



## Case report

# Hybrid repair of a distal aortic arch aneurysm with aberrant right subclavian artery and Kommerell's diverticulum: A case report

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## ABSTRACT

**Introduction and importance:** Aberrant right subclavian artery (ARSA) and Kommerell's diverticulum (KD) are common vascular anomalies of the aortic arch. Anatomic reconstruction of ARSA is difficult with only the median sternotomy approach.

**Case presentation:** A 55-year-old woman was referred to our hospital for a thoracic aneurysm. CT showed 46 mm diameter of distal aortic arch aneurysm with ARSA and KD. ARSA branched from the distal aortic arch and crossed behind the esophagus. It was difficult to reconstruct ARSA anatomically via the median sternotomy approach. We performed coil embolization of ARSA and total aortic arch replacement (TAR) and extra-anatomic right subclavian artery reconstruction for the distal aortic arch aneurysm with ARSA and KD. The patient was discharged home with no complications.

**Clinical discussion:** There were differences in blood pressure of the upper extremities after coil embolization of ARSA; however, subclavian steal syndrome or cerebral complications did not occur. If there is no abnormal finding in head and neck arteries before surgery, coil embolization of ARSA is safe and open distal anastomosis of the distal aortic arch can be performed in a bloodless field.

**Conclusion:** Hybrid repair by coil embolization and TAR for the distal aortic arch aneurysm with ARSA and KD were considered to be a useful in the absence of cerebral vascular stenosis or obstruction.

## 1. Introduction

Aberrant right subclavian artery (ARSA) is one of the common vascular anomalies of the aortic arch. ARSA is identified in 0.5%–2% of the population, and 60% of ARSA cases are associated with Kommerell's diverticulum (KD) [1–3]. Given that 83% of ARSA crosses behind the esophagus [4], anatomic reconstruction may be difficult with only the median sternotomy approach.

In the endovascular aortic repair for the distal aortic arch aneurysm, coverage of the left subclavian artery does not increase the risk of cerebral complications if there is no stenosis or occlusion in the vertebralbasilar artery system [5,6]. A similar procedure would be applicable to the right subclavian artery.

We described a case of distal aortic arch aneurysm with ARSA and KD that was successfully treated with coil embolization of ARSA and total

aortic arch replacement (TAR) and extra-anatomic right subclavian artery reconstruction.

## 2. Case report

A 55-year-old woman who had no particular medical history except for hypertension was referred to our hospital because of a thoracic aneurysm detected by computed tomography (CT) performed during her annual medical checkup. Contrast-enhanced CT showed that the diameter of the ascending aorta was 43 mm. The distal aortic arch was enlarged to 46 mm, and localized aortic dissection was observed on the greater curvature side of the distal aortic arch (Fig. 1c–f). The orifice of the ARSA enlarged to approximately 3 cm. It was thought to be the KD (Fig. 1d, e, g, h). Given that she had a family history of acute aortic dissection, she consented to undergo thoracic aneurysm repair. ARSA

**Abbreviations:** ARSA, aberrant right subclavian artery; KD, Kommerell's diverticulum; TAR, total aortic arch replacement; TEVAR, thoracic endovascular aortic repair.

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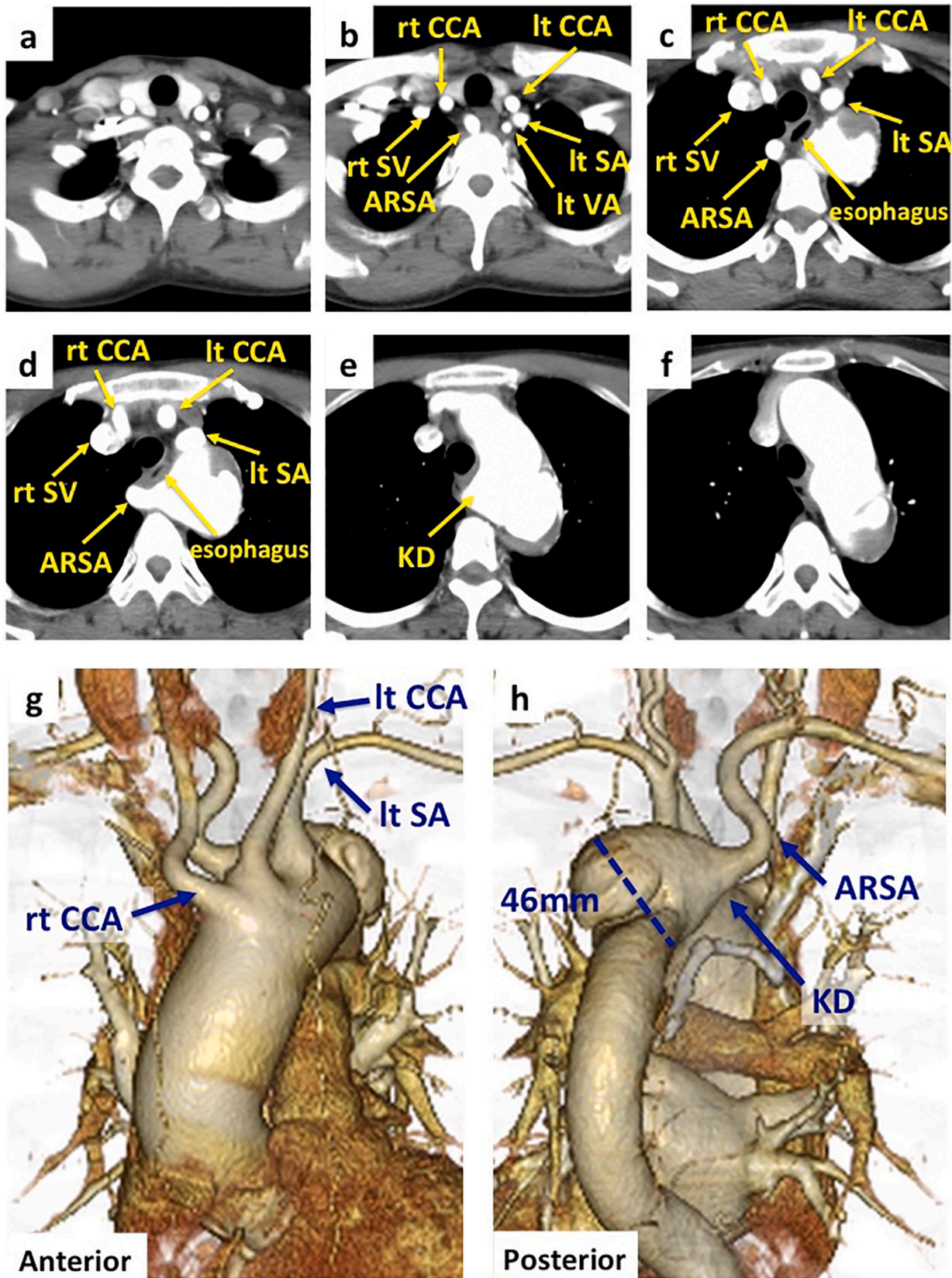
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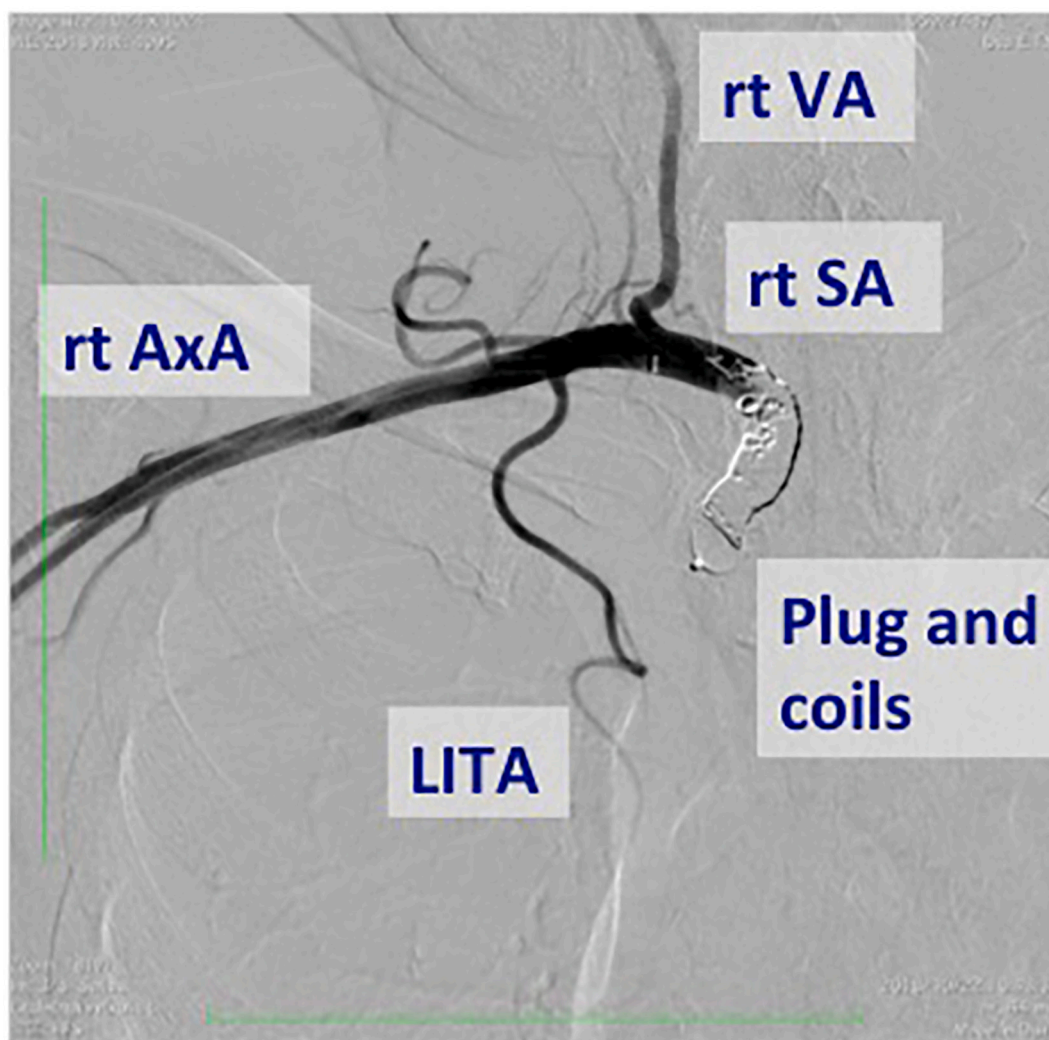
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**Fig. 1.** Pre-operative contrast-enhanced and three-dimensional (3D) computed tomography (CT). a–f. Contrast-enhanced axial CT shows a left-sided aortic arch with aberrant right subclavian artery (ARSA). The ARSA branched from the distal aortic arch and crossed behind the esophagus. g, h. The orifice of the ARSA was enlarged, which is considered as the Kommerell's diverticulum (KD). Abbreviations: ARSA: aberrant right subclavian artery, KD: Kommerell's diverticulum, lt CCA: left common carotid artery, lt SA: left subclavian artery, lt VA: left vertebral artery, rt. CCA: Rt common carotid artery, rt. SA: right subclavian artery, rt. VA: right vertebral artery.





**Fig. 2.** Coil embolization of the aberrant right subclavian artery (ARSA).

Right subclavian artery and right axillary artery were enhanced by reverse flow in the right vertebral artery and right internal thoracic artery after the coil embolization of the ARSA.

Abbreviations: LITA: left internal thoracic artery, rt. AxA: right axillary artery, rt. SA: right subclavian artery, rt. VA: right vertebral artery.

branched from the distal aortic arch and crossed behind the esophagus. It was difficult to expose the orifice of ARSA and to reconstruct ARSA anatomically via the median sternotomy approach. Given that there was no abnormal finding detected by magnetic resonance angiography of the brain and carotid artery ultrasonography, and also no atherosclerotic stenosis of subclavian and axillary arteries was shown in Contrast-enhanced CT, we planned a two-staged hybrid repair and performed coil embolization of ARSA on the day before total aortic arch replacement (TAR). Coil procedure was performed by KS, and TAR was mainly performed by TA. This work has been reported in line with the SCARE 2020 criteria [7].

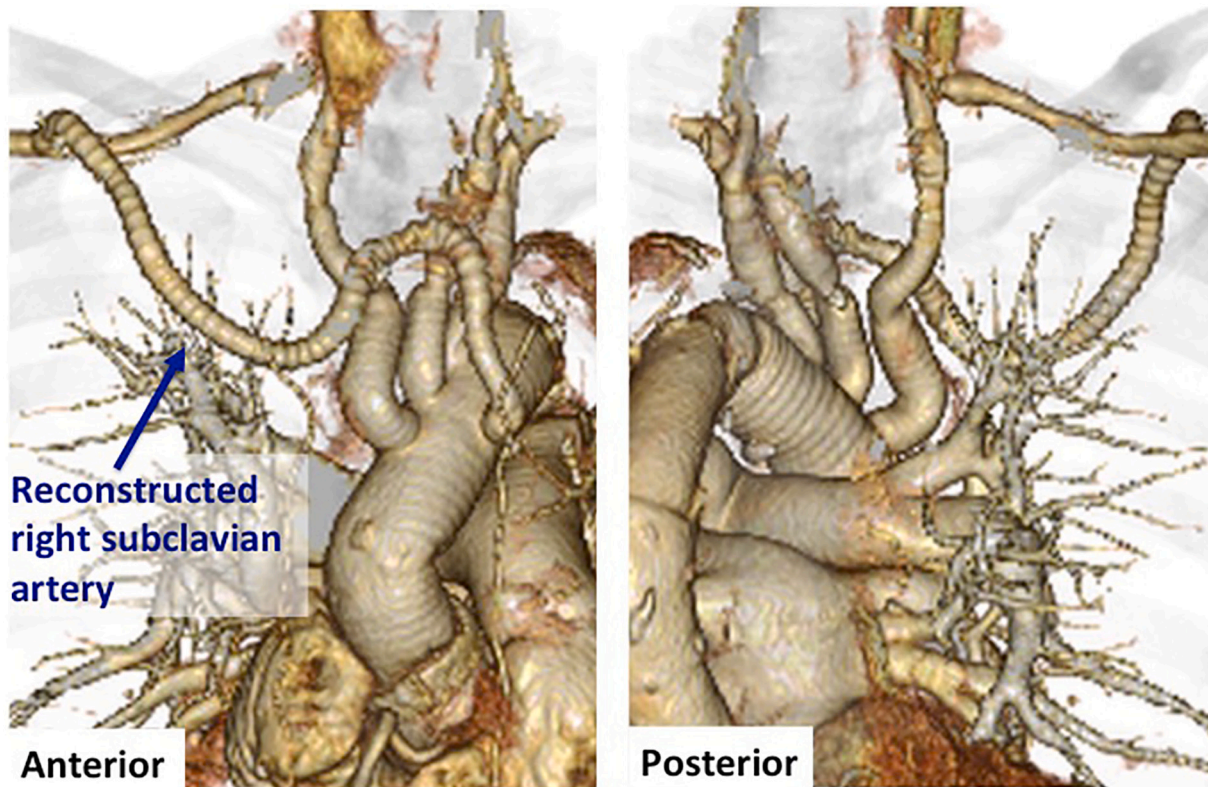
### 2.1. Coil embolization of the ARSA

A 6-Fr sheath was inserted via the right brachial artery access. ARSA was occluded with 14 mm of an Amplatzer Vascular Plug II® (Abbott, Chicago, IL, USA), 8 mm × 20 cm and 6 mm × 20 cm of IDC18® coils (Boston Scientific, Marlborough, MA, USA), 7 mm × 33 cm and 10 mm × 40 cm of Deltafill® coils (Johnson & Johnson, New Brunswick, NJ, USA), and 3 0.018-inch Tornade® coils (Cook Medical, Canton, IN, USA). The right subclavian artery and right axillary artery were enhanced by reverse flow in the right vertebral artery and right internal

thoracic artery after the coil embolization of the ARSA (Fig. 2). The procedural time was 1 h and 35 min. After coil embolization, the difference between the right and left arm blood pressures was observed (right arm: 96/68 mmHg, left arm: 124/80 mmHg); however, subclavian steal syndrome or cerebral complications did not occur while the patient was on bed rest.

### 2.2. TAR with elephant trunk technique and extra-anatomic reconstruction of right subclavian artery

Median sternotomy was performed under general anesthesia. Cardiopulmonary bypass was established with an arterial access of the ascending aorta and venous access of the superior and inferior vena cava. The right axillary artery was exposed by right subclavian incision. A 6-mm ringed polytetrafluoroethylene graft (Propaten®, W.L. Gore & Associates, Newark, DE, USA) was anastomosed to the second portion of the right axillary artery in an end-to-side fashion. Under the condition of moderate hypothermia circulatory arrest at a bladder temperature of 25 °C, the aortic arch was transected, and selective cerebral perfusion to both common carotid arteries and the left subclavian artery was initiated. Open distal anastomosis with an elephant trunk technique was performed distal to KD. A branched Dacron graft (22 mm of J Graft



**Fig. 3.** Post-operative three-dimensional (3D) computed tomography (CT).

After the coil embolization of aberrant right subclavian artery, total aortic arch replacement with the elephant trunk technique and extra-anatomic reconstruction of the right subclavian artery were performed. The right subclavian artery was reconstructed by the ringed polytetrafluoroethylene graft, which was anastomosed to the second portion of the right axillary artery.

Shield Neo®, Japan Lifeline Co., Ltd., Tokyo, Japan) was sewn onto the transected aorta. The left subclavian artery and both common carotid arteries were anastomosed onto the side branches of the graft. After rewarming was started, proximal anastomosis was created approximately 1 cm above the sinotubular junction. Finally, the ringed graft anastomosed to the right subclavian artery was led to the mediastinum and sewn onto the neo arch in a side-to-end manner (Fig. 3). Operative time was 6 h and 53 min. Cardiopulmonary bypass time was 241 min. Aortic clamping time was 185 min. Selective antegrade cerebral perfusion time was 134 min. Minimum body temperature during surgery was 22.5 °C. Bleeding volume during surgery was 919 mL; thus, 2 U of packed red blood cells, 2 U of fresh frozen plasma, and 20 U of platelets were transfused during surgery. She was extubated 5 h after surgery and discharged from the intensive care unit on the third postoperative day. Low-dose aspirin was added as anticoagulation therapy for extra-anatomical bypass of the right subclavian artery. Since she had a history of hypertension, we prescribed 5 mg of amlodipine and 5 mg of imidapril to keep systolic blood pressure below 130 mmHg after surgery. She was discharged home on the eighth postoperative day without any complications. The pathological finding of the aortic wall was cystic medial necrosis. More than 3 years had passed since the operation, however, she received regular outpatient treatment in our hospital without complications.

### 3. Discussion

KD is an arterial diverticulum located at the bifurcation of the subclavian artery, which is the remnant of the dorsal aortic root. KD is common in G and N type classifications of the aortic arch by Williams et al. [8] The aortic arch of this patient is classified as G type which has left aortic arch with ARSA. ARSA often branches from the distal aortic

arch and crosses behind the esophagus. N type is mirrored image of G type. Patients with KD are at risk for acute aortic syndrome, because 6%–53% of them had aortic rupture or aortic dissection [9,10]. Surgery for patients with KD has a high mortality rate of 8%–18% [9,10]. Surgical interventions are preferred for KD with a diameter of >3 cm preferable to [10]. Moreover, early interventions are recommended because of the good outcomes of elective surgeries for KD [11]. In our case, the maximum diameter of KD was 46 mm and the diameter of the orifice of ARSA was approximately 3 cm. A localized dissection was observed in the aortic arch, and the pathological diagnosis of the resected aortic wall was cystic medial necrosis. Moreover, she had a family history of acute aortic dissection. Therefore, the surgical intervention at this stage was considered appropriate. There have been some reports of hybrid repair with thoracic endovascular aortic repair (TEVAR) or open stent grafting for thoracic aortic disease with KD, but there are no reports on hybrid repair with coil embolization. It is difficult to anatomically reconstruct the ARSA, which crosses behind the esophagus and has an enlarged orifice due to KD, only via a median sternotomy approach. In our case, we performed coil embolization of the ARSA before TAR. Although patients undergoing coil embolization of the left subclavian artery are at risk for subclavian steal syndrome or cerebral complications, the simple closure of the left subclavian artery does not increase the risk of cerebral complications in Zone 2 TEVAR in the absence of stenosis or obstruction of the vertebrobasilar system. A similar procedure could be applied to the right subclavian artery. In our case, there were differences in blood pressure of the upper extremities after coil embolization of ARSA; however, subclavian steal syndrome or cerebral complications did not occur. If any symptoms appeared, we would plan to add left carotid axillary bypass surgery immediately. In addition, when the aortic arch was incised during surgery, there was no reverse blood flow from the ARSA, and open distal anastomosis of the

distal aortic arch could be performed in a bloodless field. No major adverse cardiac and cerebrovascular events occurred after surgery.

#### 4. Conclusion

Hybrid repair by coil embolization and TAR for the distal aortic arch aneurysm with ARSA and KD was considered to be a useful technique in the absence of cerebral vascular stenosis or obstruction.

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#### Ethical approval

Informed consent was obtained in the form of opt-out on the website.

#### Consent

Written informed consent was obtained from the patient for publication of this case report.

#### Registration of research studies

N/A.

#### Guarantor

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Study conception: YK, TA

Data collection: YK, WT

Data analysis and interpretation: YK, TA

Writing: YK

Critical review and revision: all authors

Final approval of the article: all authors

Accountability for all aspects of the work: all authors.

#### Declaration of competing interest

All authors have no conflict of interest.

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