Retrospective Clinical Research Report

Next-day discharge following small uniportal thoracoscopic bullectomy assisted with an anchoring suture

Chu Zhang¹,*, Miao Zhang²,*, Haiyong Wang¹, Zhifeng Ma¹, Yuanlin Wu¹, Linhai Fu¹, Ting Zhu¹ and Guangmao Yu¹

Abstract

Objective: Manipulating the instruments during uniportal video-assisted thoracoscopic surgery (U-VATS) bullectomy requires a relatively large incision. This study aimed to investigate the feasibility of next-day discharge following U-VATS bullectomy using an anchoring suture.

Methods: A stapler and a scope were inserted through a single incision in the anchoring group. The bullae were retracted by the suture, which was inserted from outside of the chest wall into the thorax, and then bullectomy was performed. For those in the control group, resection of the bullae was performed with the assistance of a grasping forceps.

Results: The length of the incision of the patients in the anchoring group ([13.2 ± 2.2] mm) was significantly smaller than in the control group ([26.2 ± 3.9] mm). In addition, the number of staplers used in the anchoring group was significantly less than in the control group ([1.2 ± 0.4] vs. [1.4 ± 0.5]). Furthermore, 36 (92.3%) cases in the anchoring group were uneventfully discharged within 24 hours after bullectomy.

Conclusion: Next-day discharge after U-VATS bullectomy through a small incision assisted with an anchoring suture is safe and feasible.

¹Department of Thoracic Surgery, Shaoxing People’s Hospital (Shaoxing Hospital, Zhejiang University School of Medicine), Shaoxing, Zhejiang, P. R. China
²Department of Thoracic Surgery, Xuzhou Central Hospital Affiliated to Southeast University, Xuzhou, Jiangsu, P. R. China

*These authors contributed equally to this work.

Corresponding author:
Guangmao Yu, Department of Thoracic Surgery, Shaoxing People’s Hospital (Shaoxing Hospital, Zhejiang University School of Medicine), 568 Zhongxing North Road, Shaoxing, Zhejiang 312000, P. R. China.
Email: woodbirdzhang@163.com

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).
Keywords
Uniportal, single-port, video-assisted thoracoscopic surgery (VATS), primary spontaneous pneumothorax (PSP), enhanced recovery after surgery (ERAS), serratus anterior plane block (SAPB), anchoring suture, bullectomy

Date received: 4 September 2019; accepted: 3 December 2019

Introduction
Uniportal video-assisted thoracoscopic surgery (U-VATS) bullectomy has been utilized widely for primary spontaneous pneumothorax (PSP). However, the major concern of this procedure is the collision between the surgical instruments and the thoracoscope, which usually requires a large incision (>20 mm). Therefore, a modified technique for minimally invasive resection of bullae is needed.

The reported method for retraction of the target bullae for resection using an anchoring suture was used, and a small access (with a mean length about 15 mm) was created for U-VATS bullectomy in our hospital starting in August 2015. Most of the patients were discharged uneventfully from the hospital within 24 hours after the surgery. The aim of this study was to evaluate the effectiveness and the potential advantages of next-day discharge after U-VATS bullectomy assisted with an anchoring suture.

Patients and methods
Patient selection
We retrospectively reviewed patients who underwent a U-VATS bullectomy with or without an anchoring suture by the same surgeon between August 2015 and December 2018. Inclusion criteria included the following: (1) recurrent pneumothorax after prior medical treatment; (2) patients whose lung collapse exceeded 30% estimated by chest x-ray, and obvious bullae were identified on computed tomography (CT) images; (3) persistent air leak longer than 1 month after chest tube drainage; (4) patients with normal hematology, electrolytes, and liver and kidney function; (5) patients understood the risk of U-VATS such as conversion and bleeding, and voluntarily provided written informed consent. Exclusion criteria were as follows: (1) patients were afraid of the potential risks and refused U-VATS; (2) estimated severe pleural adhesion due to history of thoracic surgery; (3) spontaneous pneumothorax secondary to diffuse emphysema, asthma, fibrosis, thoracic injury, tuberculosis, and malignancy; (4) no significant bullae on CT images, and the chest tube drainage with or without medical pleurodesis was effective; (5) inability of the patients to provide informed consent. This study was approved by the Ethics Committee and Institutional Review Board of Shaoxing People’s Hospital (SXPH-ZJ-20190701-014, July 21, 2015). Informed written consent was obtained from every patient or their parents or caregivers before the surgical treatment.

Surgical technique
All of the patients enrolled for bullectomy underwent a CT scan to identify the location and size of the bullae, which were not adequately visible on chest x-ray. The surgery was performed step-by-step. For the patients in the anchoring group, a small incision of
about 15 mm was created. The bullae were identified using a $^{30}$C14, 5-mm-diameter thoracoscope through the incision, and a 1-0 silk suture was passed from outside of the chest wall into the thorax for bidirectional traction of the bullae (Figure 1). Next, the bullae were lifted by pulling the suture on the side of the chest wall and the surgical incision to create a resection angle, and then a wedge resection was performed using the endo-staplers. (c) The bullae located in the apex of the lung were retracted using an anchoring silk by the assistant surgeon. U-VATS, uniportal video-assisted thoracoscopic surgery.

Moreover, ultrasound-guided serratus anterior plane block (SAPB) was performed for postoperative pain control after closure of the surgical incision $^4$ using 0.2% bupivacaine (Marcaine, AstraZeneca, UK) at a dosage of 0.3 mL/kg of body weight.

The visual analog scale for pain

The postoperative pain of the patients was evaluated using the visual analog scale (VAS) score in a range of 0 to 10, with 0 representing no pain and 10 representing unbearable pain. In case of discharge within 3 days, the patients’ pain VAS was obtained by remote interview using a smartphone.

The operative time, estimated blood loss during surgery, duration and total volume of postoperative chest drainage, surgery-related complications, pain VAS on postoperative day (POD) 1 to 3, and postoperative hospital stay of the patients in the two groups were compared.

Statistics

Descriptive continuous variables were recorded as means and standard deviations (SD) and were analyzed using Student’s
unpaired t-test and one-way analysis of variance (ANOVA) as appropriate. The pain VAS between the groups was compared using repeated-measures ANOVA. Categorical variables were assessed by Fisher’s exact test and Pearson Chi-square test. The statistical analysis was performed using SPSS version 19 (IBM Corp., Armonk, NY, USA). A p-value less than 0.05 was considered statistically significant.

Results

Seventy-nine PSP patients were enrolled and were divided into the control group (40 cases) and the anchoring group (39 patients). The two groups had similar baseline characteristics except for age distribution (Table 1).

The surgical outcomes are shown in Table 2. Conversion to thoracotomy, perioperative mortality, hemothorax, and recurrence were not observed in this cohort. Two patients in the control group were converted to multi-port VATS, while there was no patient in the anchoring group that needed an additional surgical incision. The incision length of the patients in the anchoring group ([13.2 ± 2.2] mm) was significantly shorter than in the control group ([26.2 ± 3.9] mm, p < 0.05). Moreover, the number of staplers used in the anchoring group was significantly less than in the control group ([1.2 ± 0.4] vs [1.4 ± 0.5], p < 0.05).

In addition, 36 (92.3%) cases in the anchoring group and one (2.5%) patient in the control group were discharged within 24 hours after the operation. The chest tube duration of the patients in the anchoring group was noticeably shorter than in the control group ([1.6 ± 2.1] days vs. [3.2 ± 1.7] days, p < 0.05). Moreover, the total drainage volume of the patients in the anchoring group was also significantly less than in the control group ([110.8 ± 161.1] mL vs. [276.3 ± 133.5] mL, p < 0.05).

The patients’ VAS of pain in the anchoring and the control group on POD 1, 2, and 3 were ([2.6 ± 0.8] vs. [2.9 ± 1.1]), ([2.1 ± 0.9] vs. [2.4 ± 0.9]), and ([2.4 ± 0.9] vs. [2.7 ± 0.7]), respectively, with a statistical difference between the two groups (p < 0.05). Furthermore, the patients did not have a difference in terms of the operative time, estimated intraoperative blood loss, or the incidence of surgery-related complications.

Table 1. Baseline characteristics of the patients.

| Characteristics                          | Control group (n = 40) | Anchoring group (n = 39) | p-value |
|-----------------------------------------|------------------------|--------------------------|---------|
| Mean age, years                         | 29.3 ± 16.8            | 23.0 ± 10.1              | 0.048   |
| Female/Male, n                          | 5/35                   | 9/30                     | 0.252   |
| Body mass index, kg/m²                  | 24.7 ± 1.3             | 24.8 ± 1.5               | 0.593   |
| Smoking history, n                      |                        |                          | 0.115   |
| Never                                   | 31                     | 36                       |         |
| Previous                                | 9                      | 3                        |         |
| Side involved, n                        |                        |                          | 0.498   |
| Right                                   | 19                     | 15                       |         |
| Left                                    | 21                     | 24                       |         |
| Pulmonary comorbidities, n              |                        |                          | 0.615   |
| Emphysema                               | 1                      | 2                        |         |
| Chronic obstructive pulmonary disease   | 0                      | 1                        |         |
| Bronchiectasis                          | 0                      | 1                        |         |

Note: Age was shown as the mean ± standard deviation (SD). n, number.
Table 2. Perioperative parameters of the patients who underwent U-VATS bullectomy.

| Variables                               | Control group (n = 40) | Anchoring group (n = 39) | p-value |
|-----------------------------------------|------------------------|--------------------------|---------|
| Length of incision, mm                  | 26.2 ± 3.9             | 13.2 ± 2.2               | <0.001  |
| Mechanical pleurodesis, n               | 32                     | 27                       | 0.310   |
| Fibrin glue used, n                     | 16                     | 11                       | 0.344   |
| Mean operation time, minutes            | 54.0 ± 25.9            | 48.1 ± 15.9              | 0.230   |
| Number of staplers used in surgery      | 1.4 ± 0.5              | 1.2 ± 0.4                | 0.048   |
| Conversion to multiport VATS, n         | 2                      | 0                        | 0.494   |
| Blood loss, mL                          | 18.4 ± 9.1             | 18.1 ± 10.8              | 0.895   |
| Chest tube drainage                     |                        |                          |         |
| Duration (mean, range), days            | 3.2 ± 1.7              | 1.6 ± 2.1                | <0.001  |
| Total volume, mL                        | 276.3 ± 133.5          | 110.8 ± 161.1            | <0.001  |
| Postoperative complications, n          |                        |                          |         |
| Pneumonia, n                            | 0                      | 0                        |         |
| Atelectasis, n                          | 0                      | 0                        |         |
| Prolonged air leak (>5 days), n         | 2                      | 3                        |         |
| Arrhythmia, n                           | 5                      | 2                        |         |
| Wound infection                         | 0                      | 0                        |         |
| Postoperative hospital stay, days       | 3.7 ± 1.5              | 1.6 ± 2.1                | <0.001  |
| 1 day, n                                | 1                      | 36                       | <0.001  |
| >1 day, n                               | 39                     | 3                        |         |
| VAS pain score (0–10)                   |                        |                          | 0.045   |
| POD1                                    | 2.9 ± 1.1              | 2.6 ± 0.8                |         |
| POD2                                    | 2.4 ± 0.9              | 2.1 ± 0.9                |         |
| POD3                                    | 2.7 ± 0.7              | 2.4 ± 0.9                |         |
| Recurrence during follow-up, n          | 0                      | 0                        |         |

U-VATS, uniportal video-assisted thoracoscopic surgery; n, number; VAS, visual analog scale.

Discussion

U-VATS bullectomy through a small incision assisted with an anchoring suture in 39 patients was successfully performed in this cohort study, of which 36 (92.3%) were discharged uneventfully on POD 1.

Surgical resection of the bullae is recommended for patients with recurrent or complicated pneumothorax. Additionally, it may be the standard of care when high-resolution CT reveals significant bullae ≥2 cm in size. A review indicates that wedge resection is favored for the management of PSP, while an additional pleural abrasion or chemical pleurodesis could be considered to potentially decrease the risk of recurrence after surgery. However, surgery should also be selected strictly based on the risk factors and the patients’ wishes to avoid overtreatment.

U-VATS may have advantages over a multiport procedure in terms of postoperative pain, but high-quality evidence is still lacking. The major concern of U-VATS is the collision of the instruments through a single port, necessitating a relatively long skin incision (at least ≥20 mm). To minimize the collisions between the surgical instruments within a shortened incision during bullectomy, an anchoring suture instead of a grasper for pulling of the bullae has been utilized, the previous reports of which are listed in Table 3. This procedure demonstrated some merits such
| First author   | Sample size | Age, years | Thoracoscope | Suture      | Incision size, mm | Operative time, minutes (range) | Conversion to MVATS | Staplers used | Complications | Pain VAS (range) | Postoperative hospital stay, days (range) | Recurrence |
|---------------|-------------|------------|--------------|-------------|-------------------|------------------------------|---------------------|---------------|---------------|-----------------|------------------------------------------|------------|
| Jeon HW       | 1           | 40         | 5-mm, 30°    | 1-0 nylon   | 11.5              | 37.3 ± 11.2                | 0                   | NA            | 2 (5.0%)      | POD1: 3.5 ± 1.6 | 3.1 ± 1.8                                | 2 (5.0%)    |
| Lee SK        | 1           | 48         | 5-mm, 30°    | 1-0 Prolene  | 20                | NA                         | 0                   | NA            | 0             | POD1: 1.3 ± 0.5 | (0-2)                                    | 4.5 ± 1.1   | NA          |
| Tsuboshima K  | 2           | 34         | 5-mm, 30°    | 2-0 nylon   | 17.25             | 67.9 ± 19.4                | 0                   | Not serious   | NA            | NA                         | 3.6 ± 2.0 | 4 (11.8%)  |
| Son BS        | 14          | 104        | 5-mm, 30°    | 1-0 Prolene  | <20               | 49.7 ± 13.9                | 3 (2.8%)            | 2.6 ± 0.6     | 6 (5.8%)      | POD1: 2.3 ± 1.3 | 4.8 ± 1.7                                | 1 (0.9%)    |
| Tsuboshima K  | 16          | 57         | 5-mm, 30°    | 2-0 nylon   | 18                | 66.7 ± 19.0                | 0                   | 3.4 ± 0.9     | Not serious   | NA                         | NA         | 0           |
| Chong Y       | 15          | 52         | 5-mm, 30°    | 0-0 Vicryl   | 15                | 34.3 ± 11.5                | 0                   | NA            | 1 (1.9%)      | POD1: 2.3 ± 0.8 | 3.2 ± 1.3                                | 2 (3.8%)    |
| Tsuboshima K  | 17          | 23         | 5-mm, 30°    | 2-0 nylon   | NA                | 74.7 ± 14.9                | 0                   | 3.7 ± 1.1     | NA            | NA                         | NA         | 1 (4.4%)   |
| Campisi A     | 18          | 1           | 5-mm, 30°    | Non-absorbable braided | 20              | 60                         | 0                   | NA            | 0             | POD1: 2.6 ± 0.8 | 1.6 ± 2.1                                | 0           |
| Our study     | 19          | 39         | 5-mm, 30°    | 1-0 silk     | 13.2 ± 2.2        | 48.1 ± 15.9                | 0                   | 1.2 ± 0.4     | 5 (12.8%)     | POD1: 2.0 ± 1.5 | 1.6 ± 2.1                                | 0           |

U-VATS, uniportal video-assisted thoracoscopic surgery; MVATS, multi-port video-assisted thoracoscopic surgery; VAS, visual analog scale; POD, postoperative day; NA, not available.
as comfort of manipulation and cosmetic advantages. Moreover, an anchoring suture for two-directional traction of the bullae is helpful to avoid the collisions between the instruments. U-VATS through a small (<20 mm) incision assisted with a bidirectional anchoring suture yielded acceptable outcomes. Furthermore, the utilization of two anchoring sutures that facilitate the small incision U-VATS for the treatment of multiple or comprehensive bullae could be considered.

It is noteworthy that the incidence of 30-day unplanned readmission in PSP patients is reported to be 13.6%, and middle age and history of cancer are two independent risk factors for readmission. Mechanical pleurodesis is widely used with the aim to decrease the risk of postoperative recurrence of PSP after bullectomy, while there is little evidence of this to date. A trial showed that the application of mechanical pleurodesis did not significantly decrease the incidence of PSP recurrence compared with simple wedge resection. Hong et al. reported that staple line coverage with a polyglycolic acid patch and fibrin glue, instead of pleural abrasion, may reduce the recurrence rate of PSP after bullectomy.

Furthermore, a retrospective review showed that appropriately identified patients could safely be discharged on POD 1 after lobectomy without an increase in 30-day unplanned readmission, morbidity, or mortality. In our study, most patients in the anchoring group were discharged uneventfully on POD 1.

Conclusions

Next-day discharge after small incision (<20 mm) U-VATS bullectomy assisted with an anchoring suture is safe and feasible for selected patients. However, high-quality trials are warranted to verify our findings.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This study was supported by Zhejiang Medical and Health Research Fund Project (No. 2018KY171).

References

1. Jeon HW and Kim YD. Does 11.5 mm guided single port surgery has clinical advantage than multi-port thoracoscopic surgery in spontaneous pneumothorax? J Thorac Dis 2016; 8: 2924–2930. DOI: 10.21037/jtd.2016.10.56.
2. Ocakcioglu I, Alpay L, Demir M, et al. Is single port enough in minimally surgery for pneumothorax? Surg Endosc 2016; 30: 59–64. DOI: 10.1007/s00464-015-4161-6.
3. Son BS, Park JM, Seok JP, et al. Modified incision and closure techniques for single-incision thoracoscopic lobectomy. Ann Thorac Surg 2015; 99: 349–351. DOI: 10.1016/j.athoracsur.2014.07.062.
4. Rahimzadeh P, Imani F, Faiz SHR, et al. Impact of the ultrasound-guided serratus anterior plane block on post-mastectomy pain: a randomised clinical study. Turk J Anaesthesiol Reanim 2018; 46: 388–392. DOI: 10.5152/TJAR.2018.86719.
5. Hsu HH and Chen JS. The etiology and therapy of primary spontaneous pneumothoraces. Expert Rev Respir Med 2015; 9: 655–665. DOI: 10.1586/17476348.2015.1083427.
6. Olesen WH, Katballe N, Sindby JE, et al. Surgical treatment versus conventional chest tube drainage in primary spontaneous pneumothorax: a randomized controlled trial. Eur J Cardiothorac Surg 2018; 54: 113–121. DOI: 10.1093/ejcts/ezy003.
7. Sudduth CL, Shinnick JK, Geng Z, et al. Optimal surgical technique in spontaneous pneumothorax: a systematic review and meta-analysis. J Surg Res 2017; 210: 32–46. DOI: 10.1016/j.jss.2016.10.024.
8. Hofmann HS, Suttner T, Neu R, et al. Burden between undersupply and
overtreatment in the care of primary spontaneous pneumothorax. *Thorac Cardiovasc Surg* 2018; 66: 575–582. DOI: 10.1055/s-0037-1609011.

9. Sihoe ADL. Uniportal lung cancer surgery: state of the evidence. *Ann Thorac Surg* 2019; 107: 962–972. DOI: 10.1016/j.athoracsur.2018.08.023.

10. Nachira D, Ismail M, Meacci E, et al. Uniportal vs. triportal video-assisted thoracic surgery in the treatment of primary pneumothorax—a propensity matched bicentric study. *J Thorac Dis* 2018; 10: S3712–S3719. DOI: 10.21037/jtd.2018.04.124.

11. Lee SK, Son BS, Ahn HY, et al. Single-incision thoracoscopic surgery using an anchoring suture of the lung parenchyma for two-directional traction. *Ann Thorac Surg* 2014; 97: e89–e91. DOI: 10.1016/j.athoracsur.2013.10.061.

12. Tsuboshima K, Wakahara T, Matoba Y, et al. Single-incision thoracoscopic surgery using a chest wall pulley for lung excision in patients with primary spontaneous pneumothorax. *Surg Today* 2015; 45: 595–599. DOI: 10.1007/s00595-014-0992-3.

13. Son BS, Kim DH, Lee SK, et al. Small single-incision thoracoscopic surgery using an anchoring suture in patients with primary spontaneous pneumothorax: a safe and feasible procedure. *Ann Thorac Surg* 2015; 100: 1224–1229. DOI: 10.1016/j.athoracsur.2015.04.095.

14. Tsuboshima K, Nagata M, Wakahara T, et al. Modified chest wall pulley for lung excision during single-incision thoracoscopic surgery for primary spontaneous pneumothorax. *Ann Thorac Cardiovasc Surg* 2016; 22: 359–362. DOI: 10.5761/atcs.nm.16-00125.

15. Chong Y, Cho HJ, Kang SK, et al. Outcomes of the tower crane technique with a 15-mm trocar in primary spontaneous pneumothorax. *Korean J Thorac Cardiovasc Surg* 2016; 49: 80–84. DOI: 10.5090/kjtc.s.2016.49.2.80.

16. Tsuboshima K, Nagata M, Wakahara T, et al. Feasibility of single-incision thoracoscopic surgery using a modified chest wall pulley for primary spontaneous pneumothorax: a propensity score matching analysis. *Surg Today* 2017; 47: 1129–1134. DOI: 10.1007/s00595-017-1483-0.

17. Campisi A, Dell’Amore A, Giunta D, et al. Micro-incision thoracoscopic treatment of primary spontaneous pneumothorax: the “loop” technique. *J Vis Surg* 2018; 4: 35. DOI: 10.21037/jovs.2018.02.01.

18. Mukhtar O, Shrestha B, Khalid M, et al. Characteristics of 30-day readmission in spontaneous pneumothorax in the United States: a nationwide retrospective study. *J Community Hosp Intern Med Perspect* 2019; 9: 215–220. DOI: 10.1080/20009666.2019.1618135.

19. Min X, Huang Y, Yang Y, et al. Mechanical pleurodesis does not reduce recurrence of spontaneous pneumothorax: a randomized trial. *Ann Thorac Surg* 2014; 98: 1790–1796; discussion 1796. DOI: 10.1016/j.athoracsur.2014.06.034.

20. Hong KP, Kim DK and Kang KH. Staple line coverage with a polyglycolic acid patch and fibrin glue without pleural abrasion after thoracoscopic bullectomy for primary spontaneous pneumothorax. *Korean J Thorac Cardiovasc Surg* 2016; 49: 85–91. DOI: 10.5090/kjtc.s.2016.49.2.85.

21. Greer S, Miller AD, Smith JS, et al. Safety of next day discharge after lobectomy: have we broken the speed limit? *Ann Thorac Surg* 2018; 106: 998–1001. DOI: 10.1016/j.athoracsur.2018.05.034.