General Thoracic and Cardiovascular Surgery (2019) 67:720–722
https://doi.org/10.1007/s11748-018-1009-8

CASE REPORT

Thoracoscopic resection of mediastinal tumor in a patient with azygos continuation of the inferior vena cava

Hiroaki Komatsu[1] · Nobuhiro Izumi[1] · Takuma Tsukioka[1] · Hidetoshi Inoue[1] · Kantaro Hara[1] · Hikaru Miyamoto[1] · Noritoshi Nishiyama[1]

Received: 31 July 2018 / Accepted: 6 September 2018 / Published online: 18 September 2018
© The Japanese Association for Thoracic Surgery 2018

Abstract
A 68-year-old man was referred to our hospital because of mediastinal tumor on chest computed tomography (CT). Contrast-enhanced CT showed azygos continuation of the inferior vena cava (IVC). The retro-hepatic IVC was absent superior to the renal veins. The IVC continued into the dilated azygos vein, which joined the superior vena cava. The hepatic vein drained directly into the right atrium. The mediastinal tumor was close to the dilated azygos vein. Video-assisted thoracoscopic resection of the mediastinal tumor was performed, using four ports and CO_2 insufflation. Histological examination of the resected specimen revealed a pericardial cyst without malignancy. After a favorable postoperative course, the patient was discharged 4 days after surgery. It is important to recognize this anomaly before thoracic surgery, because transection of the azygos vein can be fatal. Video-assisted thoracoscopic resection of mediastinal tumor close to the azygos vein using CO_2 insufflation avoids injury to the azygos vein.

Keywords Azygos continuation of the inferior vena cava · Mediastinal tumor · Video-assisted thoracoscopic surgery · Thoracic surgery · CO_2 insufflation

Introduction

Azygos continuation of the inferior vena cava (IVC) is rare congenital disease [1]. It is important to recognize this condition before thoracic surgery, because transection of the azygos vein in a patient with azygos continuation of the IVC can be fatal [2]. There have been a few reports of thoracic surgery in patients with azygos continuation of the IVC [2–7]. We herein report a patient with azygos continuation of the IVC who underwent video-assisted thoracoscopic resection of a mediastinal tumor close to the azygos vein using carbon dioxide (CO_2) insufflation.

✉ Hiroaki Komatsu
m1111276@med.osaka-cu.ac.jp

[1] Department of Thoracic Surgery, Osaka City University Hospital, 1-4-3 Asahi-machi, Abeno-ku, Osaka 545-8585, Japan

Case report

A 68-year-old man was referred to our hospital because of a mediastinal tumor discovered on chest computed tomography (CT). Contrast-enhanced CT showed azygos continuation of the IVC (Figs. 1, 2). The retro-hepatic IVC was absent superior to the renal veins. The IVC continued into the dilated azygos vein with a diameter of 25 mm, which joined the superior vena cava (SVC). The hepatic vein drained directly into the right atrium. The mediastinal tumor with a diameter of 20 mm was located at the pretracheal region and close to the dilated azygos vein. The patient had multiple spleens on the left side and intestinal malrotation, but no heterotaxia of other organs. Chest magnetic resonance imaging showed a mediastinal tumor with low-signal intensity on T1-weighted images and high-signal intensity on T2-weighted images, which was diagnosed as a cystic tumor. Echocardiography revealed no cardiac anomalies. Compared with the previous chest CT, the mediastinal tumor has increased in 3 months (diameter 16–20 mm). To confirm the diagnosis and treat the mediastinal cystic tumor, we performed

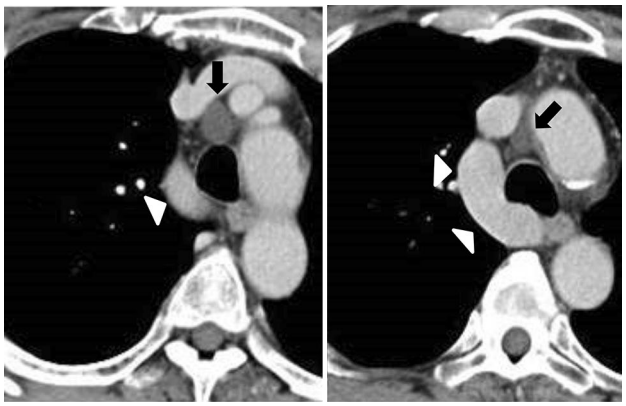

Fig. 1 Computed tomography (CT) showing the mediastinal tumor (arrow) with a diameter of 20 mm located at the pretracheal region close to the dilated azygos vein (arrowhead) with a diameter of 25 mm

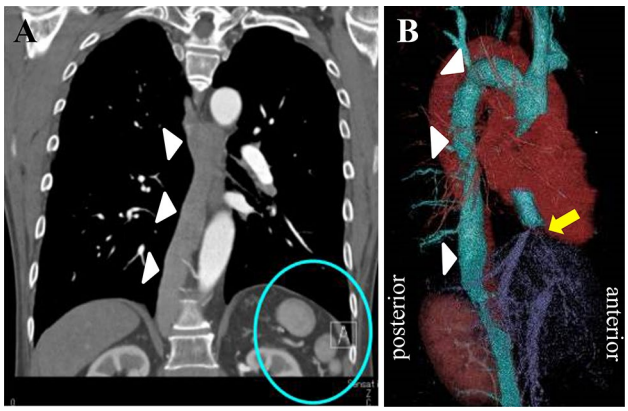

Fig. 2 **a** Coronal view and **b** three-dimensional reconstruction of CT, showing that the IVC continued into the dilated azygos vein (arrowhead), which joined the superior vena cava (SVC). There were multiple spleens on the left side (blue circle). Three-dimensional reconstruction showed agenesis of the retro-hepatic IVC, and the hepatic vein drained directly into the right atrium (yellow arrow)

video-assisted thoracoscopic surgery (VATS) using four ports (three 5-mm ports and one 10-mm port) and CO_2 insufflation with an intrapleural pressure of 7 mm Hg. The azygos vein, which was dilated and close to the tumor, was dissected from the tumor. Considering possibility of malignancy and surgical margin, the tumor and pretracheal lymph node were resected en bloc (Fig. 3). The lymph nodes close to the azygos vein were not resected and remained because of the possible azygos vein injury. The intraoperative-frozen pathological examination was not performed. Histological examination of the resected specimen revealed pericardial cyst with no malignancy. The patient's postoperative course was favorable and he was discharged 4 days after surgery.

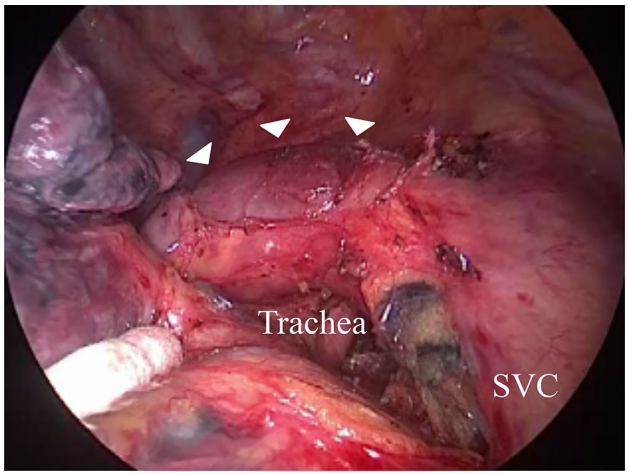

Fig. 3 Surgical view showing the dilated azygos vein (arrowhead) after resection of the mediastinal tumor

Discussion

Azygos continuation of the IVC is rare congenital anomaly of the vena cava, which has an incidence of 0.6% in patients with congenital heart defect [1]. It is commonly associated with polysplenia syndrome, a type of situs ambiguus [8, 9]. The majority of patients with polysplenia syndrome have been reported to die by the age of 5 years from severe cardiac anomalies; less than 10% of patients have normal hearts or minor cardiac defects and reach adulthood without symptoms [10]. Our patient had multiple spleens and intestinal malrotation, but no heterotaxia of other organs or cardiac anomalies. This was probably why he remained asymptomatic, with the anomaly not being detected until he was in his 60s. Isolated azygos continuation of the IVC with no associated congenital anomalies has also been reported [11], and this anomaly should be suspected in all patients with an enlarged azygos vein. In addition, it must be differentiated from congestive heart failure, an obstruction of the SVC, and splenic or portal vein thrombosis with portal hypertension [4].

The literature contains some reports of thoracic surgery in patients with azygos continuation of the IVC [2–7]. When these patients undergo thoracic surgery, surgeons should avoid ligation or transection of the azygos vein, because acute interruption of venous return from bilateral kidney and lower body leads to acute renal insufficiency and hypotension [2, 6]. In an esophageal surgery procedure, the azygos vein is transected conventionally to facilitate the resection of carcinomas, lymph-node dissection, and gastroesophageal anastomosis [7]. A standard right thoracotomy [4, 5, 7], left thoracotomy [3], transection of the right superior intercostal vein [4], or veno-venous

bypass between the left femoral vein and the jugular vein [7] were considered necessary to provide a sufficient operative field of view in patients with azygos continuation of the IVC. Martín-Malagón et al. performed the second right thoracotomy after azygos vein transection and reconstructed the vein with a prosthetic polytetrafluoroethylene graft. However, the patient's condition deteriorated due to acute graft thrombosis, which led to death 1 day later. If the azygos vein is injured or transected in patients with azygos continuation of the IVC, not only venous reconstruction or bypass but also postoperative anticoagulation therapy should be considered. Although there have been a few reports of thoracic surgery except for esophageal surgery in patients with azygos continuation of the IVC, surgeons should be aware of this anomaly when performing not only esophageal surgery but also surgery for lung cancer or mediastinal tumor.

VATS has been increasingly adopted for mediastinal tumor resection [12]. When performing VATS, CO_2 insufflation is used to compress the ipsilateral lung and mediastinum, providing a better operative field of view and making the dissection safer [13]. As shown in Fig. 3, CO_2 insufflation has enlarged the pretracheal space, and we gained enough operative field to dissect the tumor from the dilated azygos vein. It has been reported that CO_2 insufflation with single-lung ventilation increases central venous pressure, while low-pressure CO_2 insufflation (< 10 mmHg) does not have adverse hemodynamic effects [14]. In this patient, we should care the decrease of venous return from not only upper body but also lower body through the dilated azygos vein, and this could cause hemodynamic effects. Therefore, we used low-pressure CO_2 insufflation with an intrapleural pressure of 7 mm Hg, and there were neither hemodynamic nor respiratory disturbances. We chose a VATS approach using CO_2 insufflation to enable safe resection of the mediastinal tumor while avoiding injury to the azygos vein.

Conclusion

We encountered a patient with azygos continuation of the IVC who underwent video-assisted thoracoscopic resection of mediastinal tumor close to the azygos vein. It is important to recognize this anomaly before surgery and avoid injury to the azygos vein.

Acknowledgements We thank Hugh McGonigle, from Edanz Group (http://www.edanzediting.com/ac), for editing a draft of the manuscript.

Compliance with ethical standards

Conflict of interest The author(s) declare that they have no conflict of interest.

References

1. Andreson RC, Adams P Jr, Burke B. Anomalous inferior vena cava with azygos continuation (infrahepatic interruption of the inferior vena cava). Report of 15 new cases. J Pediatr. 1961;59:370–83.
2. Martín-Malagón A, Bravo A, Arteaga I, Rodríguez L, Estévez F, Alarcó A. Ivor Lewis esophagectomy in a patient with enlarged azygos vein: a lesson to learn. Ann Thorac Surg. 2008;85:326–8.
3. Oakes DD. Esophagectomy in patients with polysplenia: technical considerations. J Clin Gastroenterol. 1997;24:92–6.
4. Haraguchi S, Hioki M, Hisayoshi T, Yamashita Y, Sato M, Koizumi K, et al. Enucleation of esophageal leiomyoma with azygos continuation of the inferior vena cava: report of a case. Surg Today. 2006;36:722–6.
5. Hardwick T, Belcher E, Sabharwal T, King J. Interrupted inferior vena cava: high-risk anatomy for right thoracotomy. Interact Cardiovasc Thorac Surg. 2011;12:850–2.
6. Veltman ES, Ruurda JP, van Berge Henegouwen MI. Inferior vena cava agenesis in a patient with esophagectomy for esophageal cancer. Dis Esophagus. 2013;26:338–9.
7. Shen Y, Zhuang X, Xiao P, Dai W, Li Q. Oesophagectomy in a patient with azygos vein continuation of the inferior vena cava: report of a case. World J Surg Oncol. 2015;13:242.
8. Sheley RC, Nyberg DA, Kapur R. Azygous continuation of the interrupted inferior vena cava: a clue to prenatal diagnosis of the cardiosplenic syndromes. J Ultrasound Med. 1995;14:381–7.
9. Applegate KE, Goske MJ, Pierce G, Murphy D. Situs revisited: imaging of the heterotaxy syndrome. Radiographics. 1999;19:837–52 (**discussion 853–4**).
10. Gayer G, Apter S, Jonas T, Amitai M, Zissin R, Sella T, et al. Polysplenia syndrome detected in adulthood: report of eight cases and review of the literature. Abdom Imaging. 1999;24:178–84.
11. Fernandes R, Israel RH. Isolated azygos continuation of the inferior vena cava in the elderly. Respiration. 2000;67:229–33.
12. Ye B, Tantai JC, Ge XX, Li W, Feng J, Cheng M, et al. Surgical techniques for early-stage thymoma: video-assisted thoracoscopic thymectomy versus transsternal thymectomy. J Thorac Cardiovasc Surg. 2014;147:1599–603.
13. Petersen RH. Video-assisted thoracoscopic thymectomy using 5-mm ports and carbon dioxide insufflation. Ann Cardiothorac Surg. 2016;5:51–5.
14. Wolfer RS, Krasna MJ, Hasnain JU, McLaughlin JS. Hemodynamic effects of carbon dioxide insufflation during thoracoscopy. Ann Thorac Surg. 1994;58:404–7 (**discussion 407–8**).