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CASE REPORT

Anomalous right upper lobe pulmonary veins draining posterior to the pulmonary artery

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Abstract

The anatomy of pulmonary vessels varies. The right upper pulmonary vein usually drains in front of the pulmonary artery to the left atrium. We herein describe a case of the right upper lobe pulmonary vein draining posterior to the pulmonary artery and absent right upper lobe pulmonary vein in the ventral hilum. A 64-year-old woman suspected to have lung cancer and scheduled for surgery underwent pre-operative three-dimensional computed tomography (3D-CT), which revealed that pulmonary vessels V1 + 3 and V2 drain posteriorly to the pulmonary artery. Video-assisted right upper lobectomy was performed because the patient was diagnosed with lung adenocarcinoma through intraoperative pathologic analysis, and all the pulmonary vessels were identified correctly during the operation. Despite the limited surgical field of video-assisted lobectomy, the operation was performed safely because the pre-operative 3D-CT assessment revealed the anatomy of the anomalous pulmonary vessels, helping us avoid missing any anomaly and vessel injury.

Keywords Anomalous pulmonary vein · Three-dimensional computed tomography · Video-assisted thoracotomy · Lung cancer

Introduction

With the prevalence of video-assisted thoracoscopic surgery (VATS) for lung cancer treatment, correct understanding of pulmonary vessel anatomy is becoming more important. Pulmonary vessels display many variant anatomies, especially in the pulmonary veins [1]. The venous drainage of the right upper lobe is usually anterior to the hilum. We herein describe a case of a patient with lung cancer whose pulmonary vein of the right upper lobe was draining posterior to the pulmonary artery, which was identified through pre-operative three-dimensional computed tomography (3D-CT).

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Case

A 64-year-old woman was found to have an abnormal lung shadow via computed tomography (CT) during a medical checkup. The CT image revealed a 19-mm partly solid ground-grass nodule (GGN) in the right upper lobe (Fig. 1a) and bilateral hilar lymph node swelling. 18-Fluorine-fluorodeoxyglucose positron-emission tomography/computed tomography (^{18}F-FDG PET/CT) revealed an FDG accumulation maximum standardized uptake value of 3.74 in the GGN and 5.1 in the bilateral hilar lymph nodes. Radiological findings were consistent with stage IA lung cancer and sarcoidosis. The CT image revealed a relatively small right upper lobe because the middle lobe was located superiorly (Fig. 1b). Furthermore, the right pulmonary vessels V1 + 3 were revealed to be draining posterior to the pulmonary artery and anterior to the right upper bronchus. V2 drained directly into the left atrium, passing behind the bronchus intermedius (Fig. 1c). VATS right upper lobectomy, which also served as a diagnostic procedure, was planned.

A 4-cm incision was made in the fourth intercostal space, and two additional ports were made in the sixth and seventh intercostal spaces. Wedge resection of the right upper lobe was performed, and intraoperative pathologic analysis

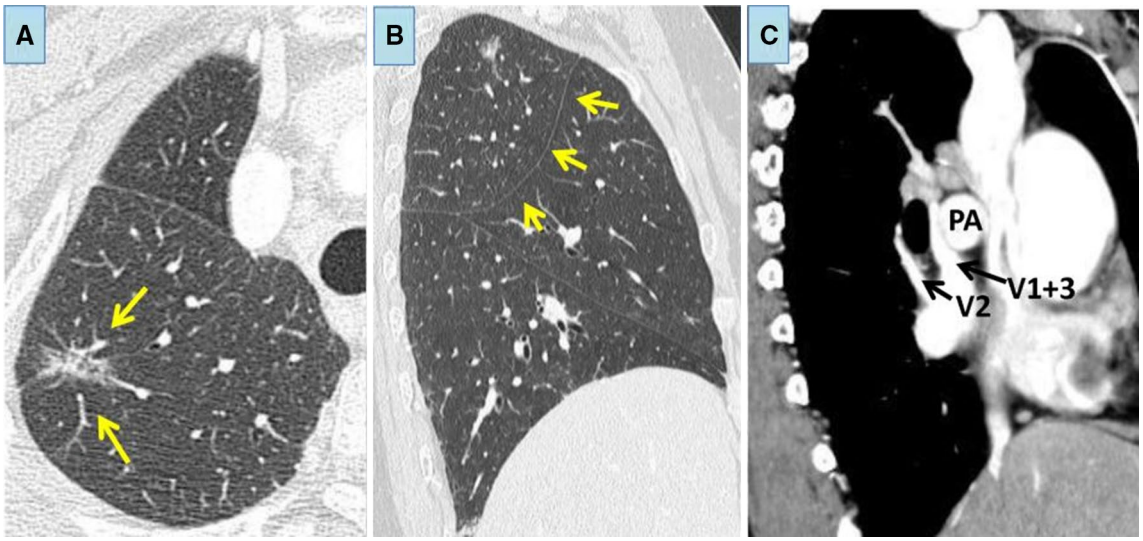

Fig. 1 **a** Partly solid ground-grass nodule found in the right upper lobe. **b** Sagittal computed tomography image showing that the right upper lobe was relatively small because the middle lobe was located superiorly. **c** Sagittal computed tomography image showing all the right upper lobe veins behind the pulmonary artery

revealed the tumor to be lung adenocarcinoma. Right upper lobectomy was performed. Intraoperative findings showed swelling of several lymph nodes, which were removed for intraoperative pathologic analysis, and the patient was diagnosed with sarcoidosis. A2, which branched from A6, was encircled and transected. After the major and minor fissures were completed with staplers, A1 + 3 were encircled and transected. V1 + 3 were transected between the main pulmonary artery and the right upper lobe bronchus (Fig. 2a, b). V2, which was posterior to the bronchus intermedius, drained directly into the left atrium and was transected. None of the right upper pulmonary veins were at the ventral hilum (Fig. 2c). The right upper lobe bronchus was transected and the resected lobe was removed from the 4-cm port. The total operation time was 213 min. The volume of blood loss was 20 mL. Correct identification of the anomalous anatomy and safe ligation of the right upper pulmonary vessels were made possible by perioperative 3D-CT.

The post-operative course was uneventful and the patient was discharged on the 7th post-operative day.

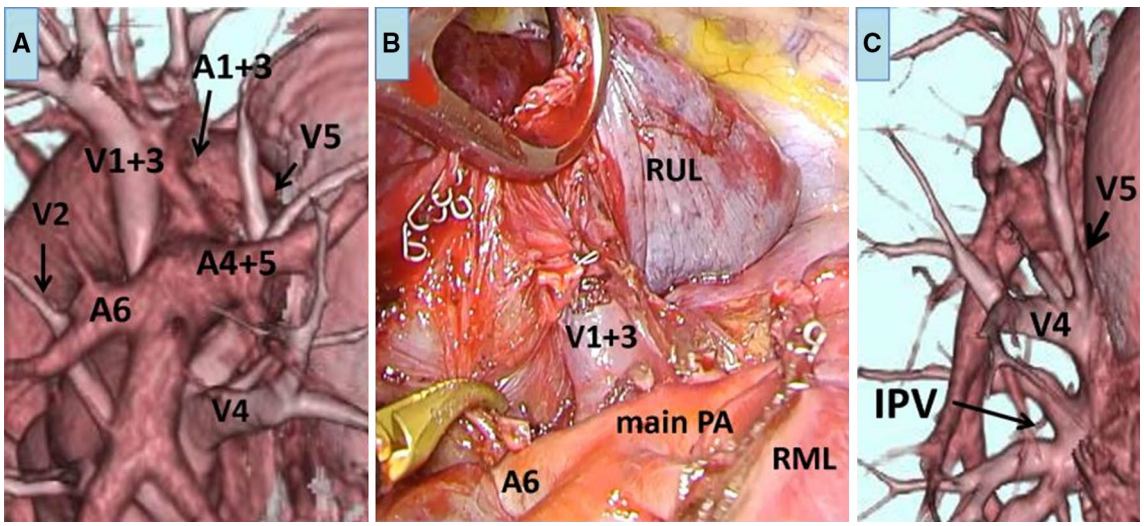

Fig. 2 **a** Three-dimensional computed tomography (3D-CT) image of the right pulmonary vessels showing V1 + 3 behind the pulmonary artery. **b** The intraoperative finding in this patient was the same as that seen in the 3D-CT after A1 + 3 ligation. **c** 3D-CT image of the right pulmonary vessels viewed from the ventral hilum showing only the middle lobe veins

Discussion

The pulmonary veins, especially the right upper veins, have been reported to have various anatomy [1]. Shimizu et al. [2] reviewed 338 3D-CT images and classified the right upper pulmonary veins into the following four types: anterior with central Iab, $n=184$ (54%); anterior with central Ib, $n=89$ (26%); central, $n=23$ (7%); anterior, $n=42$ (12%). However, in our case, the right upper pulmonary veins did not correspond to any of the aforementioned types. Several previous reports have identified anomalous right upper veins, such as V2 located behind the bronchus intermedius like our case [3] or partial anomalous pulmonary venous connection, which is defined as an uncommon congenital anomaly of the pulmonary vein draining to systemic circulation instead of the left atrium [4]. To our knowledge, there are only two reports on anomalous right upper lobe pulmonary veins located posterior to the pulmonary artery; one case of anomalous right upper lobe pulmonary veins was detected during right upper lobectomy, and the other one was right lower lobectomy [5, 6]. In our case, we were aware of the anomalous pulmonary veins before right upper lobectomy was performed.

Because the VATS approach has limited surgical field of view, some reports have stated the usefulness of pre-operative 3D-CT in evaluating pulmonary vessels [7, 8]. When VATS lobectomy is performed in patients with anomalous vessels, such as in this case, vessel injury and/or ligation of incorrect vessels may lead to serious problems such as uncontrolled bleeding if the anomalous vessels are not correctly evaluated. In this case, ligation of the middle pulmonary lobe vein was possible because V5 was draining most superiorly at the ventral hilum and V5 could have been incorrectly identified as the right upper lobe veins and V4 as the middle lobe veins unless we recognized the anomalous veins by pre-operative 3D-CT imaging.

We presented a case of VATS lobectomy performed safely on a patient with anomalous vessels owing to pre-operative understanding the vessel anomalies through 3D-CT imaging.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to disclose.

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