Debate: Arch Debranching Is Best

Without sufficient long-term data on the use of chimney or branched grafts, arch debranching is the preferred treatment modality.

BY STEPHEN W. K. CHENG, MD

The best treatment strategy for aortic arch aneurysms is still being debated. Aside from best medical therapy, there are four main surgical options: open repair, hybrid aortic debranching and thoracic endovascular aortic repair (TEVAR), fenestrated or branched endografts, and TEVAR with chimneys or snorkels. Success must be judged not only by perioperative mortality and complications, but also long-term supra-aortic branch patency, endoleak rates, reinterventions, and changes in aneurysm diameter. Anatomical feasibility is also an important consideration when choosing among treatment modalities.

TEVAR has provided a minimally invasive option for treating arch pathology. The major challenge of TEVAR in the arch is to optimize the proximal landing zone while preserving the supra-aortic branches. Due to the proximity of the origin of the three major arch vessels, the majority of cases do not offer a 2-cm healthy aortic segment as a landing zone unless the endograft is extended into zone 0.

Currently, no randomized or comparative studies of hybrid debranching and chimney procedures have been published. Many reports in the literature were small experiences with no clear definition of the pathology. The preference of one over the other is largely governed by the surgeon's skills, preference, and assessment of durability.

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OPEN ARCH REPAIR

Traditional open repair of an aortic arch aneurysm involves a median sternotomy, cardiopulmonary bypass, and hypothermic cardiac arrest. Even with the use of retrograde or antegrade cerebral perfusion, the operation still incurs significant risks of death, myocardial injury, and stroke. Most patients with arch aneurysms are elderly, and many will be deemed unfit for open surgical reconstruction. In addition, a substantial subset of patients with aortic arch aneurysms has chronic dissection disease with residual arch degeneration after previous open ascending aortic repair or a Bentall procedure. The added risk of a "redo" sternotomy in these patients is another reason that they were turned down for open repair.

ARCH DEBRANCHING

Introduced as early as the mid-2000s, arch debranching eliminates the need for cardiopulmonary bypass and hypothermia. Debranching of supra-aortic vessels using various bypass methods is well within vascular surgeons' skill set. In most centers, a left carotid-subclavian bypass or transposition can be effectively and safely performed with a single supraclavicular incision. Even a carotid-carotid bypass, whether through a subcutaneous or retropharyngeal route, adds little morbidity and should not be a deterrent when the landing zone is in question.

A recent publication of 104 consecutive patients with elective debranching and TEVAR included 19 patients with zone 0 disease requiring total debranching.[1] The 30-day death, stroke, and spinal ischemia rates were 5.7%, 3.8%, and 2.9%, respectively. There were, however, four retrograde dissections, two of which were fatal. At 1, 3, and 5 years, the survival rates were 89%, 83%, and 71%,

and freedom from endoleak was 96%, 93%, and 88%. There was a low rate of late aortic-related deaths and reinterventions, and the results compare very favorably to surgery.

Most current TEVAR devices do not perform well in terms of accuracy of deployment in the arch, and conformance to the arch anatomy is also an issue. Many of the early unsatisfactory results of TEVAR regarding type I endoleaks were due to landing zone compromises in order to avoid landing in zones 0 or 1. Total arch debranching allows the most secure proximal landing zone. We have previously shown that this can be performed with minimum morbidity and mortality.[2] In selected cases, this may even be combined with a banding procedure in patients with dilated ascending aortas,[3] or for external suturing and added strength of the proximal seal. Another advantage was the possibility of inline left subclavian revascularization in selected cases and the allowance of antegrade deployment of stent grafts to avoid tight angulations in the aorta or poor access vessels from below.

The majority of true arch aneurysms has no secure landing zone in zones 1 or 2, and the efficacy of supra-aortic branch preservation procedures should be assessed only when the left common carotid artery is involved. A review of 18 studies comprising 195 patients undergoing supra-aortic debranching, but excluding all carotid-subclavian bypasses, reported a 9% incidence of endoleak and perioperative mortality and stroke rates of 9% and 7%, respectively.[4] Although the morbidity rates were not insignificant, 122 procedures (63%) were true arch procedures with zone 0 landing. This is therefore a highly selected cohort reflecting the true nature of the difficulty in treating complex arch pathology and should not be compared with a simple chimney procedure in the left subclavian artery.

CHIMNEYS AND SNORKELS IN THE ARCH

The use of chimney or parallel grafts originated from a salvage procedure when the arch vessels were unintentionally covered. This technique has not gained widespread popularity in the arch. The main advantages are freedom from aortic clamping and the simplicity of using chimney grafts. Like its abdominal counterparts, the use of the chimney technique, in particular with multiple chimney grafts, has been criticized for the possibility of gutter endoleaks, stent compression, possible device interaction, and uncertain long-term durability.

A recent review of the chimney procedure (also called the *snorkel technique*) in supra-aortic branches identified 18 reports comprising 124 patients and 136 chimneys. The investigators reported a high primary success rate of more than 99%, with a mortality rate of 4.8% and a stroke rate of 4%.[5] A large number of different bare or covered stents were used. However, the overall endoleak rate was 18.5%, with 10.5% being type I endoleaks. Median follow-up was only 11 months, albeit with no graft occlusions. Of particular note was that the average number of chimney grafts per patient was only 1.1, and only 18% were placed in the innominate artery (44% in the left common carotid and 38% in the left subclavian). Only 28 patients (26%) had a degenerative aneurysm, most likely in the distal arch. The fact that a chimney can be safely and effectively placed does not automatically mean the procedure itself is effective. Almost 60% of procedures in this collective experience were in patients with aortic dissections, in whom revascularization of the innominate artery was not an issue, and the proximal landing zone nondegenerated.

Although most reported chimney procedures are confined to the left subclavian and the left common carotid arteries, the true need for a minimally invasive procedure is at landing zone 0, and yet chimneys have not provided a good answer in this area. The diameter of the innominate artery will pose an issue with seal, and the added distance of the second chimney means a longer graft and a higher chance of compression and occlusion.

Chimneys require an average of 20% to 30% oversizing of the endograft. Because most patients with arch aneurysms are elderly and have degenerations in the ascending aorta, the applicability of chimneys in the context of a dilated ascending aorta is questionable. Some reports indicate that gutter endoleaks increase with the size of the chimneys. Aggressive oversizing and ballooning in this area, as is recommended in most chimney procedures, may produce adverse results. The hemodynamic forces on the stent graft components in this area remain unknown, and there may be a theoretical higher chance of retrograde type A dissection.

The largest series that involves degenerating aneurysms with supra-aortic chimneys in the innominate and left common carotid arteries studied only six patients.[6] Furthermore, when the results were scrutinized in the accompanying commentary,[7] it appeared that four out of the six patients were either dead or had a significant type Ia leak at 6 months, and 50% required secondary intervention within 30 days. The chimney technique in arch aneurysms remains untested and should not be used as an acceptable treatment other than for salvage. It is likely that aortic branch devices will supersede this technique in the near future.

ARCH BRANCH DEVICES

The design of a one- or two-branched graft in the arch, combined with hybrid debranching, appears to be the ultimate solution to treat arch aneurysms. A recent published report of a global multicenter study of the Cook arched branch graft (Cook Medical) in 38 patients showed a technical success rate of 84% and a 30-day mortality rate of 13%.[8] These arch branched procedures were hampered by a relatively high incidence of stroke (15.8% in this series). With experience, the mortality was lowered to 7% in the latter part of the series. More significantly, an ascending aortic diameter of > 38 mm was found to be the main independent risk factor of mortality and neurologic complications, which would make this procedure contraindicated in patients with dilated ascending aortas. Until we have a better endovascular solution for treating a dilated ascending aorta, total debranching is still the only solution other than traditional open arch replacement.

CONCLUSION

Hybrid treatment of complex aortic disease remains a viable alternative to open surgery, especially for high-risk patients. The current results are acceptable, but carry some concerns of stroke. Until better long-term results can be provided with chimneys or branched grafts, debranching remains the procedure of choice, aside from best medical treatment. ■

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