Cancer Cell Research 21 (2019) 565-568

Available at http:// www.cancercellresearch.org ISSN 2161-2609

Esophageal cancer associated with right aortic arch: a surgical treatment case report and literature review

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Abstract: **Esophageal cancer is one of the six major malignant tumors worldwide. Radical resection is regarded as an effective treatment method for patients with good general condition and no proof of metastasis. Because esophageal cancer is separated from the location of the left descending aorta, the operative approach is divided into the following three main types: triple incision approach (trans-cervix, right thorax and abdomen) for upper esophageal cancer, double incision approach (trans-right thorax and abdomen) for middle esophageal cancer and single incision approach (trans-left thorax) for lower esophageal or cardia cancer. A right aortic arch is a rare vascular malformation, and the incidence of a right aortic arch associated with esophageal cancer is even rarer. This anatomical abnormality has driven thoracic surgeons worldwide to explore and discuss the best choice of surgical method. Here, we introduce one case of surgical treatment of esophageal cancer associated with right aortic arch (RAA) that has been integrated with the theory of enhanced recovery after surgery (ERAS).**

Keywords: Right aortic arch (RAA); Esophageal cancer; Surgical treatment; Enhanced recovery after surgery (ERAS)

Received 29 January 2019, Revised 5 March 2019, Accepted 8 March 2019

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1. Introduction

Esophageal cancer is one of the six major malignant tumors worldwide. Radical resection is regarded as an effective treatment for patients with good general condition and no proof of metastasis. Because esophageal cancer is separated from the location of the left descending aorta, the operative approach is divided into the following three main types: triple incision approach (trans-cervix, right thorax and abdomen) for upper esophageal cancer, double incision approach (trans-right thorax and abdomen) for middle esophageal cancer and single incision approach (trans-left thorax) for lower esophageal or cardia cancer. A right aortic arch is a rare vascular malformation, and the incidence of a right aortic arch associated with esophageal cancer is even rarer. This anatomical abnormality has driven thoracic surgeons worldwide to explore and discuss the best choice of surgical method. Here, we introduce one case of surgical treatment of esophageal cancer associated with right aortic arch (RAA) that has been integrated with the theory of enhanced recovery after surgery (ERAS).

2. Case Report

A 54-year-old male patient was admitted to our Department of Thoracic Surgery for surgical treatment with biopsy-proven esophageal carcinoma. The patient was following a semiliquid diet with complaints of progressive dysphagia for 4 months and hoarseness for 2 months. Gastroscopy at the local hospital showed that the superficial depressed lesion was located in the upper third of the esophagus approximately 25 – 30 cm from the foretooth. Biopsy samples of the lesion revealed squamous cell carcinoma. The enhanced computed tomographic (CT) images from the chest showed that the middle esophageal wall was thickened, conforming to the appearance of esophageal cancer and malrotation of the aortic arch and descending aorta (Figs. 1 and 2). An electronic laryngoscope was performed due to the hoarseness symptom and showed good mobility of the bilateral vocal cords and a laryngeal mass that was revealed to be chronic inflammation by biopsy. The bilateral recurrent laryngeal nerve was considered functional. Other examinations, including cranial computed tomography, upper abdominal computed tomography, bone scintigraphic imaging and cardiography, indicated no obvious abnormalities.

The patient underwent esophageal radical resection with regional lymphadenectomy via the left thoracic approach (7th intercostal space), and an esophagogastrostomy was implemented above the aortic arch. During the operation, the left subclavian artery was found to branch from the aortic arch and lay to the left side of the spine. First, the diaphragm was opened, and the stomach, including the omentum, was fully mobilized to ensure that no tension was present during anastomosis of the gastric conduit and proximal intrathoracic esophagus. The esophagus, which was encircled by a ring structure consisting of the

pulmonary arterial ligament, the aortic arch and the trachea, was mobilized to the level of the aortic arch. Because the ring structure obstructed mobilization of the proximal intrathoracic esophagus, we decided to transect the pulmonary arterial ligament for better exposure (Fig. 3). A subtotal esophagectomy with radical dissection of the para-esophageal and mediastinal lymph nodes was performed. The postoperative pathological results were as follows: (esophageal) poorly differentiated squamous cell carcinoma (ulcer type, range 2.6 × 2.6 cm), no deep muscular invasion, no lymph node metastasis and uninvolved surgical margins. Pathological stage: pT2N0M0 (ⅡA period).

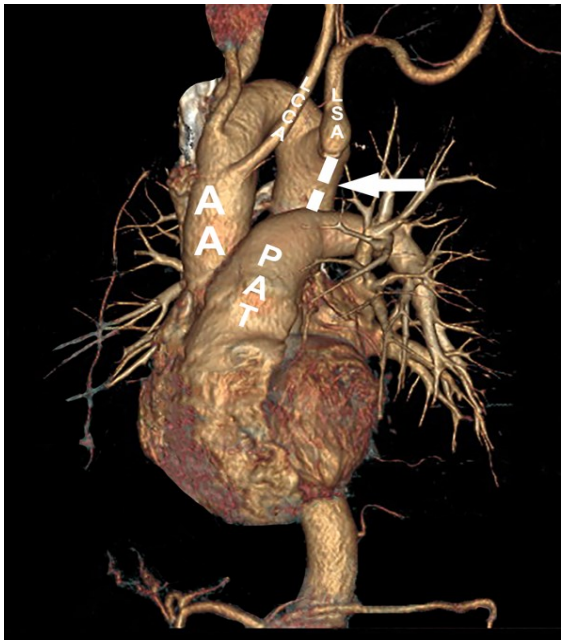

Figure 1. Anterior view of the CT three-dimensional construction. AA: Ascending aorta, PAT: Pulmonary artery trunk, LCCA: Left common carotid artery, LSA: Left subclavian artery. The dotted line indicated by the arrowhead: Arterial ligament.

The theory of enhanced recovery after surgery (ERAS) was applied to the postoperative treatment, which included a fasting diet for 2 days, enteral nutritional support for 2 days, parenteral nutritional support for 4 days and prevention of infection for 7 days. The patient was required to drink water on the 3rd day after surgery and change to a liquid diet on the 4th day in the absence of fever or dyspepsia symptoms. The patient was given a semiliquid diet on the 6th day, and the nasogastric tube was removed afterwards. The thorax drainage tube was drawn out on the 8th day without chylothorax when the patient was discharged. After follow-up for six months, the patient could eat normally without gastrointestinal regurgitation symptoms. No obvious recurrence or metastasis was noted in the chest CT. The follow-up is still in progress.

3. Discussion

A RAA is rare congenital variability in a large vessel that often coincides with other cardiovascular and nervous system abnormalities in the mediastinum. It is present in 0.05% to 0.1% of radiology series and 0.04%-0.1% of autopsy series[1]. Stewart[2] and his partners divided the aortic arch deformity into 3 subtypes; subtype I presented with two branches that split from the aortic arch and descended along both sides of the spine, subtype II had a left subclavian artery that abnormally originated from the aortic arch, and subtype III had a left subclavian artery that did not originate from the aortic arch. In our case, this patient is considered a subtype II right aortic arch deformity based on preoperative CT three-dimensional reconstruction (Figure 1 and 2).

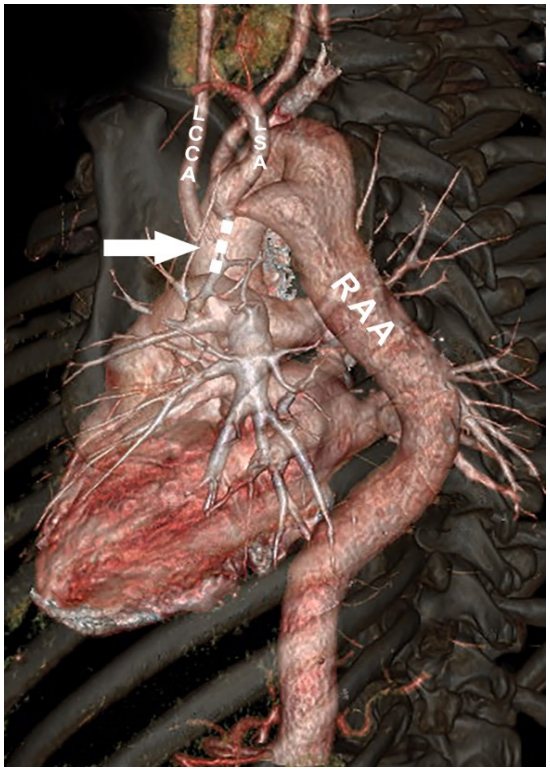

Figure 2. Posterior view of the CT three-dimensional construction. LCCA: Left common carotid artery, LSA: Left subclavian artery, RAA: right aortic arch. The dotted line indicated by the arrowhead: Arterial ligament

For middle thoracic esophageal carcinoma, which is a common site of esophageal cancer[3], the main surgical approaches are Ivor-Lewis surgery and McKeown surgery. For our patient, Ivor-Lewis surgery would result in a blockage of exposure of the esophageal lesion by the right descending aorta. Additionally, this approach would not be conducive to dissection of the middle and lower esophagus, which would further affect the radical excision of the middle and lower paraesophageal and subcarinal lymph nodes.

Moreover, there was no indication of metastasis in the lymph nodes or other organs. Therefore, we decided to perform the surgery with the McKeown surgical method through the left thoracic approach with an aim of achieving radical resection of the esophageal lesion and lymph nodes. A review of the literature identified 42 esophageal cancer cases associated with right aortic arch reported to date. Among these patients, 4 cases[4-7] underwent surgery via the right thoracic approach, 36 cases[3, 8-19] via the left thoracic approach and 1 case[20] via the bilateral thoracic approach. To achieve radical lymphadenectomy, certain special operative postures should be taken into consideration. Two cases[21,22] were performed in the prone position with a left thoracic approach, 4 cases[20,23,24] were performed via left thoracotomy plus sternotomy and 4 cases[4,6,16,25] were performed using the 3 incisions approach (trans-cervix, right thorax and abdomen). To summarize, when esophageal cancer is associated with a right aortic arch, approximately 87% of surgeons choose to perform a left chest approach for surgery to achieve a more convenient and thorough surgical resection. We agree with this choice.

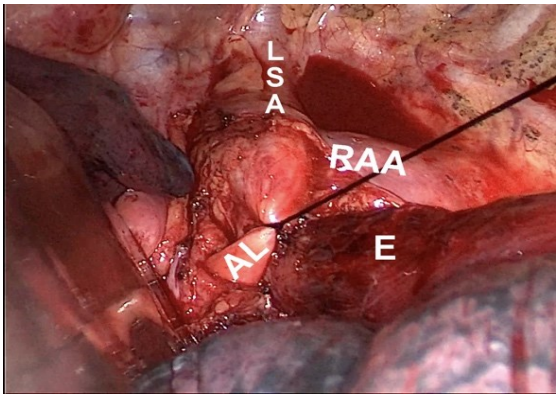

Figure 3. Intraoperative view of the upper mediastinum. LSA: Left subclavian artery, RAA: Right aortic arch, AL: Arterial ligament, E: Esophagus.

Another key point of this case was the transection of the pulmonary arterial ligament during the operation. As shown in the operative field (Figure 3), the pulmonary arterial ligament was a cord-like, fibrous, connective tissue between the pulmonary arterial trunk and the right aortic arch diverticulum. This information considered with the preoperative imaging results allowed us to exclude this fibrous connective tissue, which we considered a closed pulmonary arterial ligament, from the pulsatile blood vessels. When the ligament was transected, dissection of the upper and middle esophagus and the esophageal lymph nodes became much easier. Kubo[16] et al. also transected the pulmonary arterial ligament for better exposure. Kanaji[21] et al. reaffirmed the importance of transecting the pulmonary arterial ligament for better lymph node dissection.

Enhanced recovery after surgery (ERAS) is a multimodal and multidisciplinary approach for care of the surgical patient[26]. The ERAS concept is being applied to clinical treatment by surgeons globally because it can significantly shorten hospital stays and hospitalization costs and reduce the incidence of surgical complications[27-30]. The measures we took for the patient included immediate removal of the tracheal tube to restore spontaneous breathing after surgery, water intake to restore gastrointestinal motility the day after surgery, provision of a fluid diet on the second day after surgery and a semiliquid diet on the fourth day to restore digestive function, and removal of the stomach tube on the sixth day after surgery to allow resumption of spontaneous food intake. On the eighth day, the thoracic drainage tube was successfully discharged. With the help of the nursing team, the patient got out of bed on the day after surgery to promote gastrointestinal motility. After the above various measures, the patient was discharged from the hospital 1 week after the operation without any complications, which greatly reduced the hospitalization time and cost. The above treatment measures refer to the ERAS guide for esophagectomy[31].

To summarize, most cases of esophageal cancer associated with RAA are treated using the McKeown operation through the left thoracic approach, which can be associated with an abdominal or neck incision to achieve the purpose of radical lymphadenectomy. Radical resection is always considered the best treatment for early-stage esophageal squamous cell carcinoma[19,22]. With development of medical devices, an endoscopic technique for radical resection of esophageal cancer is being applied more commonly in the clinic. For patients with esophageal cancer and abnormal vascular anatomy, we should ensure sufficient preoperative discussion and preoperative preparation to maximize the goal of radical resection and reduce the risk of postoperative complications in order to provide the best prognosis and quality of life for the patient.

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