

Evolving Endovascular Treatment of Type B Dissection

Two leading centers weigh in on current practice.

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How has your dissection practice evolved with availability of endovascular devices and expanding experience?

Drs. Knowles & Farber, University of North Carolina at Chapel Hill (UNC): Over the last 10 years, the landscape in the management of aortic pathology has changed significantly. Unlike in the infrarenal aorta, devices for the treatment of thoracic pathology have to deal with more complex anatomy and encompass more diverse etiologies including aortic aneurysms, traumatic injuries, penetrating atherosclerotic ulcers, and dissections. The combination of endovascular device proliferation, experience with endovascular aortic surgery, and the improvement of device performance has provided vascular specialists with endovascular options for the management of patients with both complicated and uncomplicated Type B dissections. Improvement in various aspects of endovascular devices include improvements in

fixation, delivery sheath profile reduction, precision with proximal deployment, and conformability within the arch. Furthermore, the use of intravascular ultrasound has allowed for improved safety and efficacy during these procedures by adding information regarding lumen size, septal movement, and confirmation of presence within true lumen. In addition, our increasing understanding of aortic Type B dissections has allowed us to identify patients who are at higher risk for complications or aneurysmal degeneration over time. All these improvements have allowed us to treat more patients with improved outcomes.

Drs. Crawford & Taylor, University of Maryland (UMD): Endovascular technology has allowed interventionists worldwide the opportunity to treat patients whom would have been managed medically in years past. We see and manage all patients with aortic dissection in our

comprehensive aortic center, a multidisciplinary unit with cardiac, vascular, and antihypertensive experts. This has expanded the availability of options. The advent of thoracic endovascular aneurysm repair (TEVAR) has given us the option to be more aggressive in treating all pathologies related to dissection. There is no question that for acute complicated dissection, TEVAR is the preferred method. With increasing experience, the option to treat uncomplicated and chronic dissections with endovascular methods is also gaining favor, as is the idea that because of its excellent safety profile, other pathologies, such as penetrating ulcers and intramural hematomas, should be treated more aggressively when encountered. Our personal experience has evolved in this manner. We have clearly moved from a more traditional approach of “treat complicated cases only” to a posture where we are able to recognize additional factors that push us to intervene sooner.

How does your center ensure efficient flow from diagnosis to treatment of dissections?

Drs. Crawford & Taylor, UMD: We work closely with regional emergency departments across the mid-Atlantic region and have a 24-hour, 365-day call center. Our outreach program is very active in terms of education about dissection. First, we mounted an extensive campaign that started in our emergency department to educate practitioners about the signs and symptoms of aortic dissections. We followed this up with guidelines about the type of imaging modalities that are required for the appropriate diagnosis of the condition. The University of Maryland Medical System is comprised of more than a dozen hospitals coordinated through a central command system (called Express Care). This system permits any hospital in the system access to specialists at our flagship hospital where patients with diagnosed or suspected dissections can be transferred and treated. We advanced our message throughout all the system area hospitals using this structure. The goal is to have outside practitioners think about acute aortic emergencies in patients who they are treating, when appropriate. Members of the Center for Aortic Disease regularly lecture at all hospitals about the need to transfer dissections promptly and to refer chronic patients to our specialized clinic. We have newsletters, a strong website presence, and education campaigns using public radio. We attack this problem in multiple ways.

Drs. Knowles & Farber, UNC: The University of North Carolina Hospital System encompasses a large area in the Southeast United States. The use of an aortic network allows for local or regional education of available aortic pathologies treatment options, facilitates the transfer for acute aortic syndromes, and the referral of nonurgent patients. All dissections are referrals to the vascular surgery service, and all patients are managed by the vascular surgery aortic

team unless they are isolated to the ascending aorta. This management strategy uses a multidisciplinary approach, including intensive care unit intensivists and consultative services for the management of these patients to assist in the management of hypertension and the sequelae of aortic dissections. Diagnosis is primarily through computerized tomographic angiography (CTA) imaging. Repeat imaging is necessary when symptoms do not resolve after appropriate therapy. Surgical (endovascular) repair is typically based on complications related to the Type B dissection, or patients with uncomplicated Type B dissection who are at significant risk for subsequent aneurysmal degeneration or the development of complications. Furthermore, good communication with the patient's outpatient primary care provider for the appropriate medical management is prudent for the avoidance of sequelae related to the Type B dissection and hypertension.

What are the characteristics of dissection patients you treat early with endovascular or surgical intervention?

Drs. Knowles & Farber, UNC: Patients generally fall into three categories: complicated, high risk/uncomplicated, and low risk/uncomplicated. With respect to complicated patients, we initiate early repair for patients with persistent hypertension and/or pain despite best medical management, signs of malperfusion (limb ischemia, visceral ischemia, spinal ischemia), or findings suggestive of rupture or impending rupture. Due to the risk of retrograde Type A dissection, early intervention is only performed for these complicated patients who did not improve with medical management and not for uncomplicated patients.¹ Uncomplicated patients with high-risk morphologic and anatomic characteristics are typically treated during the subacute period (8-12 weeks). These patients have specific predictive prognostic indicators of growth and progression.

Patients deemed to be low risk/uncomplicated are monitored with best medical management and serial imaging with CTA. If there is growth or progression, surgical repair is then considered. We feel strongly that treatment of uncomplicated aortic Type B dissections should occur in patients with these specific predictive prognostic indicators to avoid proximal or distal aneurysmal degeneration or extension of the dissection, as it potentially complicates subsequent repair and increases the morbidity and mortality. A thoracic endograft can typically be placed to cover the proximal entry tear and cause depressurization or thrombosis of the false lumen, and avoid further sequelae from the dissection. Earlier repair can avoid extension into the brachiocephalic vessels proximally or into the visceral vessels distally (Figure 1). If this were to occur, the need for brachiocephalic vessel debranching or visceral vessel branched/fenestrated devices adds to the complexity, morbidity, and mortality of these repairs.

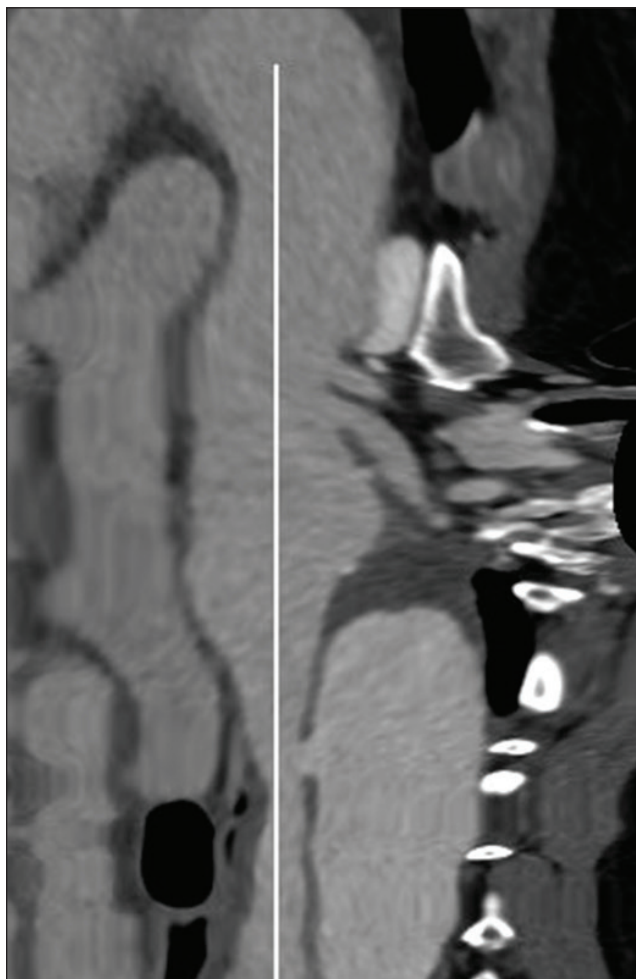


Figure 1. Centerline imaging on Type B aortic dissection with large proximal entry tear and retrograde aneurysm degeneration involving the origin of the left subclavian artery.

Drs. Crawford & Taylor, UMD: The patients we treat early are those who have the following life-threatening features: malperfusion of a limb, spinal cord, intestines, or kidney; rupture; or expansion. Pain and refractory hypertension are no longer considered soft indications. In our experience, these are harbingers of early, continued growth and rupture. Therefore, we treat early in the acute phase if we are concerned that a patient's life or limb is at risk. Consideration to delay is made when the patient has significant coronary disease that must be addressed first or if they have no signs of brain activity. It is safe to say that our approach is an endovascular first approach. Any patient who shows any signs of complications or anatomical features that are worrisome—for example a severely collapsed true lumen feeding mesenteric vessels—is treated early. This is the advantage of the availability of an endovascular approach.

There is another group of patients in whom a preponderance of anatomical and physiological factors (e.g., false lumen configuration, size, aortic size, tear diameter, location of tear, age, location of largest diameter), which

have been discussed in the literature, has prompted earlier treatment. This is a very important area of research. The short answer is that we tend to “cool off” these patients and extend them as much as we can into a subacute period that can range from a few days to a few weeks before treatment. We feel this is an optimal approach that avoids additional complications such as retrograde or antegrade extensions of the dissections, and/or conversion to a complicated pathology. We base this not just on anecdotal data, but also on our own experience in the treatment of patients with similar aortic pathologies (i.e., transections). In this group of patients, delay of treatment when possible decreases the incidence of complication and prevents exacerbations of concurrent pathologies such as head trauma. The benefits of waiting for the acute inflammatory phase to die down is something that has also been seen in the treatment of other acute conditions in orthopedics and general surgery. As the specific indications for earlier treatment of uncomplicated dissections become more well accepted, the issue of the timing will also have to be examined.

How do you define or identify high risk/uncomplicated patients?

Drs. Knowles & Farber, UNC: Uncomplicated dissection patients who have high-risk characteristics are offered repair. Growth > 5 mm during the acute phase (in the first 30 days) is believed to be high risk and should mandate repair between 8 and 12 weeks. In addition, a total aortic size of 55 mm in the chronic phase including the false and true lumen requires repair.² Patients with a large total lumen > 45 mm at 3 months are particularly at risk for further degeneration.³⁻⁵ An enlarged false lumen size measured from the aortic wall perpendicular to the septum > 22 mm,⁶ false lumen thrombus formation,^{7,8} and entry tear size ≥ 10 mm^{9,10} also has been shown to cause degeneration and should prompt repair between 8 and 12 weeks. Type IIIB dissection with extension distal to the left subclavian artery and patients with appropriate landing zones should undergo repair, as proximal and distal degeneration over time could lead to a more complicated repair. True lumen shape can influence the need for repair,^{9,10} such as high-risk patients having completely encircled thrombus. At our institution, 8 to 12 weeks is considered the optimal timing for the endovascular repair of patients with uncomplicated dissections. This timing avoids the early risk of retrograde Type A dissection, but decreases the risk of degeneration and the need for more complicated repair.

Drs. Crawford & Taylor, UMD: We define high-risk, uncomplicated patients as those who have one or more of the following features: total aorta > 4.4 cm, false lumen > 2.2 cm, true lumen ≤ 1 cm, primary entry tear > 1 cm. Young patients, patients with suitable anatomy (e.g., good proximal landing, reasonable chance of distal seal, all vessels coming off true lumen, good access), large total aortic diameter at

presentation, largest diameter at the proximal descending thoracic aorta, or large tear with no outflow are considered for earlier intervention. Just as important, the ability of a patient to have appropriate follow-up and adherence to blood pressure medication regimens is also a factor. The idea of “maximal medical management” is only as good as the adherence to said regimen. There are many patients in whom a reasonable blood pressure goal is hard to achieve despite best efforts from the practitioners and patients. In this group, an early intervention might be protective of a major catastrophe. Finally, we consider when patients have more than one risk factor, or even three. This definitely tips the scale for us in terms of early treatment and is also supported in the literature.

We want to get the patient out of the early “inflammatory phase” of the disease process into a subacute phase. This can take up to 2 weeks. For other reasons, we might treat the patient before they leave the hospital, in which case we allow at least a few days to a week for this process. The optimal timing is still a hot debate topic, but the idea of a cool down period is becoming well accepted.

What are the benefits and risks of stenting a dissection patient? Do the benefits and risks vary by dissection subtype?

Drs. Knowles & Farber, UNC: In our experience, procedural complications and reintervention rates differ between complicated and uncomplicated patients. The risk of stroke, paraplegia, and retrograde Type A dissection all increase with acute complicated repair, especially in the early setting (< 14 days). Morbidity and mortality may be high in patients with acute Type B dissections, with mortality rates in excess of 10% when complications occur.¹¹ We recommend delayed repair of uncomplicated Type B dissections for this reason. This delayed timing decreases the risk of complications without impacting the ability of the aorta to remodel. In addition, dissections involving the visceral aorta are likely to need additional adjunctive procedures, which increases the risk of complications. We allow approximately 3 months to pass in uncomplicated patients to decrease the complications that are associated in the acute phase. Short-term outcomes favor TEVAR compared with open repair with a low mortality rate of 3.2% and a paraplegia rate of 0.4%.¹²⁻¹⁴ There is no extensive long-term data currently available, but we hope that on-going and future studies will provide better guidance on uncomplicated patient management. Some data suggests that in uncomplicated patients, aortic specific survival is improved beyond 5 years in patients who undergo endovascular management compared with those who undergo best medical management.⁹ Long-term outcomes after TEVAR for dissection are related to successful thrombosis of the false lumen and aortic remodeling. Outcomes do appear to be improved in patients with a Type IIIA dissection due to improved complete thrombosis in this group.¹⁵

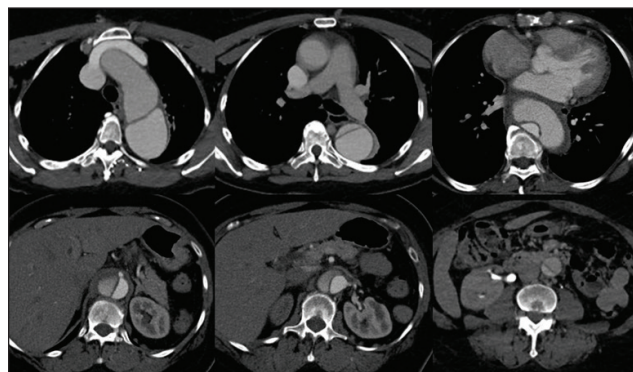


Figure 2. Chronic Type B aortic dissection extending from a tear just distal to the left subclavian artery down into the iliac vessels. Aneurysmal degeneration measuring 6.2 cm (false and true lumen) identified in the proximal descending thoracic artery.

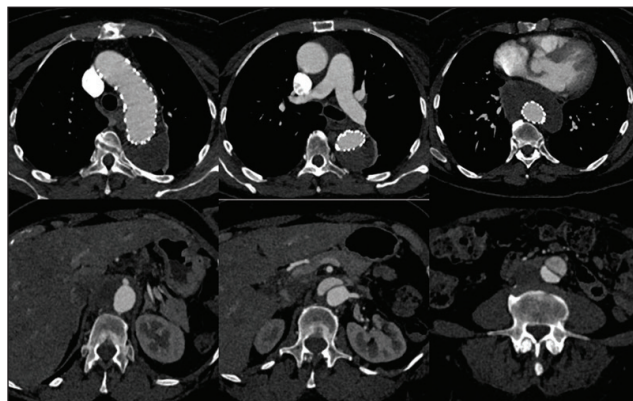


Figure 3. Chronic Type B aortic dissection after repair with a Conformable GORE® TAG® Thoracic Device from the left subclavian to the level of the celiac artery, with complete thrombosis of the false lumen behind the graft. Serial imaging with computerized tomographic angiography will continue to assess for any growth after repair in the thoracic aorta, and in the visceral and infrarenal aorta to ensure degeneration does not occur.

The risk of not intervening in uncomplicated Type B dissections includes the concern that medical management will not be optimal. However, even with best medical management, the dissection can potentially extend either proximally and/or distally, and aneurysm degeneration can occur which will make any repair more difficult. Furthermore, as the dissection propagates, further septal tears can develop that complicates thrombosis of the false lumen with subsequent intervention. A repair prior to the development of propagation that involves a simple endograft to cover a proximal tear will likely depressurize or cause thrombosis of the false lumen and minimize any further sequelae (Figures 2 and 3). With the delay in management, proximal extension of the dissection with aneurysmal changes make brachiocephalic vessel involvement a higher likelihood, which will require a branched endograft, extrathoracic debranching, or

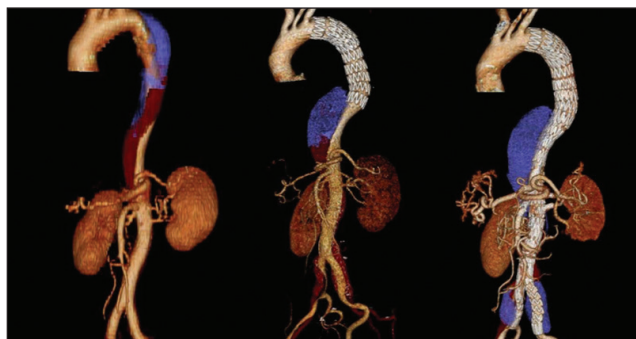


Figure 4. Acute Type B dissection extending to the common iliac vessels. The patient was initially treated for the acute dissection, but developed dilation in the visceral segment. The patient then underwent repair with a 5-vessel custom-made device with excellent result.

debranching from the ascending aorta. The risk to the patient is subsequently much higher with more invasive proximal intervention. The dissection can also propagate distally and develop aneurysmal degeneration into the visceral vessels. This will require fenestrated/branched devices for management of these patients which further increases the risk to the patient (Figure 4).

Drs. Crawford & Taylor, UMD: The benefits of stenting a dissection patient is that the aorta is stabilized. The true lumen expands while flow in the false lumen decreases. The goal is to achieve thrombosis of the false lumen.

In our experience, procedural complications and reintervention rates do not differ between complicated or uncomplicated patients. In general, we prefer to wait if possible until a subacute phase. We believe the risk of retrograde Type A dissection decreases as the acute injury and inflammation phase of a Type B aortic dissection passes. In our hands, we have not seen a flurry of procedural complications related to acute patients. The balance is far in favor of endovascular treatment. We see occasional extensions of dissections in acute patients, however, they are rare. For uncomplicated patients, any complication is important. Practitioners must be very vigilant of their own results when embarking on the endovascular treatment of uncomplicated dissections. A major complication rate of < 2% is a requirement in order to advance a practice centered on these patients. For chronic patients, continued perfusion of the false lumen is the major obstacle we encounter. We have begun to proactively use techniques (e.g., Knickerbocker, coil embolization) to promote false lumen thrombosis. As devices that can treat the visceral segment become commercially available (e.g., distal bare stents, GORE® EXCLUDER® Thoracoabdominal Branch Endoprosthesis [TAMBE]*), I think this problem might be better tackled. Nonetheless, we are very happy with our ability to treat chronic thoracic dissections using TEVAR.

*Caution: Investigational device. Limited by United States law to investigational use.

Acute dissections do very well. Our own results show a < 5% major complication rate (paraplegia and death) for this group, with excellent remodeling data. The uncomplicated group treated in the subacute phase does as good or better than the acute group and we attempt to push all patients into this timeframe when possible. Chronic patients have even fewer major complications, but with the caveat of some needing reinterventions for continued aneurysmal growth of the aorta.

The risks of not treating an uncomplicated patient are further expansion of the aorta and late aortic death. Untreated Type B aortic dissection can carry a mortality risk of 40% to 50% at 5 years. Good results can be obtained in patients who respond and adhere to blood pressure control regimens. At the Center for Aortic Disease in Maryland, we have a specialist solely dedicated to treat hypertension in our dissection patients. Follow-up is available and intense. However, compliance is strictly patient dependent, and without it, the best regimen will fail. We have seen a higher than expected proportion of patients back with early complications when treated conservatively. Large rapid growth and extension of the dissection are the most common modes of failure we observe. More importantly, in patients with focal aortic pathologies (intramural hematomas, penetrating ulcers, and chronic pseudoaneurysms) treated conservatively, we see a high failure rate (rupture, readmission for pain, conversion to full dissection). Because of this, we have become very aggressive in this patient population and we tend to treat a high proportion of asymptomatic patients with these pathologies.

What are the trade-offs between early and late treatment?

Drs. Knowles & Farber, UNC: The timing of management for Type B aortic dissections is a balance between the risks of early treatment including retrograde Type A dissection and the risk over time of further degeneration or development of worsening symptoms.¹ Wire manipulation in an early acute aortic syndrome can place the patient at risk for complications. The greatest risk in these patients is within the first few days, and decreases after 2 weeks. The longer the aorta has time to “cool down,” the less likely these complications are to occur. The early timing of repair must also be taken into consideration when assessing the ability to control the patient’s hypertension or improvement of any other symptoms such as limb, visceral, spinal cord ischemia, or rapid enlargement of an aneurysm. The patient should undergo serial imaging, and should undergo imaging with any change in status. Beyond 90 days the risk is unlikely to decrease any further. However, with more extensive delay, the risk of proximal and distal extension of disease with the requirement for a more invasive procedure goes up. This is especially true in patients with high-risk characteristics.

Drs. Crawford & Taylor, UMD: Our approach is guided by how the patient is doing clinically. We don't use days but rather clinical features to guide whether we treat a dissection or not. We look at this in a simpler way at our institution. Complicated and impending catastrophes get treated right away. High-risk uncomplicated patients with poor follow-up or evidence of in-hospital progression (we tend to rescan patients with high-risk features before considering discharge), get treated during index admission. Uncomplicated patients who are reliable and stabilize, or have high-risk features we treat between 2 weeks and 1 month. Otherwise, patients go into our chronic dissection pathway.

How does your center prepare to prevent potential complications such as stroke, paraplegia, and retrograde Type A aortic dissection?

Drs. Crawford & Taylor, UMD: There is a multidisciplinary approach to preventing these complications. For stroke prevention and prevention of retrograde Type A dissection, careful procedural practices are probably the most important. We use caution in the number of times we cross the arch of the aorta with a wire. Stiff wires are exchanged via a catheter and the tips of the wires are carefully monitored. We perform a transesophageal echocardiograph at the end of every case to access the ascending aorta and confirm there is not a retrograde Type A dissection. Clean wire and anticoagulation management are paramount for this issue. For paraplegia management, awareness of the problem is important. At the University of Maryland, we have a liberal spinal drain policy whereby more than 90% of our patients are treated with a spinal drain, especially for any case that requires a piece that is > 15 cm in length or if they have high-risk features (previous abdominal aortic aneurysm repair, aorto-iliac occlusive disease, coverage of T10 area and chronic renal failure) that place them at increased risk of spinal cord injury. Never is a spinal drain more needed than when we decide not to put it in in the first place. We also use neuromonitoring in every case. Post-procedure, all patients are extubated in order to make the neurological examination easier to perform. This we consider is a very important point. We have trained intensive care unit staff who can recognize spinal cord complications, which responds immediately with blood pressure management, additional drainage, and pharmacologic interventions.

Drs. Knowles & Farber, UNC: Our group carefully reviews each case to identify the timing of potential treatment. This is the first step in the avoidance of potential complications. If the patient has a complicated Type B dissection, and early treatment cannot be avoided, care and attention to detail during the procedure is prudent. Intravascular ultrasound and centerline reconstructive imaging should be used to assist in the appropriate sizing of endografts and for the identification of the true lumen. It is critically important to ensure the

leading edge of the prosthesis is in undissected aorta. Careful wire management skills and catheter exchanges can decrease the chance of a retrograde Type A dissection and stroke. Patients with brachiocephalic vessel involvement should undergo CTA imaging of the neck and head to assess collateral circulation and how repair will impact circulation. This imaging of the head and neck also assists in the evaluation of the need to revascularize the left subclavian artery if involved. We feel strongly about revascularization of the left subclavian artery in dissection cases, as typically a large amount of the thoracic aorta requires coverage with an endograft, or develops false lumen thrombosis, and the risk of spinal cord ischemia is higher with coverage of the left subclavian artery. The aggressive use of spinal cord drainage in these patients can decrease the risk of paraplegia, however it is rarely used in emergent malperfusion scenarios when it would result in a significant treatment delay.

What is your practice in dissection patient care and monitoring pre- and post-treatment?

Drs. Knowles & Farber, UNC: Patients with aortic dissections should be managed by physicians in facilities that have the infrastructure to handle the potential complications. Due to familiarity throughout the facility, the more dissections treated at an institution the better the outcomes. The use of spinal drainage should be considered in patients at risk for spinal cord ischemia, and depending on the facility can either be placed preprocedurally or expectantly. Protocols should be in place for emergent placement of a spinal cord drain if you elect to expectantly place them when symptoms arise. The ability to have expedited placement of these catheters needs to be able to occur 24 hours a day, 7 days a week. Any changes in the motor or sensory exam after TEVAR require rapid placement of a spinal cord drain if not already present with removal of cerebrospinal fluid and elevation of the mean arterial pressure > 80 mmHg. Up to approximately 30% of patients with dissection can exhibit ischemia to the spine, lower extremities, or viscera and care must be taken to identify and treat these patients.^{16,17} Patients undergo serial imaging with CTA to follow dissections before and after treatment. Serial imaging examinations should examine the chest/abdomen/pelvis as a whole, as well as an attention to portions of the aorta that did not have coverage of a stent graft, to check for progressive aneurysmal degeneration. Any changes in symptoms should necessitate a new CTA for further evaluation.

Drs. Crawford & Taylor, UMD: All our Type B aortic patients, whether treated with a stent graft or managed medically, are followed in a comprehensive aortic center. Our follow-up consists of a 2-week visit for wound checks and a CTA within 1 month. We add a 3-month scan in order to recognize early aneurysmal degeneration. This is followed by a 6-month and 1-year scan. A dedicated blood pressure

specialist concurrently sees patients and some are plugged into a transitional care program to monitor adherence to blood pressure control regimens. We view this as a lifelong disease state that requires lifelong surveillance. ■

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