It is without question that FET techniques will continue to be refined and outcomes optimized. The current report from the *Journal* highlights the remarkable results achieved at a national level with this complex procedure. That said, the future relevancy of this procedure is unclear. Understanding and acknowledging contemporary outcomes for complex arch replacement and FET will be critical as we examine outcomes from future aortic arch TEVAR trials. Within the next decade, we will be faced with the challenge of creating guidelines for open (hybrid) arch replacement versus entirely endovascular therapies with these novel branched devices. It is likely that this will follow a similar pattern to transcatheter aortic valve replacement, first used in high- and prohibitive-risk patients, and as technologies and experience evolve, their efficacy and utility assessed in lower-risk populations. With such dynamic evolution, collaborative interdisciplinary aortic surgical teams will need continue to expand and broaden their endovascular and open arch repair (including FET) expertise, to not overly narrow their focus on a "one-size-fits-all" approach but rather maintain discernment and flexibility to individualize and optimize outcomes and treatment of complex arch pathologies.

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Commentary: Elephant trunk: Straight-up or frozen?

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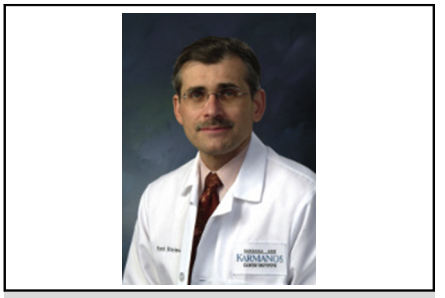

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CENTRAL MESSAGE

Both straight-up elephant trunk and frozen elephant trunk (FET) for arch replacement in acute and chronic type A aortic dissection and aortic arch aneurysm gave outstanding results. The increased incidence of paraplegia incidence with FET merits review.

A Japanese collaborative of 41 cardiac centers compared a group of patients undergoing arch replacement (AR) with standard or straight-up elephant trunk (SET) placed in the proximal descending thoracic aorta with a second group undergoing AR with a new J-graft Frozenix stent[1] positioned in the proximal descending aorta (frozen elephant trunk [FET]). The study reported by Ogino and colleagues[2] in this issue of the *Journal* included patients with both acute and chronic type A aortic dissection (AD), chronic type B AD with retrograde arch involvement, and aortic arch aneurysm (AA). The protocol allowed the participating institutions to select the recruited patients and use their method

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of repair, their cooling protocol, and their method of cerebral protection.

The study demonstrated outstanding results in both groups, with 30-day mortality, in-hospital mortality, incidence of cerebrovascular accident (CVA), and incidence of paraplegia of 0.3%, 0.6%, 2.2%, and 0%, respectively, for the SET group and 0.8%, 1.6%, 5.7%, and 1.6% for the FET group. Even when the groups were propensity-matched for the same end points, 0%, 0.6%, 1.2%, and 0% of outcomes, respectively, favored the SET group, compared with 0%, 1.2%, 4.1%, and 1.2% for the FET group. Previous studies[3-8] including patients with acute AD and AA have shown a 30-day mortality of 2.4%-32.0%, an CVA incidence of 4.8%-16.0%, and a paraplegia rate of 2.9%-4.0% in SET recipients, compared with a 30-day mortality of 1.4%-20.0%, CVA rate of 6.3%-15%, and paraplegia rate of 4.8%-21.7%.

The better than expected results in this report may be related to the relatively few patients with acute type A AD having malperfusion syndrome (12.3%). The requirement for informed consent including use of the recently released J-graft Frozenix stent likely selected for more stable "urgent or emergency" patients. The cardiac surgery centers included were major cardiac sites, so a significant number of patients may have been transported from outlying institutions, which also would select for a better-risk patient population. The inclusion of 72 chronic dissections in the FET group and 31 subacute/chronic dissections in the SET group also would favor better outcomes. Finally, incomplete data collection for 65 patients required removal of 17 patients with acute AD and 43 with AA (presumably the other 5 were chronic AD or type B AD) from the dataset, which might have affected the results.

How do we reconcile the increased paraplegia and stroke rate in the FET group? One explanation for the increased paraplegia was that not only were there more patients with acute AD in the FET group, but also 72 additional patients with chronic type A AD or chronic type B AD with arch aneurysms were mixed in. Second, the graft length was likely longer for FET compared with SET, possibly obstructing the flow to more intercostal arteries supplying the spinal cord. Moreover, the occlusive nature of the entire length of the FET graft compromises more intercostals than the SET graft, which is suspended in the descending thoracic aorta.

The increased rate of paraplegia associated with the use of FET is usually balanced by the relative ease of stenting the aneurysmal or dissected descending thoracic aorta in the second part of the repair. With SET, endovascular stenting is more difficult, and thoracotomy may be required to complete the 2-stage intervention.

If retrograde femoral perfusion were the primary aortic perfusion technique for the AD procedures or was used temporarily after the FET or SET was deployed (before antegrade aortic perfusion via the replaced aortic arch), this might increase the paraplegia rate.

The higher CVA in the FET group is likely secondary to the greater incidence of acute type A AD and chronic/subacute dissections compared with the SET group and the emergency status of 44.2% in this group versus 29.2% for the SET group.

The report mentions that only a "majority" in each group received antegrade cerebral perfusion. It states that if the patient received retrograde cerebral perfusion, arch reconstruction was performed first. How did earlier reconstruction of cerebral blood flow in the retrograde perfusion group versus longer antegrade cerebral protection affect the CVA rate? Digging out the 41 institutions' cooling protocols for cerebral protection and their cerebral perfusion technique might explain the increased CVA rate in the FET cohort. The longer cross-clamp and bypass times for the FET group also might have contributed to the increased CVA rate.

The study's excellent outcomes were surprising, with 19% of patients in the FET group and 13.9% in the SET group labeled as having "bleeding." In this study, bleeding was defined as >5000 mL of blood or >40 units of blood platelets transfused.

This multicenter, nonrandomized study begs a more careful comparison of SET and FET in more precisely matched acute and chronic type A AD, and AA groups. FET appears to be associated with a higher incidence of paraplegia in this and other studies. Determination of FET length, use of spinal drains, and indications for FET have yet to be resolved. The decision to deploy either SET or FET remains the purview of the operating surgeon.

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