PANEL DISCUSSION

Decision-Making for Type B Aortic Dissection

Device choices and approaches to de novo TBAD presenting with malperfusion or an enlarging thoracoabdominal aortic diameter after TEVAR, thoughts on whether to intervene on the false lumen, and surveillance protocols after TEVAR.

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For a de novo type B aortic dissection (TBAD) presenting with malperfusion, what is your endograft of choice, your approach, and why? What adjunctive devices (bare-metal, fenestration techniques, false lumen [FL] embolization) might be used, and why?

Dr. Mastracci: The current generation of endovascular devices for dissection are quite well engineered, and there

are many good options from which to choose. At our center, we have both the Gore TAG (Gore & Associates) and Zenith (Cook Medical) devices on the shelf, and I've had good success with both. Occasionally, sheath size, anatomy, or arch tortuosity may make me favor one over the other, but this is likely more "style" than factually based. I think for a center trying to decide what's best for them, the rational option is to use the platform that they use most often. This ensures good clinical support, a high degree of confidence for troubleshooting difficulties, and hopefully a consignment that allows for "game day" decision-making that will benefit the patient.

As for adjunctive devices, I don't think an operative theater is complete without intravascular ultrasound (IVUS) when treating dissection. Although transesophageal echocardiography is valuable and plays a role in even our treatment algorithm, the confidence conveyed by using IVUS is second to none. IVUS can ensure placement in the true lumen (TL) and can be used to assess the movement of the dissection flap after placement. Identification of tears is also imperative, and the role of IVUS in this task is only recently being understood. I am hopeful that IVUS technology will soon become more embedded in operating theaters and become a part of fusion imaging, so that it can provide even more information to inform device placement.

Thus, it follows that a second important adjunct is a fusion imaging system. Having a roadmap with which initial wire placement can be steered decreases contrast use and fluoroscopy time and gives further confidence in the placement of devices. It also allows for the identification of branch vessels quickly, ensuring perfusion can be maintained and assisting in any embolization procedures that might be required.

Ultimately, in our center, imaging modalities more so than devices have provided a step change in the treatment of dissected aortic diseases.

Prof. Melissano and Dr. Mascia: Endograft choice is an important step for the endovascular treatment of TBAD. Generally, stent grafts with proximal bare stents with a high radial force and/or acute angles are not indicated. The Zenith TX2 Dissection endovascular graft with proform (Cook Medical) is specifically designed and approved for the treatment of patients with TBAD, having neither a proximal bare stent nor barbs at the level of the first sealing stent. Regarding the use of adjunctive devices, especially in the scenario of ongoing TL collapse and malperfusion, the Zenith Dissection endovascular stent is intended to provide support to delaminated aortic segments and can be used. Moreover, to be best of our knowledge, it is the only bare stent device on the market approved for aortic dissection due to its low radial force. Of note, if the STABILISE technique is performed, operators should keep in mind that this procedure currently lays outside the instructions for use of the device because it entails the ballooning of the stent. Regarding the STABILISE technique, we are confident that the procedure itself can be considered to treat TBADs, and in order to set this goal, we need hard data from large series with standardized procedures and follow-up. Thus, we are promoting an international registry, which is in the enrollment phase, and we encourage all operators who are interested in the procedure to join (stabiliseregistry@gmail.com).

Prof. Nienaber: A de novo TBAD with evidence of malperfusion (either clinically with symptoms or radiographic malperfusion) is a real challenge, as endovascular treatment is relatively urgently required to improve outcomes and even save organ function or life. In such cases, I follow the rule of thumb to first reconstruct the TL of the dissection and reestablish flow to the distal aorta and dependent organs; the use of an atraumatic conformable stent graft with relatively low radial force would be preferred (certainly with no bare-metal component or hooks at the top). Often, proper placement of such a stent graft (up to 200 mm) with preservation of the left subclavian artery is enough, and further interventions can be deferred (as indicated by follow-up imaging in our surveillance clinic). However, if signs of distal or organ malperfusion persist during the index intervention, we are liberal to entertain the PETTICOAT concept (eg, use a provisional extension with bare-metal [nitinol based] open stents to open up the distal TL and generate distal flow with no threat to side branches at the level of the abdominal aorta). This concept was established in 2006 and is being used worldwide. Only in rare situations is a selective side branch navigation and ostial stenting required to reestablish organ perfusion. Distal extension by use of bare-metal open (uncovered) stents also has been shown to improve distal realignment and even aortic remodeling distally (as a bonus).

Dr. Kölbel: We use the Zenith ZTEG (Cook Medical) in a tapered configuration. I prefer this device over the ZDEG because of the active fixation. Especially in an acute TBAD, proximal bare-metal stents should be avoided on the thoracic endovascular aortic repair (TEVAR) device. I rarely use a Zenith Dissection stent, but it can happen in malperfusion. I use fenestration techniques, usually employing a transseptal BRK needle and sheath. In my opinion, FL embolization is a technique mainly for subacute and chronic TBAD, so I wouldn't use it for a malperfusion.

Dr. Roselli: For this emergency indication, there are two critical objectives: The first is to address dynamic obstruction by covering the primary entry tear, and the second is to open any branch vessels affected by static obstruction. For the first objective, any of the commercially available endografts can achieve that goal. It is important to minimize risk of retrograde dissection by limiting oversizing to < 10%. Both the Zenith and Relay (Terumo Aortic) devices are available without proximal bare stents, and the Gore TAG bare-stent extensions are minimal. For short landing zones, I like the precision afforded by all these devices. The Gore TAG thoracic branch endoprosthesis device offers the option to maintain left subclavian artery patency quickly if that is important. If the entry tear is particularly proximal, I will perform a frozen elephant trunk repair as a B-SAFER procedure through a sternotomy.

Self-expanding bare stents are typically all that are needed to address most static occlusive processes causing malperfusion in an acute dissection. And the Zenith Dissection device is outstanding for optimizing TL perfusion throughout the aorta without compromising branch vessel flow.

I have found that fenestration is usually unnecessary but can be a life-saving technique in the rare case where the main aortic dissection flap itself is completely occlusive, and this can happen in patients who have undergone previous open abdominal aortic repair when the dissection flap becomes an obstructive "wall" at the proximal end of an old anastomosis. FL embolization is primarily reserved for patients with chronic dissection to promote positive remodeling.

For a patient who has undergone prior TEVAR for TBAD with enlarging thoracoabdominal aortic diameters not yet meeting diameter threshold for repair:

1. Would you intervene on the FL? What is the trigger to do so, and why?

Dr. Roselli: If the aortic diameter is clearly enlarging (beyond the margin of error of a couple of millimeters), then the writing is on the wall. An enlarging diameter at the level of the diaphragm has been shown repeatedly to be a strong predictor of death after both open and endovascular repair. If I can reverse or stabilize the downstream growth of the aorta with a simple technique like FL embolization where a clear path for FL pressurization is occurring, then I would intervene.

Prof. Melissano and Dr. Mascia: If the dilatation is limited to the thoracic aorta, a valid approach could be to plug the FL using dedicated devices such as the candy-plug device.

Dr. Kölbel: No, generally not. I use FL embolization in conjunction with TEVAR when patients meet indications for repair, which are diameter ≥ 55 mm, rapid progression, rupture, or malperfusion.

Dr. Mastracci: I have rarely made the decision to intervene in the FL for a partially excluded dissection if I wasn't otherwise planning a TL intervention. In these patients, I believe there is some role for stent graft coverage to the level of the celiac, and for patients who continue to have descending thoracic aorta (DTA) expansion after TEVAR, I would reintervene with a second TEVAR to ensure the entire DTA is fully covered. During these procedures, I have also recently started using a knickerbocker approach, ensuring that the TL is fully expanded through the majority of the stent. If there is a patent inferior mesenteric artery (IMA) contributing to FL flow, I would embolize it. However, I haven't routinely left coils or candy plugs in the FL because I'm not fully convinced that either changes the natural history of the disease (although admittedly, the evidence for candy plugs is becoming more compelling).

In my practice, if a thoracoabdominal aortic aneurysm (TAAA) is continuing to expand after TEVAR for dissection, that is an indication for TAAA repair, and my most likely recommendation to the fit patient is a fenestrated repair for TAAA.

Prof. Nienaber: Distal aneurysmal degeneration after proximal treatment of dissection (both in classic type B dissection and in residual distal dissection after surgery to type A/DeBakey type 1 dissection) can call for intervention to the FL to stop diameter progression and induce complete FL thrombosis and promote remodeling.

2. Describe the techniques you like to use in these situations and why.

Prof. Nienaber: In this scenario (again, usually identified with surveillance imaging), I prefer a targeted individualized approach using the FLIRT concept (FL intervention to promote remodeling and thrombosis). FLIRT is a gentle approach targeting reentry tears and closing them to isolate the FL from pressure and flow, thereby promoting remodeling; the key is to address the FL by sealing communication with focal occluders with coils or thrombogenic glue in the FL. I am not fan of candy plug because it exerts extra stress on the thin outer wall of the FL and still leaves distal aspects of the FL exposed to pressure and flow. In advanced cases of distal aneurysmal degeneration, complex multibranched or fenestrated stent grafts remain an option.

Dr. Mastracci: When FL embolization is necessary, my most likely intervention is a targeted coiling of branches. I don't believe leaving coils alone in the FL has ever changed the natural history of disease. Although candy plugs are a compelling next step, I have found that exclusion of the dissection in its entirety, including the coiling of any branches feeding the aneurysm, has a very satisfactory outcome.

Dr. Roselli: Oftentimes, we see this retrograde FL perfusion occurring from beyond a previous repair, and the endograft is compressed in the TL. If there is a landing zone into normal-caliber aorta, then TEVAR extension with balloon fracture fenestration to fully expand the TEVAR against the aortic outer wall is a very satisfying technique to address this problem. The risk for stent graft–induced new entry postballooning seems to be mitigated by protecting the downstream abdominal aorta with bare-metal stenting into the TL. This technique is not only helpful in the aorta; branch vessels like the left subclavian artery may also be conducive to this therapy if a downstream reentry tear is backfeeding the FL of the aorta. Later, any residual flow into the FL may be addressed with additional embolization of the tract.

Dr. Kölbel: Most of the time, I use the candy-plug technique. In the infrarenal segment, the iliac arteries, and visceral vessels, I also use coils, Amplatzer vascular plugs (Abbott), and glue.

3. How important is it to intervene on the FL in the thoracic aorta? How important is it to intervene on the FL in the abdominal aorta and distally?

Prof. Melissano and Dr. Mascia: The natural history of aortic dissection suggests that patients treated medically or by means of TEVAR with or without PETTICOAT will experience distal aortic dilatation over the long term (5-10 years) in one-third to one-half of cases. So, putting a bare stent along the paravisceral and abdominal aorta and ballooning it to create a single-channel aorta with no FL is a serious attempt to avoid such a complication, but this is more effective if done in the acute/subacute phase.

Dr. Kölbel: When the indication for treatment is the aneurysmatic diameter and there are branch vessels originating from the FL, in my mind, embolization is mandatory in chronic aortic dissection to close the backdoor.

Dr. Mastracci: Although this question focuses on the FL, I believe the entire aorta always bears consideration in dissection. It is unlikely that the FL acts independently of downstream disease—and frequently scrolling slightly further downstream in the CT scan will provide insight into the cause of ongoing FL expansion. Throughout my career, I have adopted the approach of making assessments of dissections using the entire aorta and doing my best to change the flow dynamics of the construct of the repair to cover as many fenestrations in the dissection flap as possible. This often "takes the wind out of the sails" of FL expansion, and if it doesn't, it bears considering other malign actors such as connective tissue disease or infection.

Prof. Nienaber: Direct intervention to the FL at the level of the thoracic aorta (after previous classic TEVAR) is not frequently needed if the index procedure went according to plan, but if a relevant communication (tear in the lamella) has not been closed at the level of the thoracic aorta, a stent graft extension or FLIRT have a place.

In cases where aneurysmal degeneration at the level of the abdominal aorta takes place, an intervention has to be considered in the presence of significant progression, at a diameter threshold of > 55 mm, or in the case of symptoms. Those interventions range from targeted FLIRT (if feasible) to multibranched/fenestrated stent graft solutions (or even open repair in highly selected cases).

Dr. Roselli: The thoracic aorta is exposed to the highest stress and shear forces and is most vulnerable to aneurysmal changes in the setting of chronic dissection, but any segment of the aorta that is demonstrating active growth should undergo more proactive therapy to promote positive remodeling.

What surveillance would you use after these interventions, and what would be the indication to reintervene or findings that would lead you to continue to monitor?

Dr. Roselli: If contrast can be used safely, then all patients get predischarge triple-phase CT scans to establish a new baseline for subsequent comparison. They are then brought back as outpatients for repeat triple-phase CT imaging of the entire aorta at 3 months. If we are seeing good results at that time, the next imaging study is scheduled 9 months later for a 1-year anniversary study from the latest intervention, and then annual visits thereafter. If there is an area of concern, I may image that patient in 3 to 6 months again to watch things a little closer until I am satisfied we are seeing the intended results and stability has been safely reached.

If significant new growth is noted with an obvious source for perfusion and FL pressurization, then we intervene. This occurs in about 15% of patients within inter-

mediate follow-up, but we have had good success with secondary interventions. Rarely, you see a patient with aortic growth and no obvious source many years after a prior treatment, and these patients may benefit from relining of their thoracic stent grafts.

Prof. Nienaber: Follow-up in our surveillance clinic occurs 3 months after an index event/intervention and then in annual intervals. Accompanying CT or MRI is offered in annual intervals as well; these intervals are shortened if clinically dictated or longer if clinically silent and historically stable.

Dr. Kölbel: Same as for all TAAAs: CTA at 30 days and 1, 3, 6, and 11 years. Indications to reintervene are further growth ≥ 5 mm or progression in other segments.

Dr. Mastracci: Our center is currently examining the schedule for surveillance imaging after dissection, because this patient population has been exposed to a frighteningly large postoperative radiation dose. A combination of well-intentioned clinical suspicion, and occasionally a lack of coordination between subspecialists or different hospital systems, may lead to a disproportionately high number of scans being performed. Currently, we image dissections after TEVAR at 1, 3, 6, and 12 months (with the 3-month scan reserved for patients with active growth at 1 month) and then annually thereafter. However, I believe this schedule may be reconsidered in the setting of a closer monitoring system for patients at home. For this reason, we have implemented a remote monitoring system (OrtusiHealth) that allows us to track patient blood pressures and symptoms in real time. It is our hope that after a few years of data have been collected, we will be able to recommend bespoke imaging surveillance protocols for patients followed at our center.

Reintervention is usually reserved for patients with ongoing growth or with evolution of the dissection. In these cases, the decisions are made in a case-by-case fashion, once again considering the whole aorta before deciding on definitive treatment.

Prof. Melissano and Dr. Mascia: Surveillance is very important in these patients, and we routinely perform a CT scan after the procedure, at 6 months, and yearly thereafter, unless the patient is very young. In this case, we need to limit the radiation exposure. The aortic enlargement (especially at the abdominal level) is an indication for reintervention when it reaches the diameter for aortic repair (5.5-6 cm), but the procedure can be performed earlier if patients have an inheritable aortic disease or are symptomatic. ■

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