Hybrid Procedure for a Kommerell’s Diverticulum in a Right-Sided Aortic Arch

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A rare case of an aneurysmal Kommerell’s diverticulum in a right-sided aortic arch was successfully treated using a hybrid procedure comprising total arch replacement and percutaneous stent grafting. A 65-year-old man with dysphagia was diagnosed with an ectatic right-sided aortic arch and a saccular aneurysm of the Kommerell’s diverticulum. Since its radical resection during a single surgery was unfeasible because of its complex configuration, a 2-stage procedure was adopted.

Keywords: aneurysm (aortic arch), aortic arch, aortic operation, endovascular procedures/stents

Introduction

A Kommerell’s diverticulum in a right-sided aortic arch (RAA), which is located at the base of an aberrant left subclavian artery (ALSCA), is a rare anomaly. Although individuals with this variation are normally asymptomatic, the diverticulum often enlarges into an aneurysm and causes symptoms, e.g., dysphagia or dyspnea, because of compression of the adjacent organs. An aneurysmal diverticulum should be resected surgically as the risk of rupture is high when its maximum diameter exceeds 5 cm. However, surgery for such an aneurysm requires deliberate strategies, including the surgical approach, because of the complexity of its anatomical configuration. We describe the successful treatment of an aneurysmal Kommerell’s diverticulum in the RAA, for which a hybrid procedure comprising open heart total arch replacement and percutaneous stent grafting was adopted.

Case Report

The patient was a 65-year-old man who was examined for progressive dysphagia. Contrast-enhanced computed tomography (CECT) showed an ectatic RAA with maximum diameter greater than 6 cm, and a saccular aneurysm of the Kommerell’s diverticulum (Fig. 1). CT also demonstrated uncommon variation of the aortic arch vessels associated with the RAA, namely, the left common carotid artery (LCCA), right common carotid artery (RCCA), right subclavian artery (RSCA), and ALSCA branching off from the diverticulum, in that order from the proximal side of the aorta (Fig. 2). Surgical intervention was indicated by the configuration of the Kommerell’s diverticulum, as well as the ectatic region of the aortic arch. In the present case, along with the position of the diverticulum in the thoracic cavity, the curvature of the aorta where it was located made a simple surgical resection or percutaneous stent grafting unfeasible. Therefore, we chose a combined procedure of total arch replacement and post-surgery percutaneous stent grafting. Informed consent was obtained from the patient for these procedures.

Total arch replacement with a distal elephant trunk was performed through a median sternotomy. The aortic arch vessels, i.e. LCCA, RCCA, and RSCA, were exposed. Simultaneously, the distal part of the left subclavian artery was...
Fig. 1  Contrast-enhanced computed tomography (CECT) showing an ectatic RAA and a saccular aneurysm of the Kommerell’s diverticulum. RAA: right-sided aortic arch.

Fig. 2  CT scan demonstrating a dilated Kommerell’s diverticulum at the base of the ALSCA in the distal aortic arch. ALSCA: aberrant left subclavian artery; LCCA: left common carotid artery; RCCA: right common carotid artery; RSCA: right subclavian artery.
Hybrid Procedure for Kommerell’s Diverticulum

artery (LSCA) was exposed and anastomosed with an 8-mm Dacron graft (Gelweave; Vascutek Ltd., Inchinnan, UK) for the later bypass. A cardiopulmonary bypass (CPB) was established by placing an arterial cannula through the ascending aorta and a venous cannula through the right atrium. The ALSCA was ligated with 2–0 silk in the left thoracic cavity. Under circulatory arrest with hypothermia at 28°C, the ascending aorta was opened. Balloon-tipped cannulae for selective cerebral perfusion were inserted into the RCCA, RSCA, LCCA, and the anastomosed LSCA graft. The Kommerell’s diverticulum could not be identified in the surgical field because of its deep location. For the distal anastomosis, we adopted a stepwise technique to place an elephant trunk graft. A 6-cm invaginated tube graft (a section of the 22-mm Gelweave Dacron quadrifurcated arch graft) was inserted into the distal arch and anastomosed at the aortic arch using a running suture of 4–0 polypropylene. After the distal end of the inserted graft was extracted proximally, it was anastomosed with the body part of the graft. Subsequently, the aortic arch vessels were reconstructed with the branches of the graft by using running sutures of 5–0 polypropylene. The graft to the LSCA was connected with a branch of the main graft, to which the LCCA was anastomosed. The proximal anastomosis was then performed. Weaning from the CPB and hemostasis were achieved easily. The selective cerebral perfusion time, CPB time, and operation time were 125, 149, and 323 min, respectively. The patient was extubated on the following day and showed neither hemodynamic nor neurological problems.

The second stage of the procedure, stent grafting, was performed after the patient recovered from the previous operation. The patient was sedated and given local anesthesia. A 22-mm self-expandable stent graft was delivered through the right femoral artery and connected with the elephant trunk graft without leakage to the Kommerell’s diverticulum. Postoperative CT showed that the diverticulum was excluded, and good blood flow to the reconstructed aortic arch vessels was maintained (Fig. 3). After recovering without any complications, the patient was discharged from the hospital. During the follow-up, remission of dysphagia was observed, and recession of the diverticulum was confirmed on CT scans.

Discussion

A Kommerell’s diverticulum associated with an RAA is a rare anomaly observed in 0.05%–0.1% of the population. It is located at the base of an ALSCA, which is attributed to the abnormal regression of the fourth primitive aortic arch during embryonic development. In many cases, individuals with a Kommerell’s diverticulum are asymptomatic; however, symptoms, e.g., dysphagia, chest discomfort, and dyspnea, often appear due to the compression of the adjacent organs by the dilated
diverticulum.

As indications for surgery, along with the symptoms, the diameter and configuration of the diverticulum are considered since the mortality rate of patients with an aneurysmal diverticulum is high because of the high incidence of rupture. In the present case, the shape and size of the diverticulum indicated need for surgical treatment—open heart or endovascular surgery. Similarly, according to the guidelines for the treatment of thoracic aneurysm, maximum diameter of >6 cm in the aortic arch is class I surgical indication, even though the patient is asymptomatic. Thus, it is reasonable that total arch replacement was performed as a part of the surgical procedures for the aneurysmal Kommerell’s diverticulum.

The 2-stage procedure for the Kommerell’s diverticulum in the present case was determined with the consideration of several problems. One concern for the surgical approach to an aneurysmal Kommerell’s diverticulum is the anatomical variation of the aortic arch vessels, especially the ALSCA, which is derived from the diverticulum and runs behind the esophagus. A Kommerell’s diverticulum has been resected successfully via thoracotomy; however, in the present case, a right thoracotomy would have been required to approach the distal site of the diverticulum, while manipulation of the ALSCA would have been needed in the left thoracic cavity since the diverticulum protruded over spines from the right to the left side. The thoracotomy would have been dangerous as the respiratory function of the patient was deteriorated due to chronic obstructive pulmonary disease. Moreover, the diverticulum was located very deep in the sharply curved distal arch, because of which anastomosis to the descending aorta would be difficult through a median sternotomy, and both percutaneous and open direct stent grafting during surgery were not feasible. Therefore, we adopted a hybrid procedure of total arch replacement and secondary percutaneous stent grafting in order to exclude the diverticulum.

This hybrid procedure had some advantages. First, total arch replacement with a distal elephant trunk did not require thoracotomy, which reduced the probability of postoperative respiratory failure. Second, distal anastomosis could be performed at a suitable arterial site without calcification in the proximal aortic arch without any difficulty. Furthermore, the placement of a stent graft into the elephant trunk was less invasive under local anesthesia, thereby avoiding surgical risks. As a result, the procedures were accomplished without any complications despite the anatomical complexity.

**Conclusion**

We successfully treated a rare case of a Kommerell’s diverticulum in the RAA using a hybrid surgical procedure constituting of total arch replacement and percutaneous stent grafting. Since standard methods for this rare disease have not been established, and there are some variations of the aortic vessels, a deliberate strategy is required because of the complex anatomical configuration.

**Disclosure Statement**

The authors do not have any conflict of interest, financial or otherwise, to declare.

**References**