Successful Resection of Esophageal Cancer with Right Aortic Arch by Video-Assisted Thoracoscopic Surgery: A Case Report

NAOISHI KUBO1, MASAICHI OHIRA1, TOMOHIRO LEE1, KATSUNOBU SAKURAI1, TAKAHIRO TOYOKAWA1, HIROAKI TANAKA1, KAZUYA MUGURUMA1, KENJIRO KIMURA1, HISASHI NAGAHARA1, EIIJI NODA1, RYOSUKE AMANO1, HIROSHI OHTANI1, YOSHIITO YAMASHITA2, MASAKAZU YASHIRO1, KIYOSHI MAEDA1 and KOSEI HIRAKAWA1

1Department of Surgical Oncology, Osaka City University Graduate School of Medicine, Osaka, Japan; 2Department of Gastroenterological Surgery, Osaka City General Hospital, Osaka, Japan

Abstract. The right aortic arch (RAA) forms a vascular ring, encircling both the esophagus and trachea. We herein report a case of thoracic esophageal cancer with RAA successfully resected using video-assisted thoracoscopic surgery (VATS). A 64-year-old man who presented with a complaint of abdominal pain, was admitted to our hospital. Further examinations revealed gall stones and multiple superficial esophageal carcinomas. Three-dimensional computed tomographic images showed RAA and aortic diverticulum. The trachea and esophagus were completely encircled by the RAA, the aortic diverticulum and the pulmonary artery. We successfully and safely performed VATS esophagectomy for esophageal cancer accompanied with RAA. To the best of our knowledge, this report is the first case for which VATS esophagectomy for esophageal cancer associated with RAA was carried out. Marking of the left recurrent laryngeal nerve with colored tape at the cervical part of the surgery made it easy to identify it during the thoracoscopic part of the surgery.

Right-sided aortic arch (RAA), which is a rare vascular malformation, forms a vascular ring encircling both the esophagus and trachea. Consequently, esophagectomy for esophageal cancer associated with RAA is extremely rare; only approximately 30 such cases have been reported. Because most cases with RAA have vessel and nervous system anomalies in the mediastinum, it is very important to understand the anatomy of these systems in order to safely perform an operation. Recently, video-assisted thoracoscopic surgery (VATS) has been applied in esophagectomy and has been reported to deliver better surgical outcomes. VATS for patients with esophageal cancer has several advantages, such as a good surgical view by means of visual enlargement, and less trauma to the thoracic wall, compared with conventional open thoracotomy. We herein report a case of thoracic esophageal cancer with RAA, successfully resected using VATS. All previously reported cases with esophageal cancer associated with RAA underwent open esophagectomy. To the best of our knowledge, this case is the first report of a patient undergoing VATS esophagectomy for esophageal cancer associated with RAA. We were easily able to understand the unusual anatomical localization of RAA and safely dissected the mediastinal lymph nodes by visual enlargement thorough the thoracoscope. In addition, it was very useful to mark the left recurrent laryngeal nerve (LRLN) with colored tape during the cervical portion of the surgery before the thoracoscopic portion of the surgery started.

Case Report

A 64-year-old man visited a local physician with a complaint of abdominal pain.

Further examinations showed acute cholecystitis due to gallstones. Esophageal cancer was accidentally found by upper gastrointestinal endoscopic examination. The patient was admitted to our hospital for surgical treatment for acute cholecystitis and esophageal cancer.

Chest radiography demonstrated an RAA with normal cardiac findings.

Barium esophagography showed right indentations in the upper thoracic esophagus at the point of the aortic arch, and no tumor was identified (Figure 1A). Esophagoscopy showed...
multiple superficial depressed lesions located approximately 30-32, 35-37, and 38-39 cm distal from the incisors (Figure 1B). Biopsy samples of the lesions revealed moderately-differentiated squamous cell carcinomas. Three-dimensional computed tomographic (3D-CT) images showed an RAA and aortic diverticulum, known as Kommerell’s diverticulum (Figure 2). The trachea and esophagus were completely encircled by the RAA, Kommerell’s diverticulum and the pulmonary artery. Chest 3D-CT revealed that the right common carotid artery and subclavian artery branched from the RAA, while the left common carotid artery and subclavian artery branched from Kommerell’s diverticulum. From these findings, we diagnosed multiple superficial esophageal carcinomas accompanied with an RAA and gallstones. Subtotal esophagectomy and three-field lymphadenectomy using VATS and cholecystectomy was performed.

Operative findings. The operation consisted of two steps. The first step was cervical and abdominal lymphadenectomy and reconstruction using a gastric tube through the retrosternal route in the supine position. The second step was subtotal esophagectomy and mediastinal lymph node dissection using VATS in the right lateral position. For the first step, the patient was positioned in the supine position. Through a cervical collar incision, lymphadenectomy along the left and right recurrent laryngeal nerve and above both clavicles was performed by a cervical team. Subsequently, the LRLN was marked with colored vessel tape. Simultaneously, an abdominal team performed cholecystectomy and mobilized the stomach by hand-assisted laparoscopic surgery. Subsequently, celiac and perigastric lymph node dissection was performed, after which a 4-cm width gastric conduit was made extracorporeally by an automatic suturing instrument. The gastric conduit was pulled up through a retrosternal route and cervical esophago-gastric anastomosis was performed. The patient was then turned into the right lateral position and underwent a subtotal esophagectomy and mediastinal lymphadenectomy with left minithoracotomy under VATS. A 5-cm minithoracotomy was made in the fourth intercostal space (ICS) on the anterior axillary line,

Figure 1. A: Barium esophagography showing the indentation of the upper thoracic esophagus at the point of a right aortic arch (arrowhead). B: Esophagoscopy with the iodine stain showing multiple depressed lesions located at the middle and lower thoracic esophagus.
where the camera and metal retractor were inserted. Three other trocars were inserted as follows: One 10-mm trocar for an assistant was placed at the second ICS on the anterior axillary line, and two 10-mm trocars for the operator were placed at the fourth ICS on the posterior axillary line and fifth ICS on the middle axillary line. The thoracoscope revealed that the trachea and esophagus were completely encircled by a vascular ring consisting of an aortic arch, aortic diverticulum, left ductus arteriosus and pulmonary artery. The left ductus arteriosus was found to be closed and was preserved. The LRLN marked with colored vessel tape at the cervical procedure was easily identified and preserved. The LRLN passed behind the left ductus arteriosus and ascended posteriorly (Figure 3). Subtotal esophagectomy with radical dissection of para-esophageal and mediastinal lymph nodes was performed. Lymph nodes along the right recurrent laryngeal nerve (RRLN) were dissected through a neck incision. The postoperative course was uneventful and the patient was discharged from the hospital 21 days postoperatively. Macroscopic findings showed multiple superficial esophageal cancers, and microscopic findings showed moderately differentiated squamous cell carcinoma within the mucosal layer and no metastatic lymph nodes at any site. According to the TNM classification version 7 (1), these tumors were classified as T1N0M0 stage IA.

Discussion

RAA is a rare vascular anomaly and has been reported to be present in 0.04-0.1% of autopsy cases in Western countries (2). Because the trachea and esophagus of a patient with RAA are compressed by a vascular circle, most patients with this malformation have respiratory symptoms such as stridor or gastrointestinal symptoms, choking with food from infancy and early childhood (3). Edwards et al. (4) identified three types of aortic anomalies based on a theoretical concept of the development of the aortic arch. RAA is Group III of this classification. Stewart et al. also showed RAA was in turn divided into three subtypes (5) (Figure 4): subtype I exhibits a mirror image branching of the normal left aortic arch, subtype II an aberrant left subclavian artery, and subtype III a left subclavian artery which is no longer connected. The present case demonstrated the type of RAA with aortic diverticulum, while the left carotid artery and subclavian artery branched from the aortic diverticulum (Figure 5). This case did not belong to any of the subtypes from the Stewart et al.’s classification. The left ductus arteriosus connected the aortic diverticulum and the pulmonary artery. The LRLN passed behind the left ductus arteriosus and ascended posteriorly. Shimakawa et al. (6) reviewed the as then 28
reported cases of esophageal cancer with RAA and showed eight cases had RAA of subtype IIIA, while 19 cases had RAA of subtype IIIB according to Stewart et al.’s classification. However, there was no report of esophageal cancer with RAA as found in the present case. Shimakawa et al. reported that subtotal esophagectomy and mediastinal lymph-node dissection through a left thoracotomy have been performed in most cases of RAA with esophageal cancer. All patients with esophageal cancer accompanied by RAA, underwent open esophagectomy through a left thoracotomy. Left thoracotomy has been reported to give a better view into the mediastinum for esophagectomy in patients with RAA than an approach through the right thoracotomy because RAA and right-sided descending aorta interfere with the mobilization of the esophagus located at the left side of the RAA through a right thoracotomy. However, it is difficult to carry out an adequate dissection of lymph nodes around the RRLN through a left thoracotomy alone. Lymph nodes around both recurrent laryngeal nerves are common sites of metastasis. Kinoshita et al. (7) stated that a median sternotomy should be added to a left thoracotomy in cases with advanced thoracic esophageal cancer with RAA to resect completely the lymph nodes along the RRLN. Moreover, Noguchi et al. (8) reported that the left door open method was useful for radical dissection of lymph nodes along RRLN and LRLN. Since in the present case, the tumor depth was considered to be superficial and the preoperative chest CT and PET-CT showed no evidence of lymph node metastasis around the RRLN, we performed the lymph node dissection along the RRLN through the neck incision alone, considering that sternotomy or left door open method would add unnecessary stress.

One of the most important parts of thoracic esophagectomy for esophageal cancer is the LN dissection along the LRLN. Shimakawa et al. Reported that in most cases with RAA, the LRLN branched from the vagal nerve...
and passed behind the left ductus arteriosus and ascended to the neck along the trachea. We were easily able to identify the LRLN, as it had been marked with colored vessel tape at the first-step cervical procedure. This procedure was very useful in this case because RAA had unusual vessel anomalies and nerve system.

VATS for esophageal cancer was first reported by Cuschieri et al. (9) in 1992. Since then, many reports of the advantages and non-inferiority of VATS compared to open surgery for esophageal cancer have been published (10, 11). At our institute, VATS esophagectomy was first applied for esophageal cancer in July 2000 and since then has been performed safely for about 140 patients with esophageal cancer at stages up to T3 with regional lymph node metastasis without severe pleural adhesion. In this case, we were easily able to understand the unusual anatomical situation of RAA and safely dissected the mediastinal lymph nodes by visual enlargement thorough the thoracoscope. To our knowledge there is no report of esophageal cancer accompanied with RAA treated with VATS esophagectomy.

In summary, we successfully performed the first reported VATS esophagectomy for esophageal cancer accompanied by RAA. We recommend VATS esophagectomy by a well-trained team of endoscopic surgeons for patients with esophageal cancer with RAA. In addition, marking of the LRLN with vessel tape at the cervical part of the surgery made it easy to identify it during the thoracoscopic part of the surgery.

Figure 4. Classification of the right aortic arch by Stewart et al. (4): Right aortic arch with mirror-image branching (type I), with aberrant left subclavian artery (LSA) (type II), with isolation of the left LSA (type III). RSA: Right subclavian artery, RCA: right common carotid artery, LCA: left common carotid artery.

Figure 5. A schematic illustration of the mediastinal structure of the present case. The trachea and esophagus were encircled completely by the right aortic arch (RAA), aortic diverticulum (AD) and left ductus arteriosus (LDA). The AD gave rise to the left subclavian artery (LSA) and left common carotid artery (LCA). RSA: Right subclavian artery, RCA: right common carotid artery, LCA: left common carotid artery, DA: descending aorta, PA: pulmonary artery, VN: vagus nerve, LRLN: left recurrent laryngeal nerve, T: trachea, E: esophagus.
References


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