Thoracoscopic Esophagectomy in the Prone Position for Esophageal Cancer with Right Aortic Arch: Case Report

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Abstract. A congenital anomaly of the right aortic arch (RAA) is rare, and esophageal cancer associated with the vascular ring is even more rare. In such cases, it is very important to understand the anatomical situation in the upper mediastinum in order to perform a safe and curative operation. A 52-year-old man who presented with odynophagia was admitted to our department after a diagnosis of advanced esophageal cancer. Chest computed tomography revealed an RAA with an aberrant subclavian artery and showed that the esophagus was completely encircled by the RAA, aortic diverticulum, and pulmonary artery. By the thoracoscopic view with the patient in the prone position, we were able to easily and safely identify the anatomical location of the upper mediastinum and successfully perform thoracoscopic esophagectomy. To the best of our knowledge, this is the first report of a patient undergoing total thoracoscopic esophagectomy in the prone position without thoracotomy.

Esophageal carcinoma associated with a right aortic arch (RAA) is very rare (1, 2). In such cases, it is extremely important to recognize the anatomical situation in the upper mediastinum because of vessel and nervous system anomalies. To date, only approximately 30 such resected cases have been reported (3). Almost all of the previously reported cases of esophageal cancer with an RAA underwent open left thoracotomy, with the exception of one patient who underwent video-assisted thoracoscopic surgery (VATS) with a 5-cm minithoracotomy in the right lateral decubitus position (3). Here, we report on a patient with thoracic esophageal cancer with an RAA who underwent successful resection by thoracoscopy with the left approach while in the prone position. A previous report suggested that a thoracoscopic esophagectomy using the right approach with the patient in the prone position increased operative exposure and improved surgical ergonomics compared to the left lateral decubitus position (4). To the best of our knowledge, this is the first report of a patient undergoing total thoracoscopic esophagectomy in the prone position without thoracotomy. We were easily able to identify the unusual anatomical location of upper mediastinum by this procedure.

Case Report

A 52-year-old man visited a local physician with the complaint of odynophagia in December 2012. He was referred to our Department after a diagnosis of esophageal cancer was made from an upper gastrointestinal series. Chest X-ray showed that the aortic arch was on the right side. Barium radiography revealed right indentations in the upper thoracic esophagus at the point of the aortic arch, and a 3-cm irregular ulcerated lesion with marginal elevation was seen in the lower thoracic esophagus involving almost half the circumference of the esophageal wall (Figure 1A). Esophagoscopy showed an ulcerated localized lesion that covered almost one third of the circumference of the esophageal wall at a point 35-38 cm from the incisors (Figure 1B).

Chest and abdominal computed tomography (CT) showed a circumferential wall thickening 3 cm in length in the lower thoracic esophagus. Perigastric lymph node metastases were detected. There were no metastases in the lung and liver.
Three-dimensional CT showed an RAA and aortic diverticulum, known as Kommerell’s diverticulum (KD) (Figure 2A). Since the presence of an RAA was demonstrated with an aberrant subclavian artery, it was classified as an aortic arch anomaly of type II according to the Stewart classification (or type IIIB1 according to the Edward classification) (5, 6). As the left ductus arteriosus (LDA) between the KD and pulmonary artery (PA) was not enhanced and detected on CT, we consider that there was no blood flow in the LDA.

From the findings described above, a diagnosis of advanced esophageal cancer (T3N2M0 stage IIIA according to the TNM classification version 7) (7), associated with an RAA was made. The patient underwent two courses of neoadjuvant chemotherapy with cisplatin plus 5-fluorouracil, followed by esophagectomy with lymph node dissection.

Surgical findings. Under general anesthesia and using a single-lumen endotracheal tube with bronchial blocker for single-lung ventilation, the patient was initially placed in a prone position. All surgeons stood on the left side of the patient, and a video monitor was set up on the opposite side. A 12-mm blunt trocar was inserted into the seventh intercostal space (ICS) behind the posterior axillary line. Another three trocars were inserted under thoracoscopic control: a 5-mm trocar in the third ICS behind the midaxillary line, a 5-mm trocar in the fifth ICS on the posterior axillary line, and a 12-mm trocar in the ninth ICS on the scapular angle line (Figure 4, black circles). We added two trocars to obtain a better surgical view in the upper mediastinum: a 3-mm trocar in the sixth ICS and a 12-mm trocar in the eighth ICS on the scapular angle line (Figure 4, white circles). Carbon dioxide pneumothorax was achieved at a pressure of 6 mmHg to collapse the right lung and to expand the mediastinum. As was observed under preoperative 3D-CT imaging, the thoracoscope revealed that the trachea and esophagus were completely encircled by a vascular ring (Figure 5A). The left recurrent laryngeal nerve (LRLN), and LDA were easily recognized by dissection along the left vagus nerve to the foot side. The LRLN passed behind the LDA and ascended posteriorly (Figure 5B). After the lymphadenectomy around the LRLN, we carefully exposed the LDA between the KD and PA. The trachea was rolled back carefully and firmly to the left and ventrally by the assistant’s grasper that held a small gauze to explore the LDA and the PA. The LDA was cut after clipping without injury to the surrounding vessels (Figure 5C). After cutting the LDA, the upper thoracic esophagus was easily released from the vascular ring (Figure 5D), and we performed subtotal esophagectomy. The patient was then turned to the supine position, and we began open laparotomy. Celiac and
perigastric lymph node dissection was performed, after which a 3-cm wide gastric conduit was made extracorporeally by an automatic suturing instrument. Subsequently, the cervical lymphadenectomy was performed through a cervical collar incision. We intended to use the retrosternal route for reconstruction. Since the upper sternum was pulled forward by the anomaly of the left brachiocephalic artery, we could not ensure that the retrosternal space was adequate. Because of fear that the gastric conduit would be strongly compressed, the patient underwent the reconstruction through an anterothoracic wall route.

Histological findings showed moderately-differentiated squamous cell carcinoma within adventitia layer and perigastric lymph node metastases. According to the TNM classification version 7, this tumor was T3N2M0 stage IIIA.

The postoperative course of the patient was uneventful. On postoperative day 1, the endotracheal tube was extracted. On postoperative day 7, the patient began to take food orally. About 24 days after surgery, he was discharged. At 2 months after surgery, he is currently visiting a hospital as an outpatient.
Discussion

An RAA is a rare condition and is reported to affect 1-2 in 1,500 persons in Japan (1) or 0.03-0.04% of autopsy cases in Western countries (2). In patients with an RAA, the aorta surrounds the esophagus and trachea, causing compression and deviation of these structures, as well as deviation of the recurrent laryngeal nerve. Because of such deviations and compression, great care must be taken when esophageal cancer is treated surgically in these patients.

Edwards et al. identified three types of aortic anomalies based on a theoretical concept of the development of the aortic arch (5). RAA belongs to group III of this classification, and our case was type IIIB1. Stewart et al. (6) also showed that the RAA could in turn be divided into three subtypes (Figure 3). According to Stewart et al.’s classification, our case was type II in that the LRLN ran around one side of the LDA.

Although the most common approach for resection of esophageal cancer is right thoracotomy, it was not used in any of the patients with RAA previously reported. Left thoracotomy has been reported to give a better view into the mediastinum for esophagectomy in patients with an RAA, because the RAA and right-sided descending aorta interface with the mobilization of the esophagus located at the left side of the RAA through a right thoracotomy. In thoracoscopic surgery for esophageal cancer with an RAA, we also used the left approach with the prone position.

For adequate dissection of lymph nodes around the right recurrent laryngeal nerve (RRLN) through a left thoracotomy alone, a midline sternotomy should be added (8) or a left-open door method should be used (9) to make the operation as curative as possible. In our case, it was difficult to recognize the RRLN and surrounding tissue even with a magnified thoracoscopic view due to interference by the descending aorta. Since in the present case the chest CT showed no evidence of lymph node metastasis around the RRLN, we did not perform curative lymph node dissection along the RRLN, considering that sternotomy or a left-open door method would add unnecessary stress.

In 1994, Cuschieri et al. first reported on thoracic surgery performed in six patients placed in the prone position (10).
More recently, Palanivelu et al. reported their experience with 130 patients treated by thoracoscopic esophagectomy in the prone position and stimulated new interest in this approach (11). Fabian et al. reported that thoracoscopic esophagectomy with the right approach with the patient in the prone position increased operative exposure, improved surgeon ergonomics, and shortened operative time compared with surgery from the left lateral decubitus position (4). At our institute, thoracoscopic esophagectomy performed by the right approach with the patient in the prone position was first applied for resectable esophageal cancer in January 2010 and thereafter has been performed safely in about 130 patients with esophageal cancer. From the prone position, mediastinal organs and structures were exposed spontaneously by both gravity and artificial pneumothorax without any help from an assistant. The lung fell away with or without minimal handling. In addition, the surgeon’s wrists and shoulder joints were in a neutral position in relation to the forearms and upper arms, minimizing fatigue and maximizing ergonomic function. The view of one monitor standing in a single line to the operative field and the improved surgeon ergonomics contributed to better hand-eye coordination. The identification and management of the LDA is most important in order to release the upper thoracic esophagus in surgery for esophageal cancer with an RAA, especially in type II according to Stewart et al.’s classification in which the esophagus is completely encircled by arteries. An insufficient view of the upper mediastinum may cause critical injury of the KD and the PA. In the present case, we were easily able to identify the LRLN, LDA, and PA. The LRLN passed behind the LD and ascended posteriorly. The length of the connection of LDA with the KD and PD was short, approximately only 0.5 inches. The LDA was adequately divided at origins of both the KD and PA. Subsequently, the LDA was cut after clipping with a magnified operative view and good surgeon ergonomics without mini-thoracotomy. After cutting the LDA, we were easily able to release the upper thoracic esophagus from the vascular ring and perform the esophagectomy.

We successfully performed a total thoracoscopic esophagectomy with the patient in the prone position. We consider that this procedure is useful for esophageal cancer with an RAA, especially from the safety viewpoint of identification and management around the LDA.

References

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