

Alternative Access Options for TEVAR

Summary and review of current access methods for thoracic endovascular aneurysm repair.

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Owing to its decreased morbidity and quicker recovery, thoracic endovascular aneurysm repair (TEVAR) has become the treatment of choice for thoracic aortic pathology (aneurysm, dissection, penetrating ulcer, transection). Although the future holds the promise of lower-profile devices, there will always be the need for alternative access methods to treat patients with prohibitive or challenging anatomy. Currently, 9% to 21% of patients undergoing TEVAR require an alternative access option. In cases with challenging access, the correct site for alternative access will vary based on the anatomy, the device used, as well as the region of the aorta to be treated. The currently available devices have an outer diameter (OD) of 24 to 25 F, and some require a sheath, which results in an OD of 26 to 27 F. Currently available low-profile devices include the new Zenith Alpha device (Cook Medical), which has a 16- to 20-F (inner diameter [ID]) delivery system that can be delivered through a 6- to 7.7-mm vessel and treats an aorta with a diameter of 15 to 42 mm. The RelayPro next-generation thoracic device (Bolton Medical, Inc.) has reduced dimensions by 4 F across its portfolio, making the OD 19 to 22 F. This is currently under investigation in the United States. The Valiant Evo low-profile thoracic stent (Medtronic) is also being studied in a trial that started in the United States in May 2016. The Valiant Evo device has an 18- to 20-F OD for most proximal size configurations. Similar low-profile devices are expected from Gore & Associates as well.

In this article, we explore and review the current status of alternative access methods (ie, anything other than access via the common femoral artery), including transiliac, endoconduits, balloon-expandable sheaths, transaxillary, transcarotid, transapical, transcaval, and direct aortic access methods.

TRANSILIAC

In the majority of cases where alternative access is required, the common iliac artery is usually adequately sized to accommodate the required device. The common iliac artery can readily be accessed via a supra-inguinal oblique incision through the external and internal oblique muscles and into the retroperitoneum. Care is taken to identify the ureter, and the peritoneal contents are swept medially. Once the iliac has been identified, circumferential control is not necessary and can lead to venous injury. Adequate exposure is required for clamping, if necessary, and the artery can be accessed by either placing circumferential 4-0 Prolene purse-string sutures or sewing a 10-mm conduit onto the iliac. Direct puncture has the benefit of avoiding the use of prosthetic graft material and is quicker. A counter incision in the skin is also often helpful to ensure a proper delivery angle. Upon removal of the device, the purse-string sutures are secured, and in most cases, a clamp is not required.

In a comparative analysis of retroperitoneal open iliac conduit versus transfemoral access for TEVAR, a single-center trial retrospectively evaluating 133 patients did not demonstrate a significant difference in technical outcomes and 30-day mortality between the two groups.¹ However, in a 2015 article using a multivariate-matched comparison of patients who underwent EVAR and received an iliac conduit or direct access versus those who did not, the iliac conduit/direct access group had higher perioperative mortality, as well as cardiac, pulmonary, and bleeding complications.² In addition, data from the American College of Surgeons National Surgical Quality Improvement Program database demonstrated that the use of conduits is independently associated with increased mortality and bleeding.³

Retroperitoneal access may be associated with increased morbidity and mortality as well. This should factor into decisions of alternative access and the risk/benefit equation when selecting the access route. Undoubtedly, it will often still be the preferred choice, but the increased risks, as well as other options discussed later, should be considered.

ENDOCONDUITS

Endoconduits consist of balloon fracturing of the iliac plaque using a noncompliant balloon in an already placed covered stent to rupture the plaque and artery in a controlled fashion, thereby enlarging the flow lumen and allowing access. Once deployed and dilated, the covered stent then serves as the conduit through which the stent graft is delivered. In a study of 39 patients receiving either an open iliac conduit (23 patients) or an endoconduit (16 patients), those who received an endoconduit had a lower incidence of iliofemoral complications (26.1% vs 12.5%) at a mean follow-up of 10.1 months.⁴ In this study, the ipsilateral hypogastric artery was covered 37.5% of the time. Although not a definitive comparison, the use of an endoconduit appears to be a reasonable option and should be considered.

BALLOON-EXPANDABLE SHEATHS

Balloon-expandable sheaths offer the advantage of a small OD upon insertion with controlled balloon expansion and fracture/angioplasty to the required ID to accommodate the device. The SoloPath device (Terumo Interventional Systems) is currently the only available balloon-expandable sheath capable of accommodating TEVAR devices. The folded 15-F (5-mm vessel) device will expand to an ID of 24 F (8 mm) and an OD of 28.5 F (9.5 mm). Current published outcomes data are limited to use in transcatheter aortic valve replacement (TAVR). A 2015 propensity score–matched analysis assessing the ability of a balloon-expandable large-bore sheath to increase access site availability and reduce vascular complications in patients undergoing TAVR found no significant difference in 30-day and 1-year mortality, major vascular complications, or major bleeding in the cohort who received the SoloPath device compared to those in the standard sheath group.⁵

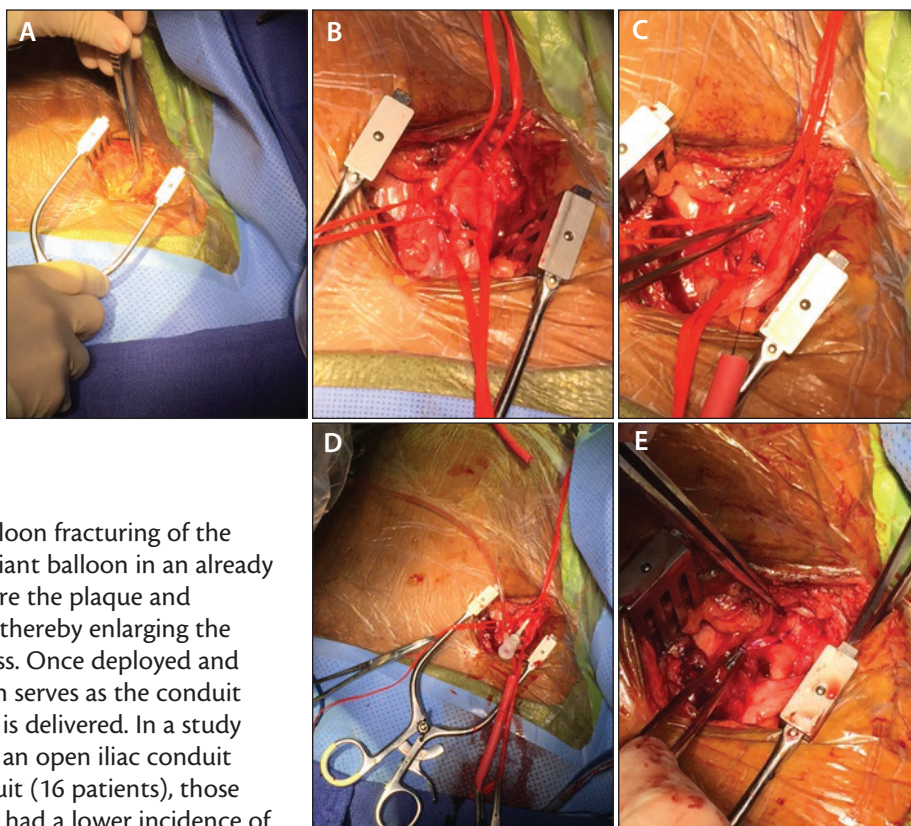


Figure 1. Transaxillary access showing exposure (A) and isolation (B) of the axillary artery, proposed site of puncture within purse-string sutures (C), a 5-F sheath in place (D), and after large sheath removal with purse-string sutures secured (E).

TRANSAXILLARY

An exposure familiar to all cardiac and vascular surgeons, the axillary artery is readily identifiable either in the deltopectoral groove (Figure 1) or with an infraclavicular approach. Sizing is similar to the femoral artery, with special attention paid to the tortuosity of the artery, ostial calcification, and type of arch. Similar to an iliac approach, the artery can be accessed by either direct stick or conduit. Coaxiality at the proximal landing zone when landing in the arch can be challenging and should be a consideration when evaluating this approach.

Extensive reported experience with this approach does not exist. A 2010 case series describing the use of the axillary artery in five patients with thoracic aortic disease showed that all patients underwent successful implantation without complications. Although there is a general paucity of data, the axillary artery is an attractive alternative in patients with contraindications to an iliofemoral approach.⁶ Anecdotally, this approach avoids entering

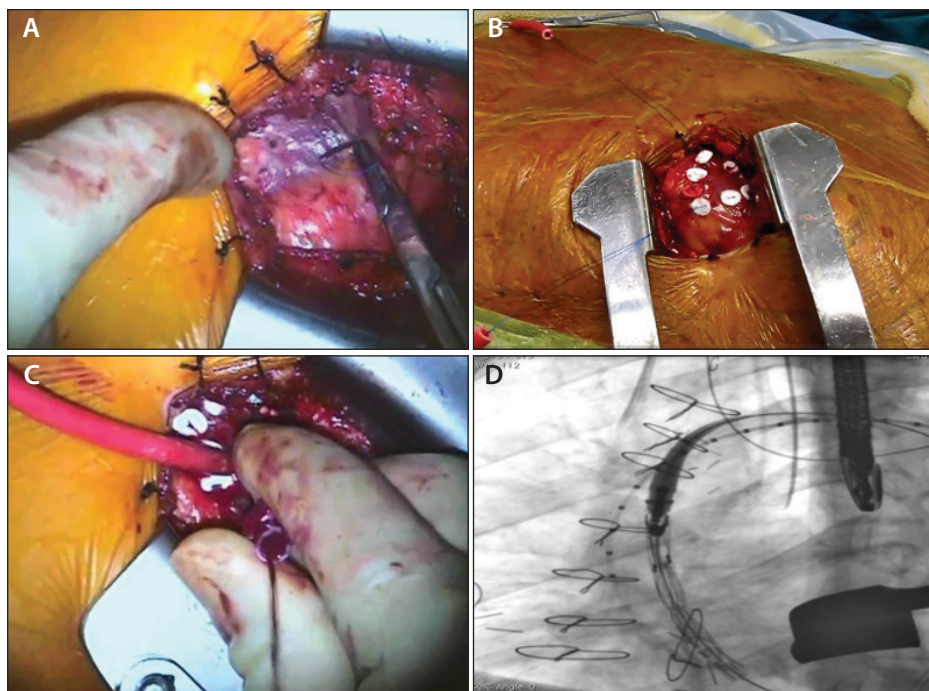


Figure 2. Left ventricular apex exposure (A), with sutures in place (B), needle access (C), and fluoroscopy showing antegrade advancement of the stent in the ascending aorta (D).

either the retroperitoneum or the chest, and in our TAVR experience, it has resulted in very rapid recovery and minimal morbidity.

TRANSCAROTID

Large-bore access for device delivery via the carotid artery has evolved into a robust alternative access option. Initially performed with shunts and patch repair or use of a conduit, the majority of transcarotid TAVRs are now done without shunting and via direct arterial stick. That being said, TEVAR may still require these adjuncts, as the devices still have a larger profile. In this approach, the common carotid artery is approached medial to the sternocleidomastoid, and it is critical to ensure that the vessel is free of disease.

There are currently no reported cases of transcarotid TEVAR. Much experience has already been gained using the transcarotid approach for TAVR, including a 2016 series of 96 patients that resulted in no major bleeds or vascular complications related to the access site, but an overall stroke/transient ischemia attack rate of 6.3%.⁷

TRANSAPICAL

Much has been learned about transapical access in the last several years as a result of TAVR. It has come to be recognized as an effective and reproducible

alternative access site, and in the last 5 years, it has begun to be adopted as an alternative access site for TEVAR as well. Transapical access can accommodate any sheath size because the left ventricle forms a straight, uncalfied, and large-bore entry site to both the aorta and the aortic valve. The apex is visualized under fluoroscopy, and an incision is typically made at the level of the inframammary fold, over the interspace that corresponds to the apex on fluoroscopy (Figure 2). Single-lung ventilation is not required, and once in the chest, the pericardium is identified and opened. Silk retention sutures are

used to create optimal exposure. The apex (or the area of bare muscle toward the apex and lateral to the left anterior descending artery) is identified. In cases of significant epicardial fat or in a reoperative chest where significant adhesions exist, coronary angiography of the left anterior descending artery can be performed to confirm the location. Transesophageal echocardiography (TEE) is also helpful, and the desired access site can be confirmed with a poking finger visualized by TEE. Once the site is identified, two circumferential pledgeted sutures are placed around the access site, and the apex is accessed with a needle and wire. After deployment, the sheath is removed, and the purse-string sutures are secured to achieve hemostasis.

A 2009 case report utilized transapical left ventricular access to facilitate endovascular repair of a thoracic aortic aneurysm with minimal physiologic compromise.⁸ In another report, three patients with inaccessible peripheral vasculature were successfully treated with TEVAR through transapical access. This report emphasized the utility of a through-and-through guidewire, rapid pacing, and TEE guidance.⁹

Early experience indicates that the transapical approach is feasible in appropriate patients with careful planning and a thorough risk-benefit analysis. Although rare, potential complications include ventricular pseudoaneurysms and injury to cardiac struc-

tures.¹⁰ Assuming safe and reproducible techniques for stenting the ascending aorta are developed, transapical access will likely factor more prominently.

TRANSAORTIC

The aorta can be approached via a retroperitoneal, abdominal, thoracic, or sternal incision. Size is rarely an issue, except in cases of severe atherosclerotic disease. Access can be achieved via a conduit or direct stick. This approach is familiar to most cardiac surgeons, and in our practice, it is most commonly utilized in the context of aortic arch debranching and antegrade deployment of a stent into the aortic arch. Relative to other methods discussed, it is considered invasive.

There is a paucity of data on transaortic TEVAR. One case report from 2014 resulted in the successful implantation of a combined transaortic transcatheter valve and a thoracic endograft.¹¹ A 2016 article reports two successful cases of direct transaortic TEVAR. Stent grafts were delivered from the ascending aorta without external conduits. Final aortic angiography revealed satisfactory results in both patients who were without aortic complications at 2- and 5-year follow-up.¹²

TRANSCAVAL

Transcaval access involves transcatheter puncture of the abdominal aorta via the inferior vena cava. Standard access is achieved via the common femoral vein. A transjugular liver biopsy needle can then be used to access the aorta, and standard TEVAR is performed. Tract closure is then achieved using a nitinol occlusion device.

Successful use of the transcaval approach has primarily been demonstrated in TAVR.¹³ In a 2014 series, Greenbaum et al successfully used this technique to access and close the tract in 19 patients undergoing TAVR. There were no deaths related to caval-aortic access and no complications related to tract creation or closure. The first reported transcaval access for TEVAR was well tolerated without major complications.¹⁴ Although transcaval access is not commonly used in TEVAR, it may prove to be favorable in patients with certain anatomic features.

SUMMARY

TEVAR has clearly become the standard of care for most types of thoracic aortic pathologies. However, device size can still pose challenges from an access perspective. As device profiles continue to decrease, iliofemoral access will likely be less challenging. In the meantime, multiple alternative access routes are

available to deliver the devices. Alternatively, some of these routes may be more desirable even with lower-profile devices. ■

1. Etezadi V, Katzen BT, Benenati JF, et al. Retroperitoneal versus direct femoral artery approach for thoracic endovascular aortic repair access: a case-control study. *Ann Vasc Surg.* 2011;25:340-344.
2. Nzara R, Rybin D, Doros G, et al. Perioperative outcomes in patients requiring iliac conduits or direct access for endovascular abdominal aortic aneurysm repair. *Ann Vasc Surg.* 2015;29:1548-1553.
3. Tsilimparis N, Dayama A, Perez S, Ricotta J. Iliac conduits for endovascular repair of aortic pathologies. *Eur J Vasc Endovasc Surg.* 2013;45:443-448.
4. van Bogerijen GH, Williams DM, Eliason JL, et al. Alternative access techniques with thoracic endovascular aortic repair, open iliac conduit versus endoconduit technique. *J Vasc Surg.* 2014;60:1168-1176.
5. Sedaghat A, von Döbbele C, Sontag B, et al. Use of a balloon-expandable transfemoral sheath in a TAVI cohort with complex access site—a propensity score matched analysis. *EuroIntervention.* 2015;11:698-704.
6. Saadi E, Dussin L, Moura L, Machado A. The axillary artery—a new approach for endovascular treatment of thoracic aortic diseases. *Interact CardioVasc Surg.* 2010;11:617-619.
7. Mylotte D, Sudre A, Teiger E, et al. Transcatheter aortic valve replacement: feasibility and safety. *JACC: Cardiovasc Interv.* 2016;9:472-480.
8. MacDonald S, Cheung A, Sidhu R, et al. Endovascular aortic aneurysm repair via the left ventricular apex of a beating heart. *J Vasc Surg.* 2009;49:759-762.
9. Saouti N, Vos J, van de Heuvel D, et al. Thoracic aorta stent grafting through transapical access. *Ann Vasc Surg.* 2015;29:362.e5-362.e9.
10. Ramponi F, Stephen MS, Wilson MK, Valley MP. Think differently: transapical platform for TEVAR. *Ann Cardiothorac Surg.* 2012;1:412-416.
11. Komlo CM, Vallabhajosyula P, Bavaria JE, et al. Combined transaortic transcatheter valve replacement and thoracic endografting. *Ann Thorac Surg.* 2014;97:696-698.
12. Botta L, Giuseppe B, Fratto P, et al. Direct transaortic TEVAR: An alternative option for selected patients with unsuitable peripheral access. *Ann Thorac Surg.* 2016;102:e117-e119.
13. Greenbaum AB, O'Neil WW, Paone G, et al. Caval-aortic access to allow transcatheter aortic valve replacement in otherwise ineligible patients. *J Am Coll Cardiol.* 2014;63:2795-2804.
14. Uflacker A, Lim S, Ragosta M, et al. Transcaval aortic access for percutaneous thoracic aortic aneurysm repair: initial human experience. *J Vasc Interv Radiol.* 2015;26:1437-1441.

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