Performance of Chimney Grafts in Aortic Arch Pathologies

Lessons from the PERICLES study and considerations on potential utility.

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Historically, the gold standard for repairing proximal descending and transverse aortic arch disease is open surgical repair,[1] but outcomes of mixed hemiarch and total arch repair with elephant trunk or frozen elephant trunk have variable elective morbidity (15%–40%) and mortality rates (6%–22%).[2,3] Due to variable pathologies, presentations, and the complexity of these procedures, it is difficult to characterize the degree to which each of multiple factors drive outcomes in these series.[4] With improvements in operative technique and perioperative care, contemporary results show that 30-day mortality for patients undergoing open thoracic aortic repair ranges between 2% to 20%.[5]

One alternative approach that may reduce the risks of complex proximal aortic reconstruction is fenestrated/branched thoracic endovascular aortic repair (TEVAR).[6] However, at this time, dedicated devices for these anatomies are not widely available nor universally suitable to all variants, and they require specialized operator skillsets. These limitations further suggest a role for chimney endografting as a reasonable alternative option for more widespread use in patients deemed unfit for open repair.[7,8]

The chimney technique, which simultaneously covers thoracic aortic lesions and reconstructs the supra-aortic branches, is an increasingly applied alternative (Figure 1). The technique was first used in the endovascular treatment of abdominal aortic aneurysm as a bail-out approach in case of inadvertent coverage of aortic side branches. Later, the creation of a chimney/snorkel configuration was suggested as an alternative therapeutic modality extending the sealing zone in short-neck aortic aneurysms via placement of covered stents outside and parallel to thoracic and abdominal devices.

PUBLISHED EXPERIENCE: CHIMNEY GRAFTS IN THE AORTIC ARCH

In 2013, Hogendoorn et al and Moulakakis et al published reviews of previously reported studies involving the chimney technique in the aortic arch.[9,10] Both reviews agreed on the feasibility of TEVAR using chimneys due to its lower mortality compared with open and hybrid repair, while also calling attention to endoleaks and stroke risk. Both studies analyzed the existing literature including published reports of patient series comprising usually no more than 10 cases. Other limitations include incomplete data in terms of technical information, with key procedural details such as the type of chimney graft lacking, and poor follow-up observed.

PERICLES EXPERIENCE

To overcome the existing literature limitations, the PERICLES group collected the first multicenter experi-

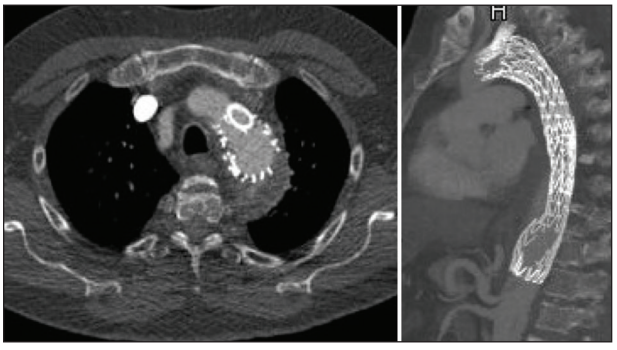

Figure 1. Thoracic chimney in the LSA using a 13-mm Viabahn (Gore & Associates) as a chimney stent lining with a bare-metal stent and TEVAR using a Conformable TAG device (Gore & Associates).

ence regarding the utility of the chimney technique in pathologies of the aortic arch.[11]

Population

In this registry, data from 95 patients undergoing endovascular treatment of aortic arch conditions at four European centers were collected. Patients with degenerative aneurysms with diameters > 55 mm, type B aortic dissections, penetrating aortic ulcers, and type I endoleak after previous repair were included. Thirty enrolled patients had a neck length of 0 mm; otherwise, the mean neck length was 6.9 ± 4.9 mm.

Periprocedural Results

In total, 102 chimney stents of varying types were placed: 61 self-expanding covered stents (SECS), 29 balloon-expandable covered stents (BECS), and 12 bare-metal stents. Postprocedure neck lengths were observed to be 26.5 ± 7.4 mm. Although type Ia endoleaks were observed on completion angiography in 10 patients, all chimney grafts were placed as intended and were patent on final angiography.

Follow-Up Outcomes

Primary chimney graft patency was observed in 98% of patients, although the two occlusions—both SECS in the left subclavian artery (LSA)—were asymptomatic and the patients were receiving warfarin at the time. Both were successfully resolved using thrombectomy/recanalization, with no determination of the underlying cause.

At 30-day follow-up, stroke was reported in four patients, two of whom died of major stroke and two who experienced minor strokes that spontaneously resolved. One of the cases involving fatal stroke had three separate chimneys placed in order to preserve all arch branches.

Half of the 10 reported type Ia endoleaks spontaneously resolved within the first 30 postprocedural days. Revisions in the other five cases included successful coil embolization, arch debranching bypass with proximal extension, and observation/no reintervention (low-flow endoleak with transient paraparesis). Two patients experiencing endoleaks died of multiorgan and heart failure.

Long-term data have been published for PERICLES patients out to 5 years. These include rates of freedom from reintervention of 96.5% at 1 year, 93.6% at 2 years, and 88.6% at 5 years. Reasons for chimney-related reintervention included occlusion (two patients), high-grade in-stent restenosis (two patients), and LSA BECS chimney-related endoleak (one patient).

The results of PERICLES indicate that combinations of suitably sized stent grafts and SECS or BECS arch vessel chimneys seem to work well, with suitable interaction of the device components as they combine to minimize gutter formation.

DISCUSSION

The satisfactory results we encountered seem to support wider applicability of the chimney technique, particularly in urgent cases where the utility of such a strategy is undeniable. Gutter-related type I endoleaks and risk of embolic stroke related to upper extremity arterial access remain major issues. The majority of the type Ia endoleaks spontaneously resolved within the first 30 days, and only a limited number of patients underwent a secondary procedure for treatment of a persistent type I endoleak. However, a variety of thoracic branch stent graft devices were used, and it is therefore still not possible to perform comparisons of the platforms or provide specific recommendations regarding device combinations.

Following the experience of our group, achievement of at least 2 to 3 cm of new sealing zone is pursued in most instances, with special emphasis in degenerative aneurysm cases. In general, 10% chimney stent and 30% thoracic stent graft oversizing is attempted except in acute dissection where oversizing is typically minimized to 10%. Our threshold for internal chimney graft reinforcement is low because the device-to-device and device-to-vessel interaction may lead to extrinsic compression and final occlusion of the stent grafts. Finally, the cerebrovascular events that may occur, although common for any surgery involving the aortic arch,[12,13] raise concern and the need for caution. The use of embolic protection devices has been recommended, although further investigation is still warranted.[14,15]

CONCLUSION

The significant increase in neck length afforded by chimney graft placement has enabled successful endograft fixation and seal. In this context, combinations of a suitably sized thoracic aortic stent graft with arch branch chimneys using SECS and BECS seem to perform favorably. However, there is a need for further evaluation and testing to improve the conformability and interactions of the devices and minimize the risk of persistent gutter formation associated with type Ia endoleaks. ■

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