

## WHAT WOULD YOU DO?

# Residual Dissection and False Lumen Aneurysm After TEVAR

**MODERATOR:** MARK FARBER, MD

**PANEL:** YAZAN DUWAYRI, MD; MATTHEW J. EAGLETON, MD; WILLIAM D. JORDAN JR, MD; TILO KÖLBEL, MD, PhD; AND ERIC L.G. VERHOEVEN, MD, PhD

## CASE PRESENTATION

A 67-year-old man underwent thoracic endovascular aortic repair (TEVAR) for acute type B dissection at a neighboring institution 3 years prior to this presentation. During his initial procedure, the patient was noted to have renal insufficiency (serum creatinine, 1.8 mg/dL), persistent hypertension, and back pain despite aggressive anti-impulse therapy. After treatment with TEVAR, his pain and hypertension resolved, and renal function returned to normal.

Despite aggressive medical treatment and documented good blood pressure and heart rate control with medical therapy including  $\beta$  blockade, his thoracic and abdominal aorta have increased in size. Over the past 3 years, his thoracic aorta has increased from 3.8 to 5.7 cm (Figures 1 and 2). The visceral aorta is  $> 4.3$  cm at the level of the superior mesenteric artery (SMA) but decreases to 3.0 cm at the level of the lowest renal artery. Inspection of a recent CT scan demonstrates that all visceral vessels are perfused by the true lumen (with two left renal arteries both  $> 5$  mm) (Figure 3), and the dissection extends down into the iliac region. The left hypogastric artery contains a reentry communication as well as the right external iliac artery.

The patient has significant comorbid conditions including an ejection fraction of 50%, chronic obstructive pulmonary disease, and previous myocardial infarction with percutaneous transluminal coronary angioplasty more than 5 years ago. Although the patient would agree to having an open repair if that is his only



Figure 1

- Largest aortic diameter 5.7 cm (3-4 cm above CA)
- Just above CA grown from 3.5 cm to 5.0 cm in 3 yrs

Three years prior

Now

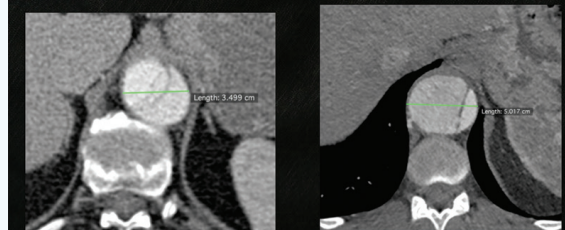


Figure 2

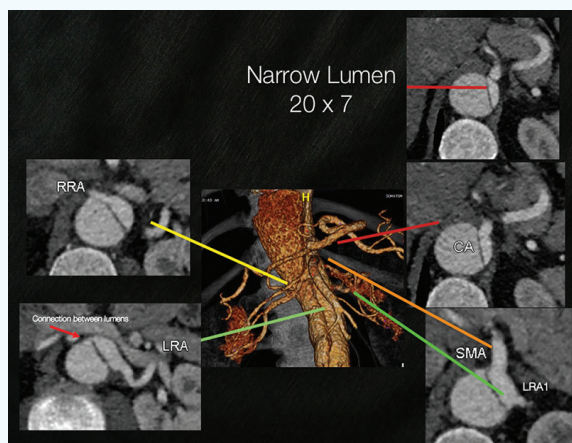


Figure 3

option, he would like an opinion as to whether there are any other solutions that may be used to manage his residual chronic dissection and reduce his risk of rupture.



#### How would you approach this patient and why?

- False lumen thrombosis (plugging)
- Stabilize
- Fenestrated endovascular aneurysm repair (FEVAR)
- Chimney

**Drs. Duwayri and Jordan:** It is important to emphasize that the goal of treatment should be aortic rupture prevention, which is accomplished by addressing the aortic zone in which the risk of rupture is highest. In this case, growth can be demonstrated in the entire thoracoabdominal aorta despite coverage of the primary entry tear. However, this growth is most noticeable in the descending thoracic aorta, where the size has reached 5.7 cm, and to a much lesser extent in the visceral and abdominal aorta. The most likely etiology of the continued thoracic aortic degeneration is the continued pressurization of the false lumen in a retrograde fashion.

Therefore, we propose the simplified treatment strategy consisting of thoracic false lumen embolization and continued distal aortic surveillance. After angiographic confirmation of adequate proximal entry tear coverage, the true and false lumens are accessed distally under intravascular ultrasound guidance. The thoracic endograft can then be extended distally in the true lumen to the level of the celiac artery. Another endograft is then deployed in the false lumen with a reverse taper, fol-

lowed by plug deployment in the superior tapered portion of the false lumen endograft to eliminate further retrograde flow into the false lumen.

**Dr. Eagleton:** This is a typical scenario for a complex problem associated with aortic dissections. My approach would be to treat this with a fenestrated/branched endograft, which offers a therapy to patients through a less invasive approach. The goal would be to exclude as much of the false lumen flow as possible. The repair would involve a fenestrated/branched device with inclusion of all three renal arteries, the SMA, and the celiac artery. I would use a construction of a combination of fenestrations and directional branches. These would be preloaded (ie, a catheter and wire system would be part of the delivery system, allowing direct access into the fenestrations and branches). I would cover the aorta down to at least the aortic bifurcation.

I would likely stop at this point and not proceed with any repair at the level of the aortic bifurcation. I would provide follow-up imaging to assess for false lumen thrombosis. If the aneurysmal section has persistent flow, then I would consider extending the repair further. More detailed information about the iliac system would be helpful in planning that repair. Options include placement of a branched aortic component with the addition of the one of the following: (1) embolization of the left hypogastric artery (to eliminate the reentry point) and extension into the left external iliac artery; (2) placement of a bifurcate component, landing in both common iliac arteries with coverage of the reentry point in the left external iliac artery with a covered self-expanding stent and then reassessing the response to flow in the false lumen; or (3) use of a hypogastric branch endograft on the left.

**Dr. Kölbel:** This patient has a typical residual dissection and false lumen aneurysm after TEVAR for type B aortic dissection. The false lumen aneurysm appears to extend from the stented segment to the visceral aorta and has a general indication for treatment with a maximum diameter of 5.7 cm. The patient is relatively young, and despite some comorbidities, I see an indication for operative treatment other than blood pressure optimization in order to prevent further enlargement and rupture. Still, this is an elective treatment situation without any urgency. Because no genetic aortic syndrome is suspected and the patient has some significant comorbidities, endovascular treatment is the first choice.

False lumen occlusion should be a part of the endovascular solution, as this allows the repair to be limited to the mid-infrarenal aorta, which has normal

diameters. This is a good choice, as it limits the coverage of segmental arteries and reduces the risk for spinal cord ischemia.

The extension of the false lumen dilation to the celiac artery does not allow for sufficient seal proximal to the celiac artery with a candy-plug technique in the distal descending aorta. As a result, a fenestrated cuff would be required, with a diameter of around 20 mm. Fenestrations can probably be planned for all five major vessels. The 15-mm landing zone in the right renal artery would require short, 15- to 18-mm-long balloon-expandable bridging stents. Both left renal arteries qualify for preservation with 5-mm diameter. Distances and clock positions need to be checked for manufacturing constraints.

Distal landing in the true lumen should be about 4 cm distally to the renal arteries to allow sufficient overlap for potential later distal extension of the repair. At the same level, false lumen occlusion should be done using iliac plugs, vascular plugs, and/or coils. If the diameter of the false lumen is too large for commercially available plugs, a custom-made candy-plug II can be planned with oversizing of 10% to 30%. Access to the false lumen seems to be present at the right external iliac artery. Evaluation of the CTA will be able to define the best level and show which lumbar arteries can be preserved by this technique.

Of course, FEVAR can also be performed that includes an aorto-bi-iliac extension landing in both common iliac arteries and occluding the false lumen at the level of the common iliac arteries. Alternatively, iliac side branch devices could be used to extend the repair into hypogastric and external iliac arteries, but these options are clearly the second and third choices, as limiting aortic coverage is key to a low spinal cord ischemia rate.

Stabilization describes uncovered scaffolding of the true lumen combined with balloon dilatation to rupture the dissection flap. This is a questionable solution as (1) the flap may not rupture easily, (2) it may result in target vessel occlusion by flap material, (3) the aneurysmal false lumen at the level of the descending thoracic aorta would be continuously pressurized, and (4) the material may prevent future necessary fenestrated repair.

Chimney/sandwich repair has no place in this case because it carries significant risks for unintended flap rupture, gutter endoleak, and stroke due to antegrade access and it does not allow later endovascular repair by complicating access to target vessels.

**Prof. Verhoeven:** Based on his history, I would inform the patient that a treatment will be needed for

this postdissection aneurysm. We usually wait until 6 cm, but patients in follow-up are certainly considered for further treatment if they have a progressing aneurysm that reaches 5.7 cm in diameter. At our institution, open repair is reserved for connective tissue disease patients or younger and healthier patients in whom a good endovascular solution is not possible due to complex anatomy. We would first consider a repair with fenestrated and branched grafts, but we have also recently treated a few patients with stabilization when the diameter is < 3.5 cm at the level of the visceral arteries. Although we actively look for other false lumen occlusion techniques, including knickerbocker or candy-plug techniques, we have not applied them in our patients yet.

In looking at the images, I would conclude that this enlarged false lumen needs complete exclusion. I would therefore go for a fenestrated/branched graft. The visceral arteries do not seem to be a major problem, although I would choose a FEVAR graft with five fenestrations and try to preserve both 5-mm left renal arteries. On the right, I would intraoperatively decide whether to stop just before the renal artery bifurcation and maybe extend with a noncovered self-expanding stent for more fixation or just overstent the smaller branch of the right renal artery.

Distally, I would try to seal on the abdominal aorta above a patent inferior mesenteric artery and hope for false lumen occlusion. If that does not work, I would perform a planned staged approach and extend with a bifurcated graft, possibly including iliac branched devices.



### What are the pros and cons of your approach?

**Dr. Kölbel:** Limited fenestrated repair combined with false lumen occlusion techniques can be done from transfemoral access only, with low rates of stroke and spinal cord ischemia and minimal coverage of segmental arteries, and without compromising later distal extension. The high success rate and low complication rate of this approach make it the best option for the patient. Any further distal treatment appears unnecessary. The downside to this approach is the limited availability and necessity to use surgeon-modified techniques in some countries.

**Drs. Duwayri and Jordan:** The main benefit of our approach is its simplicity. It adds a few centimeters of aortic coverage in the thoracic aorta and adds minimal paraplegia risk. It is effective in achieving false lumen thrombosis and therefore thoracic aortic aneurysm

regression. Of course, the main disadvantage of this technique is that the visceral aorta will remain at risk of continued aneurysm degeneration. Close follow-up will need to be maintained to detect delayed failure, such as endoleaks or continued aortic degeneration. If the aortic diameter continues to increase in size, recurrent pressurization of the thoracic false lumen would require more aggressive coverage of the visceral aorta, which is best achieved with a four-vessel fenestrated endograft extension.

On the other hand, complete endovascular thoracoabdominal repair utilizing fenestrated endografts or chimney techniques requires extensive aortic coverage, which carries a definite increase in paraplegia risk. We do not believe that this is a necessary risk at this stage.

Others may suggest the stabilize concept as an option. We feel that stabilization is a wonderful strategy if balloon-induced intimal disruption can result in obliteration of the false lumen entirely. For this to succeed, the diameter of the covered endograft in the distal thoracic aorta should ideally match the total aortic diameter to achieve reapproximation of the intima and allow the distal bare stent to promote abdominal aortic remodeling. In this case, the large aortic diameter above the celiac artery level will result in persistent retrograde false lumen perfusion around the endograft and will lead to early “stabilize” failure.

**Prof. Verhoeven:** I think that this approach, if feasible, provides the most durable exclusion of the aneurysm. In my opinion, this case is far from ideal to use a “stabilize” technique or another false lumen occlusion technique. Obviously, this approach represents the most difficult treatment option, but in this straight anatomy, I would no doubt also choose FEVAR over open repair for this patient.

**Dr. Eagleton:** A hypothetical risk for this procedure is the small true lumen. This may make alignment of the fenestrations or access into the target vessels from the branches difficult. I think most operators with experience performing FEVAR or branched EVAR in these situations report that alignment is not difficult, and access into the target vessels can be easier than in large aneurysmal disease. One technique is to do partial deployment of the system with access into the target vessels from an antegrade approach. With all of the vessels arising from the true lumen, this should be possible. However, these devices are not widely available to most operators in the United States. In addition, the reported use of these devices for the treatment of chronic aortic dissections is limited.

The renal arteries complicate this procedure. The right renal artery has a short trunk until its bifurcation. A key to success is to obtain maximal coverage without sacrificing one of its branches. If an endoleak is present, however, sacrificing the smaller of the two branches may be necessary. Given this, it is important to salvage both left renal arteries. Incorporating more than two renal arteries has been described with successful outcomes. The small true lumen makes this a bit more technically challenging. Aligning five fenestrations (especially in a small lumen) is quite difficult. In addition, five directional branches may consume too much of the true lumen, thus the use of a combination of both directional branches and fenestrations. The left renal arteries are large enough (> 4 mm) that their size should not affect long-term patency.

The distal treatment has many potential problems. Given the extent of the aorta that would already be excluded, including this in the first stage of repair, which may not be necessary to stop the flow in the false lumen, may increase the risk of spinal cord ischemia. Unless pressed to perform this at the time of the FEVAR, I would stage it. Embolizing the left hypogastric artery certainly increases this risk as well, and this would be my least favorite approach. A hypogastric branched endograft would be a good option provided there was sufficient room within the left common iliac artery to accommodate such a device.

Finally, coverage of the entire true lumen does not necessarily negate flow in the false lumen. Many of these patients require multiple reinterventions after these types of procedures. There can be brisk flow with persistent perfusion arising from a type II endoleak from persistent intercostal and lumbar arteries. If these provided persistent flow, then access into the false lumen would be necessary, with embolization of these vessels, which would likely be performed through a translumbar approach if all true lumen to false lumen entry tears are covered.

## APPROACH OF THE MODERATOR

This patient was managed in a two-staged fashion with a custom-manufactured device branched for the visceral arteries and three fenestrations for the renals utilizing a preloaded design (Figure 4). As Dr. Eagleton mentioned, this can be accomplished at experienced institutions with minimal complications with a preloaded delivery system and sequential deployment and catheterization of the target vessels.

The right renal artery landing zone was short but we managed to get a seal in the main trunk. We chose to extend distally during the first procedure to the



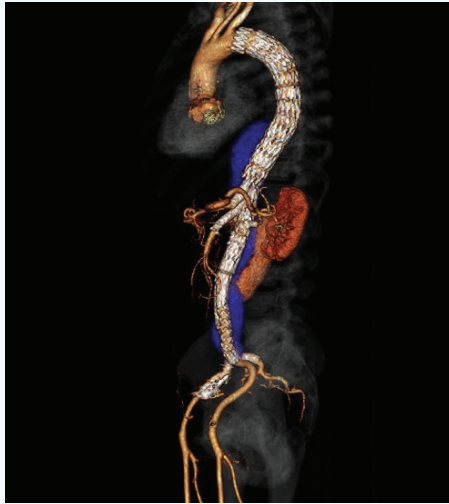


Figure 4

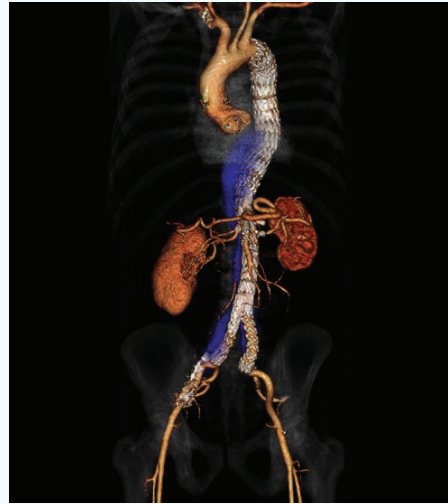


Figure 5

common iliac arteries bilaterally. On the left side, the false lumen was excluded by placing a stent graft into the native hypogastric artery without the use of a branched graft. Finally, the right external iliac false lumen communication was managed with coil embolization of the false lumen (Figure 5). ■

#### Mark Farber, MD

Professor of Surgery and Radiology  
Division of Vascular Surgery  
Director, Aortic Network and Vascular Surgery Program  
University of North Carolina  
Chapel Hill, North Carolina  
mark\_farber@med.unc.edu

*Disclosures: Clinical trial support and consulting fees from Gore & Associates, Endologix, and Medtronic; clinical trial support, consulting fees, and research support from Cook Medical.*

#### Yazan Duwayri, MD

Co-Director, Emory Aortic Center  
Associate Professor of Surgery  
Division of Vascular Surgery and Endovascular Therapies  
Emory University School of Medicine  
Atlanta, Georgia  
yazan.duwayri@emory.edu

*Disclosures: Clinical trial support, proctoring fees, and consulting fees from Cook Medical; clinical trial support from Bolton Medical.*

#### Matthew J. Eagleton, MD

Chief, Division of Vascular and Endovascular Surgery  
Co-Director, Fireman Vascular Center  
Massachusetts General Hospital  
Boston, Massachusetts  
meagleton@mgh.harvard.edu

*Disclosures: None.*

#### William D. Jordan Jr, MD

Professor and Chief  
Division of Vascular Surgery and Endovascular Therapy  
Emory University Hospital  
Atlanta, Georgia  
williamjordan@emory.edu

*Disclosures: None.*

#### Tilo Kölbel, MD, PhD

German Aortic Center Hamburg  
Department of Vascular Medicine  
University Heart Center  
Hamburg, Germany  
tilokoelbel@gmail.com

*Disclosures: Proctoring fees, speaking fees, consulting fees, travel grants, research grants, royalties, and intellectual property holder with Cook Medical.*

#### Eric L.G. Verhoeven, MD, PhD

Chief, Department of Vascular and Endovascular Surgery  
General Hospital Nuremberg  
Paracelsus Medical University Nuremberg  
Nuremberg, Germany  
eric.verhoeven@klinikum-nuernberg.de

*Disclosures: Educational grants and consultant fees from Cook Medical, Gore & Associates, Siemens, Bentley, and Getinge.*