

Endovascular Thoracic Aortic Intervention

Notes for a successful repair in this challenging anatomy.

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ACCESS SITE

Femoral

Because of the large introducer sheath of the thoracic endograft, femoral artery cut-down is preferred. The right common femoral artery is chosen for endograft delivery if no significant occlusive disease is present.

Percutaneous access is established in the left or contralateral side for diagnostic angiographic purposes.

Iliac

If a preoperative imaging study reveals significant femoral artery occlusive disease, an

iliac artery conduit is performed using a 8-mm Dacron graft via a retroperitoneal incision. This prosthetic conduit is connected to the common iliac artery in an end-to-side fashion to allow introducer sheath insertion. At the completion of the thoracic endovascular aneurysm repair, the distal end of the iliac conduit graft is attached to the common femoral artery in an end-to-side fashion, thereby completing an iliofemoral bypass.

Brachial

We routinely establish a brachial artery access with a 5-F introducer sheath on the left arm for an isolated descending thoracic aneurysm procedure. If the left subclavian artery will be covered by the thoracic endograft, the right brachial artery access is used for thoracic aortography.

PHARMACOLOGY

IV heparin: 100 IU/kg bolus is administered initially when the introducer sheath is inserted. An additional 1,000 IU/h is given after the initial bolus administration. Maintain activated clotting time at >250 seconds.

DIAGNOSTIC DEVICES

Sheath Sizes

- 6-F introducer sheath for diagnostic angiography
- 20-F or 24-F Check-Flo introducer set (Cook Medical,

Bloomington, IN). The size of the introducer depends on the endograft size.

- 20-F to 24-F Gore introducer sheath (Gore & Associates, Flagstaff, AZ) if the Gore TAG endograft (Gore & Associates) device is used.

Guidewires

- .035-inch X 260-cm TFE-coated Lunderquist extra-stiff double-curved guidewire (Cook Medical) is the author's preferred guidewire for endograft delivery.
- .035-inch X 260-cm Amplatz Extra Stiff guidewire (Cook Medical).

Diagnostic Catheter for Thoracic Aortography

A 5-F to 6-F pigtail catheter is placed in the contralateral femoral artery and/or left brachial artery for thoracic aortography. If the left subclavian artery will be covered by the thoracic endograft, the right brachial artery access is used for thoracic aortography.

BALLOONS

The Tri-Lobe balloon catheter (Gore & Associates) requires a 20-F introducer sheath. This balloon is used to dilate the thoracic endograft after device deployment while maintaining partial aortic antegrade flow during balloon inflation. The inflation diameter of this compliant balloon is dependent on the volume given.

THORACIC ENDOGRAFT DEVICES

The Gore TAG Endoprosthesis

The Gore TAG Endoprosthesis is currently the only tho-



Figure 1. The Gore TAG endoprosthesis.

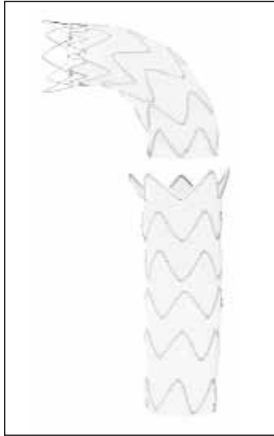


Figure 2. The Medtronic Talent stent graft system (Medtronic CardioVascular, Santa Rosa, CA) consists of two components. The proximal stent graft device is a straight tubular endograft with proximal FreeFlo bare stent configuration. The distal stent graft component is a tapered tubular endograft with an open-web proximal configuration and closed-web distal configuration.

racic device approved by the FDA for thoracic aortic aneurysm application. A variety of device diameters are available, ranging from 26, 28, 31, 34, 37, and 40 mm. Three device lengths are available, ranging from 10, 15, and 20 cm. The Gore TAG endoprosthesis is composed of an ePTFE tube externally reinforced with a layer of ePTFE/fluorinated ethylene propylene (FEP). An exoskeleton consisting of nitinol stents is attached to the entire external surface of the graft with ePTFE/FEP bonding tape. Both proximal and distal segments of the endograft have scalloped flares that facilitate endograft conformity in a tortuous thoracic aorta. (Figure 1).

The Talent Thoracic Device

The Talent Thoracic device is composed of a self-expanding serpentine-shaped nitinol endoskeleton inlaid in a woven polyester graft. The proximal end of this stent graft is made in two configurations, which include either a serrated (open-web configuration) or an open bare-stent segment (FreeFlo configuration). The Talent's delivery systems have profiles between 22 and 25 F. The Talent system consists of two device components. The proximal device is available in diameters of 22 to 46 mm in 2-mm increments. Covered lengths of the proximal device range from 112 mm (largest diameters) to 116 mm (smallest diameters). In contrast, the distal Talent device is a tapered-tube endograft system with a 4-mm difference in diameter between the proximal and distal orifices. The proximal orifice of the distal Talent device has an open-web configuration, whereas the distal orifice of the



Figure 4. The Zenith TX2 endograft system (Cook Medical) is designed as a two-piece modular endograft system for thoracic aneurysm treatment.

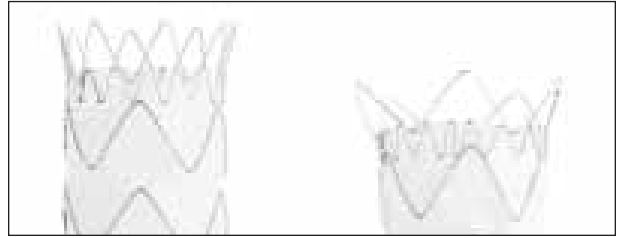


Figure 3. The Valiant Stent Graft (Medtronic) has a modified proximal FreeFlo configuration with eight bare-peak wires (left) compared to the five bare-peak wires found in the Talent stent graft (right).

same component has a closed-web configuration (Figure 2). The distal Talent device is available in diameters ranging from 22 to 44 mm in 2-mm increments. Covered lengths of the distal Talent endograft range from 110 mm (largest diameters) to 114 mm (smallest diameters). This device is currently undergoing a clinical trial for FDA approval.

The Valiant Thoracic Device

The Valiant Thoracic stent graft represents a modified version of the Talent thoracic endograft device and features a more flexible shaft compared to the Talent device, which facilitates the device deployment and implantation accuracy. The Valiant stent graft has a modified proximal FreeFlo configuration with eight bare-peak wires compared to the five bare-peak wires found in the Talent stent graft (Figure 3). This modification allows for the same radial force as the Talent system with less stent flare while distributing similar radial force across more points of contact with less force and stress per point of contact. The Valiant stent graft is available in lengths ranging from 100 to 227 mm, and its proximal neck diameters range from 24 to 46 mm with 2-mm increments. This device is currently undergoing a clinical trial for FDA approval.

The Zenith TX2 TAA Endovascular Device

The Zenith TX2 TAA endovascular device is designed as a two-piece modular system, although implantation of a single device may be sufficient for focal thoracic aortic lesions



Figure 5. The Zenith TX2 distal bare stent component (Cook Medical) is designed for the treatment of aortic dissections, and is used as a distal extension with the main Zenith TX2 component.



Figure 6. A glass model depicting the treatment strategy using the Zenith TX2 proximal component with the distal bare-stent component. Note how the bare stent can be deployed over the abdominal visceral vessels in the setting of aortic dissection or malperfusion syndrome.



Figure 7. The Relay thoracic stent graft system (Bolton Medical, Sunrise, FL).

(Figure 4). The Zenith TX2 endograft is constructed of Dacron fabric covered by stainless steel Z-stents. The proximal end is covered and has stainless steel barbs protruding through the graft fabric, which anchor the graft directly to the aortic wall.

The Zenith TX2 proximal component

is available in diameters ranging from 28 to 42 mm and lengths ranging from 12 to 21.6 cm. The Z-Trak delivery systems for the Zenith TX2 device have profiles of 20 to 22 F. The device is deployed by withdrawing an external sheath. The Zenith TX2 distal component has an uncovered bare-metal stent similar to the proximal end of the Zenith Abdominal Aortic Endovascular Graft for abdominal aortic aneurysms. This bare-stent configuration allows fixation of the device over the origins of the visceral vessels, which may be relatively less diseased, and the covered portion can extend to the origin of the celiac artery. The TX2 proximal component device diameters range from 28 to 42 mm, and lengths range from 12.7 to 20.7 cm. This device is currently undergoing a clinical trial for FDA approval.

The Zenith TX2 Dissection Endovascular Device

The Zenith TX2 Dissection endograft component is designed for use in conjunction with the Zenith TX2 covered stent in the setting of aortic dissection. This bare stent component is constructed of stacked Z-stents joined by polypropylene sutures, which can be deployed through a 16-F sheath and inserted through the existing Zenith TX2 proximal component sheath (Figure 5). A single stent diameter accommodates aortic luminal diameters ranging from 24 to 38 mm and is available in 82-, 123-, and 164-mm lengths. The Z-stents exert a minimal radial force that allows gradual opposition of the dissection septum and re-expansion of the true lumen. The large open-strut architecture allows maintenance of branch vessel perfusion so that the stent can be safely deployed across the origins of intercostal, visceral, and renal arteries. In the scenario of persistent malperfusion due to a dissection flap into or a re-entry tear near a vessel origin, the bare Z-stent component provides structural scaffolding for placement of a bare or covered peripheral stent from the true lumen into the branch vessel bridging across the false lumen (Figure 6). This device is currently undergoing a clinical trial for FDA approval.

The Relay Thoracic Stent Graft

The Relay device is composed of self-expanding nitinol stents that are sutured to a polyester fabric graft. The skeleton of the device is made up of a series of sinusoidal stents placed along the length of the graft fabric. To provide a longitudinal support for this device, a curved nitinol wire is attached to the outer curve of the endograft fabric by a series of sutures, which provides greater device flexibility. A series of radiopaque markers, composed of platinum and iridium, are attached to the endograft in various locations to enhance fluoroscopic visualization. The Relay device is available in various sizes and configurations, both tapered and nontapered (Figure 7). Graft lengths up to 200 mm are available, with diameters from 22 to 46 mm. The profile of the primary introducer sheath ranges from 22 to 26 F, depending on graft diameter and length. This device is currently undergoing a clinical trial for FDA approval.

Tips & Tricks

Thoracic Endografting

Procedural planning, technical considerations, and periprocedural preferences.

PREOPERATIVE IMAGING AND DEVICE SIZING

Appropriate device sizing and careful preoperative imaging evaluation largely influence the success of a thoracic aortic endovascular procedure. We prefer to evalu-

ate the aortic anatomy and determine device measurement using a dedicated three-dimensional workstation with center-path, orthogonal cross-sectional reconstructions (Aquarius 3D Workstation, TeraRecon, Inc., San

Mateo, CA). The diameter of the nonaneurysmal aorta is measured both proximally and distally over a length of at least 5 cm. The thoracic endograft is selected to allow for 15% to 20% oversizing of the aortic diameter. We choose the device length to allow sufficient distance for full coverage between the proximal and distal landing zones, including the intervening device-to-device overlapping coverage. The minimum distance of this device-to-device coverage is 5 cm. The common iliac and external iliac arteries are assessed in terms of their size and quality, with particular attention paid to the degree of calcifications and tortuosity. An iliac artery conduit is performed if significant femoral artery occlusive disease is noted on the preoperative imaging study.

SPINAL DRAINAGE

We perform selective spinal drainage in the following clinical conditions: (1) patients with previous abdominal aortic aneurysm operation, either with open or endovascular approach; (2) patients with previous aortobifemoral bypass for aortoiliac artery occlusive disease; (3) patients with a history of spinal cord ischemia due to aortic operation; and (4) planned left subclavian artery coverage in patients with an absent or hypoplastic left vertebral artery.

VESSEL ACCESS FOR ENDOGRAFT DELIVERY

The choice of access vessel for the thoracic endograft delivery is determined by the size and caliber of the femoral or iliac arteries. If the femoral artery does not have significant calcification and contains an outer luminal diameter of 10 mm, it becomes the access vessel for endograft delivery. When bilateral access vessels are equivalent in diameter, we prefer to access the right groin via a cutdown to accommodate introducer sheath insertion. When there is a doubt regarding the accessibility of a femoral artery, we prefer to test the vessel integrity using the Coons dilator (Cook Medical), which is an over-the-wire hydrophilic dilator available in a set of 22 and 24 F. If probing with a 22-F Coons dilator in the femoral artery is met with significant resistance, do not attempt to insert a 22- or 24-F endograft device because it will likely cause significant vessel trauma including iliofemoral artery rupture. An iliac artery conduit should be created under this circumstance to facilitate device delivery.

THORACIC ENDOGRAFTING PROCEDURE

Technical maneuvering in thoracic device deployment is a device-specific subject, which is beyond the scope of this discussion. Precise deployment of a thoracic device with preservation of critical aortic branch vessels is essential. Some physicians have advocated that intentional hypotension or transient asystole may facilitate the device deployment. We have not found that pharmacological induction of hypotension or asystole to be

particularly useful during device deployment. However, during the time of balloon inflation to enhance device fixation, transient hypotension is useful to reduce the cardiac afterload, particularly in patients with compromised cardiac function.

Thoracic Device Fixation

Selecting the appropriate aortic landing zone in both the proximal and distal segments is an incontrovertible prerequisite for the thoracic endografting procedure. The minimum distance is 2 cm of normal or nonaneurysmal aorta, but 3 cm of landing zone is generally preferred. Appropriate device oversizing relative to the aorta is device specific. Generally, an oversize of 15% to 20% of thoracic endograft to the aorta is recommended. One must be cautioned regarding significant device oversize in traumatic aortic injury, because significant device-related complications such as collapse, migration, or infolding have been reported. Device selection for the treatment of acute dissection, however, should be based on proximal aortic diameters, with minimal or no device oversizing. It is noteworthy that an increase in the device fixation length as well as the degree of device oversizing should correspond with an increase in the thoracic aortic diameter at the proximal and distal landing zones. If insufficient proximal or distal aortic landing zone is encountered, bypass grafting of the subclavian or celiac artery can be performed to increase the device fixation neck length. If multiple endograft devices are necessary to cover the thoracic aneurysm, it is critical to maintain the sufficient device overlapping distance of at least 5 cm because this will reduce the risk of device disconnection in the event of aneurysm remodeling. Lastly, when a thoracic device is implanted within another thoracic component, an oversizing of the inner component of 2 to 4 mm relative to the outer component should be considered. The precise degree of device overlapping relative to each other, however, should be based on the device-specific recommendation. ■

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