

Development of an Integrated Stent Graft–Dacron Prosthesis for Intended One-Stage Repair in Complex Thoracic Aortic Disease

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Complex thoracic aortic disease involving the ascending aorta, the aortic arch and the descending aorta still represents a challenge for the cardiothoracic surgeon. The classic approach for this pathology consists of a two-stage strategy, summing up to a mortality up to 40%, with a 5% mortality for the waiting period between both surgical stages [1–3].

One-stage repair can be performed, if required, via a clamshell thoracotomy, but is associated with major surgical trauma and perioperative morbidity as pulmonary or renal dysfunction, indicating that elderly patients probably are poor candidates for this strategy [4].

With the introduction of endovascular stenting in combination with classic aortic arch surgery an attractive treatment alternative has emerged for facilitated repair of complex aneurysmal disease in the thoracic aorta [5, 6]. Modifying this new technique using self-expanding descending aortic stent grafts and the classic ascending and aortic arch replacement techniques seems to be the logical consequence for intended one-stage repair, which was started by our group 06/2001 [7, 8].

Standard thoracic aortic stent graft devices (e.g., Medtronic Talent®, Minneapolis, MN,

USA) are designed for retrograde aortic delivery, which demonstrate shortcomings for the antegrade use: their stiffness limits steerability, causing problems to pass the angle between the distal aortic arch and proximal descending aorta, resulting in significant friction to the inner aortic wall. This is worsened by the stiff outer plastic sheath which frequently shows kinking when curved > 45°. The most rigid zone is identified to be at the proximal border between stent graft and tip of the introducer and at the distal site between stent graft and the wire-reinforced inner pusher, limiting continuous and precise stent graft opening. At that point the already opened distal bare springs only allow for minor correction in proximal direction in case of displacement.

A second significant problem is caused by the longitudinal wire (connecting bar), which is positioned along the outer curvature of the stent. This force provokes the stent to straighten up resulting in a significant protrusion of the proximal bare springs into the aortic wall.

To overcome those shortcomings, a new integrated stent graft-Dacron prosthesis for antegrade delivery through the open aortic arch into the descending aorta in an “elephant trunk”-like manner was created. This “Essen I prosthesis” (E-vita open; Jotec®, Hechingen, Germany [Figure 1]) consists of a polyester fabric with an extremely flexible Nitinol wire skeleton, fixed on the outer aspect of the fabric with polypropylene sutures. To increase flexibility, a longitudinal wire is abandoned, and no open bar ends or reinforced circular springs are incorporated distally or proximally. At the proximal end, a woven crimped vascular Dacron prosthesis of 7 cm length is incorporated continuously to the stent graft prosthesis, allowing for direct replacement of the aortic arch without an additional anastomosis like in classic elephant trunk operations, by simply pulling back the invaginated Dacron prosthesis at its sewn suture sling into the arch position. Stent graft re-



Figure 1. Picture of Essen I prosthesis and application set.

Abbildung 1. Darstellung der entfalteten, integrierten Dacron-Stentgraft-Prothese und des Applikators mit abgegründeter Spitze und Führungsdraht.

lease is realized as a pullback system introduced over the previously placed guide wire from the femoral artery. To reduce release forces to a minimum, the stent graft is covered by a thin textile cover sheath only. For unhampered intravascular advancing, the tip of the delivery system is made soft and rounded.

Out of 17 patients in total, the last three patients (mean age 60 years, range 42–73 years) received the newly designed integrated stent graft-Dacron prosthesis for chronic type A dissection (n = 1) and aneurysmal disease (n = 2). Written informed consent was obtained by all patients according to the protocol approved by the institutional review board of the Essen University Hospital.

Preoperatively, all patients underwent spiral computed contrast tomography (CCT), fluoroscopic aortography and transesophageal ultrasound investigation (TEE) to determine the exact aortic dimensions for precise stent graft sizing. Coronary angiography (CA) was routinely performed.

Surgery was performed with extracorporeal circulation (ECC) and hypothermic circulatory arrest (HCA) at 24 °C core temperature, with selective antegrade cerebral perfusion (SACP).

Stent graft implantation was performed in all patients in over-the-wire technique. A 0.0035-inch stiff backup Meier guide wire (Boston Scientific Corp., Boston, MA, USA) was placed via the femoral artery into the distal aortic arch under X-ray control.

After resection of the ascending aorta and supra-avalvular replacement with Dacron prosthesis, the aortic arch was opened and resected. Then the new device was introduced into the descending aorta guided by the previously placed femoro-aortic guide wire. Thereafter, the anastomosis between the most proximal (5 mm) rim of the slightly pulled back Dacron prosthesis and the transected descending aorta was constructed. After full retraction of the Dacron prosthesis into the arch position, the island anastomosis to the head vessels was performed, as well as the anastomosis to the supraannular ascending aorta prosthesis.

During whole-body reperfusion, TEE and Doppler flow control was performed to reassure correct placement of the stent graft and, in case of aortic dissection, to determine the flow conditions in the true and false lumen (Figure 2).

In all three patients treated with the new prosthesis, the ascending aorta, the arch and the descending aorta were replaced with the integrated stent graft-Dacron prosthesis. Deploy-

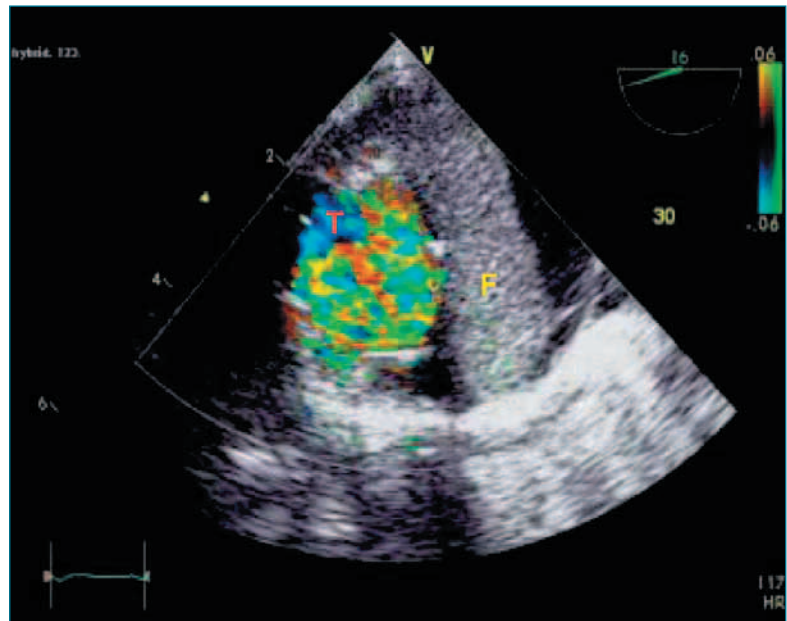
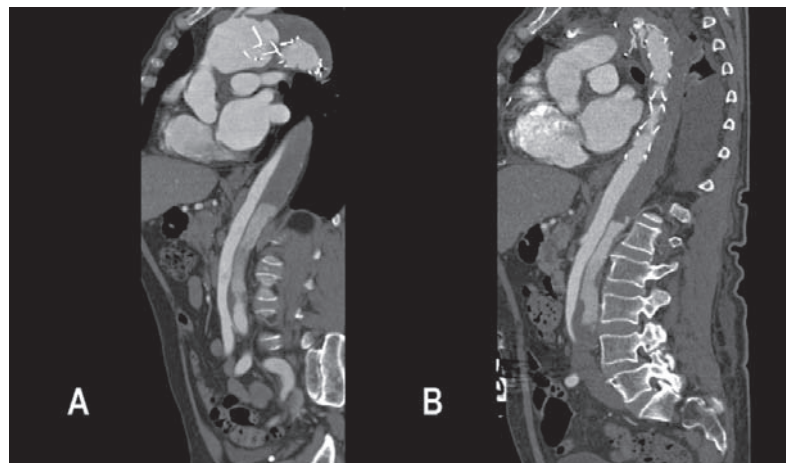


Figure 2. Chronic type A dissection: transesophageal ultrasound demonstrating thrombosis of the false lumen (F) 12 min after protamine sulphate administration. Normal antegrade flow patterns are only detected within the stent graft (T).

Abbildung 2. Chronische Typ-A-Dissektion: Im TEE zeigt sich die Thrombosierung des falschen Lumens (F) 12 min nach Protamingabe. Normale antegrade Flusssignale ausschließlich durch das Stentgraft (T).



Figures 3A and 3B. 70-year-old male. A) Stent-induced aneurysm of the aortic arch with a diameter of 60 mm and an endoleak at the distal end of the stent. Chronic type B dissection after retrograde stenting of the descending aorta 21 months before and thrombin injection into the persisting false lumen 19 months before. B) Result of the operative replacement of the distal ascending aorta and the aortic arch with antegrade stenting of the descending aorta with the new prosthesis.

Abbildungen 3A und 3B. 70-jähriger Patient. A) Stentinduziertes Aortenbogenaneurysma mit 60 mm Durchmesser und Endoleak am distalen Stentende bei z.n. retrogradem Stenting einer chronischen Typ-B-Dissektion vor 21 Monaten und Thrombininjektion in das persistierende falsche Lumen vor 19 Monaten. B) Ergebnis nach operativem Ersatz der distalen Aorta ascendens und des Aortenbogens sowie antegradem Stentgrafting der Aorta descendens mit der neuen Kombinationsprothese.

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ment of the stent graft in the descending aorta could be done with ease and good steerability. The underlying pathology – chronic type A dissection, true aneurysmal disease and aneurysmal disease with proximal descending walled off rupture – was eliminated in all three patients in one stage.

All patients had an uneventful recovery. Follow-up protocol schedules the patients to a TEE and CT scan restudy after 3, 6, 12, and 24 months, thereafter annually (Figures 3A and 3B).

Although long-term results are still missing, we do believe that the integration of the classic open technique with the stent graft technology opens up a promising method toward intended single-stage therapy of complex thoracic aortic disease.

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