

Successful Endovascular Repair of a Kommerell's Diverticulum and a Right-Sided Aortic Arch

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ABSTRACT

Background: A 57-year-old woman was diagnosed with Kommerell's diverticulum in the setting of a right aortic arch on computed tomography.

Case report: Although asymptomatic, the maximum diameter of the aneurysm was 55 mm; thus, she underwent surgery to prevent rupture of the aneurysm. A bypass was constructed from the left common carotid artery to the left subclavian artery. A stent-graft was deployed from the distal right subclavian artery, and coil embolization of the diverticulum was performed via the left subclavian artery. She was discharged after 12 days of surgery. The postoperative four-month follow up showed a smaller aneurysm.

Conclusion: Thoracic endovascular aortic repair is feasible and effective for Kommerell's diverticulum.

INTRODUCTION

Kommerell's diverticulum (KD) associated with a right-sided aortic arch and an aberrant left subclavian artery (ALSA) is an extremely rare condition with an incidence of 0.05–0.1% [Tsukabe 2001]. Notably, 53% of KD cases have been reported to undergo dissection or get ruptured [Cina 2004], often resulting in death. In this case report, we describe a successful outcome achieved by debranching thoracic endovascular aortic repair (TEVAR) in managing a Kommerell's diverticulum associated with a right aortic arch.

CASE PRESENTATION

A 57-year-old woman was incidentally detected to have an abnormal aortic shadow on a computed tomography (CT)

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scan performed for investigating vertigo. Contrast-enhanced CT showed a KD associated with a right-sided aortic arch and an ALSA. The cervical artery diverged in order of the left common carotid artery (LCCA), right common carotid artery (RCCA), right subclavian artery (RSCA), and ALSA. The maximum diameter of the aortic aneurysm was 55 mm, and the length of the diverticulum was 30 mm (Figure 1). Although the patient was asymptomatic, a surgical intervention was planned to prevent rupture.

The procedure was performed under general anesthesia. First, a bypass from the left common carotid artery to the left subclavian artery was constructed using an 8 mm vascular prosthesis (GORE® PROPATEN®, W.L. Gore and Associates, Flagstaff, AZ, USA). Next, a 34 mm × 34 mm × 100 mm stent graft (GORE® TAG® Conformable Thoracic Stent Graft with ACTIVE CONTROL System, W.L. Gore and Associates, Flagstaff, AZ, USA) was inserted through the right femoral artery, with the proximal end placed just below the origin of the right subclavian artery. The primary deployment handle was removed to deploy the stent graft to its intermediate diameter. The angle on the proximal end of the stent graft was adjusted by rotating the angulation control dial to conform to the inner curvature of the aortic arch (Figure 2A). After removing the secondary deployment handle, the stent graft was deployed to its full diameter. The angle on the proximal end of the stent graft was once more adjusted by rotating the angulation control dial, so that the stent graft conformed to the inner curvature of the aortic arch. As a

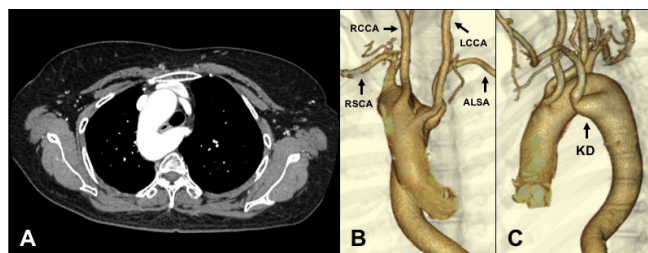


Figure 1. A, Contrast-enhanced computed tomography showing a Kommerell's diverticulum associated with a right-sided aortic arch and an ALSA. B, C, The cervical artery diverged in order of the LCCA, the RCCA, the RSCA, and the ALSA.

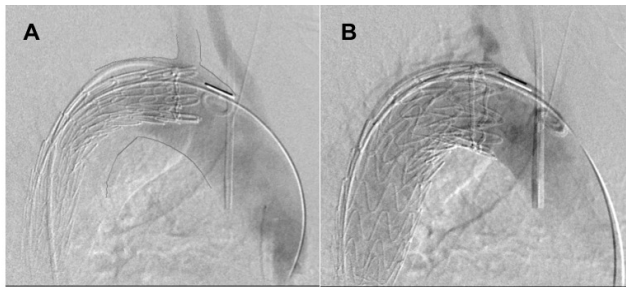


Figure 2. Intraoperative findings. A, After removing the primary deployment handle, the stent graft was deployed to its intermediate diameter. B, After the angle on the proximal end of the stent graft was adjusted, the secondary deployment handle was removed to deploy the stent graft to its full diameter.

result, the proximal angle of the stent graft was adjusted to the lesser curvature side by 32 degrees (Figure 2B). Finally, a coil embolization was performed distal to the KD in the left subclavian artery. A final aortography confirmed the successful exclusion of the KD with no endoleak.

The patient's postoperative course was uneventful, and she was discharged on postoperative day 12 (Figure 3A). Four months later, a follow-up CT showed that the stent graft had been placed properly without a bird beak configuration in the inner curvature, and the size of aneurysm had reduced from 55 mm to 52 mm (Figures 3B and 3C).

DISCUSSION

KD, a phenomenon first reported by Burckhard F. Kommerell in 1936, is a saccular remnant formed owing to incomplete retraction of the dorsal aorta during the embryonic period [Kommerell 1936]. It often is accompanied by an aberrant subclavian artery. A KD involving a right-sided aortic arch and an ALSA is relatively rare, with a reported incidence of 0.05–0.1% [Tsukabe 2001].

In patients with KD, esophageal or tracheal compression, or complications including dissection and rupture of the aneurysm, are considered indications for surgery [Nonaka 2014]. Surgery also has been indicated for asymptomatic KD, due to the risk of dissection or rupture. Kim et al found that histological examination of KDs revealed medial degeneration and necrosis in the diverticulum wall in all cases, indicating the fragility of the aortic wall [Kim 2014]. Therefore, in asymptomatic cases, Ota et al suggested that aneurysms with a diameter of over 50 mm should be considered an indication for surgery [Ota 2006], and Cina et al suggested that in patients with a low risk of surgery, a diverticulum diameter of over 30 mm could be used as an indication for surgery [Cina 2004].

The standard surgical procedure for KD is aortic graft replacement by open surgery [Tsukabe 2001]. Open surgeries previously have been reported in the setting of a KD, including a total aortic replacement with a median sternotomy and a descending aortic replacement with a right thoracotomy

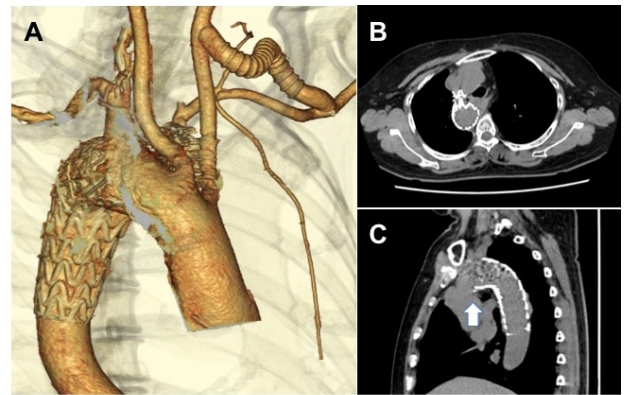


Figure 3. A, Postoperative contrast-enhanced computed tomography showing successful exclusion of the Kommerell's diverticulum (KD) with no endoleak. B, C, Four months after thoracic endovascular aortic repair, computed tomography shows a reduction in the KD. Moreover, the stent graft was deployed at the expected position without a bird beak configuration (arrow).

under circulatory arrest [Ota 2006; Kouchoukos 2007]. There also have been reports of hybrid surgeries in which thoracotomy and TEVAR were performed in two stages [Onohara 2014]. In recent years, there have been reports of employing TEVAR to manage KDs associated with a right aortic arch. Kazuno et al reported a successful TEVAR with positive results in a KD patient, who had similar anatomy to the patient in the present case [Kazuno 2017].

An open surgery may lead to several problems for KD patients with a right-sided aortic arch. The KD often runs behind the esophagus, and in cases where the diverticulum protrudes over the spine from the right to the left side, a right and left thoracotomy may be necessary to manipulate the ALSA. Consequently, the surgery may be much more invasive as compared with cases involving a left aortic arch. Consequently, the risk of esophageal injury, respiratory complications, phrenic nerve paralysis and other nerve disorders, and hemorrhage are increased [Onohara 2014]. Thus, if KD patients with a right-sided aortic arch are indicated for surgery, TEVAR may be a viable option, even for young people.

The steepness of the aortic arch poses a major challenge in performing TEVAR for a KD with a right-sided aortic arch. The steep angle of the aortic arch may predispose the patient to a bird beak configuration, where the central part of the device floats on the inner curvature of the aorta and a type 1a endoleak [Kazuno 2017]. To alleviate these anatomical problems, we chose to use a GORE® TAG® Conformable Thoracic Stent Graft with ACTIVE CONTROL System (W.L. Gore and Associates, Flagstaff, AZ, USA), which better conforms to the shape of the aorta. The conformable GORE TAG® (cTAG) thoracic stent graft is a third-generation GORE TAG device that exhibits improved adhesion to the inner curvature of the aorta and has no angle restrictions compared to conventional devices. In addition, the active control on the cTAG allows for central angle adjustment, preventing a bird beak configuration and a type 1a endoleak

[Mariani 2019]. In the present case, the active control was used to adjust the angle on the proximal side of the stent graft, allowing us to secure sufficient landing zone on the inner curvature of the aorta. As a result, the proximal end of the stent graft could be deployed just below the origin of the right subclavian artery without a bird beak configuration of the stent graft, and a type 1a endoleak was prevented. Finally, the addition of a left subclavian artery coil embolization allowed the exclusion of the KD.

CONCLUSION

We successfully have performed debranching TEVAR for KD with a right-sided aortic arch. With the advancement of medical technology, TEVAR may become the first-line therapy for KD.

REFERENCES

- Cina CS, Althani H, Pasenau J, et al. 2004. Kommerell's diverticulum and right-sided aortic arch: a cohort study and review of the literature. *J Vasc Surg* 39:131-9.
- Kazuno K, Murata S. 2017. Endovascular repair for Kommerell's diverticulum and right-sided aortic arch. *Ann Vasc Dis* 10:48-50.
- Kim KM, Cambria RP, Isselbacher EM, et al. 2014. Contemporary surgical approaches and outcomes in adults with Kommerell diverticulum. *Ann Thorac Surg* 98:1347-54.
- Kommerell B. 1936. Verlagerung des Oesophagus durch eine abnorm verlaufende Arteria subclavia dextra (Arteria lusoria). *Fortschr Geb Roentgenstrahlen* 54:590-5.
- Kouchoukos NT, Masetti P. 2007. Aberrant subclavian artery and Kommerell aneurysm: Surgical treatment with a standard approach. *J Thorac Cardiovasc Surg* 133:888-92.
- Mariani C, Weijde E, Smith T, et al. 2019. The GORE TAG conformable thoracic stent graft with the new ACTIVE CONTROL deployment system. *J Vasc Surg* 70:432-7.
- Nonaka M, An K, Nakatsuka D, et al. 2014. Hybrid procedure for a Kommerell's diverticulum in a right-sided aortic arch. *Ann Thorac Cardiovasc Surg Supplement*: 821-4.
- Onohara T, Nakamura Y, Kishimoto Y, et al. 2014. Two cases of thoracic aortic aneurysm with right aortic arch: comparison of two operative strategies for hybrid thoracic endovascular repair. *Ann Vasc Dis* 7:343-6.
- Ota T, Okada K, Takashi S, et al. 2006. Surgical treatment for Kommerell's diverticulum. *J Thorac Cardiovasc Surg* 131:574-8.
- Tsukabe T, Ataka K, Sakata M, et al. 2001. Surgical treatment of an aneurysm in the right aortic arch with aberrant left subclavian artery. *Ann Thorac Surg* 71:1710-1.