

Case Report

A new model for reducing the risk of surgery for oesophageal cancer with right-side aortic arch-3D reconstruction

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Abstract: This study reported a 63-year-old male patient with oesophageal carcinoma complicated with right-side aortic arch who was admitted to the hospital due to difficulties eating. The enhanced chest CT examination of the patient showed thickening of the middle segment of the oesophagus and right deviation of the aortic arch. Ultrasonic gastroscopy revealed a nodular eminence in the wall of the oesophagus 25 cm-28 cm away from the incisor. The ultrasound showed uneven echo inside the nodules, marked thickening of the mucosa and submucosa, and an unclear boundary with the muscularis propria. The pathological diagnosis was squamous cell carcinoma. Since the patient could also have a right-side aortic arch, the normal anatomical structure around the aortic arch may be altered, which may cause some interference during surgery for the thoracic oesophagus. In addition, the optimal surgical approach cannot be determined by imaging data alone, so we used three-dimensional reconstruction technology to reconstruct the location map of the oesophagus, trachea and aorta before surgery. The tumour location was accurately located, and the right thoracoscopic-assisted approach was adopted after simulating the surgical approach. Preoperative three-dimensional reconstruction played a key role in this case and can be of guiding significance for oesophageal cancer patients with large vessel abnormalities.

Keywords: Esophagus cancer, right-side aortic arch (RAA), three-dimensional reconstruction, surgical approach, precision medicine

Introduction

In past reports at home and abroad, most oesophageal cancers complicated by right-side aortic arch (RAA) were surgically treated by left thoracotomy [1], which may be related to the high incidence of anastomotic stenosis through the right approach. However, the mechanism is not clear [2, 3]. The development of endoscopic technology simplified the complicated procedure of opening and closing the chest and reduced injury to the human body. A foreign multicentre randomized controlled study was conducted to compare the short-term therapeutic efficacy, incidence of pulmonary infection, overall length of hospital stay, subjective patient experience, and long-term postoperative survival. The study concluded that endoscopic radical resection of oesophageal cancer

has potential advantages in reducing tissue injury and accelerating functional recovery [4, 5]. In this case, an endoscope was used to enter the chest cavity from the right side of the patient; based on the 3D reconstruction, mechanical anastomosis of the chest, abdomen and neck was successfully completed. Ten groups of lymph nodes were completely removed, and the operation was very successful.

Case report

In March 2018, our hospital admitted a 63-year-old male patient who was preliminarily diagnosed with middle oesophageal squamous cell carcinoma. The chief complaint was a choking sensation that persisted for 2 months and became aggravated over 2 days. The patient underwent gastroscopy and biopsy at the local

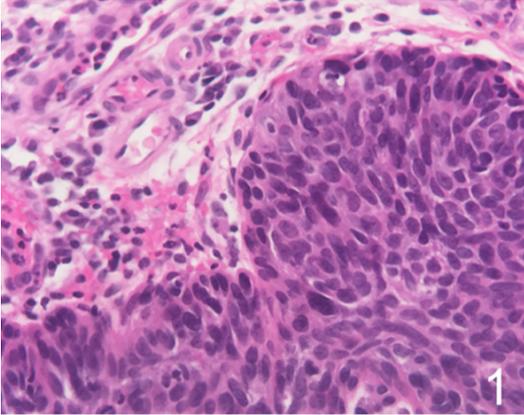


Figure 1. Preoperative pathology confirmed squamous cell carcinoma (H&E \times 200).

hospital before admission; a central oesophageal space was found, and the biopsy revealed squamous cell carcinoma. A chest-enhanced CT and abdominal plain scan were performed after admission and showed localized thickening of the middle oesophagus, which was confirmed as oesophageal cancer by pathology (**Figure 1**). In addition, the patient's enhanced CT, or mediastinal window, clearly showed that the aortic arch was mutated to the right from the heart and descended along the right vertebral body behind the oesophagus (**Figure 2**), which was preliminarily diagnosed as oesophageal cancer complicated with RAA. To more accurately understand the positional relationship between the oesophagus and the aortic arch and to choose the best surgical method, we reconstructed the thoracic organs of the patient based on the data of the enhanced CT and compared the advantages and disadvantages of the surgical approaches from the left and right sides. From the 3D reconstruction of the thoracic cavity, it can be seen in the left-side surgical approach, the middle and lower segment of the oesophageal is closely related to the posterior wall of the heart, which is not easily separated under endoscopy. Due to the presence of the heart, the operation space is narrow, and the mediastinum, trachea and oesophageal groove lymph nodes cannot be easily removed, nor can the azygos vein be severed directly. It is also difficult to clear the right recurrent laryngeal nerve lymph node, it has some advantages when the lesion is located under the aortic arch in the left-side surgical approach, but the lesion in this case is located at the upper part of the aortic arch. During the

process of the right-side surgical approach, there is a wide operating space, the oesophageal and aortic arch could be exposed clearly, and the tracheal membrane, carina, azygos vein, left and right recurrent laryngeal nerve and thoracic duct can be dissected directly, the upper mediastinal lymph nodes are also easier to clean than the left, and para-oesophageal lymph nodes below the clavicle plane could be all cleared. We believed that the minimally invasive approach on the right side would benefit the patient the most (**Figures 3, 4**).

The enhanced chest CT showed no signs of external invasion at the lesion site, and ultrasonic gastroscopy indicated that the lesion did not break through the muscularis propria (**Figure 5**) and had surgical indications. After full preparation, we performed surgery on the patient, and the procedure is described below.

The operation included three parts: (1) freeing the oesophagus through the right thoracic cavity, (2) freeing the proximal gastric body through the abdominal cavity, and (3) inserting a tube made *in vitro* into the stomach and finishing the neck anastomosis. The patient was in a left lateral position when the thoracic oesophagus was dissected. The field of view was established with the 7th rib of the right midaxillary line, and the operating holes were established in the 4th intercostal space on the right axillary front, the 5th intercostal space on the midaxillary line, and the 9th intercostal space on the posterior axillary line. Under the microscope, partial membranous adhesions of the right thoracic cavity could be observed. After the aorta was repositioned from the back of the heart, it crossed the main bronchus to the right and turned to the back through the right side of the oesophagus. Oesophageal pressure marks could be seen, and a hard mass can be palpated (**Figure 6**). The azygos venous arch was routinely cut off [6] close to the anterior wall of the aorta, and the oesophagus was carefully separated from the thoracic roof. During the surgery, the related lymph nodes were cleared, and the descending aorta was found to be close to the oesophagus and descended along the right side of the vertebra. When separating the proximal gastric body, the patient was returned to a recumbent position with the left shoulder raised by a pad to fully expose the left neck. The field of view was set up 1 cm to the left and

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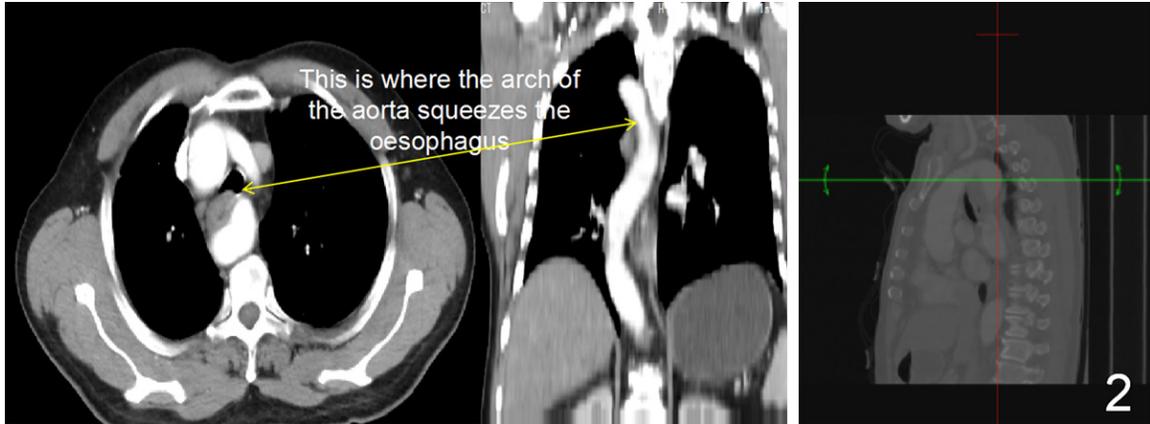


Figure 2. The enhanced chest CT showed a thickened oesophageal lumen and heterotopic aortic arch extruded and wrapped around the oesophagus.

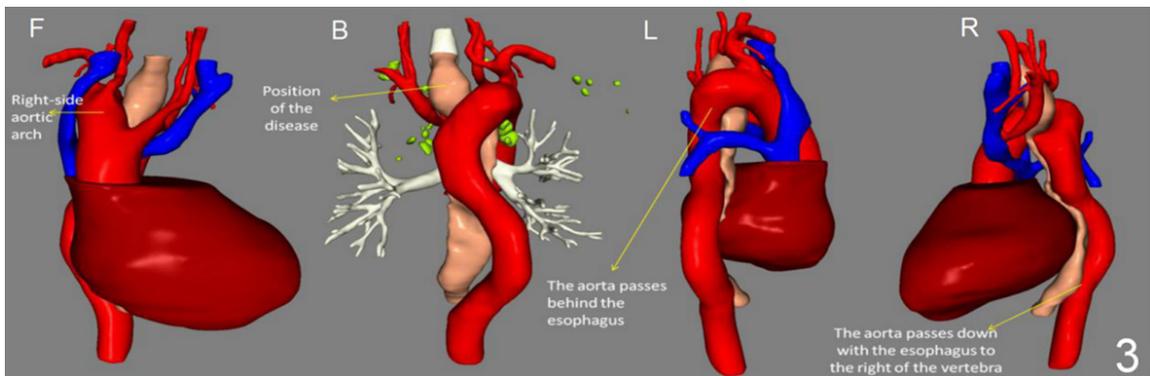


Figure 3. After three-dimensional reconstruction, the right side of the aortic arch can be seen semi-circumcircling the oesophagus and descending along the right vertebra. The pressure trace caused by the aorta in the upper segment of the oesophagus can be clearly seen and the location of the tumour can be revealed.

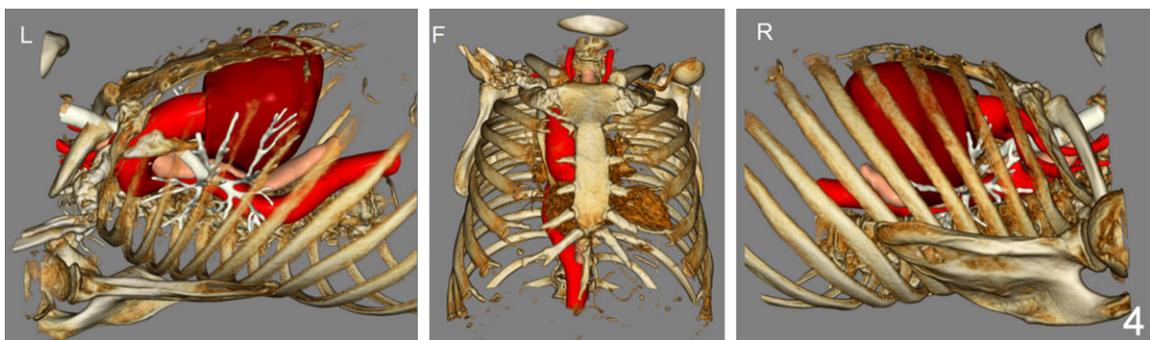


Figure 4. Reconstruction of the whole thoracic cavity allowed for simulations of the advantages and disadvantages of the left and right-side approaches and direct exposure of the location of the organs in the thoracic cavity.

below the umbilicus, and another 4 cannula ports were set up. The lower oesophagus and stomach were routinely separated, and the perigastric blood vessels were successively cut off. Meanwhile, the lymph nodes around the

left gastric artery and the cardia were dissected. An incision was made along the anterior margin of the sternocleidomastoid muscle in the left neck, and the oesophagus was severed. The oesophagus and stomach were pull-

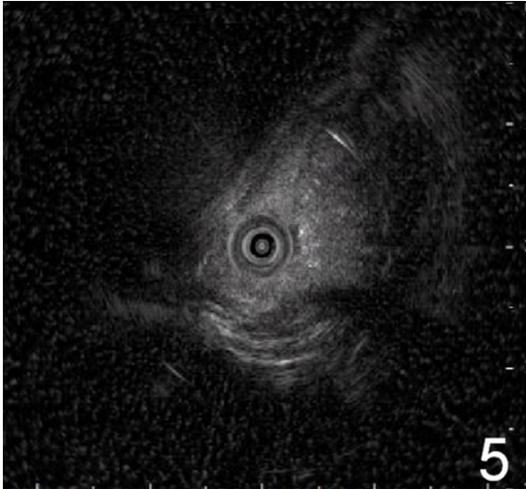


Figure 5. Ultrasonic gastroscopy indicated that the lesion did not break through the muscularis propria.

ed out from the central incision of the abdomen. The diseased oesophagus and part of the stomach were removed with a linear cutter [7], and the incisional margin was continuously embedded with absorbable lines. After reconstruction of the tubular stomach via the abdomen, the chest was lifted to the neck, CDH21 tube stapling anastomosis [8] was performed external to the TCR75 nail placement [9], which was close the wall of the stomach stapling and reoccupied after continuous embedding of cervical anastomotic neoveil® [10] wrapped around the anastomotic site; a nutrition tube was placed, and layered sutures were placed after counting the instrument gauze and correcting the neck and abdominal incision.

Results

The patient recovered well after surgery. The postoperative pathology showed (oesophageal) squamous cell carcinoma with high and medium differentiation and infiltration into the superficial muscle layer; no metastasis was observed in the lymph nodes, and no invasion was observed at the incisional margin. Postoperatively, the patient received 4 cycles of adjuvant chemotherapy and was followed up for 8 months; the patient was in good condition and had no recurrence.

Discussion

Right-side aortic arch (RAA) [11] is a congenital malformation of the aortic arch of the heart

that is caused by abnormal vascular development in the embryonic period and has an incidence of approximately 0.1% [12]. After the RAA extrudes from the heart, the aorta can bypass the posterior wall of the oesophagus, reach the posterior wall of the left thoracic cavity and descend along the left vertebra or directly down the right side of the oesophagus [13]. Simple RAAs are rare and are often associated with severe heart defects [14]. This kind of abnormality is asymptomatic in more than 90% of the cases; children behave normally other than difficulty breathing, and the symptoms of elderly patients can increase gradually as the aortic wall thickens and flexibility decreases as the aorta wraps around the oesophagus to cause oppression, which leads to the subjective expression of difficult deglutition [15]. It is worth noting that the heterotopic aorta may be misdiagnosed as oesophageal cancer by X-ray examination; in contrast, cardiac colour doppler ultrasound, enhanced CT, and MRI can clearly diagnose heterotopic aortas [16, 17]. Oesophageal cancer with RAA is very rare, and the anatomical locations of the two anatomical structures are close, so conventional surgery extremely challenging [18]. We reported this rare case to demonstrate a new surgical idea, a preoperative three-dimensional reconstruction and simulation approach, to reduce the surgical risk and maximize the benefits for patients. Three-dimensional reconstruction is an important form of precision medicine and has significant guidance capabilities for patients with thoracic disease combined with great vessel variation.

Conclusions

RAA is a normal variation, but its presence increases the risk of mediastinal surgery [19]. Without reference to the simulated surgical approach, simply relying on clinical experience would likely lead the surgeon into an unknown situation, so it is extremely important to fully understand the structure of the thoracic cavity before surgery. Three-dimensional reconstruction can meet the needs of the surgical approach through design. The reconstruction only requires contrast-enhanced CT data to realize the morphological structure of the organs, and the anatomical relationship between adjacent organs can be clearly shown; reconstruction does not require an invasive examination, which is also an advantage [20, 21].

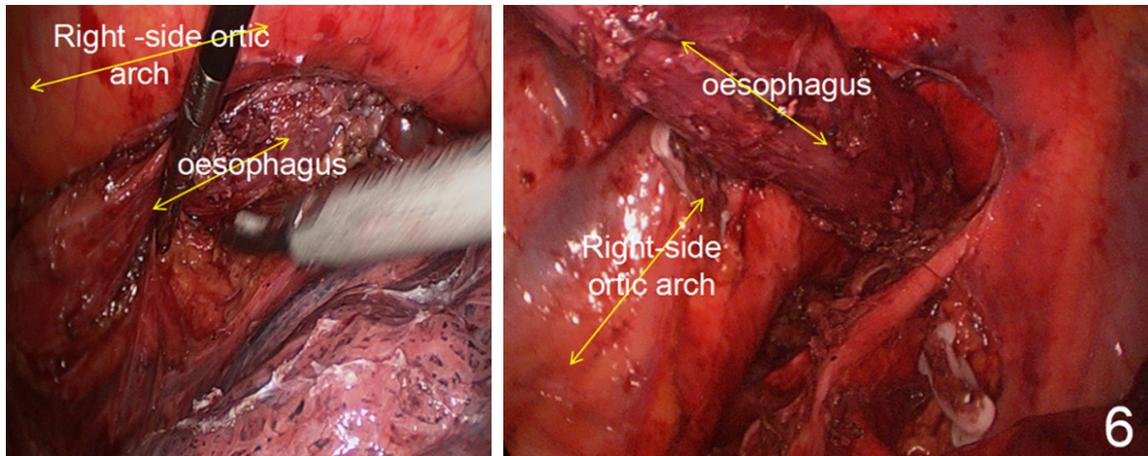


Figure 6. Endoscopic entry into the chest revealed that the aorta, after emanating from the back of the heart, crossed the main bronchus to the right and turned back through the right side of the oesophagus. Pressure marks of the oesophagus could be seen, and a hard mass could be palpated.

Disclosure of conflict of interest

None.

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