Technical considerations in robotic aberrant right subclavian artery resection for dysphagia lusoria

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ABSTRACT

Dysphagia lusoria occurs due to compression of the esophagus as an aberrant right subclavian artery (ARSA) crosses the mediastinum. Surgical management includes open, hybrid, and endovascular techniques, with no consensus gold standard. There are few reports of robotic-assisted ARSA resection. We describe the innovative technique and outcomes for two patients who successfully underwent robotic-assisted transthoracic resection of an ARSA after right carotid–subclavian bypass for dysphagia lusoria. Both patients experienced improvement or resolution of their dysphagia and no major complications. In select patients with a noncalcified origin of the ARSA without aneurysmal degeneration, the robotic-assisted approach represents a viable option. (J Vasc Surg Cases Innov Tech 2024;10:101525.)

Keywords: Aberrant subclavian artery; Dysphagia lusoria; Innovative technique; Minimally invasive surgery; Robotic surgery

An aberrant right subclavian artery (ARSA) represents the most prevalent congenital anomaly associated with the aortic arch,[1] in which the aberrant artery originates from the proximal descending aorta and crosses the mediastinum to course into the right upper extremity.[2] An ARSA occurs in approximately 1% of the population and is usually asymptomatic.[3,4] The indications for surgical intervention include dysphagia, chest pain, dyspnea, and aneurysmal degeneration of the arterial origin, known as Kommerell diverticulum.[5]

Given the rarity of these conditions, the literature primarily consists of case reports and case series studying the optimal treatment approaches for an ARSA.[6] Traditionally, the surgical method involved subclavian-to-carotid transposition and thoracotomy with ligation of the ARSA origin. However, minimally invasive alternatives are now more common, including total endovascular or hybrid techniques.[7]

There are few reports in the literature of minimally invasive ligation and resection of the ARSA, with only one case report using a robotic-assisted approach.[8,9] We present a series of two patients with dysphagia lusoria who underwent open common carotid artery to right subclavian artery bypass (CSB), followed by robotic-assisted transthoracic ARSA ligation and resection.

CASE REPORT

Two patients who underwent robotic transthoracic resection of the ARSA were identified. The electronic medical records were reviewed, including all preoperative history, radiographic imaging, operative details, and outcomes. Both patients included in this study provided written informed consent for the report of their case details and imaging studies.

Patient characteristics. Patient 1 is a 56-year-old woman with a history of hypertension, peripheral vascular disease, and chest pain who presented with a 3-month history of worsening dysphagia and fatigue. She was evaluated by cardiology. She subsequently underwent computed tomography angiography, which revealed an ARSA with a mass effect on the esophagus (Fig 1, *A and B*).

Patient 2 is a 75-year-old woman with a history of dysphagia, gastroesophageal reflux, and hiatal hernia repair with fundoplication. She presented with progressive dysphagia and odynophagia associated with an 80-lb weight loss. A prior contrast-enhanced esophagram showed no narrowing of the esophagus. A gastroenterology workup ruled out esophagogastric junction outlet obstruction and esophageal dysmotility as a cause of dysphagia. An esophagogastroduodenoscopy revealed an extrinsic pulsatile compression in the proximal thoracic esophagus, and computed tomography of the chest with contrast revealed an ARSA with a mass effect (Fig 1, *C and D* and Table).

Operative planning. A two-stage approach was planned for each case, including an initial open right CSB. The patients would then remain in-patient to recover from the CSB and return to the operating room for right transthoracic robotic-assisted resection of the ARSA from its origin using the Da Vinci Xi robotic system (Intuitive Surgical).

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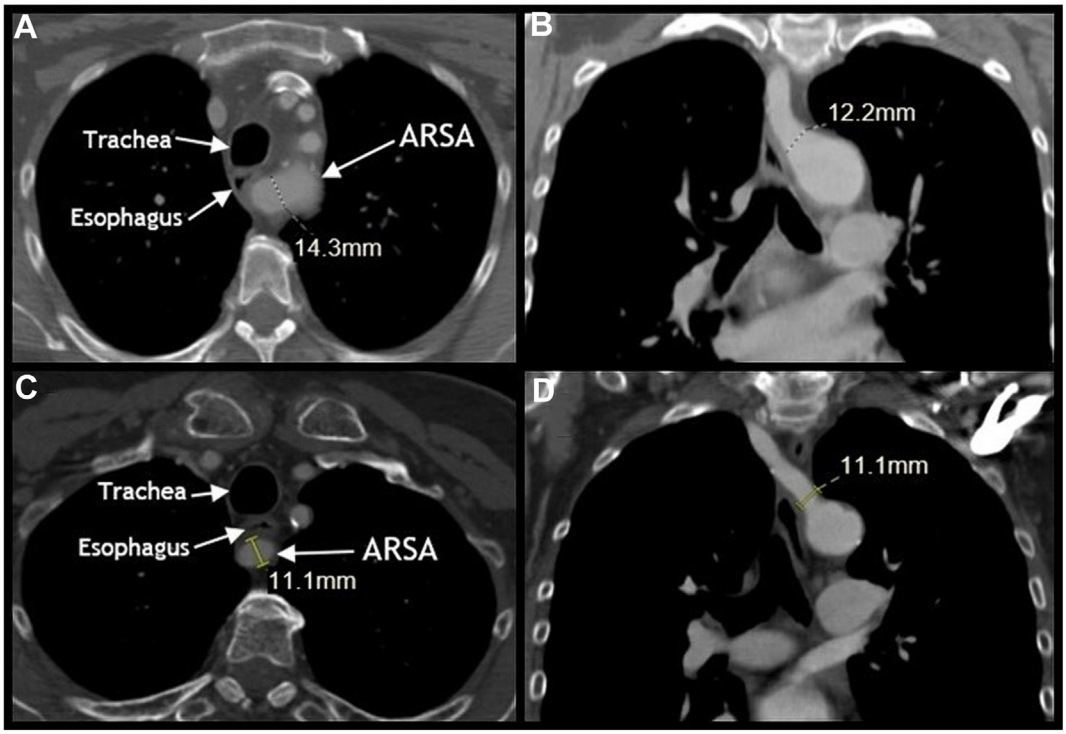

Fig 1. Preoperative computed tomography angiograms. Axial **(A)** and coronal **(B)** images for patient 1. Axial **(C)** and coronal **(D)** images for patient 2. *ARSA,* Aberrant right subclavian artery.

RESULTS

Operative details. Open right CSB was performed in both cases via a right supraclavicular approach using an 8-mm Dacron graft. We anastomosed the graft to the subclavian artery with a parachute technique in an end-to-side fashion (Supplementary Fig). The proximal subclavian artery was not ligated. There were no postoperative complications in either case.

To avoid the risk of graft thrombosis due to competitive flow, the patients returned to the operating room for transthoracic resection of the ARSA 4 days later. Double lumen intubation for single lung ventilation was used in each case. A right radial arterial line was used to ensure adequate perfusion of the right upper extremity throughout. Access to the right side of the chest was obtained at the eighth intercostal space at the apex of the chest wall. Five robotic ports were placed, with the size and locations depicted in Fig 2.

First, the posterior mediastinal pleura was opened superiorly. Next, the azygos vein was ligated using the robotic vascular stapler to expose the visualized ARSA. The ARSA was then mobilized from the esophagus and posterior mediastinum using the Force Bipolar and Da Vinci SynchroSeal (energy dissector instruments; Intuitive Surgical for both). Dissection extended to the origin off the descending aorta. The right recurrent laryngeal nerve was not encountered, and the phrenic nerve was visualized anteriorly and preserved. A vessel loop was used for retraction of the ARSA to allow for distal ligation using a robotic vascular stapler. The distal aspect of the artery was then retracted for resection of the ARSA at its origin using the robotic vascular stapler (Fig 3). Care was taken to avoid tension on the artery during ligation and resection to avoid bleeding, injury to the artery, and avulsion.

In patient 1, the lateral aspect of the thymus was mobilized and sutured in between the arterial staple line and esophagus (Supplementary Video).[10] In patient 2, a third intercostal space intercostal muscle flap was harvested and sutured in placed over the arterial staple line (Fig 4). The operative case video of patient 2 is also included (Supplementary Video).

Surgical outcomes. The patients were admitted to a monitored unit postoperatively. There were no postoperative bleeding events. Patient 1 had immediate resolution of her dysphagia symptoms with solids and liquids. Patient 2 had improvement of dysphagia with liquids but continued to have dysphagia, for which she continued to follow-up with gastroenterology (Table).

DISCUSSION

We present two cases of dysphagia lusoria effectively managed through an initial open right CSB, followed by the novel technique of robotic transthoracic resection of the ARSA. The robotic approach allowed for meticulous dissection and mobilization of the ARSA with

Table. Patient demographics, history, and surgical outcomes

Variable	Patient 1	Patient 2
Age, years	57	75
Sex	Female	Female
Charlson comorbidity index	3	7
Relevant surgical history	Cervical fusion	Robotic hiatal hernia repair, EGD
Maximum diameter of the ARSA, mm	14.3	12.2
Operative time, minutes		
Carotid–subclavian bypass	238	219
Robotic resection of ARSA	211	322
Estimated blood loss, mL		
Carotid–subclavian bypass	15	100
Robotic resection of ARSA	20	50
Interval between operations, days	4	4
Day of chest tube removal	POD1	POD2
Length of stay, days	10	13
Discharge to rehab	No	Yes
Readmission by 30 days	No	No

ARSA, Aberrant right subclavian artery; *EGD*, esophagogastroduodenoscopy; *POD*, postoperative day.

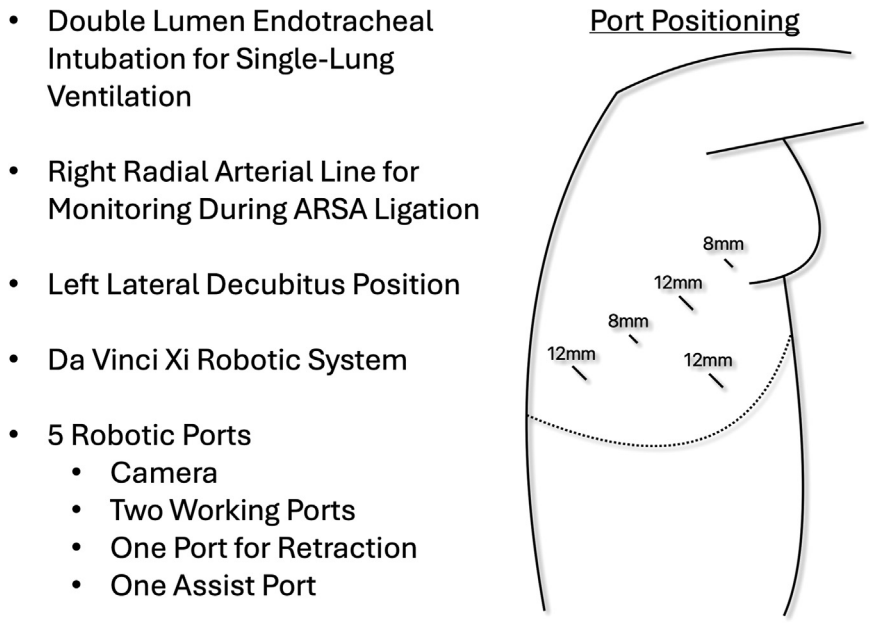

Fig 2. Operative preparation and port placement. *ARSA*, Aberrant right subclavian artery.

excellent visualization. The single published report, to the best of our knowledge, that detailed robotic ARSA resection using clips for ligation suggested the potential use of a robotic vascular stapler.[8] In our cases, the robotic stapler allowed for secure ligation and resection of the ARSA. Additionally, due to the proximity of the descending aorta to the esophagus, we believe the thymic tissue and intercostal muscle flap we used for coverage of the arterial staple line will minimize any risk of fistulization to mediastinal structures.

A noteworthy study by Bath et al[11] provided valuable insights from the Vascular Low Frequency Disease Consortium, highlighting that 36% of aberrant subclavian artery cases were performed open and 64% used a total endovascular or hybrid approach. In the largest single-center case series by Tallarita et al,[12] reviewing the

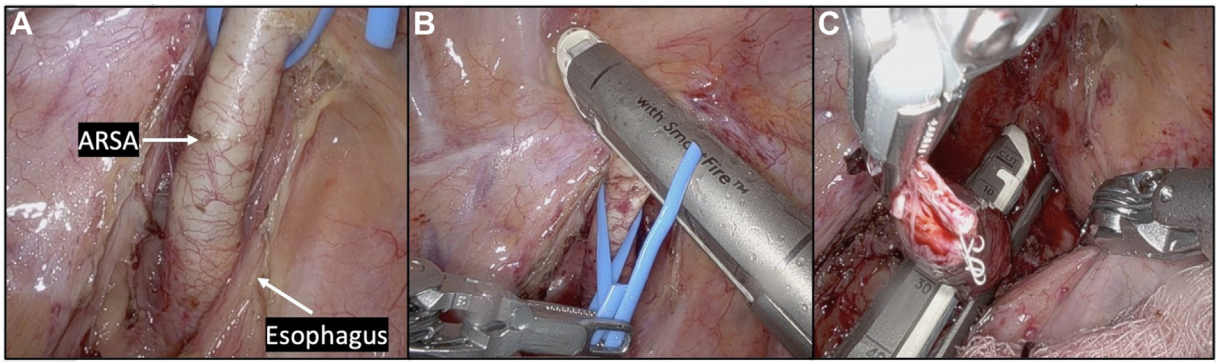

Fig 3. A, Aberrant right subclavian artery (ARSA) dissected free from the esophagus and posterior mediastinum. **B,** Distal ligation of the ARSA with a robotic vascular stapler. **C,** Proximal resection of the ARSA from its origin off the proximal descending aorta with a robotic vascular stapler.

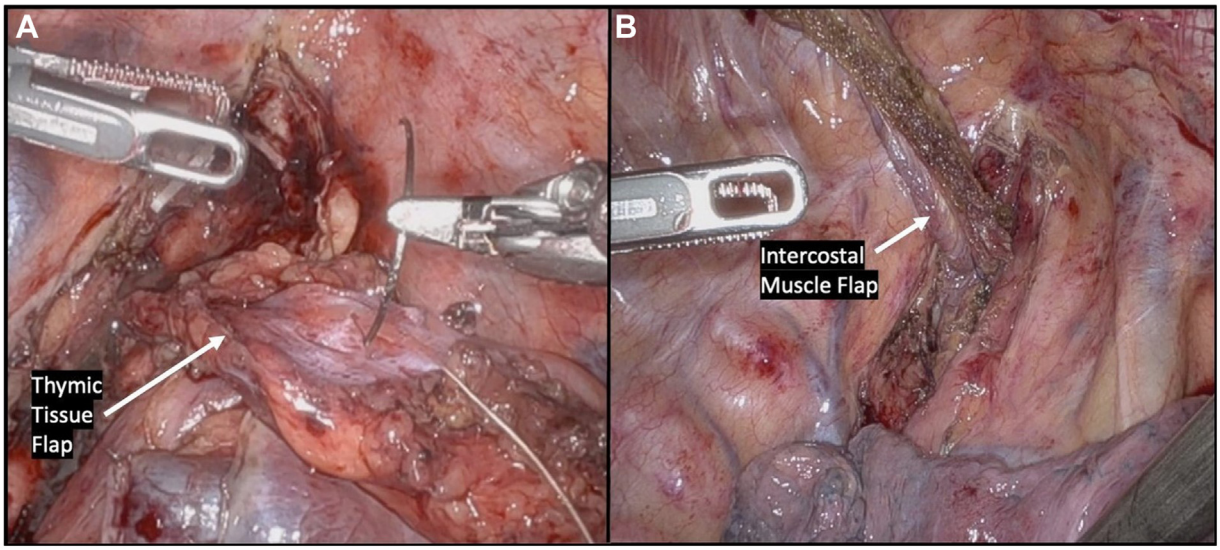

Fig 4. A, Arterial staple line coverage with thymic tissue flap in patient 1. **B,** Arterial staple line coverage with intercostal muscle flap in patient 2.

management of 38 patients with an ARSA, open repair was completed in 32 cases and a hybrid approach in 6 cases. Notably, both of these studies have a proportion of patients treated for ARSA without Kommerell diverticulum,[11,12] similar to the patients presented in our series. In a systematic review and meta-analysis by Konstantinou et al,[6] the rate of symptomatic relief was >95% regardless of the technique used, indicating that the ARSA does not have to be resected to achieve a high rate of symptomatic relief. However, in our patients, the left subclavian artery and ARSA origins were in close proximity, complicating stent graft coverage. Resection of the ARSA, instead of stent graft coverage, obviated the need for left subclavian artery transposition or left CSB.

Analyzing the complications rates will be important as the robotic technique gains wider acceptance. Importantly, the ARSA's origin in each of our cases did not exhibit significant calcification or aneurysmal degeneration. Before intervention, surgeons should complete the appropriate diagnostic studies to rule out other causes of dysphagia. We strongly advise collaboration between vascular surgery and cardiothoracic surgery.

CONCLUSIONS

In select patients with favorable anatomy, this novel robotic-assisted, minimally invasive approach represents a viable option for ARSA resection in the context of dysphagia lusoria after a right CSB.

DISCLOSURES

O.T.O. is a consultant for Intuitive Surgical and Johnson & Johnson. The remaining authors have no conflicts of interest to disclose.

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