Original Article

Evaluation of the safety of drainless uniportal video-assisted thoracoscopic surgery for the treatment of primary spontaneous pneumothorax: a two-institution retrospective study

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Background: Uniportal video-assisted thoracoscopic surgery (U-VATS) offers good cosmetic outcomes with minimal pain for the treatment of primary spontaneous pneumothorax (PSP). Moreover, the early removal of postoperative chest drains reduces postoperative pain and hospitalization duration for patients with PSP. We aimed to investigate the safety and feasibility of drainless U-VATS in patients with PSP and compare postoperative outcomes between specialists and residents.

Methods: We retrospectively analyzed data obtained from the medical records of consecutive patients diagnosed with PSP who underwent surgery at Yamagata Prefectural Central Hospital and Tokyo Metropolitan Bokutoh Hospital between April 2023 and March 2024. Yamagata Prefectural Central Hospital and Tokyo Metropolitan Bokutoh Hospital initiated the drainless protocol in April and July 2023, respectively. All surgeries were performed using the U-VATS approach with a 1.8–2.0-cm incision.

Results: We retrospectively reviewed the medical records of 54 patients who underwent U-VATS according to the protocol. Postoperative repeated drainage was not required for any patient. The median postoperative length of hospital stay was 1 day. No multiport conversions were required. The specialists performed significantly better than the residents based on operative time; however, the other perioperative outcomes were not significantly different.

Conclusions: Protocol-compliant drainless surgery for PSP is safe and feasible. The results from the two institutions suggest that residents can adequately perform U-VATS for spontaneous pneumothorax with perioperative outcomes comparable to those of specialists.

Keywords: Drainless; pneumothorax; tubeless; uniportal video-assisted thoracoscopic surgery (U-VATS)

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Introduction

Uniportal video-assisted thoracoscopic surgery (U-VATS) offers good cosmetic outcomes with minimal pain for the treatment of primary spontaneous pneumothorax (PSP), which is commonly observed in young patients. Recent studies have suggested the implementation of a no-chest tube strategy following wedge resection if an air leak is not detected at the intraoperative air leak test or after surgery (1-7). However, an air leak is sometimes encountered during extubation or after waking from anesthesia, even when no air leak is detected during or immediately postoperatively. Therefore, a no-chest tube strategy entails potential risks of undetected bleeding, pneumothorax, and pleural effusion (2-4,8). On the other hand, the early removal of postoperative chest drains reduces postoperative pain and hospitalization duration for patients with PSP, thereby contributing to early reintegration and improved school attendance (6,7,9-11).

PSP surgery is a rudimentary technique involving the use of a stapler by junior/senior residents, although U-VATS, which has been increasingly used in clinical practice, can be considered challenging due to limited manipulation in small wounds (12,13). Moreover, postoperative outcomes may be affected by a resident's inexperience with this technique.

We conducted a retrospective study at two institutions to investigate the safety and feasibility of drainless U-VATS in patients with PSP. We also compared its outcomes when performed by specialists and residents. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-972/rc).

Highlight box

Key findings

- Protocol-compliant drainless surgery via uniportal video-assisted thoracoscopic surgery (U-VATS) for primary spontaneous pneumothorax (PSP) is safe and feasible.

What is known and what is new?

- No-chest tube strategy after thoracic surgery entails potential risks of undetected bleeding, pneumothorax, and pleural effusion.
- U-VATS is less invasive than multiportal VATS but requires specific techniques and surgical skills.
- We were able to safely perform the drainless protocol of PSP surgery in our resident surgery.

What is the implication, and what should change now?

- No-chest tube strategy after PSP surgery via U-VATS is safe and feasible, with excellent perioperative outcomes.
- PSP surgery via U-VATS can be safely performed by residents, is safe even without a drain, and should be considered.

Methods

Study details

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The retrospective study protocol was approved by the Ethics Committees of the Yamagata Prefectural Central Hospital (#17, May 8, 2024) and Tokyo Metropolitan Bokutoh Hospital (#05-094, December 7, 2023). The requirement for obtaining written informed consent for publication from each patient was waived by the Institutional Review Board of both hospitals. Informed consent for surgical treatment was obtained from all patients.

Data were obtained from consecutive patients diagnosed with PSP. These patients underwent surgery at Yamagata Prefectural Hospital and Tokyo Metropolitan Bokutoh Hospital between April 2023 and March 2024. Data obtained from medical records were retrospectively analyzed. Yamagata Prefectural Central Hospital initiated a drainless protocol in April 2023, whereas Tokyo Metropolitan Bokutoh Hospital initiated it in July 2023. The inclusion and exclusion criteria are presented in *Figure 1*. The assessed outcomes were operative time, intraoperative blood loss volume, lung expansion on radiographs, numeric rating scale (NRS) for pain in the early postoperative period, duration of chest tube drainage, length of hospital stay, and early postoperative complications. The surgical and postoperative outcomes were assessed using descriptive statistics. There was no loss to follow-up because the patients could be followed up through outpatient visits. We used the NRS to evaluate pain intensity (0–3, mild pain; 4–6, moderate pain; and 7–10, severe pain); the comfort of the patient was prioritized (0–3, mild pain).

The surgeons were classified as specialist [board-certified members of the Japanese Respiratory Society (general thoracic surgeon) or board-certified surgeons (general surgeon)] and resident groups. There were three and two specialists at Yamagata Prefectural Hospital and Tokyo Metropolitan Bokutoh Hospital, respectively. There were two and three junior resident surgeons at Yamagata Prefectural Hospital and Tokyo Metropolitan Bokutoh Hospital, respectively. Our junior residents had limited surgical experience. The specialist participated in the

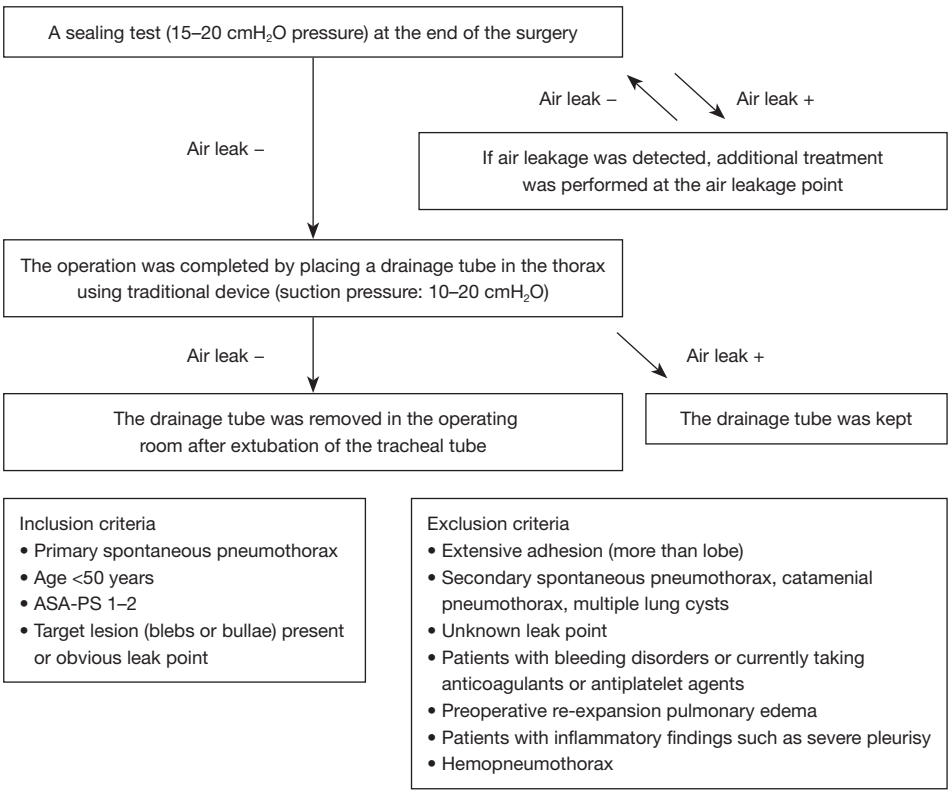
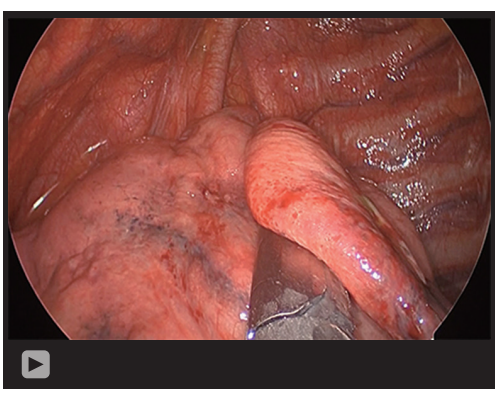


Figure 1 Our protocol for early drain removal. ASA-PS, American Society of Anesthesiologists physical status classification system.



Video 1 Our surgical technique for primary spontaneous pneumothorax via uniportal video-assisted thoracoscopic surgery (incision size: 1.8 cm).

surgery to ensure compliance with the protocol.

Preoperative management

All patients presented with sudden dyspnea or chest pain. PSP was diagnosed based on lung collapse visible on the initial chest radiograph, in accordance with the 2010 British Thoracic Society pleural disease guidelines (14). Patients with mild lung collapse did not receive any treatment. Those with moderate lung collapse and asymptomatic patients opted for no treatment, whereas symptomatic patients opted for drainage. A drainage tube was inserted in patients with severe lung collapse upon admission.

The drainage tubes ranged from 8 to 18 Fr and were selected by the surgeon. Persistent air leakage was managed surgically. Patients without air leakage or with mild lung collapse could request surgery to avoid recurrence; in these patients, elective surgery (preventive bullectomy) was planned after outpatient follow-up.

Preoperatively, all patients underwent physical examination, laboratory testing, chest computed tomography, and cardiac consultation (if necessary).

Surgical techniques (Video 1)

All PSP surgeries were performed under general anesthesia with single-lung ventilation using a double-lumen

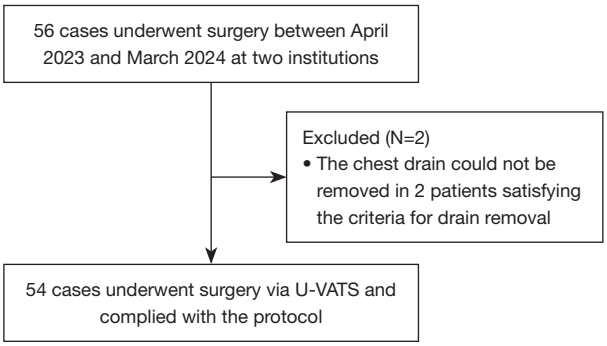


Figure 2 Patient selection criteria. U-VATS, uniportal video-assisted thoracoscopic surgery.

endotracheal tube. U-VATS was performed through a 1.8–2.0-cm incision, and a 5-mm-diameter rigid thoracoscope with 30-degree angulation was used. Bullectomy was performed using staplers without mechanical or chemical pleurodesis. Blebs or bullae that were difficult to ligate or divide using a stapler were cauterized using soft coagulation. Soft coagulation was used during surgery (AMCO, Tokyo, Japan). Each surgeon chose to cauterize the staple line with soft coagulation, use a reinforced material to cover the staple line (Endo GIA Reinforced Reload with Tri-Staple Technology®, Medtronic, Minneapolis, MN, USA) or used Echelon Endopath® Staple Line Reinforcement (Ethicon, Inc., Cincinnati, OH, USA), fibrin glue, or 50% glucose based on the lung condition; 50% glucose was used to prevent pneumothorax recurrence (15).

We performed a sealing test (15–20 cmH_2O pressure) at the end of surgery to identify any persisting pulmonary air leaks. If an air leak was detected, the leak point was ligated and cauterized with soft coagulation or fibrin glue was applied to control the air leak. In opioid-free patients, a local intercostal block (ropivacaine or levobupivacaine) was performed. The surgery was completed by placing a 16–20-Fr trocar (Argyle™ Thoracic Catheter; Medtronic, Dublin, Ireland) in the thorax. A traditional device (MERA Sucuum®, Mera Co. Ltd., Tokyo, Japan; suction pressure: 10–20 cmH_2O) was employed for drainage.

The drainage tube was removed in the operating room after confirming full lung expansion on chest radiograph and tracheal tube extubation, followed by a stable cardiorespiratory status. The postoperative drainage tube was maintained until at least the next day for the cases excluded based on the exclusion criteria or when air leakage was detected through a drainage bottle in the operating room following extubation (*Figure 1*).

A complete surgical video of our U-VATS bullectomy for PSP is available on YouTube (16).

Postoperative management

Patients were ambulatory 2 h after surgery and resumed eating solid food. Analgesics (non-steroidal anti-inflammatory drugs and acetaminophen) were orally administered. Patients who underwent drainage tube removal in the operating room were discharged if chest radiography on postoperative day 1 showed a well-expanded lung or mild asymptomatic lung collapse and in the absence of comorbidities. Symptomatic moderate or severe pneumothorax or pleural effusion warranted repeat drainage.

Statistical analyses

Continuous data are presented as medians with interquartile ranges, whereas categorical and count data are presented as frequencies and percentages. Chi-squared and Wilcoxon rank-sum tests were performed to compare the specialist and resident groups. Statistical significance was set at $P<0.05$. Statistical analyses were performed using JMP® 14 (SAS Institute Inc., Cary, NC, USA).

Results

We retrospectively reviewed the medical records of 54 patients who underwent U-VATS according to the protocol at our institutes between April 2023 and March 2024 (*Figure 2*). No cases were observed wherein lung expansion could not be confirmed on chest radiograph, and air leakage was not detected. The chest drain could not be removed for two patients who met the criteria for drain removal: one was the first U-VATS case at the Yamagata Prefectural Hospital, and the other was performed by only residents when the specialist was unable to participate in surgery.

The baseline characteristics and perioperative outcomes are summarized in *Tables 1*,*2*, respectively. The median age of patients was 20 years. Men and women accounted for 79.6% and 20.4% of all patients, respectively. Preoperative drainage was performed in 42.6% of the patients. A junior resident performed surgery in 38.9% of the cases. Surgery was performed for the following reasons: (I) severe collapse (including tension pneumothorax), (II) recurrent pneumothorax (III) continuous air leak, and (IV) other

Table 1 Preoperative characteristics of the participants (n=54)

Characteristics	Values
Male, n (%)	43 (79.6)
Age (years), median [IQR]	20 [17–26]
BMI (kg/m^2), median [IQR]†	18.5 [17.3–20.6]
Never smoker, n (%)	42 (77.8)
Laterality (left), n (%)	35 (64.8)
Preoperative drainage, n (%)	23 (42.6)
Re-operations on the surgical side, n (%)	3 (5.6)
Surgeon (resident), n (%)	21 (38.9)
Reason for surgery, n (%)	
Severe collapse	12 (22.2)
Recurrent	25 (46.3)
Continuous air leak	11 (20.4)
Others	6 (11.1)

†, one patient was not evaluated. IQR, interquartile range; BMI, body mass index.

Table 2 Perioperative characteristics of the participants (n=54)

Characteristics	Values
Operation time (min), median [IQR]	42 [34–54]
Bleeding (g), median [IQR]	1 [0–1]
Number of bullectomy, median [IQR]	1 [1–1]
Number of staplers, median [IQR]	2 [2–3]
Presence of pleural adhesion, n (%)	11 (20.4)
Staple-line reinforcement cover, n (%)	11 (20.4)
Other additional procedure for staple line†‡, n (%)	
None	29 (53.7)
Soft coagulation	9 (16.7)
Fibrin glue	4 (7.4)
Ligation	15 (27.8)
Other additional procedure†, n (%)	
None	19 (35.2)
Soft coagulation for bleb or bullae	2 (3.7)
50% glucose	31 (57.4)
Pleural covering	4 (7.4)
NRS on return to bed, median [IQR]	2 [0–4]
NRS on postoperative day 1, median [IOR]§	3 [1–4]
Hospital stays after surgery (days), median [IQR]	1 [1–1]
Re-drainage, n (%)	0 (0.0)
Postoperative complication (Clavien-Dindo grade ≥2), n (%)	2 (3.7)
90-day morbidity, n (%)	0 (0.0)
Conversion to multi-port, n (%)	0 (0.0)

†, overlapping (includes multiple options); ‡, in one case, only soft coagulation was used for blebs or bullae; §, two patients were not evaluated. IQR, interquartile range; NRS, numeric rating scale.

reasons such as preventing pneumothorax recurrence.

The median operation time was 42 min. The median number of bullectomy was 1, which included cases in which multiple bullae were also collectively resected *en bloc*. The median NRS was 2 on return to bed and 3 on postoperative day 1. Postoperative complications (Clavien-Dindo grade ≥2) were observed in two cases (3.7%). Both cases were nausea. Postoperative subcutaneous emphysema (Clavien-Dindo grade ≥1) was not observed in any of the patients. No cases of re-drainage were observed, and postoperative hospital duration was only 1 day.

A comparison of the procedures performed by specialists and residents and their outcomes is summarized in *Table 3*. Residents performed surgery for 21 patients. The specialist group had a significantly shorter operative time than the resident group (39 *vs.* 49 min, P=0.001). However, postoperative repeat drainage was not required for any patient, and no complications were observed. Moreover, no significant differences were observed in postoperative hospitalization duration, NRS scores, and number of staplers used, and no multiport conversions were performed.

PSP has recurred after surgery in 2 of 54 patients (3.7%) to date. Both patients included young patients and pneumothorax caused by new bullae.

Discussion

This study demonstrated the safety and feasibility of drainless U-VATS for PSP. The successful outcomes presumably contributed to early ambulation, hospital discharge, and pain improvement. Our study was a retrospective study performed at two institutions, and we believe that the results will be beneficial to other institutions introducing the uniportal approach for PSP surgery.

Table 3 Comparison of the performances of a board-certified member of the Japanese Respiratory Society or board-certified surgeon and resident

Characteristics	Board certified member of the Japanese Respiratory Society/ board certified surgeon (n=33)	Resident (n=21)	P value
Male, n (%)	26 (78.8)	17 (81.0)	>0.99
Age (years), median [IQR]	22 [17–27]	19 [17–23]	0.28
BMI (kg/m^2), median [IQR]	19 [17.2–21.0]	18.1 [17.3–20.1]	0.16
Never smoker, n (%)	25 (75.8)	17 (81.0)	0.74
Laterality (left), n (%)	18 (54.5)	17 (81.0)	0.07
Preoperative drainage, n (%)	15 (45.5)	8 (38.1)	0.77
Re-operation on the surgical side, n (%)	3 (9.1)	0 (0.0)	0.27
Operation time (min), median [IQR]	39 [32–45]	49 [42–58]	0.001
Bleeding (g), median [IQR]	1 [0–1]	1 [0–2.5]	0.91
Number of bullectomy, median [IQR]†	1 [1–1]	1 [1–1]	0.23
Number of staplers, median [IQR]†	3 [2–3]	2 [2–3]	0.96
Presence of pleural adhesion, n (%)	8 (24.2)	3 (14.3)	0.49
Staple-line reinforcement cover, n (%)	8 (24.2)	3 (14.3)	0.49
Other additional procedure for staple line, n (%)	21 (63.6)	4 (19.0)	0.002
Other additional procedure, n (%)	23 (69.7)	12 (57.1)	0.39
NRS on return to bed, median [IQR]	2 [0–4]	1 [0–4]	0.49
NRS on postoperative day 1, median [IQR]	3 [1–5]	2 [1–4]	0.51
Hospital stays after surgery (days), median [IQR]	1 [1–1]	1 [1–1]	0.06

†, in one case, only soft coagulation was used for blebs or bullae. IQR, interquartile range; BMI, body mass index; NRS, numeric rating scale.

Some studies have reported on non-drainage during wedge resection for PSP (1-7). Prospective studies and protocol-based reports without drain placement have shown early hospital discharge, reduced pain, and procedural safety (6). However, the incidence of residual pneumothorax in patients without postoperative chest drain insertion is 8–59%, with a re-intervention rate of approximately 3% (2-4). In the present study, although only young patients without comorbidities were included, no repeat drainage was observed in the protocol-compliant cases. In selected cases, drainless was considered beneficial. However, caution should be exercised for cases with intrapleural adhesions related to postoperative pleural effusion (8). In this study, pleural effusion was not observed, even in patients with adhesions. Obtaining objective data on the extent and nature of adhesions is challenging, but pleural effusions might be less frequent in this study due to minimal pleural damage from the small incision size (1.8–2.0 cm) and the absence of abrasion pleurodesis.

As the extent and duration of pain seem to be mainly related to the duration of postoperative chest tube drainage, the chest tube removal policy is a key factor in improving recovery and reducing the length of hospital stay (6,7,9-11). The hospital with the longest duration of chest tube drainage (possibly because of the higher proportion of patients with PSP) also reported the highest pain scores (10). For postoperative pain, we achieved the target NRS score (mild pain). Although we were not able to compare the scores with those of multiportal VATS or drainage cases, chest tube removal may have had a positive impact on pain reduction and early hospital discharge.

We observed two cases of recurrent pneumothorax despite the absence of a long-term follow-up period. The resection of bullae with an optimal cut line may be

challenging in certain cases treated via U-VATS, and the tension placed on the staple line may promote the formation of pulmonary cysts in the future. Nevertheless, a meta-analysis and report have shown that U-VATS, as a technique, does not have the same recurrence rate as multiportal VATS (17,18). Moreover, pleurodesis and suction therapy might influence the emergence of adhesions and pneumothorax recurrence. A similar report by drainless surgery reported no difference in pneumothorax recurrence (5). In this study, an additional procedure was performed to prevent recurrence; however, pneumothorax recurrence should be carefully evaluated in the long term.

This study also showed that junior residents may achieve acceptable surgical outcomes for the treatment of pneumothorax with U-VATS. Performing surgery for PSP provides a valuable opportunity to acquire fundamental respiratory surgical skills, including the utilization of a stapler. In contrast, U-VATS is considered more challenging as the surgical maneuvers are limited by the small wound size (12,13). Therefore, more time may be required to master the pulmonary resection technique via U-VATS than when performing conventional multiportal VATS. However, in this study, perioperative outcomes for procedures performed by junior residents at the two institutions were comparable to those of the specialists, except for the surgery duration. The increased operative time may have been attributed to the resident's lack of surgical experience and inexperience with surgical techniques. We believe that these results will contribute to the education of minimally invasive PSP surgeries at other institutions. Thus, the introduction of the U-VATS technique instead of the conventional multiportal VATS technique should be considered even for novice surgeons.

Limitations

This study has several limitations. First, it was a retrospective analysis of collected clinical data from patients at two institutions. The unresolved heterogeneity of patient backgrounds, including respiratory function, performance status, comorbid conditions, and unobserved potential confounders, can be problematic, especially in multicenter retrospective studies. Second, this study was unable to completely answer the study questions owing to the small sample size and short follow-up period. Further case accumulation and a longer observation period are warranted. Third, the skill levels of the residents varied. However, standardizing the number of thoracic surgeries performed by residents is challenging. Therefore, whether these results can be used as references for the performance of all residents is unclear.

Conclusions

In this study, the protocol-compliant drainless surgery for PSP was considered safe and feasible. The results from the two institutions suggest that residents can perform surgery in a satisfactory manner with perioperative outcomes comparable to those of specialists. This technique and protocol may be safely adopted at other facilities, irrespective of the surgeon's experience level.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-972/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-972/dss

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-972/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-972/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The retrospective study protocol was approved by the Ethics Committees of the Yamagata Prefectural Central Hospital (#17, May 8, 2024) and Tokyo Metropolitan Bokutoh Hospital (#05-094, December 7, 2023). The requirement for obtaining written informed consent for publication from each patient was waived by

the Institutional Review Board of both hospitals. Informed consent for surgical treatment was obtained from all patients.

References

1. Deng B, Qian K, Zhou JH, et al. Optimization of Chest Tube Management to Expedite Rehabilitation of Lung Cancer Patients After Video-Assisted Thoracic Surgery: A Meta-Analysis and Systematic Review. World J Surg 2017;41:2039-45.
2. Liu CY, Hsu PK, Leong KI, et al. Is tubeless uniportal video-assisted thoracic surgery for pulmonary wedge resection a safe procedure? Eur J Cardiothorac Surg 2020;58:i70-6.
3. Nakashima S, Watanabe A, Mishina T, et al. Feasibility and safety of postoperative management without chest tube placement after thoracoscopic wedge resection of the lung. Surg Today 2011;41:774-9.
4. Holbek BL, Hansen HJ, Kehlet H, et al. Thoracoscopic pulmonary wedge resection without post-operative chest drain: an observational study. Gen Thorac Cardiovasc Surg 2016;64:612-7.
5. Furuya T, Ii T, Yanada M, et al. Early chest tube removal after surgery for primary spontaneous pneumothorax. Gen Thorac Cardiovasc Surg 2019;67:794-9.
6. Igai H, Matsuura N, Numajiri K, et al. Feasibility of tubeless thoracoscopic bullectomy in primary spontaneous pneumothorax patients. Gen Thorac Cardiovasc Surg 2023;71:138-44.
7. Park JB, Hwang JJ, Lee WS, et al. Postoperative chest tube placement after thoracoscopic wedge resection of lung for primary spontaneous pneumothorax: is it mandatory? J Thorac Dis 2018;10:4812-8.
8. Lin CK, Leong KI, How CH, et al. Drainless thoracoscopic surgery should be avoided in primary spontaneous pneumothorax with pleural adhesion. Interact Cardiovasc Thorac Surg 2022;35:ivac237.
9. Allain PA, Carella M, Agrafiotis AC, et al. Comparison of several methods for pain management after video-assisted thoracic surgery for pneumothorax: an observational study. BMC Anesthesiol 2019;19:120.
10. Spaans LN, van Steenwijk QCA, Seiranjan A, et al. Pain management after pneumothorax surgery: intercostal nerve block or thoracic epidural analgesia. Interdiscip Cardiovasc Thorac Surg 2023;37:ivad180.
11. Mueller XM, Tinguely F, Tevaearai HT, et al. Impact of duration of chest tube drainage on pain after cardiac surgery. Eur J Cardiothorac Surg 2000;18:570-4.
12. Rocco G, Martin-Ucar A, Passera E. Uniportal VATS wedge pulmonary resections. Ann Thorac Surg 2004;77:726-8.
13. Gonzalez-Rivas D, Paradela M, Fernandez R, et al. Uniportal video-assisted thoracoscopic lobectomy: two years of experience. Ann Thorac Surg 2013;95:426-32.
14. MacDuff A, Arnold A, Harvey J, et al. Management of spontaneous pneumothorax: British Thoracic Society Pleural Disease Guideline 2010. Thorax 2010;65 Suppl 2:ii18-31.
15. Tsuboshima K, Wakahara T, Matoba Y, et al. Pleural Coating by 50% Glucose Solution Reduces Postoperative Recurrence of Spontaneous Pneumothorax. Ann Thorac Surg 2018;106:184-91.
16. Hiroki E. Uniportal VATS Bullectomy for spontaneous pneumothorax. non-edited ver. October 3, 2023. [cited 13/6/2024]. Available online: https://www.youtube.com/watch?v=MzCkRnw1nlI
17. Xu W, Wang Y, Song J, et al. One-port video-assisted thoracic surgery versus three-port video-assisted thoracic surgery for primary spontaneous pneumothorax: a meta-analysis. Surg Endosc 2017;31:17-24.
18. Yoshikawa R, Matsuura N, Igai H, et al. Uniportal approach as an alternative to the three-portal approach to video-assisted thoracic surgery for primary spontaneous pneumothorax. J Thorac Dis 2021;13:927-34.

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