

ORIGINAL ARTICLE

Preoperative computed tomography diagnosis of non-recurrent laryngeal nerve in patients with esophageal carcinoma

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Keywords

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Introduction

A non-recurrent laryngeal nerve (NRLN) is an anomaly with an incidence of 0.21–1.94% on the right side and 0–0.24% on the left side.^{1–14} Although it is rare, it causes a much higher risk of nerve injury and accompanied severe complications during esophagectomy, including hoarseness and pulmonary complications.¹⁵ Even to an experienced surgeon, preserving the NRLN presents an extreme challenge because it is difficult to preoperatively diagnose an NRLN by any current imaging technique.

An NRLN is almost always associated with the aberrant subclavian artery; therefore, preoperatively identifying the aberrant subclavian artery would be tantamount to diagnosing the NRLN.¹⁶ Thus, it is possible to predict an

Abstract

Background: The non-recurrent laryngeal nerve (NRLN) is a rare but potentially serious anomaly that is commonly associated with the aberrant right subclavian artery (ARSA). It is easy to damage during surgical resection of esophageal cancer, leading to severe complications.

Methods: Preoperative enhanced thoracic computed tomography (CT) scans of 2697 patients with esophageal carcinoma treated in our hospital between January 2010 and December 2013 were examined. We classified the positional relationship between the right subclavian artery and the membranous wall of the trachea into two types and used this method to predicate NRLN by identifying ARSA.

Results: Twenty-six patients (0.96%) were identified with ARSA, all of which were cases of NRLN by CT. NRLN was identified during surgery in the 26 patients, and a normal right recurrent laryngeal nerve was observed in 2671 patients. The ARSA was detected on the dorsal side of the membranous wall of the trachea in all 26 NRLN cases, while it was detected on the ventral side in all 2671 recurrent laryngeal nerve cases.

Conclusion: Enhanced CT scanning is a reliable method for predicting NRLN by identifying ARSA. Preoperative recognition of this nerve anomaly allows surgeons to avoid damaging the nerve and abnormal vessels during esophagectomy.

NRLN with a diagnosis of aberrant right subclavian artery (ARSA) using chest enhanced computed tomography (CT), which serves to warn surgeons to avoid inadvertent nerve damage and uncontrolled bleeding.

We retrospectively studied enhanced CT scans obtained before surgery for esophageal carcinoma, including 26 cases of NRLN and 2671 cases of recurrent laryngeal nerve (RLN).

The cases of NRLN and RLN used in this study were all identified during surgery. The purpose of this study was to assess the possibility of NRLN diagnosis by enhanced chest CT, which is a routine preoperative examination, performed before esophagectomy. The human research ethics board at West China Hospital of Sichuan University approved this retrospective study, and informed consent

was obtained from each patient for the use of individual data profiles within the study.

Methods

Image examination

We retrospectively studied the medical images of 2697 patients with esophageal carcinoma who underwent surgery in our hospital between January 2010 and December 2013, including 2133 men and 564 women, with ages ranging from 41 to 68 years. Twenty-six patients were diagnosed with an NRLN during surgery. An ARSA was described as the last branch arising directly from the aortic arch and crossing the midline with a retroesophageal course to reach the right axillary area (Fig 1).¹⁷ We classified the positional relationship between ARSA and the tracheoesophagus into two types according to that proposed by Watanabe *et al.* (Fig 2).¹⁷ In type 1, the horizontal line of the RSA lies on the dorsal side of the membranous wall of the trachea, while in type 2, it lies on the ventral side of the membranous wall of the trachea.

An ARSA usually can be found by chest enhanced CT. A digital subtraction angiography or magnetic resonance angiography can be helpful when ARSA diagnosis is difficult via CT.

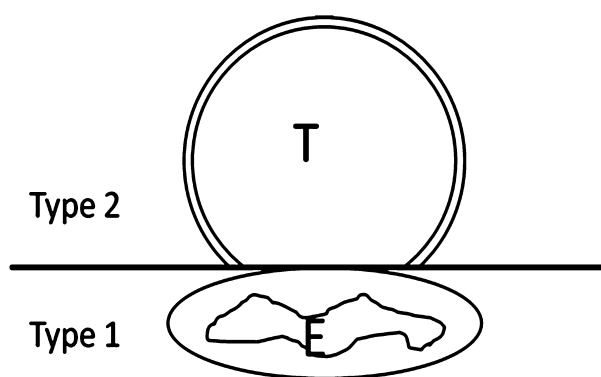


Figure 2 Classification of the positional relationship between aberrant right subclavian artery (RSA) and the tracheoesophagus. Type 1: the horizontal line of the RSA lies on the dorsal side of the membranous wall of trachea. Type 2: the horizontal line of the RSA lies on the ventral side of the membranous wall of trachea. E, esophagus; T, trachea.

Findings during surgery

During mobilization of the esophagus via left thoracotomy, an ARSA located in front of the vertebrae narrowed the area above the level of the aortic arch and the space between the esophagus and spine. Special attention was paid not to damage the ARSA when dissecting nodes along the left RLN. From the right view, during Ivor–Lewis and McKeown procedures, the ARSA crossed behind the upper esophagus, in front of the thoracic vertebrae, and above

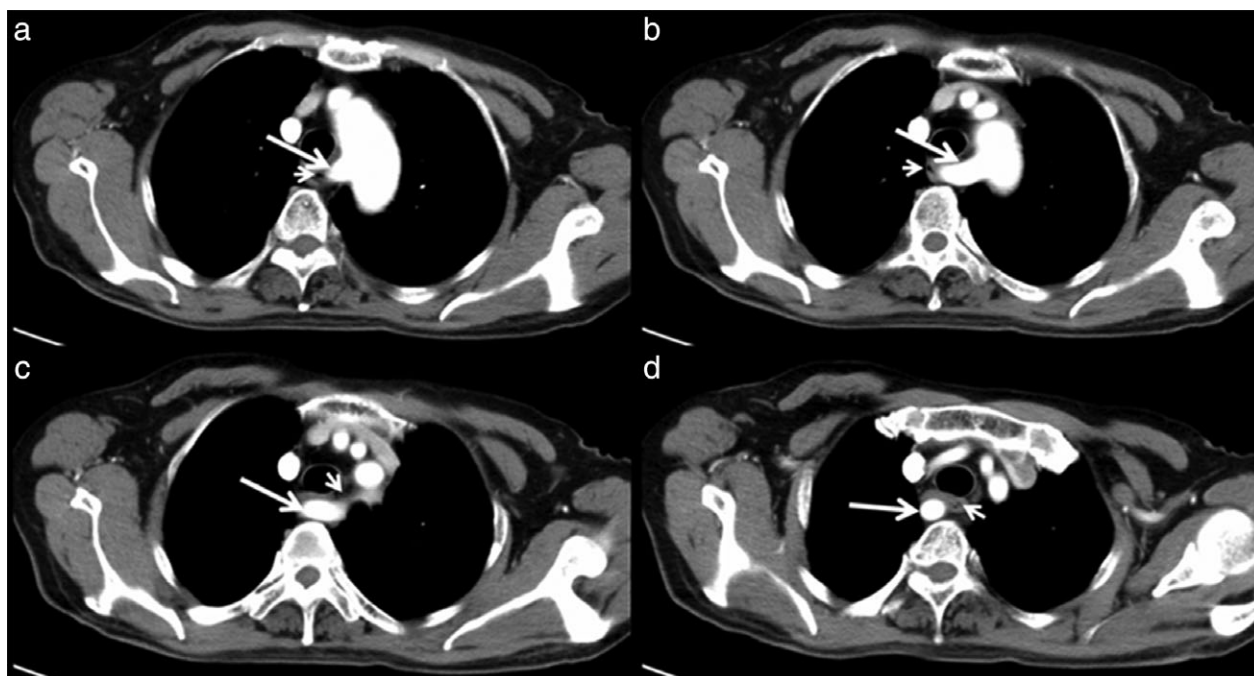


Figure 1 An aberrant right subclavian artery (long arrow) is defined as (a) the last branch arising directly from the aortic arch, and (b) crossing the midline, (c) with a retroesophageal (short arrow) course (d) to reach the right axillary area.

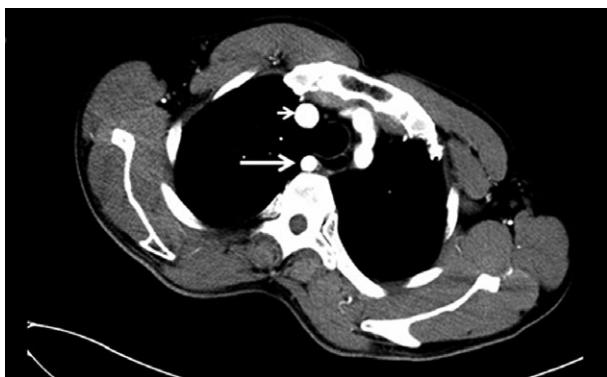


Figure 3 Chest enhanced computed tomography film of case 4. The right subclavian artery (long arrow) is on the dorsal side of the membranous wall of the trachea and further away from the common carotid artery (short arrow).

the azygos vein. Meanwhile, the right RLN was not found along the vagus nerve at the right thoracic apex. When dissecting the cervical nodes, the right RLN was located and carefully protected.

Results

Initially, 25 patients were identified as ARSA (type 1), 2669 patients as RSA (type 2), and the remaining three patients were difficult to diagnose via CT scanning preoperatively. Digital subtraction angiography and magnetic resonance angiography were then used. Two patients were diagnosed with esophageal cancer coexisting with upper mediastinal tumors, and in both, the RSA was compressed over the ventral side of the membranous wall of the trachea. According to the aforementioned criteria, they belonged to

type 1 and had a normal RLN. Therefore, 26 patients were finally preoperatively diagnosed with ARSA and 2671 with RSA. Each ARSA was located between the esophagus and spine (Figs 3,4).

All patients underwent radical-intent esophagectomy and lymphadenectomy. No operative death occurred. The vascular anomalies were confirmed in accordance with preoperative examination and were protected carefully without damage.

Discussion

An NRLN originates in the ganglion node of the vagus, crosses the posterior of the common carotid artery, and enters the larynx instead of descending along the RSA. As a result of embryologic reasons, an NRLN is always associated with an ARSA. Thus, a diagnosis of ARSA, in theory, can be predictive of an NRLN. The only clinical indicator of an ARSA is that the patient complains of dysphagia on swallowing. Whether the dysphagia is actually the result of esophageal cancer or aberrant subclavian artery is difficult to determine. In most cases, this artery anomaly causes no symptoms; therefore, diagnosis always depends upon preoperative imaging. The diagnosis of an ARSA is based on an anomalous tubular structure running from the distal part of the aortic arch to the right axillary area on scans.

In our study, three cases of ARSA were not clearly identified by the CT scans, therefore abstraction scans and enhanced magnetic resonance imaging were used to identify the presence of this abnormal artery. By classifying patients into the two types of RSA, we were able to easily reveal ARSA by enhanced chest CT and prove it by surgery. Substraction scans and enhanced magnetic resonance

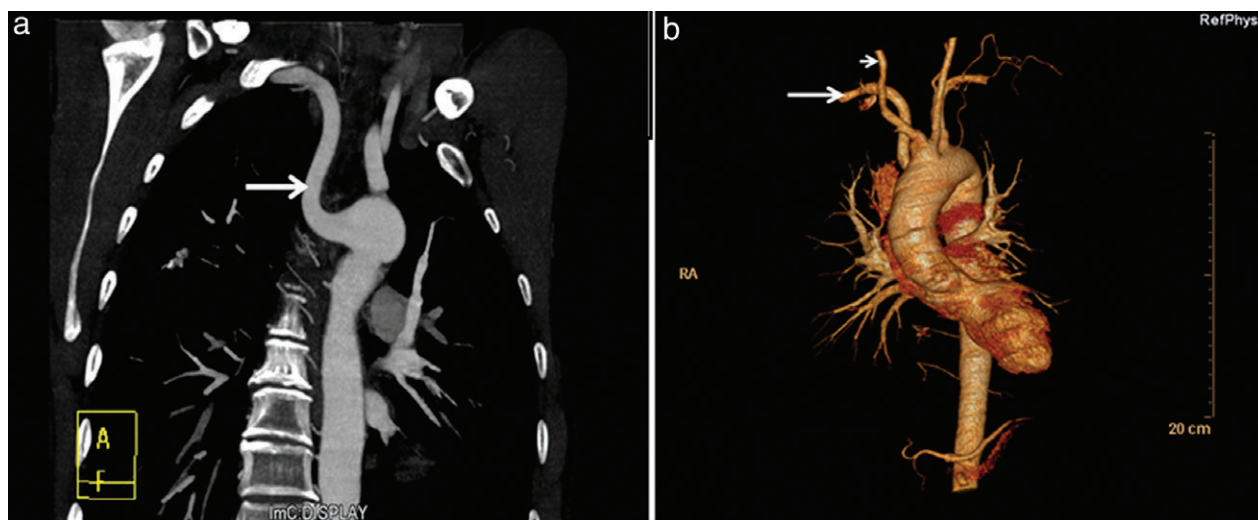


Figure 4 (a) Angiography and (b) 3D image of case 4. Long arrow: aberrant right subclavian artery. Short arrow: common carotid artery.

imaging were not necessary in later cases. The NRLN, diagnosed as an ARSA by enhanced chest CT, was confirmed intraoperatively in every case, which proves that it is feasible to diagnose an NRLN based on an ARSA by enhanced CT. In the studied cases, all of the aberrant arteries ran on the dorsal side of the membranous wall of the trachea. We did not find a relationship between tumor level and ARSA development.

At present, preoperative diagnosis of NRLN has attracted attention in thyroid and parathyroid surgery. Similar criteria are used to classify ARSA and RSA.¹⁸ None of the patients in our study had ARSA, esophageal cancer, and mediastinal tumors in combination.¹⁹ This may be because the coexistence of an ARSA and a mediastinal tumor is extremely rare in esophageal cancer patients. Many studies have demonstrated that an NRLN should be treated with great care to avoid subsequent hoarseness and other complications.^{5,8,20,21} An esophagectomy sometimes causes vocal cord palsy because of inferior laryngeal nerve paralysis. An NRLN is more likely than a RLN to be damaged during the procedure, which can cause RLN paralysis leading to severe pneumonia because of aspiration and a to high morbidity rate.¹⁵ An ARSA also results in additional difficulty to mobilize the proximal esophagus. Pop *et al.* advise that fistulas and severe bleeding are other probable complications associated with ARSA.²²

Because of these risk factors, it is important and feasible to diagnose an NRLN by the identification of an ARSA on enhanced CT scans. Preoperative chest enhanced CT scans provide a wide image to reveal the complete course of an ARSA. Once an ARSA is confirmed, meticulous care should be taken during surgery to avoid unexpected nerve and arterial damage.

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Disclosure

No authors report any conflict of interest.

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