Study objectives: Video-assisted thoracoscopic surgery (VATS) is effective for primary spontaneous pneumothorax. We sought to evaluate the outcome of VATS compared to conservative treatment and open thoracotomy, and to discuss the indications for VATS in primary spontaneous pneumothorax.

Design: Retrospective study.

Patients and interventions: Primary spontaneous pneumothorax was diagnosed in 281 consecutive patients between January 1989 and April 2001. Mean age was 29.1 years. Mean follow-up period was 78.3 months (range, 13 to 163 months). For these patients, conservative treatment, open thoracotomy, or VATS were performed, and the outcomes of the three treatments were evaluated. If recurrence occurred, outcome of treatment for the recurrence was also evaluated according to the number of times of recurrence.

Results: Recurrences were observed in 109 of 281 patients (38.8%). Forty-three patients (15.3%) had repeat recurrences. Regarding the outcome of the first episode, recurrence rates were 54.7% for conservative treatment, 7.7% for open thoracotomy, and 10.3% for VATS. Recurrence rates after the second episode were 60.3% for conservative treatment, 0% for open thoracotomy, and 18.6% for VATS. Overall recurrence rates of each treatment were 56.4%, 3.0%, and 11.7%, respectively. There was no statistical difference between the open thoracotomy and VATS groups (p = 0.15). Hospital stays from operation until discharge were 11.5 days for open thoracotomy and 4.1 days for VATS (p < 0.001).

Conclusion: The outcomes of VATS were very good compared to conservative treatment and equal to those of the open thoracotomy, not only for the first episode but also for the case of recurrence. In terms of low morbidity, low invasiveness, and cosmetic issues, VATS is superior to open thoracotomy. VATS is standard in cases of recurrence and should be considered for treatment at the first episode.

Key words: conservative treatment; open thoracotomy; primary spontaneous pneumothorax; recurrence; video-assisted thoracoscopic surgery

Abbreviation: VATS = video-assisted thoracoscopic surgery
video-assisted thoracoscopic surgery (VATS) was initiated, open thoracotomy, eg, transaxillary thoracotomy, was performed as a surgical procedure. However, increasing patient discomfort results in restricted application of open thoracotomy in a patient with a recurrence or prolonged air leakage. In 1990, the first VATS was reported by Levi et al.5 Since then, this technique has spread rapidly and VATS has taken over the role of open thoracotomy, due to its minimal invasiveness and low morbidity.5–9 However, there are still some issues remaining regarding the recurrence rate and the timing of the VATS. At what time should VATS be performed? Can we perform VATS not only in the case of prolonged air leakage or recurrence, but also for the first episode?

We initiated VATS in 1993 and have applied it aggressively for treatment of primary spontaneous pneumothorax; we perform VATS not only in the case of prolonged air leakage or recurrence, but also in patients at the first episode of pneumothorax when blebs or bullae are identified on CT scan. In this study, we evaluated the results of three different treatments: conservative treatment, open thoracotomy, and VATS. In addition, we discussed the time when we should consider VATS in the flowchart of treatment.

**Materials and Methods**

*Patients Characteristics and Treatment Protocol*

This retrospective study was carried out by reviewing medical records. Between January 1989 and April 2001, 281 consecutive patients were referred with a diagnosis of primary spontaneous pneumothorax. History of pneumothorax and treatment method were carefully reviewed. All of this information was added to our data and evaluated in this study.

Our treatment diagram is shown in Figure 1. Before November 1993 (previous to induction of VATS), conservative treatment, including observation, aspiration, and tube thoracostomy, was essentially the first-line treatment. When prolonged air leakage and/or lung collapse were observed, open thoracotomy including axillary thoracotomy including bullalectomy and/or ablation was performed. If several recurrences were observed even after conservative treatment, open thoracotomy was also performed.

In December 1993, the VATS technique was initiated at our institution. Since then, VATS has taken over the role of open thoracotomy and we have changed the treatment strategy. In the first episode in patients in whom blebs or bullae were not detected with CT scan, conservative treatment was selected as the first-line treatment. In the first episode in patients in whom blebs or bullae were observed with CT, VATS was undertaken. In cases of repeated recurrences or prolonged air leakage after conservative treatment, VATS was also performed.

Therefore, the patients undergoing open thoracotomy did so before November 1993, and the patients undergoing VATS did so after December 1993. The patients of conservative treatment were distributed in both two periods.

**Data Collection and Analysis**

The medical records including history of primary spontaneous pneumothorax were reviewed retrospectively. Means of treatment and presence of recurrence were reviewed. If recurrence was present, the number of times of recurrence and selected treatment for each recurrence were also reviewed. In cases of operation, information of duration of operation, amount of intraoperative bleeding, and period of postoperative hospital stay were also obtained. These data were compared among conservative treatment, open thoracotomy, and VATS groups. Statistical analysis was carried out using statistical software (SPSS; Chicago, IL). Freedom from recurrence in VATS was also analyzed by the Kaplan-Meier method. A difference was considered as statistically significant when p < 0.05.

**VATS Technique**

The three-port VATS technique was applied. When bullae or blebs were present, excision was performed using a linear stapler. In cases with multiple bullae and blebs, suspicious for a high rate of recurrence and thought to be unresectable, apical pleurodesis was performed. In cases in which VATS was changed to open thoracotomy for any reason, this case was added to the open thoracotomy group.

**Results**

During this study period, 281 patients (255 male and 26 female) were referred to our hospital with primary spontaneous pneumothorax. The mean (± SD) age was 29.1 ± 13.6 (range, 5 to 79 years). The right lung was involved in 127 patients, and left lung was involved in 154 patients. Data were evaluated on July 2002. The mean follow-up period was 78.3 months (range, 13 to 163 months).

A summary of clinical courses and treatments of all 281 patients is shown in Table 1. Recurrences were observed in 109 of 281 patients (38.8%). Forty-three patients (15.3%) had several recurrences. Cumulatively, either of the three treatments was performed 446 times in these patients. Conservative treatment was performed 259 times, open thoracotomy was performed 33 times, and VATS was performed 154 times. Overall recurrence rates of each treatment were 56.4%, 3.0%, and 11.7%, respectively. There was no statistical difference between open thoracotomy and VATS (p = 0.15). There were two cases in which VATS was converted to open thoracotomy, for bleeding in one patient and lung injury by forceps in the other.
When looking at which treatment was selected for the first episode, 181 of 281 patients received conservative treatment, while 13 patients and 87 patients underwent open thoracotomy and VATS, respectively. Recurrences were observed in 99 patients (54.7%) after conservative treatment, 1 patient (7.7%) after open thoracotomy, and 9 patients (10.3%) after VATS, respectively. There was no statistical difference between open thoracotomy and VATS in the recurrence rate for the first episode (p = 0.61). In these 109 recurrent patients for the second episode, conservative treatment was performed in 58 patients and recurrence was observed in 35 patients (60.3%). Open thoracotomy was performed in eight patients, and recurrence was 0. Similarly, VATS was performed in 43 patients, with recurrence in 8 patients (18.6%). Statistically, there was no difference between open thoracotomy and VATS in the second recurrence rate. Fifty six patients suffered from recurrence more than twice (the third episode or more). Recurrence rates were 60% for conservative treatment, 0% for open thoracotomy, and 23.2% for VATS.

Length of hospital stays of three groups were 14.5 days in the conservative treatment group, 22.2 days in the open thoracotomy group, and 8.3 days in the VATS group (Table 2). The length of hospital stay of the VATS group was significantly shorter than that of the other groups. VATS was significantly superior to open thoracotomy in length of operation, discharge time, operation time, and bleeding volume.

Kaplan-Meier curves for open thoracotomy and VATS are shown in Figure 2. As described above, for open thoracotomy, recurrence was observed in 1 in

![Diagram](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/22026/ on 04/18/2017)

**Table 1—Treatment and Recurrence**

<table>
<thead>
<tr>
<th>Incidence</th>
<th>Conservative Treatment</th>
<th>Open Thoracotomy</th>
<th>VATS</th>
<th>Total</th>
<th>p Value</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>At first episode</td>
<td>99/181 (54.7%)</td>
<td>1/13 (7.7%)</td>
<td>9/87 (10.3%)</td>
<td>109/281 (38.8%)</td>
<td>&lt;0.001†</td>
<td>&lt;0.61‡</td>
</tr>
<tr>
<td>At first recurrence (second episode)</td>
<td>35/58 (60.3%)</td>
<td>0/8 (0)</td>
<td>8/43 (18.6%)</td>
<td>43/109 (39.4%)</td>
<td>&lt;0.001†</td>
<td>&lt;0.42†</td>
</tr>
<tr>
<td>At second recurrence (third episode or more)</td>
<td>12/20 (60%)</td>
<td>0/12 (0)</td>
<td>1/24 (4.8%)</td>
<td>13/56 (23.2%)</td>
<td>&lt;0.001†</td>
<td>&lt;0.87†</td>
</tr>
<tr>
<td>Overall recurrence rate</td>
<td>146/259 (56.4%)</td>
<td>1/33 (3.0°)</td>
<td>18/154 (11.7°)</td>
<td>165/446 (37.0°)</td>
<td>&lt;0.001†</td>
<td>&lt;0.15†</td>
</tr>
</tbody>
</table>

*Data are presented as No. of patients/total patients (%).
†Comparison among the three treatment groups.
‡Open thoracotomy vs VATS.
33 patients. Recurrences occurred in 18 patients after VATS. Fourteen of 18 patients (78%) had a recurrence within 24 months. Twelve of the 18 patients underwent reoperation, and VATS was accomplished in all 12 patients. Based on operative observations, the causes of recurrence were considered to be new of bulla in nine patients, overlooked bulla at the previous operation in one patient, and unknown in two patients.

**Discussion**

Spontaneous primary pneumothorax has traditionally been managed by conservative treatment including observation and tube thoracotomy. Only in cases of prolonged air leakage and recurrence was a surgical procedure considered. However, since the initiation of VATS, it seems that the treatment of primary spontaneous pneumothorax has been changed dramatically. Many investigators have reported its usefulness and safety. However, there are still some issues to be discussed: (1) might VATS have a higher recurrence rate compared to open thoracotomy? (2) at what time should VATS be considered? The American College of Chest Physicians recommended VATS at the second episode.14

But can VATS be justified at the first episode due to its effectiveness, minimal invasiveness and low morbidity?

In the present study, we classified patients according to the first episode, the second episode, and subsequent recurrences, and compared the outcomes of the three treatments. We also compared open thoracotomy and VATS in terms of operative time, intraoperative bleeding, and hospital stay. Especially, in terms of the relationship between the number of recurrences and results of treatment, no reports have systematically discussed results of each treatment according to the number of recurrences.

From our data, the recurrence rate of with VATS did not show statistical difference when compared to open thoracotomy. However, VATS likely is associated with a higher recurrence than open thoracotomy, as other investigators reported.3,15 Our speculation for this is based in the lower adhesion in VATS. VATS needs smaller incisions than open thoracotomy, and this results in less adhesion, as confirmed in cases of redone VATS. We believe this lower adhesion might have some impact on the rate of recurrence. Furthermore, primary spontaneous pneumothorax is common in young people. In terms of cosmetic and social considerations, we believe the minimal invasiveness of VATS outweighs its slightly higher recurrence rate.

Conservative treatment showed very high recurrence rates, not only after the first episode but also after cases of recurrence. In contrast, VATS demonstrated low recurrence, low morbidity, and short hospitalization in the first episode and recurrence cases. A patient with once or more recurrences would be a very good indication for VATS. In this study, we included the first episode patients with bullae detected with CT scan in an indication of VATS, since bullous change detected with CT might be associated with high recurrence rate after conservative treatment.16 The recurrence rate of VATS was 10.3%. It was very low compared to conservative treatment. We believe that VATS in the first episode would be reasonable and justified. According to these findings, we believe that our treatment algorithm is reasonable and acceptable: conservative

![Figure 2. Kaplan-Meier curve of freedom from recurrence after surgical treatment. Open = open thoracotomy.](http://www.chestjournal.org)

### Table 2—Comparison of the Three Treatments

<table>
<thead>
<tr>
<th>Variables</th>
<th>Conservative Treatment</th>
<th>Open Thoracotomy</th>
<th>VATS</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay, d</td>
<td>14.5</td>
<td>22.2</td>
<td>8.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Operation to discharge, d</td>
<td>11.5</td>
<td>4.1</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Operation time, min</td>
<td>91.3</td>
<td>71.1</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Bleeding volume during operation, mL</td>
<td>63.1</td>
<td>37.9</td>
<td></td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

*Open thoracotomy vs VATS.
treatment at the first episode in patients with no bullae on CT scans, and VATS at the first episode in patients with bullae on CT scans or in patients with recurrence or prolonged air leakage.

One of the criticisms of this study could be that it was not randomized. However, the efficacy of VATS, especially its small skin incision, is already well known. It is impossible to conduct a randomized trial between VATS and open thoracotomy for primary spontaneous pneumothorax. Many investigators have reported that VATS is similar in recurrence and superior in cosmetic and morbidity to open thoracotomy. Therefore, we believe the benefit of VATS is already demonstrated and a randomized trial is not needed.

In conclusion, the outcome of VATS was very good compared to conservative treatment and equal to that of open thoracotomy in the first episode. Outcomes of VATS in cases of recurrences were also very good compared to conservative treatment, and similar to those of open thoracotomy. In terms of low morbidity, low invasiveness, and cosmetic issues, VATS is superior to open thoracotomy. Therefore, we recommend VATS not only in patients with recurrence or prolonged air leakage, but also in the first episode in patients when bullae are observed on CT.

REFERENCES