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Ajmer Singh *

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Case Report

Aberrant Right Subclavian Artery and Cardiac Surgery: Anesthetic and Surgical Implications

Ajmer Singh *, Ravina Mukati

Department of Cardiac Anaesthesia Medanta-The Medicity, Gurugram (Haryana)-122001, India.

***Corresponding Author:** Ajmer Singh, Department of Cardiac Anaesthesia Medanta-The Medicity, Gurugram (Haryana)-122001, India.

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Abstract

The aberrant right subclavian artery (ARSA) or arteria lusoria, is one of the most common anomalies of the aortic arch, with a reported incidence of about 0.5-1.8%. Most patients with aberrant right subclavian artery are often asymptomatic. About 10% patients with a retroesophageal course of the ARSA may exhibit tracheoesophageal symptoms. Radiographic diagnosis of this condition can be made by chest X-ray, fluoroscopy, computed tomography scan, or magnetic resonance imaging. During procedures involving the trachea or esophagus, there is a risk of iatrogenic damage to the vessel or surrounding tissues, which could result in fistula formation or gastroesophageal complications such as excessive gastrointestinal bleeding. During cardiac surgery, the presence of ARSA causing near complete compression of the esophagus can result in the inability to insert a transesophageal echocardiography probe.

Keywords: aberrant right subclavian artery; cardiac surgery; anesthetic implications; surgical implications

Introduction

The aberrant right subclavian artery (ARSA), also known as *arteria lusoria*, is one of the most common anomalies of the aortic arch, with a reported incidence of about 0.5-1.8%.[1] Aneurysmal dilation of the proximal portion of the ARSA can produce a pouch-like appearance referred to as diverticulum of Kommerell. Most patients with an ARSA are often asymptomatic; however, in approximately 10% of the patients, the retroesophageal course of the ARSA can become compressed between the esophagus/trachea and vertebra. These patients may report tracheo-esophageal symptoms, such as dysphagia (dysphagia lusoria), chest pain, dyspnea, cough, recurrent chest infections, or stridor.

Unlike a right aortic arch with a ductus arteriosus or a double aortic arch, which form a complete vascular ring, the ARSA does not fully encircle the trachea and esophagus. Additionally, ARSA can compress the recurrent laryngeal nerve, leading to nerve palsy, a condition known as Ortner's syndrome. This compression of the surrounding structures often occurs later in life, partly due to increased vessel wall rigidity, or aneurysm formation.[2] The relationship of an ARSA to the surrounding structure is variable; it travels upwards and to the right and posterior to the esophagus (in 80% of cases), between the esophagus and the trachea (15%), or anterior to the trachea (5%).

Case Series Report

We present a case series involving two adult patients scheduled for elective cardiac surgery who were found to have ARSA. Detailed patient information is summarized in Table 1. Computed tomography (CT) of the chest confirmed the ARSA originating from the posteromedial part of the arch of the aorta distal to the origin of the left subclavian artery and coursing posterior to the esophagus in both patients (Fig 1). The retroesophageal course of the ARSA did not exhibit any compression of the esophagus or trachea. Both patients had a left-sided aortic arch along with a common origin of the right and left common carotid artery (Fig 2). The intraoperative course, including the placement of invasive monitoring lines, cannulation, and the conduct of cardiopulmonary bypass, proceeded as planned without complications. The anticipated surgical procedures and postoperative recovery were unremarkable.

Patient No.	Age	Gender	Diagnosis	Operative Procedure
1	59	Female	Post mitral valve replacement with severe mitral stenosis, moderate mitral regurgitation	Redo mitral valve replacement
2	67	Male	Triple vessel coronary artery disease	Coronary artery bypass graft surgery

Table 1: Patients' Demographic Details

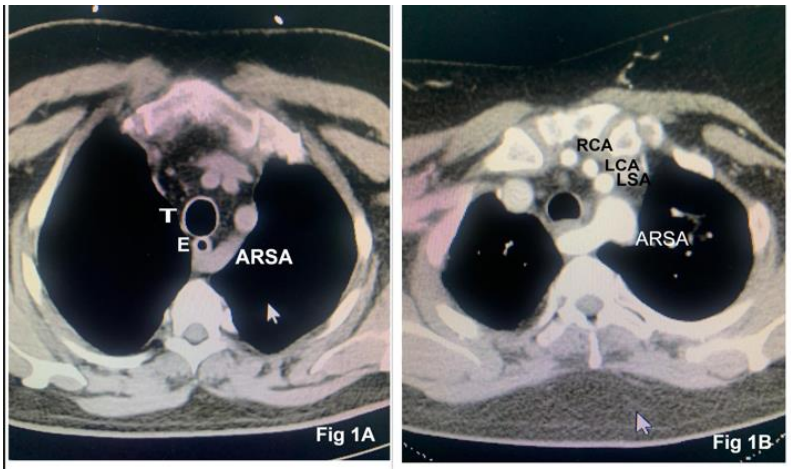

Figure 1: Preoperative computed tomography showing the aberrant right subclavian artery (ARSA) coursing behind the trachea (T) and esophagus (E) (Fig 1A). Axial sections depicting the relationship of ARSA to arch vessels (RCA: right carotid artery, LCA: left carotid artery, LSA: left subclavian artery) and trachea (Fig 1B)

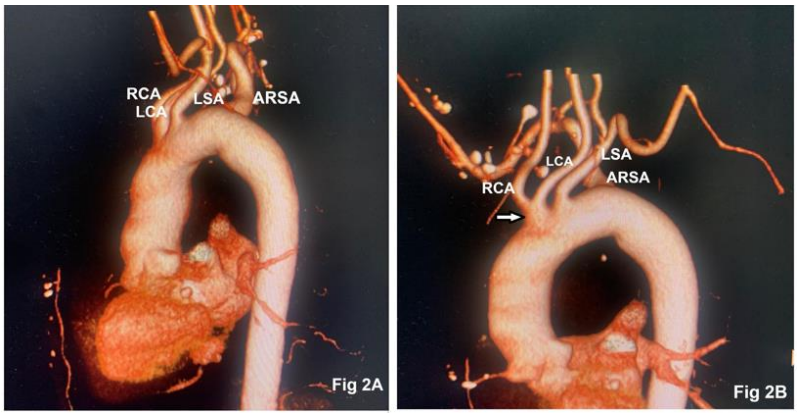

Figure 2: Digital reconstruction of axial computed tomography depicting RCA (right carotid artery), LCA (left carotid artery), LSA (left subclavian artery), and ARSA (aberrant right subclavian artery, Fig 2A). Combined origin of RCA and LCA (arrow) from the aortic arch (Fig 2B)

Discussion

During normal embryological development of the aortic arches, the right dorsal aorta regresses caudal to the origin of the 7th intersegmental artery which gives rise to the right subclavian artery. In ARSA formation, the regression occurs instead between the 7th intersegmental artery and the right common carotid artery so that the right subclavian artery is then connected to the left dorsal aorta via the part of the right dorsal aorta which normally regresses. During growth, the origin of the right subclavian artery migrates until it is just distal to that of the left subclavian artery. The common vascular anomalies associated with an ARSA include truncus bicaroticus or common origin of the right and left carotid arteries, 19.2% (as observed in this patient); Kommerell's diverticulum, 14.9%; aneurysm after the origin of arteria lusoria, 12.8%; and finally, right-sided aortic arch, 9.2%.[3]

ARSA is frequently diagnosed incidentally since most patients do not exhibit symptoms. Radiographic diagnosis of the ARSA can be made by chest X-ray, fluoroscopy, CT, or magnetic resonance imaging (MRI). Lateral chest radiographs may reveal obliteration of the retrotracheal space, while an upper gastrointestinal contrast study on fluoroscopy will demonstrate displacement of the contrast-filled esophagus due to the aberrant vessel, causing the so-called *bayonet deformity* of the ARSA. CT and MRI scans can effectively visualize the aberrant artery as it arises from the distal left aortic arch and track its path, thus clarifying its relationship with the trachea and esophagus. CT scans with contrast produce high-resolution, three-dimensional images of blood vessels, providing excellent clarity on the ARSA's position and course relative to the trachea and esophagus. MRI is similarly valuable in detailing vascular anatomy and is often favored for children to minimize radiation exposure. Diagnostic sensitivity for ARSA detection reported for various methods includes 100% for CT scans, 97.6% for Doppler studies, and 92% for transthoracic echocardiography.[3]

***Anesthetic and Surgical Implications*:** As a congenital anomaly, ARSA can present several anesthetic and surgical challenges. Potentially, ARSA can cause esophageal and tracheal compression, leading to dysphagia, dyspnea, stridor, cough, recurrent chest infections, chest pain, weight loss, and even arterioesophageal fistulas. Patients may also experience numbness in the right upper limb. During procedures involving the upper airway, such as intubation or esophageal instrumentation (e.g., gastric tube insertion), there is a risk of iatrogenic damage to the vessel or surrounding tissues, which could result in fistula formation or gastroesophageal complications. It may also lead to excessive gastrointestinal bleeding. Performing a brachial plexus block in a patient with ARSA may be challenging. The presence of the aberrant artery may alter the anatomical trajectory for brachial plexus blocks, potentially requiring alternative techniques or increasing the risk of vascular injury.

***Invasive Monitoring*:** The right radial artery may be compromised or difficult to cannulate due to the ARSA's location, requiring alternative monitoring sites or strategies. Compression of the ARSA with difficulty in right radial arterial blood pressure monitoring has been reported during transesophageal echocardiography (TEE).[2] Conversely, the presence of

ARSA causing near complete compression of the esophagus resulting in the inability to advance a TEE probe beyond 20 cm, is also reported.[2] In patients with ARSA arising distal to the coarctation of the aorta, there may be difficulty in cannulating the right radial artery and the absence of a pressure gradient between the upper and lower limbs. The proximal arterial pressure can be measured with left radial cannulation or direct ascending aortic cannulation.[4] The absence of good collaterals from the right side may predispose the patients to spinal cord ischemia and paraplegia. Preoperative evaluation, including imaging studies, is crucial for identifying the presence of ARSA and assessing its location and size. During total arch replacement with the frozen elephant trunk technique, the ARSA can be anastomosed to the reperfusion side branch of the *Thoraflex* prosthesis.[5] Patients with ARSA may develop surgical complications. The presence of an ARSA poses a substantial risk of life-threatening hemorrhage in patients undergoing esophagectomy surgery. The precise and diligent dissection of the retroesophageal space during esophagectomy may prevent any injury to the aberrant artery and consequent complications.[6] Furthermore, in the presence of a retroesophageal right subclavian artery, the right inferior laryngeal nerve will be abnormally nonrecurrent. Instead of recurring from the chest, it will pass directly from the vagus nerve at the level of the larynx to the neck. This should be taken into consideration if a thyroid or parathyroid surgery is scheduled for any reason for the patient.[7] Surgical repair of ARSA can lead to post-operative complications, including strokes, tamponades, and acute respiratory distress syndrome. Patients who undergo surgical repair of ARSA should be closely monitored for complications such as upper limb ischemia or respiratory distress.

In conclusion, an ARSA with a left aortic arch is a well-recognized anatomic variant. Patients with an ARSA with normal contours and no evidence of ectasia or aneurysmal degeneration may not need intervention in the absence of symptoms. When it does cause symptoms, surgical treatment is indicated. These patients should, however, be under constant supervision to determine the potential complications such as dysphagia lusoria, respiratory difficulties, or vascular aneurysm formation.[8]

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