**Case
Report**

Venous Branching Pattern in a Patient with Hemorrhagic Infarction in the Lingula after the Upper Division Resection of the Left Lung

Takamasa Onuki, MD,¹ Masato Kanzaki, MD,² Hideyuki Maeda, MD,² Kei Sakamoto, MD,¹ Tamami Isaka, MD,² Kunihiro Oyama, MD,² and Masahide Murasugi, MD²

Background: Because left upper division resection is similar to right upper lobectomy, this procedure is frequently employed. Few studies have used the anatomic courses of veins evaluated on preoperative computed tomography (CT) imaging to determine what types of patients are at the highest risk for hemorrhagic pulmonary infarction.

Case: We describe our experience with a patient in whom hemorrhagic pulmonary infarction occurred at 6 days after transecting two superior branches (V¹ and V³) of the three branches of the left superior pulmonary vein. We preoperatively confirmed that small-caliber lingular veins were perfused by V³. However, the patient had a poor pulmonary function, and the tumor was located distal to V³. Left upper division resection was therefore performed.

Conclusion: The division of V³ could be the cause of hemorrhagic infarction in the lingular segment after upper division segmentectomy.

Keywords: venous branching pattern, left upper division resection, lingular hemorrhagic infarction, lung cancer, thoroscopic surgery

Introduction

Two surgical textbooks recommend that the superior branches of the left superior pulmonary vein should be transected, and the middle branch of the left superior pulmonary vein (V³) should be preserved during left upper division resection.^{1,2)} However, another textbook recommends that V¹ and V³ should be transected at their origins, and only the lingular vein preserved.³⁾ Another textbook vaguely recommends that V³ should be preserved if it is

of large caliber.⁴⁾ To our knowledge, very few studies have used the anatomic courses of veins evaluated on preoperative computed tomography (CT) imaging to determine what types of patients are at the highest risk for hemorrhagic pulmonary infarction caused by few remaining veins after transection of the V³ in left upper division resection. We described our experience with a patient with lung cancer who underwent left upper division resection. Pulmonary infarction developed after the transections of V¹ and V³ at their origin, preserving only the lingular vein. We reported the clinical course of this patient, including the anatomical characteristics of the pulmonary veins.

Because there are no internationally accepted symbols for describing subsegments, Yamashita's abbreviations for the subsegments⁵⁾ are used in the figures and text of this report (**Table 1**). Although V^{3a} and V^{3b} indicate veins that run between the upper division and lingular segment in textbook, there are many variations of the venous branching pattern especially in the left upper lobe.

¹Division of Pulmonary Medicine, Shonantobu General Hospital, Chigasaki, Kanagawa, Japan

²Department of Surgery I, Tokyo Women's Medical University, Tokyo, Japan

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Corresponding author: Takamasa Onuki, MD. Division of Pulmonary Medicine, Shonantobu General Hospital, 500, Nishikubo, Chigasaki, Kanagawa 253-0083, Japan

Email: onuki@fureai-g.or.jp

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Fig. 2 A CT scan of the patient's chest obtained on postoperative day 6, showing consolidation associated with air bronchograms in the lingular segment of the left lung and plural effusion in the left side of the thoracic cavity. CT: computed tomography

of the lingular bronchi with blood inside the lumina. There were no abnormalities at the stump of the superior segmental bronchi. CT of the chest demonstrated consolidation with air bronchograms with loss of more than half of the air volume in the lingular region (**Fig. 2**). Pulmonary infarction caused by torsion and excessive venous resection was suspected, and reoperation was performed thoracoscopically again. The lingula had become dark purple and was friable, with no adhesion to the thoracic cavity. However, there was no evidence of torsion. Left lingulectomy was thus performed. Histopathological examination showed bleeding and tissue necrosis, indicating hemorrhagic infarction. The infarction was found to be stronger in S⁴ and spread in S⁵. No thrombi were found in both the arteries and veins of the resected lung. The patient was discharged from the hospital on day 9 after the second operation. At 10 years after surgery, there has been no recurrence.

Discussion and Conclusion

In our patient, we preoperatively confirmed that some of the veins in S⁴ drained into V³. Three veins that drained from S⁴ to V³ were found, and the calibers of those veins were approximately 1 mm for two and less than 1 mm for one. However, lymph-node dissection was facilitated by the following conditions: 1) the branches from S⁴ were of small caliber and 2) the mass was located distal part to V³ (**Fig. 1**). We therefore divided V¹ and V³. We decided to perform upper division resection rather than left upper lobectomy because the patient had decreased pulmonary

function, and we considered it important to preserve the lung tissue as much as possible. Consequently, some of the veins for draining in the lingular region were transected, resulting in decrease in the drainage capacity. Subclinical or latent congestion could exist in the site just after surgery, gradually progressed with time, and eventually clinically appeared on postoperative day 6. In these patients, we believed that V³ should be preserved or the left upper lobectomy should be initially performed. In the authors' institution, the upper division resections of the left lung were performed in 54 cases with lung cancer, metastatic lung tumor, and infection from January to December 2016. In 45 of total 54 cases, three-dimensional image models, where the bronchi and pulmonary vessels at the hilum were constructed from the CT data, were prepared before surgeries, and in those cases, V¹⁺² type in five cases were performed by V¹ and V³ cutting technique, and for other type cases, non-V³-cutting technique was used. No cases showing symptoms similar to those observed in the patients of this report were found. However, one case without making three-dimensional image model was treated by V¹ and V³ cutting technique and showed symptoms similar to those observed in the patients of this report.

Compared with reports on infarction in the middle lobe after the transection of the right upper-lobe, there have been a few reports about infarction in the lingular segment after the resection of the upper division.⁷⁾ To our knowledge, hemorrhagic infarction in the absence of torsion after left upper division segmentectomy has not been reported previously. Surgically, division of the two superior branches of the left superior pulmonary vein with preservation of the lowermost lingular vein is technically easy to be accomplished.⁸⁾ One textbook⁴⁾ recommends that whether V³ is preserved or not should be empirically decided intraoperatively on the basis of the caliber of V³. Venous branching patterns are diverse, and V³ drains only S³ in some patients. In other patients, V³ drains S^{1+2b} and S^{1+2c} as well as S³, similar to the patient in this report. Because of these complex venous branching patterns, the implications of different root-diameter ratios remain unclear. Our patient had a history of heavy smoking and chronic obstructive pulmonary disease (COPD), which could contribute to the development of pulmonary hemorrhagic infarction.

Disclosure Statement

The authors report no conflicts of interest.

References

- 1) Shiozawa M. Pulmonary segmentectomy. Vol 2, 134-5 Bunkodo Tokyo 1954.
- 2) Locicero J. Segmentectomy and lesser pulmonary resections. In: Thomas Shields. General Thoracic Surgery Vol 1, 433-8 Williams and Wilkins Baltimore 2000.
- 3) Chikwe J, Cooke DT, Cooke D, et al. Lung and pleura. Sublobar resection. In: Cardiothoracic Surgery, 2nd edition, 694, Oxford University press Oxford 2013.
- 4) Gossot D. Left upper lobe: superior segment. In Atlas of endoscopic major pulmonary resections. 131-42 Springer-Verlag France, Paris 2010.
- 5) Yamashita H. Roentgenologic Anatomy of the Lung. Tokyo: Igakushoin, 1978.
- 6) Kanzaki M, Wachi N, Onuki T. Simulating video-assisted thoracoscopic lung resection using a virtual 3-dimensional pulmonary model on a personal computer. J Thorac Cardiovasc Surg 2011; **142**: 243-4.
- 7) Eguchi T, Kato K, Shiina T, et al. Pulmonary torsion of the lingula following a segmentectomy of the left upper division. Gen Thorac Cardiovasc Surg 2008; **56**: 505-8.
- 8) Hung MH, Hsu HH, Chen KC, et al. Nonintubated thoracoscopic anatomical segmentectomy for lung tumors. Ann Thorac Surg 2013; **96**: 1209-15.