Editorial

How to identify and divide an intersegmental plane in uniportal VATS segmentectomy

Hitoshi Igai, Mitsuhiro Kamiyoshihara

Department of General Thoracic Surgery, Japanese Red Cross Maebashi Hospital, Gunma 371-0811, Japan

Correspondence to: Hitoshi Igai. Department of General Thoracic Surgery, Japanese Red Cross Maebashi Hospital, 389-1 Asakura-cho, Maebashi, Gunma 371-0811, Japan. Email: hitoshiigai@gmail.com.

Received: 16 December 2019; Accepted: 30 December 2019; Published: 15 March 2020.

doi: 10.21037/vats.2019.12.04

View this article at: http://dx.doi.org/10.21037/vats.2019.12.04

The number of patients with non-small cell lung cancer (NSCLC) underwent pulmonary segmentectomy is increasing worldwide because minimally invasive surgery is recently preferable in order to maintain quality of life, especially for preserving postoperative pulmonary function, in patients although lobectomy is the gold standard for the treatment of NSCLC (1,2). In patients' prognosis, large retrospective study from Japanese Association for Chest Surgery (JACS) revealed favorable results of the 5-year overall (94%) and cancer free survival rates (93.7%) for patients with clinical stage IA undergoing sublobar resections (3). Moreover, in the prospective randomized trial, Suzuki and colleagues described the patients undergoing pulmonary segmentectomy had the equivalent results of postoperative complications with the patients undergoing lobectomy except for more frequency of prolonged air leakage (4). The report finally concluded that segmentectomy will be a standard treatment if the superior pulmonary function and noninferiority in overall survival are confirmed.

As a palliative treatment for lung cancer patients with who are not tolerable for lobectomy, pulmonary segmentectomy is also adopted. Several previous reports demonstrated favorable results (5,6).

When we perform pulmonary segmentectomy, it is most important to achieve adequate surgical margins in oncological perspective because the local recurrences rate after surgical resections are correlated with the length of the safety margins. To achieve adequate surgical margins, how to identify and divide the intersegmental plane plays an important role, especially in thoracoscopic surgery, because surgeons are sometimes not able to palpate tumors due to the size or location. However, the golden standard to identify or divide the intersegmental plane is still controversial although there have been several reports describing how to identify or divide the intersegmental plane (7-14). In this study, we investigated the appropriate methods to identify or divide the intersegmental plane in uniportal video-assisted thoracic surgery (VATS) by reviewing the previous reports.

How to identify an intersegmental plane in VATS pulmonary segmentectomy

Inflation-deflation technique

This procedure is conventional and most commonly used to identify an intersegmental plane. In this method, the whole lung is inflated after occlusion of the target segmental bronchus. As a result, the target segment collapses, which will be removed (7,8).

This technique is very easy and convenient. However, the intersegmental plane sometimes becomes unclear especially in the patients with emphysema because of the collateral ventilation through the pores of Kohn. In addition, the expanded segments by inflation causes the limitations of working space in thorax during VATS procedures.

Selective inflation of target segment by jet ventilation

This technique was introduced for the first time by Tsubota and colleagues (9). Subsequently, Okada and colleagues reported the improved version of the technique (10). In this technique, target lung is inflated by jet ventilation navigated by flexible bronchoscopy, which is considered opposite

to inflation-deflation technique above described. The advantage is that we can get better surgical view and more working space even in VATS because the only target lung is inflated. However, the collaboration with another doctor such as an anesthesiologist is necessary in this technique. Therefore, it might be difficult to perform this reasonable method in any institutions. To overcome this difficulty, Kamiyoshihara and colleagues introduced "butterfly-needle method" which was the direct inflation of the segmental bronchus through a butterfly-needle from the operative field to identify the intersegmental plane (11). However, this technique is not recently utilized in Japan because the risk of an air embolism due to air blown into the vessels neighboring the bronchus.

Intravenous or endobronchial indocyanine green injection

Misaki and colleagues firstly reported the efficacy of infrared thoracoscopy (IRT) with systemic indocyanine green (ICG) intravenous injection when identifying intersegmental plane (12). In this procedure, the fluorescence covered whole lungs except for the target segment after the division of the segmental blood vessels. The advantage was that there were no inflated lungs in the thorax, which brought good surgical view. However, the duration of ICG staining had limitations. Therefore, it was required for surgeons to mark the line of intersegmental plane quickly in this procedure.

Oh and colleagues described the efficacy of transbronchial ICG injection in identifying an intersegmental plane (13). The success rate of it by using this procedure was high. However, in this procedure, bronchial stump was temporally opened, which had the possibility of contamination. In addition, the approach was through not thoracoscopy but thoracotomy.

Virtual assisted lung mapping (VAL-MAP)

VAL-MAP which is a novel technique that allows for bronchoscopic multi-spot dye markings to provide "geometric information" to the lung surface using three-dimensional virtual image has been introduced by Sato and colleagues (14). They insisted that this technique is useful in thoracoscopic segmentectomy because surgeons sometimes cannot palpate small nodules or ground glass opacity via thoracoscopic approach. However, this method required preoperative bronchoscopy, which might be a kind of burden for thoracic surgeons.

How to divide an intersegmental plane?

We can raise two procedures for division of intersegmental plane in pulmonary segmentectomy. The first procedure is using staplers, which is considered majority worldwide. I consider that many surgeons adopt this procedure in order to avoid postoperative air-leakage when we divide an intersegmental plane. On the contrary, several surgeons, especially in Japan, insisted the usefulness of electrocautery cutting in dividing an intersegmental plane because the peripheral lung was fully expanded, which can bring postoperative better pulmonary function (10). This procedure is the second one we can raise. They insisted that postoperative air-leakage can be also avoided by dividing accurate intersegmental plane which was identified by the procedures above described. This procedure was firstly introduced by Okada and colleagues, and they demonstrated the highly successful results for division of an intersegmental plane in pulmonary segmentectomy by using this technique with the combination of selective jet ventilation (10).

What is the best procedure for identification or division of intersegmental plane?

Considering the advantages and disadvantages in each procedure for identification of intersegmental plane, we recommend selective jet ventilation technique although it depends on each institutional situation. Although inflation-deflation technique is easy and convenient, inflated whole lung except for target segment can keep thoracic surgeons from getting better surgical view and larger working space for surgical instruments. Moreover, in uniportal VATS, surgical view and working space for surgical instruments is limited compared to multiportal VATS or thoracotomy approach. Although the lung is not inflated in the method of intravenous or endobronchial ICG injection or VAL-MAP, which can bring better surgical view and larger working space, these procedures need specific system such as IRT or additional preoperative bronchoscopy. Therefore, selective jet ventilation technique is suitable for identification of an intersegmental plane during uniportal VATS in terms of universal usage.

In division of intersegmental plane, we consider that using stapler is suitable for division of an intersegmental plane during uniportal VATS. Although electrocautery cutting is useful, this procedure requires counter-traction, which is difficult to perform in uniportal VATS. If not using

counter-traction in division of an intersegmental plane, we have the possibility of dividing inaccurate intersegmental plane, which can cause postoperative prolonged air-leakage. Therefore, we recommend using stapler for division of an intersegmental plane during uniportal VATS. However, we should take notice that the technique of unidirectional stapling is necessary in uniportal VATS because the angle of insertion of stapler is limited. Although we can easily insert staplers through each thoracoport in multiportal approach, it is difficult to achieve multidirectional stapling in uniportal VATS. Therefore, we should have the skill of unidirectional stapling for division of an intersegmental plane in uniportal VATS pulmonary segmentectomy.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Video-Assisted Thoracic Surgery* for the series "Uniportal VATS Segmentectomy". The article did not undergone external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/vats.2019.12.04). The series "Uniportal VATS Segmentectomy" was commissioned by the editorial office without any funding or sponsorship. HI served as the unpaid Guest Editor of the series and serves as an unpaid editorial board member of *Video-Assisted Thoracic Surgery* from Apr 2019 to Mar 2021. The authors have no other 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.

References

1. Nomori H, Shiraishi A, Cong Y, et al. Differences in postoperative changes in pulmonary functions following segmentectomy compared with lobectomy. Eur J Cardiothorac Surg 2018;53:640-7.
2. Ginsberg RJ, Rubinstein LV. Randomized trial of lobectomy versus limited resection for T1N0 non-small cell lung cancer. Lung cancer study group. Ann Thorac Surg 1995;60:615-22.
3. Yano M, Yoshida J, Koike T, et al. Survival of 1737 lobectomy-tolerable patients who underwent limited resection for cStageIA non-small-cell lung cancer. Eur J Cardiothoracic Surg 2015;47:135-42.
4. Suzuki K, Saji H, Aokage K et al. Comparison of pulmonary segmentectomy and lobectomy: Safety results of a randomized trial. J Thorac Cardiovasc Surg. 2019;158:895-907.
5. Martin-Ucar AE, Nakas A, Pilling JE, et al. A case-matched study of anatomical segmentectomy versus lobectomy for stage I lung cancer in high-risk patients. Eur J Cardiothorac Surg 2005;27:675-9.
6. Hsie M, Morbidini-Gaffney S, Kohman LJ, et al. Definitive treatment of poor-risk patients with stageI lung cancer: a single institution experience. J Thorac Oncol 2009;4:69-73.
7. Blades B. Conservation of lung tissue by partial lobectomy. Ann Surg 1943;118:353-65.
8. Overholt RH, Woods FM, Betts RH. An improved method of resection of pulmonary segments: report of a technique applied in 70 operations. J Thorac Surg 1948;17:464-79.
9. Tsubota N. An improved method for distinguishing the intersegmental plane of the lung. Surg Today 2000;30:963-4.
10. Okada M, Mimura T, Ikegaki J, et al. A novel-video-assisted anatomic segmentectomy technique: selective segmental inflation via bronchofiberoptic jet followed by cautery cutting. J Thorac Cardiovasc Surg 2007;133:753-8.
11. Kamiyoshihara M, Kakegawa S, Morishita Y. Convenient and improved method to distinguish the intersegmental plane in pulmonary segmentectomy using a butterfly needle. Ann Thorac Surg 2007;83:1913-4.
12. Misaki N, Chang SS, Gotoh M, et al. A novel method for determining adjacent lung segments with infrared thoracoscopy. J Thorac Cardiovasc Surg 2009;138:613-8.

13. Oh S, Suzuki K, Miyasaka Y, et al. New technique for lung segmentectomy using indocyanine green injection. Ann Thorac Surg 2013;95:2188-90.
14. Sato M, Murayama T, Nakajima J. Techniques of stapler-based navigational thoracoscopic segmentectomy using virtual assisted lung mapping (VAL-MAP). J Thorac Dis 2016;8:S716-30.

doi: 10.21037/vats.2019.12.04
Cite this article as: Igai H, Kamiyoshihara M. How to identify and divide an intersegmental plane in uniportal VATS segmentectomy. Video-assist Thorac Surg 2020;5:1.