Left internal mammary artery access for embolization of the left subclavian artery in a patient with type II endoleak after thoracic endovascular aortic repair for a ruptured right-sided aortic arch aneurysm

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ABSTRACT

A 65-year-old woman had presented with a ruptured type B intramural hematoma associated with a right-sided aortic arch aneurysm, a large Kommerell diverticulum (KD) and an aberrant left subclavian artery (LSA). She underwent total aortic arch replacement with elephant trunk, thoracic endovascular aortic repair, and LSA ligation distal to the left vertebral artery. She subsequently developed a brisk type II endoleak into the KD via retrograde flow from the left vertebral artery. Percutaneous access of the left internal mammary artery with coil embolization of the proximal LSA and KD was performed. At 5 years, computed tomography angiogram showed complete thoracic aortic remodeling without an endoleak. The results from the present case have illustrated the novel use of the left internal mammary artery as an alternative access for LSA embolization in patients with type II endoleak and limited access options. (J Vasc Surg Cases Innov Tech 2022;8:175-8.)

Keywords: Coil embolization; Endoleak; Intramural hematoma; Kommerell diverticulum; Left internal mammary artery; Left subclavian artery; Percutaneous embolization; TEVAR; Thoracic endovascular aortic repair; Type 2 endoleak

Thoracic endovascular aortic repair (TEVAR) has become the preferred treatment of most acute thoracic aortic pathologies.[1] Associated aneurysmal arch disease requires hybrid approaches, including extra-anatomic debranching with proximal arch endograft coverage or open total arch replacement with elephant trunk and TEVAR. Type II endoleaks after TEVAR have usually resulted from retrograde flow from the left subclavian artery (LSA) and/or intercostal arteries and can require intervention. Locating the source of the endoleak and treating the responsible back-bleeding branch can be challenging owing to postoperative changes of varying complexity and frequent difficulty in visualization on the angiogram.

We have presented a case of percutaneous left internal mammary artery (LIMA) access for treatment of a type II endoleak after complex hybrid repair in a patient with a ruptured right-sided aortic arch aneurysm (RSAAA) and an aberrant LSA associated with Kommerell diverticulum (KD). The patient provided written informed consent for the report of her case details.

CASE REPORT

A 65-year-old, previously healthy, woman had presented with a 1-week history of back pain after a fall. She complained of chest pain but reported no shortness of breath, abdominal pain, or neurologic symptoms. On the physical examination, she appeared well but was hypertensive with the systolic blood pressure in the 170s mm Hg. Computed tomography (CT) angiography (CTA) revealed a RSAAA beginning at the LSA, with a large 5.6-cm × 4.6-cm KD (Fig 1). The maximum aortic diameter at the level of the KD was 8.6 cm. CTA also showed an acute type B aortic dissection (TBAD) throughout the descending aorta that was associated with a ruptured intramural hematoma with areas of focal extravasation.

She required a median sternotomy and total aortic arch replacement using a 28-mm multibranched arch graft with a 10-cm elephant trunk under deep hypothermic circulatory

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Author conflict of interest: J.M.P. is a consultant for Medtronic, Terumo Aortic, W.L. Gore, Getinge, and Penumbra; a member of the advisory board for Medtronic; and a member of the speaker's bureau for Medtronic, Terumo Aortic, Philips Volcano, Penumbra, and W.L. Gore. F.S.A.-C., T.M., S.A.-A., and A.R. have no conflicts of interest.

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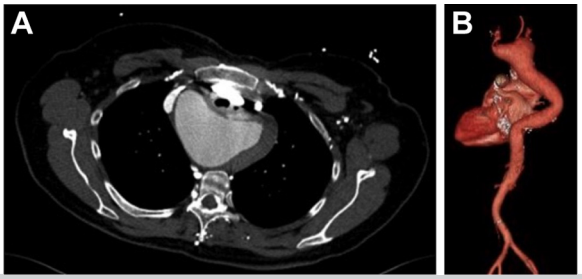

Fig 1. A, Right-sided aortic arch with a Kommerell diverticulum (KD) of the left subclavian artery (LSA). **B,** Three-dimensional reconstruction.

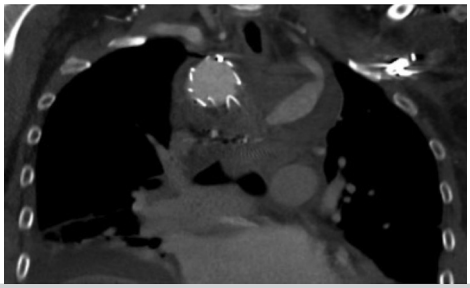

Fig 2. Coronal view of type II endoleak arising from the left subclavian artery (LSA).

arrest. Because of the dissection extending into the LSA and axillary artery and causing vessel friability, the bypass from the arch graft had to be performed end-to-end to the distal left axillary artery, and the LSA had to be ligated distal to the origin of the left vertebral artery (LVA). Next, antegrade TEVAR was performed through the perfusion limb of the arch graft. Two thoracic endografts were deployed to overlap the elephant trunk and extend distally to the level of the diaphragm. Completion angiogram revealed complete exclusion of the aneurysm and the KD with no evidence of an endoleak.

Postoperatively, she was neurologically intact and was extubated on postoperative day 1. On postoperative day 6, she reported increasing back pain and had developed hemorrhagic anemia and worsening hemothorax owing to a brisk type II endoleak into the KD via retrograde flow from the LVA into the proximal LSA (Fig 2). Given her recent aortic arch replacement and LSA ligation, the access options to address this were limited. The open surgical options were to ligate the LSA more proximally via a supraclavicular approach or a redo median sternotomy, both of which were suboptimal options <1 week after the initial surgery. Retrograde coil embolization of the proximal LSA was a much more appealing approach; however, the access options were limited, given the prior LSA ligation. Percutaneous access was easily obtained via the LIMA at the level of the left fourth intercostal space under ultrasound guidance with straightforward visualization. Angiography was performed to confirm access. Next, the proximal LSA was selected using a floppy glide wire. The wire was advanced into the KD to allow for the short sheath to be exchanged for a 5F 55-cm sheath. Embolization of the LSA proximal to the LVA takeoff was performed using a 12-mm Amplatzer plug (Abbott, Chicago, IL) with six additional coils deployed more proximally to successfully occlude the origin of the LSA. The completion angiogram showed complete resolution of the endoleak (Fig 3). An extravascular plug closure device was safely deployed, and manual pressure was used to ensure optimal hemostasis with no access complications.

The patient's back pain had resolved, and her hemoglobin levels had stabilized. Follow-up CTA performed 7 days after embolization confirmed complete resolution of the endoleak. The patient was discharged on postoperative day 26 to an inpatient rehabilitation facility. The patient's final anatomy with the arch replacement graft, four-vessel bypass grafts, and coiled LSA is shown in Fig 4, *A*. At 5 years of follow-up, the patient remained asymptomatic, and CTA revealed no evidence of endoleak with complete thoracic aortic remodeling (Fig 4, *B*).

DISCUSSION

A right-sided aortic arch associated with a KD is a rare anomaly observed in 0.05% to 0.1% of the population.[2] In autopsy series, approximately one half of right-sided aortic arches were associated with an aberrant LSA.[2] A few cases of hybrid repairs have been previously described in the literature.[3-5] Arch anomalies combined with TBAD are also a relatively rare occurrence. Khaja et al[6] identified 212 cases of KD, of which 23 (11%) were associated with aortic dissection. Our patient had presented with a RSAAA, aberrant LSA, associated KD, and ruptured acute type B intramural hematoma. This case represents an extremely rare and complex anatomic combination that was successfully managed with a hybrid approach using total arch debranching, elephant trunk, and TEVAR.

Type II endoleaks that develop after TEVAR have most often resulted from retrograde flow from the LSA and less frequently from intercostal, bronchial, or other arteries. The treatment options include open ligation, plugging, cyanoacrylate glue, and/or coil embolization via brachial or femoral access.[6] The management of KDs with TEVAR has remained controversial. Ding et al[7] recently reported their case series of 16 patients who had undergone TEVAR and extra-anatomic bypass hybrid procedures for TBAD associated with an aberrant right subclavian artery. Two patients in their series had had an associated KD, had not undergone prophylactic embolization, and had not developed type II endoleaks after TEVAR. However, Guzman and Eagleton[8] recommended using plugs and/or coils to preemptively occlude the origin of the aberrant subclavian artery to prevent type II endoleaks. They also suggested embolization of both true and false lumens when the aberrant vessel was dissected and recommended using larger plugs or coils to completely obliterate the larger lumen of the aberrant artery.

Fig 3. A, Pre-embolization angiogram showing the type II endoleak from the proximal left subclavian artery (LSA). **B,** Completion angiogram showing successful embolization of the proximal LSA with resolution of the type II endoleak.

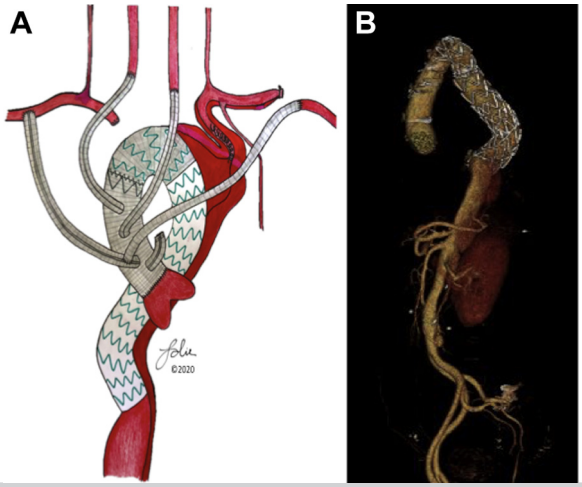

Fig 4. A, Illustration of the patient's final anatomy. **B,** Three-dimensional reconstruction of follow-up cross-sectional imaging after successful coil embolization of the left subclavian artery (LSA) origin and type II endoleak.

Type II endoleaks, combined with restrictive anatomy, such as in our patient, leave few options for treatment. Previously described approaches such as left brachial artery access with retrograde catheterization of the LVA were unavailable given prior LSA ligation. Similarly, retrograde right brachial artery access with selection of the right vertebral artery and retrograde LVA access via the basilar artery has been previously described to treat type II endoleaks.[9] However, avoiding transcerebral access is desirable to reduce the potential for neurologic complications whenever other therapeutic alternatives are available. CT-guided direct transthoracic embolization of the KD remains an option; however, LIMA access was deemed more appropriate and less invasive. To the best of our knowledge, percutaneous access of the LIMA for interventional procedures has not been thoroughly described, possibly owing to the technical challenges and perceived complexity such as the patient's rib cage and potentially prohibitive obesity, limiting the use of ultrasound guidance to achieve access. Vulev et al[10] reported a case of a type II endoleak after left hemiarch debranching and TEVAR for a ruptured 8.5-

cm aorta subclavian aneurysm with pseudocoarctation of the arch just distal to the left common carotid artery. The LSA was also ligated in their case. They performed ultrasound-guided percutaneous access of the LIMA with subsequent successful embolization of the LSA stump using Onyx glue (Medtronic, Minneapolis, MN) and detachable coils.

CONCLUSIONS

An RSAAA and associated KD of an aberrant LSA is a rare occurrence. Our patient had presented with rupture that was successfully managed with total arch replacement, elephant trunk, and TEVAR. This hybrid procedure has led to major improvements in the management of such complex cases but also has the potential to lead to the development of challenging endoleaks. The present case has illustrated the successful use of the LIMA as an alternative percutaneous access for embolization of the LSA for patients with type II endoleaks and limited access options.

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