

## Case Report

# Hybrid Repair of Kommerell's Diverticulum with Embolization of Aberrant Left Subclavian Artery

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An asymptomatic 70-year-old man presented with Kommerell's diverticulum (KD) and an aberrant left subclavian artery. Computed tomography revealed a KD diameter of 53 mm, severe aortic arch angulation, and no landing zone for thoracic endovascular aortic repair from the arch vessels to the diverticulum. We performed single-stage hybrid repair of KD of the right aortic arch, left carotid–left subclavian artery bypass, and embolization of the subclavian artery, followed by replacement of the descending aorta through deep hypothermic circulatory arrest via right thoracotomy. He was discharged home without any symptoms and remained uneventful at 1 year after the operation.


**Keywords:** Kommerell's diverticulum, hybrid repair, aberrant left subclavian artery

## Introduction

Kommerell's diverticulum (KD) of the right aortic arch is a rare aortic anomaly associated with a high risk of rupture or dissection. In the last few decades, endovascular treatment has developed dramatically. Recently, various surgical techniques, including hybrid repair, have been reported for condition.<sup>1–3)</sup> However, because of arch angulation, thoracic endovascular aortic repair (TEVAR) is not often suitable for KD. Contrarily, open repair, especially in situ reconstruction of the aberrant left subclavian artery (ALSCA), may be difficult.

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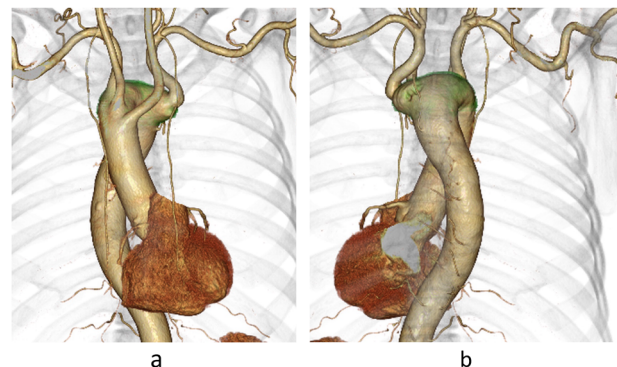
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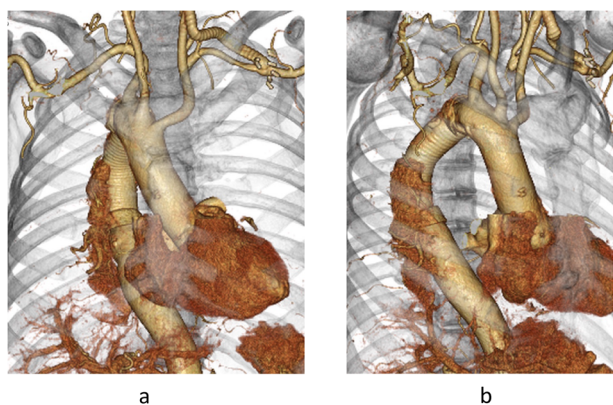
## Case Report

An asymptomatic 70-year-old man, with a history of gastrectomy for gastric cancer, presented with KD and ALSA detected on follow-up computed tomography (CT). The diameter of KD from the opposite aortic wall to the tip of the diverticulum was 53 mm (Fig. 1). Preoperative coronary angiography revealed no significant coronary artery disease, and echocardiography revealed normal cardiac function. The ALSA originating from KD passed behind the trachea and esophagus, and the bottom of the diverticulum was located on the left side of the vertebra. The CT also revealed severe aortic arch angulation and no landing zone from the arch vessels to KD. The patient was not eligible for TEVAR, and in situ reconstruction of the ALSA via right thoracotomy appeared challenging. Thus, we planned hybrid repair, left carotid artery (LCA) to the left subclavian artery (LSCA) bypass, and embolization of the LSCA prior to replacement of the descending aorta via right thoracotomy to prevent tremendous back-flow from the ALSA on the same day.

First, the LCA to LSCA bypass was performed using a 7-mm expanded polytetrafluoroethylene graft. Next, a 16-mm Amplatzer vascular plug II (Abbott Medical Japan Co., Ltd., Tokyo, Japan) was placed from the LSCA just



**Fig. 1** Three-dimensional reconstruction of computed tomographic image of Kommerell's diverticulum (KD) with aberrant left subclavian artery. The diameter of KD from the opposite aortic wall to the tip of the diverticulum was 53 mm .



**Fig. 2** Postoperative computed tomographic image of patent left carotid artery to the left subclavian artery bypass and embolization of subclavian artery.

distal to KD and proximal to the left vertebral artery. Following LSCA embolization, the patient was shifted to the left lateral recumbent position.

Right lateral thoracotomy was performed through the fourth intercostal space, and the fifth rib was divided posteriorly. Cardiopulmonary bypass was established using an aortic cannulation on the descending aorta and bicaval drainage. Traction sutures were placed on the pericardium to obtain a good working space to insert the left ventricular (LV) vent tube via the right pulmonary vein and antegrade and retrograde cardioplegia cannula. During cooling, the left phrenic and vagus nerves were preserved, and the intercostal arteries were clipped from the outside to prevent steal phenomenon before the aneurysm was opened. The ascending aorta and descending aorta were clamped with deep hypothermia (tympanic temperature, 20°C), and cardiac arrest was induced by antegrade and retrograde cardioplegia. The aneurysm was transected, and open proximal anastomosis was performed just distal to the right SCA using a 22-mm single-branched J Graft SHIELD NEO (J Graft, Japan Lifeline Co., Ltd., Tokyo, Japan) with deep hypothermic circulatory arrest (DHCA) and retrograde cerebral perfusion. Following re-warming, the bottom of KD was closed with 4-0 polypropylene sutures just in case, and distal anastomosis to the descending aorta was performed (Fig. 2). The surgical time was 435 min; bypass time, 136 min; myocardial ischemia time, 29 min; and circulatory arrest (retrograde cerebral perfusion) time, 29 min. About 2 U of red cell concentrates and 10 U of platelet concentrates were transfused. The patient had a normal recovery in the intensive care unit. He was discharged without any symptoms and remained uneventful at 1 year after the operation.

## Discussion

The prevalence of aberrant subclavian artery with the

right aortic arch is approximately 0.04%–0.4%.<sup>4)</sup> Up to 60% of these patients are associated with KD. Dyspnea or dysphagia caused by KD is considered for surgical management. However, the surgical indication for asymptomatic KD is unclear. Although the natural history of KD is unknown, several review reports<sup>4)</sup> revealed that KD was associated with a high risk of rupture and dissection of up to 50%. On the other hand, because of the advances in cardiothoracic surgery, the operative mortality of recent surgical results for elective KD has dramatically improved to nearly 0%. Ota et al. recommended surgical correction when dilation of KD was  $\geq 50$  mm.<sup>5)</sup> Some investigators suggested that KD  $\geq 3$  cm is the threshold for surgery in low-risk patients.

Various surgical approaches for KD have been reported. In pediatric patients, Backer et al. reported single ligation of the ALSA. However, in adults, ALSA reconstruction is recommended to avoid ischemic complications. In the past decade, endovascular repair, including a hybrid procedure, was reported.<sup>6)</sup> Zone 2 TEVAR with embolization of the ALSA is an attractive option for the management of KD. However, TEVAR for KD may be associated with endoleak, aortoesophageal fistula, arm claudication, and retrograde dissection. The right aortic arch in KD often shows an angulation, and such patients are not appropriate candidates for endovascular repair. Thus, graft replacement and ALSA reconstruction is the standard surgical technique for KD. Kim et al.<sup>7)</sup> recommended graft replacement by DHCA, because they experienced a retrograde type A dissection using a proximal clamp. If the aortic arches were clamped between the right carotid and right subclavian arteries, DHCA and cardiac arrest would be unnecessary. However, to avoid the risk of retrograde dissection and difficult proximal anastomosis, we chose to achieve DHCA and cardiac arrest. Kouchoukos and Masetti<sup>8)</sup> recommended carotid-to-subclavian artery bypass, thoracotomy, and graft replacement by cardiopulmonary bypass. We prefer to perform the same approach for KD. Through a right thoracotomy and retraction of the pericardium using a similar method of minimally invasive cardiac surgery for the mitral valve, the surgical field is extensive, and we can easily cannulate the antegrade and retrograde cardioplegia and LV vent. Some surgeons performed in situ reconstruction of the ALSA via thoracotomy; however, the orifice was usually located deep and at the bottom of KD. The control of back-bleeding from an ALSA is crucial. In our case, the bottom of KD was deep far from the vertebra, thereby posing a challenge to performing in situ reconstruction of the ALSA.

## Conclusion

Embolization of the ALSA prior to replacement of the

descending aorta is safe and effective to minimize back-bleeding and is a simple surgical procedure for the treatment of KD of the right aortic arch.

### Disclosure Statement

The authors have no conflicts of interest.

### Additional Note

This article was written based on enough informed consent and patient's agreement.

The study was reviewed and approved by the institutional review boards (IRB number 1-39).

### Author Contributions

Study conception: MM

Data collection: MM

Analysis: MM

Investigation: MM

Writing: MM

Funding acquisition: MM

Critical review and revision: all authors

Final approval of the article: all authors

Accountability for all aspects of work: all authors

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