Indications for stent grafts in type B aortic dissection

Aortic dissection is an uncommon, but highly lethal condition, with an estimated annual incidence of 20 cases per million.\textsuperscript{1,2} Around 0.5\% of all patients with chest or back pain suffer from aortic dissection or its precursors.\textsuperscript{3} Men are found to suffer from acute aortic dissection twice as often as women with 60\% of dissection cases classified as proximal (type A) and 40\% as distal (type B according to the Stanford classification).\textsuperscript{1} Dissection of the ascending aorta is associated with a mortality rate of 1–2\% per hour within the first 24 hours, resulting in a mortality rate of up to 50–74\% within the first 2 weeks.\textsuperscript{1} An uncomplicated acute type B dissection is less frequently lethal, with survival rates in medically treated patients of 89\% at 1 month, 84\% within 1 year, and up to 80\% within 5 years.\textsuperscript{1,5} However, patients with acute or late complications including malperfusion syndrome with renal failure, visceral or leg ischaemia, or contained rupture require urgent repair, especially when you consider a mortality rising to 20\% at day 2 and 25–50\% within 1 month.\textsuperscript{1} Similar to type A dissection, advanced age, rupture, shock and malperfusion are important independent predictors of early mortality in type B dissection.\textsuperscript{3}

While almost every patient with a type A dissection should be managed by open surgery, endovascular concepts have emerged as an alternative to manage aortic dissections, mainly distal thoracic aortic dissection. Conversely, for proximal dissection, endovascular approaches (thoracic endovascular aortic repair (TEVAR)) remain anecdotal for localised pathologies in patients unfit for open repair.

This article summarises results and recommendations for endovascular management of patients with type B aortic dissection.

Indications for TEVAR in type B aortic dissection

The natural course of aortic dissection is determined by two elements: early complications and chronic events. Early complications comprise any kind of malperfusion syndrome, persistent pains or aortic rupture, while late events are proximal progress or documented false lumen expansion with the risk for late rupture. Once a patient survives the first 2 weeks after impact of dissection, the dissection is, by definition, chronic. Acute and chronic dissections may both require similar medical treatment with primarily blood pressure control, but even acute dissections can be complicated or uncomplicated.

The feasibility and relative safety of TEVAR in descending thoracic aorta has already been established as an alternative to surgical treatment of type B aortic dissection.\textsuperscript{2,3} But due to the lack of both, randomised controlled trials and long-term follow-up data, the indications for endovascular strategies remain to be fully defined for dissection (Table 1).

There is clear observational evidence\textsuperscript{2,3,4} that depressurisation and shrinkage of the false
lumen is beneficial in acute dissection, ideally followed by complete thrombosis of the false lumen and remodeling of the entire dissected aorta (Figure 1). Similar to historically accepted indications for surgical intervention, scenarios such as malperfusion syndrome, intractable pain rapidly expanding false lumen to a total diameter over 55 mm or signs of imminent rupture are accepted indications for TEVAR in type B dissection.

Even in some cases of retrogradely extended distal dissections, stent-graft treatment of the descending thoracic aorta can also be performed as a single primary step or as a staged secondary step after initial surgical repair of the proximal part of the aorta or the arch; the surgical part may include an elephant trunk or transposition of arch vessels to allow extended landing zone for endovascular completion of such a hybrid approach. In the case of a localised retrograde type A dissection originating from an entry tear in the descending thoracic aorta, this entry can sometimes be sealed by a transfemoral stent-graft with subsequent remodeling of the entire dissected aorta. With TEVAR, paraplegia was documented in 0.8%, but, is obviously associated with extensive coverage of the aorta beyond 20 cm and with the use of multiple stent grafts, or in previously replaced infrarenal aortic aneurysm.

**Surgical**
- Type A aortic dissection
- Acute type B dissection complicated by:
  - Retrograde extension into the ascending aorta
  - Dissection in fibrillinopathies (e.g. Marfan syndrome, Ehlers-Danlos syndrome)

**Medical**
- Uncomplicated acute type B dissection
- Stable isolated aortic arch dissection
- Chronic type B dissection (under evaluation)

**Interventional**
- Unstable acute type B dissection:
  - Malperfusion
  - Rapid expansion (> 1 cm/year)
  - Critical diameter (> 5.5 cm)
  - Refractory pain
- Aortic dissection due to blunt chest trauma
- Hybrid procedure for extended type A aortic dissection

**Table 1**
Distribution of differential therapeutic strategies in aortic dissection

**Fig. 1**
A) Type B dissection originating from the aortic arch
B) One year follow-up evaluation after TEVAR revealed a thrombosed false lumen and a normalisation of the true lumen diameter
Complicated acute type B aortic dissection

While patients with stable acute type B dissection should be managed medically, about 30–42% of acute type B aortic dissection are complicated, as evidenced by haemodynamic instability or peripheral vascular ischaemia. Among other complications, acute lower limb and visceral ischaemia have been reported in 30–50%; malperfusion syndrome occurs frequently in cases of distally extended dissections and may lead to death in 50–85% if left untreated. During necropsy of 18 patients with type B dissection, full compression of the true lumen with aortic obstruction was evident in 56%. Once diagnosed, these complications require emergent therapeutic action; despite a wide array of open surgical strategies, surgical mortality for patients with acute aortic dissection complicated by renal ischaemia has been reported in 50%, and, in the case of impaired mesenteric perfusion, even up to 88%. Different treatment strategies, however, may impact on survival; in 571 patients with acute type B aortic dissection, 390 (68.3%) were treated medically; among complicated cases, 59 (10.3%) underwent standard open surgery, and 66 (11.6%) were treated with an endovascular approach. In complicated cases, in-hospital mortality was significantly lower with TEVAR (10.6%) than after open surgery (33.9%; p=0.002), approaching the survival rate of medically treated uncomplicated type B dissection. Therefore, stent-graft repair is an attractive alternative to surgical repair for correcting ischaemic complications.

Usually, TEVAR-mediated sealing of the entry site in the descending thoracic aorta results in thrombosis of the false lumen and redirection of flow to the true lumen, normalising distal vessel perfusion and restoring branch vessel patency (Figure 2). The PETTICOAT concept takes the idea even further by extending...
the stent-graft scaffold distally with open-cell bare metal stents. For instance, if malperfusion persists after coverage of the primary entry tear, additional distal open stents were deployed until distal malperfusion is corrected. With this concept, aortic fenestration maneuvers or branch vessel revascularisation with uncovered stents are usually not needed and obsolete.

The EUROSTAR/United Kingdom registry represents a large series of patients subjected to TEVAR, including 131 patients with aortic dissection (5% proximal, 81% distal and 14% not classified), of which 57% presented with symptoms of rupture, aortic expansion, or side branch occlusion, all considered complicated dissection. Although meaningful long-term data are still lacking, technical success was achieved in 89%, at the expense of a 30-day mortality of 8.4%. A series of patients at the Arizona Heart Institute, comprising 40 patients (23 acute and 17 chronic) treated with TEVAR for complicated distal aortic dissection, enjoyed a technical success in 95%. There was one perioperative death due to iliac rupture and one case of paraplegia, while 15 patients (38%) experienced transient post-procedural complications frequently of a transient renal or pulmonary nature; 1-year survival was 85%. Of the patients available for follow-up CT, 97% (30 of 31 patients) exhibited a stable or decreasing aortic diameter and no rupture during the observational period, justifying the conclusion that thoracic aortic stent grafting obviously stabilised the aorta and decreased the incidence of late expansion and rupture. Such observations were confirmed in a meta-analysis in patients subjected to TEVAR for aortic dissection. Procedural success was obtained in 98.2% of 609 cases, with an in–hospital surgical conversion rate of 2.3% and mortality rate of 5.2%. Complications such as retrograde extension of the dissection into the ascending aorta were reported in 1.9%, with neurological complications in 2.9%. Both 30-day mortality rate and in-hospital complications were more frequent with TEVAR for acute complicated aortic dissection than in patients with chronic aortic dissections (9.8% vs. 3.2%, and 21.7% vs. 9.1% respectively; p<0.05). Interestingly, a comparison between endovascular treatment of complicated type B aortic dissection with medical therapy of uncomplicated type B dissections in 56 patients, with follow-up of 18.1±16.9 months, reported similar outcomes in both groups, with better remodelling of the descending thoracic aorta in the stent-graft group; no paraplegia and no differences in the 5-year survival rate (86.3% in both groups) were found.

**Chronic type B aortic dissection**

The evolution from acute to chronic dissection involves progressive fibrosis and hardening of the intimal flap. In addition, more intimal tears are reported in chronic versus acute type B aortic dissection. Average growth rate of chronically dissected distal aorta is estimated to range from 0.1–0.74 cm per year depending on both the initial aortic diameter and the state of hypertension. Unfortunately, long-term outcomes of medical therapy alone is suboptimal, with a reported 50% mortality at 5 years and delayed expansion of the false lumen in 20–50% of patients at 4 years. Expansion of the false lumen over 4 cm in diameter and persistent perfusion of the false lumen are considered predictors of aortic rupture and death. There is consensus that TEVAR should be considered when aortic diameter exceeds 55–60 mm, there is an increase of recurrent thoracic pain, or in the presence of uncontrolled blood pressure and rapid growth of the dissecting aneurysm (> 1 cm per year; Figure 3).
Entry closure and complete thrombosis of the false lumen at 3 months were achieved in all patients. Stent-graft treatment resulted in no morbidity or mortality, whereas surgical treatment resulted in 4 deaths (33%; p=0.04) and 5 adverse events (42%; p=0.04). Similar results were obtained by Kato et al in a series of 15 patients with no mortality during a follow-up of 2 years. Eggebrecht et al investigated the clinical outcome of 38 patients with type B aortic dissection (10 acute and 28 chronic). Following TEVAR, results showed lower in-hospital mortality and a trend towards better 4-year survival rate in patients with chronic aortic dissection. However, prophylactic implantation of stent graft in patients with chronic type B aortic dissections was not superior (in terms of mortality) to efficient medical treatment with 2 years of follow-up in the INSTEAD trial.

**Traumatic aortic dissection**

Blunt aortic injury is not infrequent and 20% of cases are associated with motor vehicle accidents or deceleration trauma; pre-hospital mortality ranges between 80–90%. Without appropriate treatment, 30% of survivors who reach the hospital die within the first 6 hours. Blunt thoracic aortic injury involves the aortic isthmus, in 55–90%, the ascending aorta or aortic arch in 10–14%, and the distal descending or abdominal aorta in 15–30%. Aortic disruption is associated with other life-threatening injuries most of the time (90%), with 24% requiring major surgery before aortic repair. In this scenario, with open-surgical mortality and paraplegia occurring in 20–54%, surgery is being replaced by endoluminal stent-graft therapy, with markedly lower mortality and morbidity, completely avoiding thoracotomy, single lung...
ventilation and heparinisation. 26,27 Marcheix et al reported a primary success rate of 100% in 33 patients with aortic rupture with complete healing 1 month after TEVAR in all patients with complete reconstruction of the aortic wall and no residual pseudoaneurysm. 28 The diameter of the aorta shrunk over the stent-graft without any signs of paraplegia during a mean follow-up of 46 months. 28

Recently, a comparative meta-analysis reviewed outcomes of 699 patients referred for endovascular or open repair surgery after traumatic aortic transsections. With a technical success rate from open repair (96.5% vs. 98.5%; p=0.58), TEVAR (n=370) was associated with both lower periprocedural mortality (7.6% vs. 15.2%; p=0.076) and lower incidence of paraplegia (0% vs. 5.6%; p=0.001) and stroke (0.85% vs. 5.3%; p=0.0028). 29

On aggregate, based on the available evidence, TEVAR has become a clear therapeutic option for complicated acute distal dissection, for traumatic aortic injury with impending rupture and for selected cases of chronic dissection with emerging signs of imminent late complications.

**REFERENCES**


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