

Understanding the Predictors of Aneurysmal Degeneration in Type B Dissection

A case example illustrating when early endovascular intervention may provide the best outcome.

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A patient presenting with a type B aortic dissection may be categorized into distinct dissection subcategories. These subcategory descriptions are acute complicated, acute uncomplicated, chronic de novo/classic, or residual type B dissection following surgical repair of a type A dissection. Current treatment options are best medical therapy (BMT), thoracic endovascular aortic repair (TEVAR), and open surgical repair.

TEVAR has been established as a valuable treatment option for patients presenting with complications, due to better outcomes, including reduced in-hospital and longer-term complications.^{1,2} Patients with complications such as organ malperfusion, limb ischemia, impending rupture, and periaortic bleeding carry a substantial risk of early mortality, with mortality rates of up to 9% under BMT.^{3,4} A review of these patients reveals that they have an increased in-hospital mortality of up to 35.4%. Increasingly, physicians are using TEVAR for patients with recurrent pain and refractory hypertension and are moving away from BMT alone. Overall, results achieved with TEVAR have been encouraging in patients with acute complicated type B aortic dissections.^{5,6}

However, controversy still exists around using TEVAR in patients with uncomplicated type B aortic dissections (Figure 1). According to current guidelines, BMT remains the recommended standard treatment for uncomplicated patients.¹⁻⁴ Despite the initial success of BMT in the acute management of uncomplicated type B dissections, long-term complications resulting from aortic degeneration, disease progression, and aortic-associated mortality remain a concern. A closer look shows that acute uncomplicated type B aortic dissection patients who are treated conservatively with BMT have a 10% 30-day mortality rate, with up to 25% of patients needing intervention within the first 4 years. Some studies indicate that 20% to 50% of patients with uncomplicated type B dissections will experience disease progression and eventually require intervention.^{7,8} Therefore, it is clear that these patients

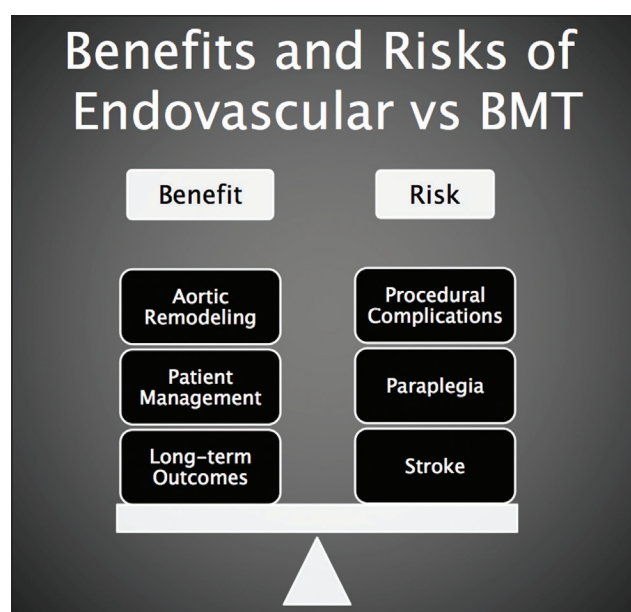


Figure 1. Balance of benefits and risks of endovascular therapy for type B dissections.

should be monitored closely for any development of complications or morphological changes that may require intervention.

One reason for intervention is aneurysmal dilatation. Estimated rupture rates of the false lumen rise to up to 30% once diameters reach 6 cm, with an associated mortality ranging from 20% to 40% within 5 years.⁷⁻¹⁰ Unfortunately, TEVAR in these progressive chronic type B dissections has been noted to be less effective with regard to aortic remodeling, which affects long-term patient outcomes.

Preoperative imaging of dissection patients can help identify impending rupture, recognize arterial compromise, and detect vulnerable anatomy, as this information may subsequently assist physicians in anticipating future complications. These predictive

TABLE 1. SUMMARY OF HIGH-RISK PREDICTORS OF DISEASE PROGRESSION IN TYPE B AORTIC DISSECTION

• Primary entry tear diameter ≥ 10 mm
• Primary entry tear location on the concavity of the thoracic aorta
• Total aortic diameter ≥ 40 mm
• False lumen diameter ≥ 22 mm
• Partial false lumen thrombosis
• Fusiform index ≥ 0.64

factors for progression and adverse events can help to identify high-risk patients who could benefit from early TEVAR rather than BMT alone. In other words, using imaging to predict a poor future prognosis could be very useful in selecting patients for whom more aggressive management may yield improved short-term and long-term outcomes.

Dake recently published a treatment algorithm for the assessment of all type B aortic dissections.¹¹ Within the algorithm, he consolidated several published high-risk predictors (Table 1) for late aortic events in acute uncomplicated type B dissection patients. Six high-risk factors were identified: (1) a primary entry tear ≥ 10 mm in diameter, (2) an entry tear located at the concavity of the distal aortic arch, (3) a maximum aortic diameter ≥ 40 mm with a patent primary entry tear site, (4) a large false lumen diameter ≥ 22 mm at the upper descending thoracic aorta, (5) partial false lumen thrombosis, and (6) a fusiform index ≥ 0.64 . Patients who fulfill one or more of these predictors may benefit from early intervention. At the very least, they should be closely observed.

Further evidence for another high-risk patient subgroup was recently published. In a 5-year, retrospective, single-center study on 164 uncomplicated type B patients, Lavingia et al concluded that volumetric analysis of the initial index CT scan is able to predict aortic growth and the need for future intervention.¹² A true lumen volume/false lumen volume ratio of < 0.8 was highly predictive for requiring an intervention.

The following case report illustrates the six literature-based predictors highlighted by Dake in one of our dissection patients. It is a retrospective evaluation of a patient who presented with an acute uncomplicated type B dissection. Morphological analysis was completed on the patient's initial presentation contrast-enhanced CT angiography (CTA). Each predictor was measured according to the originally published reference. The same analysis was conducted on the patient's 1-year



Figure 2. Initial preoperative three-dimensional VR-CTA scan showing a classic Stanford type B dissection from a left anterior oblique perspective.

follow-up CTA. The 1-year follow-up imaging allowed for tracking of disease progression/aneurysmal degeneration and for determining whether the patient could have potentially benefited from an early TEVAR intervention.

CASE REPORT

A 56-year-old man with a history of untreated arterial hypertension was admitted with a primary episode of chest pain in December 2009. An initial contrast-enhanced CTA was performed at the time of admission to the emergency department and revealed an acute uncomplicated type B aortic dissection (Figure 2). Otherwise, he reported to be in good health. The patient was enrolled in the Gore ADSORB Clinical Study (TAG 05-04)¹³ and was randomized to BMT only.

From the CTA at initial presentation, the primary entry tear size was measured on an axial slice. Evangelista et al demonstrated that large entry tears ≥ 10 mm (hazard ratio [HR], 5.8; $P > .001$) in proximal aortic locations are associated with false lumen expansion.¹⁴ On the initial

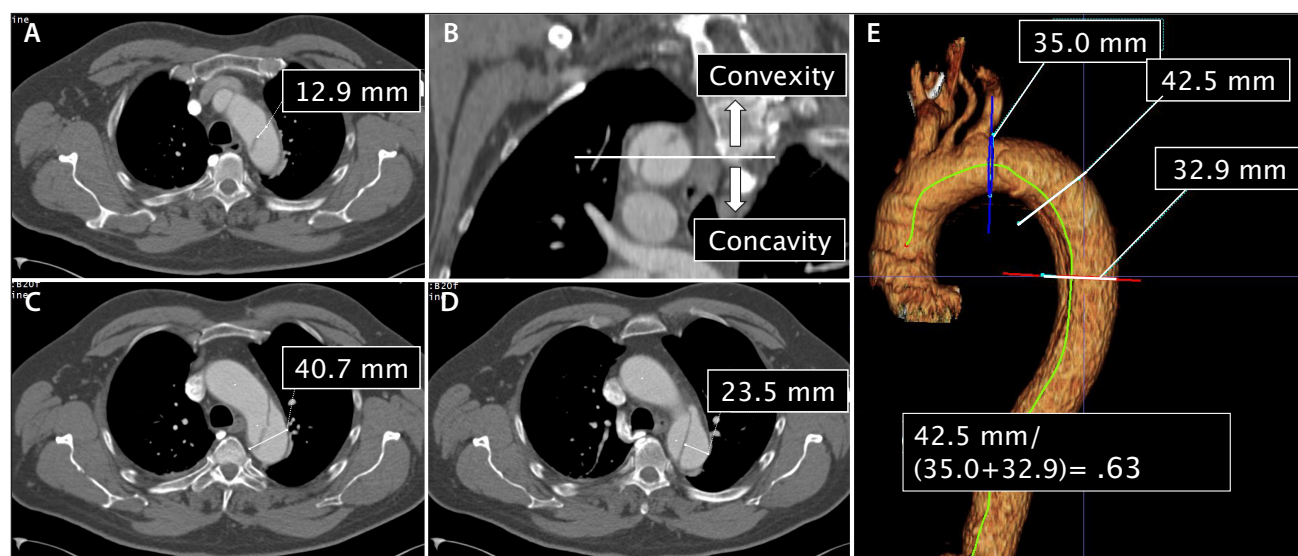


Figure 3. Measurements from our case based on predictors from the literature. At initial presentation, primary entry tear in zone 3 (A), primary entry tear location (B), total aortic diameter (C), false lumen measurement (D), and Marui fusiform index (E).

presentation of our patient, one slice captured a primary entry tear of 12.9 mm in zone 3, which was distal to the left subclavian artery (Figure 3A).

Defining an additional high-risk subgroup, Loewe et al showed that patients with a primary entry tear within the concavity of the aortic arch do have a significantly higher risk for primary complications compared to cases in which the primary entry site is located within the arch's convexity (convexity 21% vs concavity 61%; $P = .003$; HR, 1.8; 95% confidence interval [CI], 1–3.2).^{15,16} Our patient had the tear located on the convexity of the aorta (Figure 3B).

One of the well-established predictors for late aortic enlargement is the existence of a maximum total aortic diameter ≥ 40 mm during the acute phase ($P < .001$) with a patent primary entry site in the thoracic aorta ($P = .001$).¹⁷ The initial total aortic diameter near the level of the primary entry tear measured in our patient was 40.7 mm (Figure 3C).

In 2007, Song and colleagues published an article stating that a large false lumen diameter ≥ 22 mm at the upper descending thoracic aorta on the initial CT scan predicts late aneurysm dilatation with many more adverse outcomes warranting early interventions ($P < .001$).¹⁸ The measurement on initial CT for the reported patient was 23.5 mm (Figure 3D).

Marui et al developed a “fusiform index” that expresses the degree of fusiform dilatation of the proximal descending aorta during the acute phase of aortic type B dissection.¹⁹ The index is calculated by dividing the maximum total aortic diameter by the sum of the diameter of the proximal nondissected aorta (typically zone 2), and the total aortic diameter of the descending aorta at the pulmonary level. A fusiform

index of ≥ 0.64 is considered to be the threshold for late aortic events. In our patient, the fusiform index was 0.63 (Figure 3E).

At the 1-year follow-up CTA required for the Gore ADSORB Clinical Study, changes in all the aforementioned measurements could be observed (Figure 4). This patient's condition progressed with overall aortic growth (Figure 5). In addition, the false lumen now showed partial thrombosis in the distal thoracic aorta. Partial thrombosis of the false lumen, as compared with complete patency, is a significant independent predictor of post-discharge mortality (HR, 2.69; 95% CI, 1.45–4.98; $P = .002$).²⁰ The changes noted at 1 year indicate that the patient's aorta will likely continue to grow/deteriorate and require future intervention beyond BMT.

DISCUSSION

For any type B dissection patient, it is important to conduct a risk assessment at an early stage to determine the merits of medical, endovascular, or surgical intervention. In the acute phase of the disease, patients may present with clinical conditions characterized by absence of complications in almost 50% of the cases.²¹ However, despite initial stable conditions, these “uncomplicated” patients may develop complications and have an in-hospital mortality rate of up to 10%.²²

This case report is representative for a group of patients with acute uncomplicated type B dissection who could potentially benefit from early TEVAR. The identification of uncomplicated type B dissection patients who are potentially prone to future deterioration may enable the treating physicians to achieve better long-term outcomes by preemptive interventions. TEVAR results for dissection

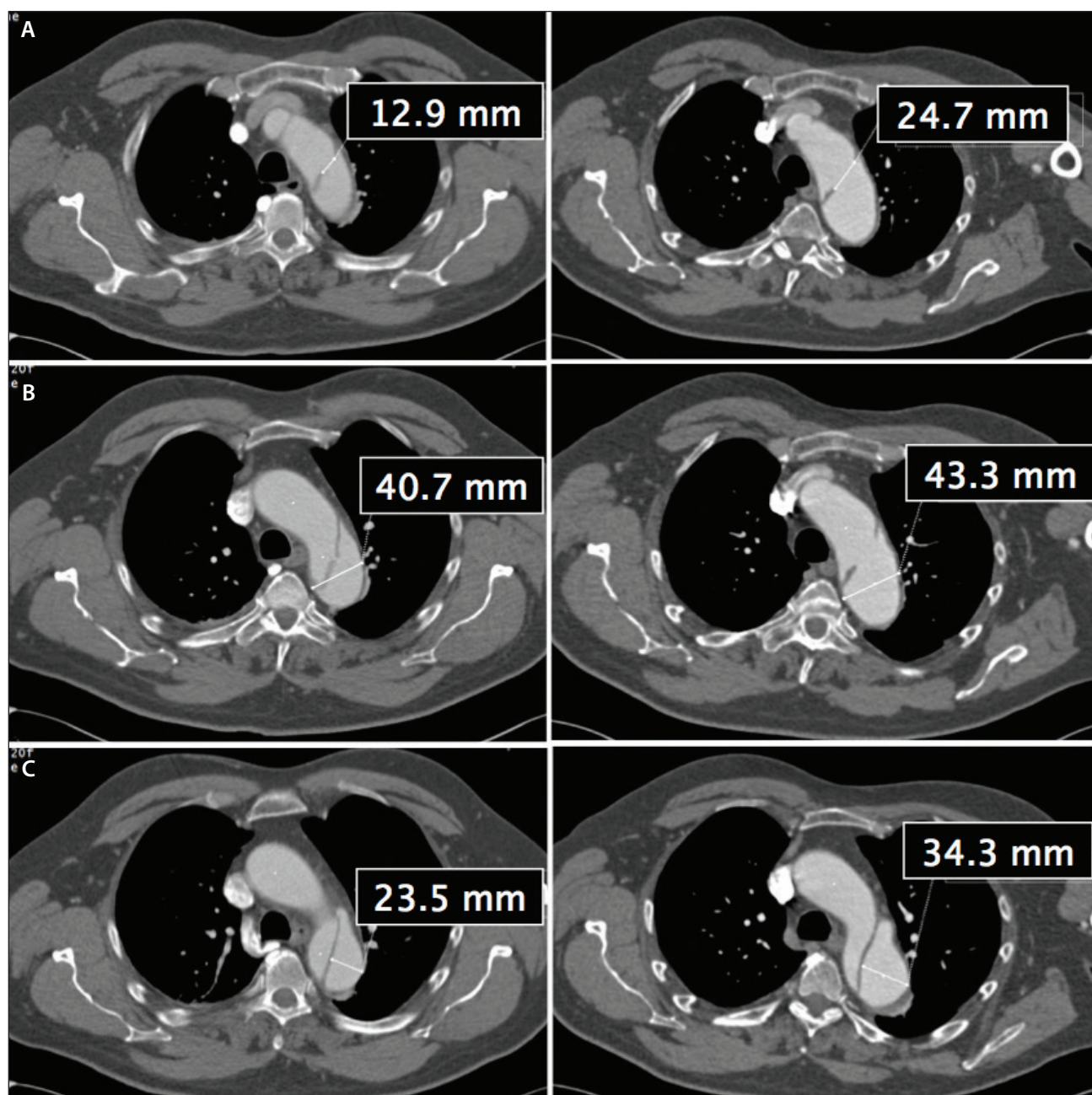


Figure 4. Initial CTA imaging (left panels) versus 1-year follow-up CTA (right panels) showing primary entry tear measurement (A), total aortic diameter (B), and false lumen measurement (C).

are promising and offer optimal aortic remodeling when performed in an acute setting.

Despite favorable results, the complications related to the procedure should be considered.⁸ Stroke is reported to occur in 3% to 10% of patients due to the manipulation of catheters in the arch/ascending aorta and is more common in patients with severe atherosclerosis in the aortic arch.²³ Although rare in dissection, spinal cord ischemia has been shown to be related to the extent of the covered aorta, previous aortic surgery, and hypotension at presentation. Arm

ischemia, paraparesis, and paraplegia may occur from branch vessel occlusion. In the case of intentional left subclavian artery coverage, revascularization of the left subclavian artery can prevent stroke, paraplegia, and/or death. Revascularization is recommended in stable patients.⁴ Retrograde type A dissection has been reported to occur in < 2% of patients, but it is associated with devastating clinical outcomes. There is also increased risk associated with balloon dilation, proximal bare stents, and rigid noncompliant devices.²⁴ Due to the previously mentioned complications, it is

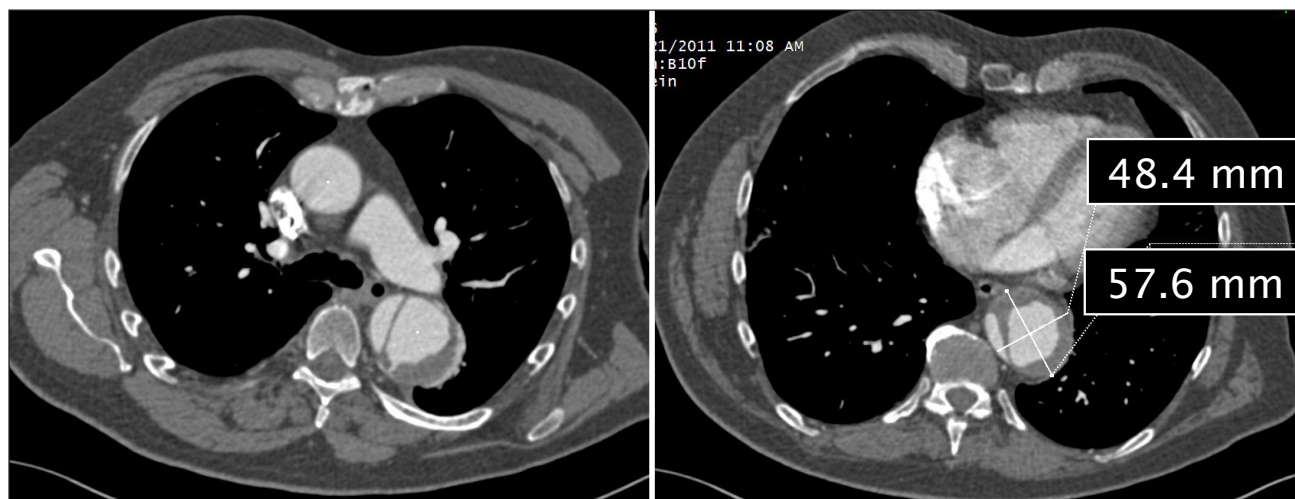


Figure 5. Partial thrombosis of the false lumen in the descending thoracic aorta.

necessary to carefully balance the benefits and risks when making clinical decisions.

Despite increasing evidence of good outcomes, questions remain open for debate in terms of which high-risk patients might benefit from early TEVAR. Is multiple device use for extended coverage necessary to achieve maximum aortic remodeling? What is the right timing for intervention and for optimal aortic remodeling after TEVAR?²⁵ Do we have the ideal stent-graft to conform to the challenging anatomy of type B dissections?²⁶ What is the optimal follow-up schedule for both conservatively as well as interventionally treated patients? And finally, which imaging technique is best?

CONCLUSION

In current clinical practice, endovascular stent-graft therapy is increasingly considered as an alternative to medical management alone for selected patients with acute uncomplicated type B dissection. Several groups have identified image-based predictive factors that correlate to high-risk patient subgroups. Once identified, these patients may benefit from earlier and more aggressive endovascular therapy. Further retrospective and prospective studies are needed to fully understand and confirm independent predictors of adverse outcomes.²⁷ As outcomes for these high-risk predictors are increasingly monitored, the importance and affect of each risk factor addressed in this systematic review will be elucidated. In summary, the trend continues toward early intervention in the management of acute uncomplicated dissection.²⁸ ■

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