clinical characteristics and surgical results including age, sex, body mass index, the side involved, smoking status, surgical indications, operative
Single-Incision Surgery for Pneumothorax

Results

Between July 2009 and December 2013, a total of 142 patients consented to undergo thoracoscopic surgery for PSP. Among them, 100 patients underwent SITS, and 42 patients were subjected to a conventional three-port VATS approach.

Demographics of the 141 patients are shown in Table 1. Of all 141 patients with PSP, the mean age was 24.5 ± 7.3 years. There were 113 male patients and 54 smokers. The indications for surgery were persistent air leakage in 32, ipsilateral recurrence in 39, contralateral recurrence in 14, and social demands in 56. More patients were treated by SITS than by the three-port VATS approach. They were of a younger age (23.8 ± 3.8 vs. 26.1 ± 8.0 years), female sex (24.0% vs. 9.8%), and more often had a social-demands indication (41.0% vs. 36.6%). More patients with a positive smoking status were treated by the three-port VATS approach than by SITS (53.7% vs. 32.0%). There was no difference in distribution of the side involved between the two groups. All patients underwent SITS had their bullae and blebs at the apex and lateral side of the upper lobe. On the other hand, the patients underwent three-port VATS had their bullae and blebs on the mediastinal side in 6 (14.6%), undetectable in 6 (14.6%), complicated with emphysema in 27 (65.9%). There were two patients (4.9%) underwent three-port VATS because of severe pleural adhesions.

Surgical outcomes of the 100 patients who underwent SITS are shown in Table 2. Operative times ranged from 24 to 111 min (mean 48.8 min). There were no conversions to three-port VATS or thoracotomy from SITS. One to five mechanical staples (median of two staples) were used to excise the blebs and bullae. The median duration of chest drainage was 1 day (range 0–2 days). The median hospital length of stay was 2 days (range 1–5 days). Early complications included one surgical-site infection and one case of air leakage, which continued for a day. During a median follow-up of 28 months, four patients (4.0%) had had an ipsilateral recurrence. One patient had a recurrence 22 days after surgery and three patients after more than 1 year postoperatively. All four patients recovered without chest drainage or surgery.

Discussion

PSP occurs in young people and is diagnosed by the presence of blebs or bullae on the lung. Surgical resection of the lesions is usually elected for patients with a refractory or bilateral condition. The VATS approach has enabled the surgery to achieve low invasiveness and a good cosmetic outcome. In 2004, Rocco et al. reported an efficacy for SITS that requires a single skin incision 2.0–2.5 cm in length. Since 2009, we also have been performing a minimally invasive procedure for PSP patients using the original SITS procedure with a 2.0-cm incision. We report herein the surgical results of the initial 100 patients who underwent our original SITS.

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Table 1  Clinical characteristics of 100 patients with primary spontaneous pneumothorax

<table>
<thead>
<tr>
<th></th>
<th>SITS (n = 100)</th>
<th>Three-port VATS (n = 41)</th>
</tr>
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<tbody>
<tr>
<td>Age, years</td>
<td>23.8 ± 6.6</td>
<td>26.1 ± 8.0</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>76</td>
<td>37</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Body mass index</td>
<td>18.9 ± 2.3</td>
<td>19.5 ± 1.8</td>
</tr>
<tr>
<td>Side involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>45</td>
<td>22</td>
</tr>
<tr>
<td>Right</td>
<td>55</td>
<td>19</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>68</td>
<td>19</td>
</tr>
<tr>
<td>Former or current</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>Surgical indication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent air leakage</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>Ipsilateral recurrence</td>
<td>29</td>
<td>10</td>
</tr>
<tr>
<td>Contralateral recurrence</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Social demands</td>
<td>41</td>
<td>15</td>
</tr>
</tbody>
</table>

Values are averages ± standard deviation for continuous variables.

Table 2  Surgical outcomes of 100 patients with primary spontaneous pneumothorax treated by single-incision thoracoscopic surgery

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<table>
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<tbody>
<tr>
<td>Operation time, minutes</td>
<td>48.8 ± 15.1</td>
</tr>
<tr>
<td>Median mechanical staplers used</td>
<td>2 (1–5)</td>
</tr>
<tr>
<td>Conversion to thoracotomy</td>
<td>0</td>
</tr>
<tr>
<td>Median postoperative drainage, days</td>
<td>1 (0–2)</td>
</tr>
<tr>
<td>Median postoperative stay, days</td>
<td>2 (1–5)</td>
</tr>
<tr>
<td>Total medical cost, yen</td>
<td>1048130</td>
</tr>
<tr>
<td>Postoperative complications</td>
<td></td>
</tr>
<tr>
<td>Air leakage</td>
<td>1</td>
</tr>
<tr>
<td>Surgical-site infection</td>
<td>1</td>
</tr>
<tr>
<td>Ipsilateral recurrence</td>
<td>4</td>
</tr>
</tbody>
</table>

Values are averages ± standard deviation for continuous variables.
In this series, SITS was described to the PSP patients, who then consented to the procedure. As a result, more patients of a younger age, females, and those whose indications included social demands were treated by SITS than with the three-port VATS approach. Younger patients usually have their bullae and blebs at the apex, lateral side, or pulmonary edge of their lung suitable for SITS. We selected the patients preoperatively according to our SITS indication. Therefore, it is considered that younger patients may considered to be operated with SITS. They had wanted a minimally invasive procedure that produced a good cosmetic outcome after surgery for PSP.

The blebs and bullae, which were located at the apex, lateral side, and pulmonary edge, were carefully examined radiographically and thoracoscopically and were deemed eligible for SITS. SITS provided practicable surgery with a favorable outcome for selected patients. It offered with low morbidity and recurrence rates. Patients who were not eligible for SITS underwent surgery with the three-port VATS approach. These patients commonly experienced more complications and had a longer operating time, longer postoperative stay, and more recurrences (data not shown). Patients not eligible for SITS should be carefully selected and treated with the three-port VATS or open thoracotomy which enable more reliable procedures. Further study is necessary to elucidate better patient selection for SITS.

Flexible fiberoscopy and flexible mechanical staplers helped manage wedge resection of the lung during SITS. The single-port approach was used for the first two patients. Thereafter, the authors added a single puncture for insertion of the Mini Loop Retractor II, thereby enabling easier retraction of the lesions. The single puncture was minimally invasive, useful, and facilitated optimal conditions.

SITS can be easily applied to wedge resection of peripheral lung tumors or parenchymal lesions. Some authors have reportedly used SITS for metastasectomy and other objectives. Recently, segmentectomy and lobectomy for lung cancer through single 2.5- to 3.5-cm incisions have been reported. Further technical modification and introduction of new devices might enable application of SITS to various thoracic procedures.

**Conclusion**

Our initial series showed that SITS is practicable for selected patients with PSP. In terms of patient selection and efficacy, further studies are necessary to evaluate the potential benefit over the open and conventional three-port VATS approaches.

**Conflict of Interest**

There were no conflicts of interest for this study.

**References**