“The reports of my death have been greatly exaggerated”: The appraisal of apicoaortic conduit in the transcatheter aortic valve replacement era

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Patients with aortic stenosis who would be at high or extreme risk if undergoing surgical aortic valve replacement (SAVR) are treated with transcatheter aortic valve replacement (TAVR). Surgical risk determination is based on physiologic and anatomic features. Physiologic features, reflected in the Society of Thoracic Surgeons predicted risk of operative mortality and frailty indices, are mostly driven by age, comorbidities, organ dysfunction, and frailty.¹ Anatomic features that preclude the safe performance of median sternotomy, aortic cannulation, crossclamp, or aortotomy are among others thoracic artery graft behind the sternum, porcelain aorta, previous radiation, mediastinitis or muscle flaps, and multiple sternotomies.² Before TAVR, patients with anatomic contraindications to SAVR were considered for an apicoaortic conduit (AAC), also known as aortic valve bypass.³ Although most such patients are now treated with TAVR, there is still a role for AAC for selected patients with a combination of anatomic contraindications to both TAVR and SAVR. Thus, to paraphrase Mark Twain, the reports of the death of the AAC are greatly exaggerated. For example, an AAC should be considered in patients who (1) do not qualify for TAVR because of risk of coronary occlusion, annular rupture, or perivalvular leak; and (2) have anatomic features that preclude SAVR. AAC placement is not an inconsequential operation, associated as it is with higher morbidity and mortality than either TAVR or SAVR, but it may be the only option in those selected patients. As such, I do not advocate for the performance of AAC in patients who are deemed high risk for physiologic reasons.

In this issue of the *Journal*, Mantini and colleagues⁴ present their experience with the performance of AAC and the evaluation of aortic and cerebral blood flows at rest. Several lessons can be learned from this article:

1. It is possible to perform this procedure without cardiopulmonary bypass by using a special coring device and apical connector. Similar techniques have been used

Apicoaortic conduit technique.

Central Message

Apicoaortic conduit placement is useful in patients with anatomic contraindications to both transcatheter and surgical aortic valve replacement, and it is associated with a unique hemodynamic profile.

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for the off-pump insertion of left ventricular assist devices.⁵ Many surgeons, however, prefer to insert the AAC on pump, without aortic crossclamping, with the heart fibrillating, and without the use of the apical connector (Figure 1).³

2. There is a double outlet to the left ventricle: 60% to 70% of the stroke volume exits the heart through the AAC, while 30% to 40% exits through the native aortic valve.
3. There is a bimodal distribution of flow in the aorta: the flow to the ascending aorta and arch vessels (myocardium, brain, and upper extremities) is provided by the still stenotic native aortic valve, while the flow to the lower extremities and abdominal viscera is provided by the AAC. Less than 10% of the flow through the AAC flows retrograde into the proximal descending aorta above the level of conduit insertion.
4. After the insertion of AAC, cerebral blood flow at rest is similar to preoperative cerebral blood flow and depends on adequate output through the native aortic valve.
5. After the insertion of the AAC, flow across the native aortic valve decreases with the consequent decrease in the peak aortic velocity. The severity of the native aortic valve stenosis not only is unchanged but likely will progress with time, leading to compromise of flow in the ascending aorta and arch vessels.

FIGURE 1. Apicoaortic conduit technique: The aortic anastomosis is constructed first. The ventricular anastomosis is then performed with large pledgeted sutures to ensure hemostasis. An apical connector is not used. The conduit valve is located as close as possible to the left ventricular apex. Finally, the ends of the conduits are anastomosed together.

The measurements in the report of Mantini and colleagues⁴ were performed at rest. Several conditions, such as exercise, progression of native aortic valve stenosis, and decreased left ventricular ejection fraction, may alter the contribution of each outlet to the total stroke volume and the distribution of flow in the aorta.⁶⁻⁹ For example, during exercise, coronary and systemic vasodilation leads to increased flow demand in the myocardium and lower extremities. Although the output through the AAC will likely increase to provide more flow to the lower extremities, the output through the stenotic aortic valve may not do so, potentially generating myocardial and brain hypoperfusion, unless retrograde flow through the descending aorta into the arch and ascending aorta

increases. Progression of the native aortic valve stenosis and worsening of left ventricular function will likely have similar effects, with decreased contribution of the native aortic valve flow to the total stroke volume and increased retrograde flow into the ascending aorta and arch. Flow disturbances have also been described after TAVR and SAVR, but both provide a single source of aortic flow, with the ability to increase cardiac output in response to increased demands. Although TAVR and SAVR improve exercise tolerance,^{10,11} the physiologic limitations associated with a double ventricular outlet and a bimodal aortic flow distribution may limit functional recovery in AAC.

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