Masters of Cardiothoracic Surgery

Thoracoabdominal aortic aneurysm: a totally endovascular approach with a branched stent-graft

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This video depicts a step-by-step description of a totally endovascular approach to treat a patient with thoracoabdominal aneurysm, using a branched stent-graft system. We compare the pre and post-operative computerized tomography and show 3D illustrations and real-life images of the technique.

Key Words: Thoracoabdominal aortic aneurysm; endovascular approach; branched stent-graft

Submitted Jul 20, 2012. Accepted for publication Aug 21, 2012.
DOI: 10.3978/j.issn.2225-319X.2012.08.12
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Introduction

In this video, we visualize a 3D reconstruction and the simultaneous axial slices of the computerized tomography (CT) scan, depicting a patient with a type III thoracoabdominal aneurysm, with extensive involvement of the visceral arteries (*Video 1*). As an added challenge, the right renal artery has an early bifurcation. We have created a parallel between the virtual and the real surgical procedure, which can be followed in a step-by-step manner. We demonstrate a totally endovascular approach to treat the thoracoabdominal aneurysm, implanting a branched stent-graft. (Cook Medical, Aus).

Operative techniques and comments

This type of procedure actually begins around 60 days before the day of surgery, since planning is fundamental both for creating the custom-made stent-graft and preparing the appropriate strategy, which may vary according to the anatomy such as in the right renal artery depicted in this video (*Video 1*).

Based on the CT scan, a comprehensive study of the proximal and distal diameters of the aorta was performed. The diameters of each of the 4 visceral arteries and the approximate clock position of the origin of each one of them was measured on the planning snapshots. We also assessed the distance of each visceral artery from the point of the proximal landing zone.

These measurements were then used to design a custom-made stent-graft with four branches for this patient, as seen in the actual photograph taken before sterilization.

The complete plan for this case consisted of:

- One proximal thoracic stent-graft, to cover the descending thoracic aorta and create a regular proximal landing zone.
- One custom-made branched stent-graft with 4 branches
- One bifurcated stent-graft, very similar to the regular one, except for the absence of a free flow stent. Since this graft will land inside the distal portion of the branched graft, only barbs are necessary for an appropriate sealing and holding of the system.
- Regular iliac stent-grafts complete the set of stent-grafts.

Step 01: proximal thoracic stent-graft + branched stent-graft

The access to the arterial system is routinely performed through bilateral transverse incisions 2 cm above the inguinal ligaments, with control of both common femoral arteries, as well as a third incision to access the distal portion of the subclavian artery, which will later serve to introduce the visceral bridging stents.

After the thoracic stent-graft is deployed, creating a proper landing zone and sealing the proximal portion of the aneurysm, the branched graft is deployed, so that each visceral oriented branch lands 2 cm proximal to the origin of the arteries. While the branched stent-graft is in place, an angiogram is performed to ensure the position of the stent-graft. Each of the visceral branches is marked with 2 golden marks at the base and 3 marks at the distal point.

Step 02: bifurcated abdominal stent-graft + iliac stent-graft extensions

After the implant of the branched stent-graft, we proceed to the implant of an abdominal bifurcated stent-graft, following the regular instructions. In this case, we perform separate arteriograms to localize the aortic and common iliac bifurcations.

The entire system is then dilated with a latex balloon, and an aortic arteriogram is performed, presenting the extensive intentional endoleak through the stent-graft branches that will provide visceral perfusion while each of the branches is catheterized and the bridging stents are implanted via the subclavian access.

At this point, before moving to the subclavian access, the femoral arteries can be reconstructed to allow perfusion of the lower limbs, sparing the patient the risks of metabolic consequences of ischemia. A 0.014" wire is inserted in a through-and-through manner from the 12-Fr sheath inserted at the subclavian artery and exiting one of the femoral artery suture lines. This wire is used to stabilize the sheath system.

Step 03: right and left renal arteries (side branches #03 and #04)

Once the subclavian is dissected, we position a 12-Fr sheath at the descending thoracic level, followed by a longer 9-Fr sheath that will actually guide the bridging stent-grafts into the visceral arteries. The 0.014" wire is in parallel to this later sheath, via a secondary puncture of the 12-Fr latex valve.

After that, each of the side branches is catheterized and the 9-Fr sheath is inserted, followed by the catheterization of the visceral artery. We then deploy the bridging stent. Up to this moment, we have been using a system comprising a covered self-expanding stent (Fluency, Bard, Germany) followed by the inner deployment of a self-expanding bare stent (Zilver, Cook Medical, US), to prevent kinking of the first. The sealing is completed with appropriate ballooning and is verified with 3-mL contrast arteriograms, after the injection of 10 mg of isosorbide mononitrate in each visceral artery.

In this case, the patient presented an early bifurcation of the right renal artery. At first sight one would think of excluding one of the renal arteries but this would cause at least a 50% loss of the right kidney.

We therefore decided to try a double catheterization, in a kissing stent technique, deploying two balloon-expandable covered stents inside the first self-expandable covered stent, to save the whole kidney.

The final arteriogram showed the complete perfusion of the right kidney.

Step 04: superior mesenteric artery (side branch #2)

The sequence of procedures is repeated for the mesenteric artery, to deploy its bridging stent through the subclavian access. The measures and the arteriogram show that an adequate sealing at the visceral artery is granted, without the loss of important mesenteric branches. Again, we first deploy a covered self-expandable stent followed by a bare self-expandable stent, for flexibility and avoidance of kinking. Usually, there is enough landing zone at the origin of the SMA, allowing us to avoid covering any mesenteric branches.

Step 05: celiac trunk (side branch #1)

Finally, the celiac trunk branch is catheterized with the 9-Fr sheath, followed by the selective catheterization of the hepatic artery, which we often prefer to preserve in case the celiac trunk is short, although this has not been an issue of concern so far in our experience. Both stents are deployed and followed by a control arteriogram.

Step 06: final angiographic control

After all bridging stents are in place we check the complete system for endoleaks and confirm the perfusion of each visceral artery.

Post-operative control CT scan

As usual for endovascular procedures, we perform a 6-month CT scan, which we can analyze and confirm the complete exclusion of the aneurysm, absence of endoleaks and complete perfusion of all the visceral branches of the stent-graft.

Acknowledgements

Disclosure: The video was entirely created and produced by the authors, with technical support from a 3D video professional artist, funded without industry support. Marcelo Ferreira is a proctor for Cook Medical.

Cite this article as: Ferreira M, Lanziotti L, Cunha R, d'Utra G. Thoracoabdominal aortic aneurysm: a totally endovascular approach with a branched stent-graft. Ann Cardiothorac Surg 2012;1(3):406-408. DOI: 10.3978/j.issn.2225-319X.2012.08.12