Expanding the indication for stent-grafting in thoracic aortic aneurysms

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Abstract

Background: Thoracic aortic aneurysms are life-threatening and continue to challenge surgeons. In recent years, transluminally placed endovascular stent-grafts have been used for a variety of descending aortic pathological conditions.
Material and methods: We report herein on two cases of thoracic aortic pathologies that have been treated with a combined surgical and endovascular procedure. The first case deals with a 71-year-old man who was admitted for severe chest pain 3 weeks after off-pump triple coronary bypass grafting. CT revealed a dissection in the ascending aorta. The second case involves a 74-year-old patient with an aortic arch aneurysm 7 cm in diameter. Annually performed CT scans revealed a rapid progression of the aneurysm with a growth rate of over 1 cm in the last year. Besides his age, the patient had significant comorbidities
Results: Both cases were treated successfully with stent-grafts. In the first case, the stent was introduced through a Dacron-graft and deployed under transesophageal echocardiography (TEE) control in the ascending aorta, right above the two proximal vein anastomoses. This led to the reapproximation of the intimal and medial layer. Blood flow to the bypass veins was unaffected and flow in the false lumen could be stopped as confirmed by TEE. The second case had a double transposition of the great arteries before the stent-graft intervention and a stent-graft was inserted into the aortic arch and deployed overstenting the left subclavian artery. The post procedural performed angio showed no sign of endoleak.
Conclusion: Stent-graft placement is a viable option in highly selected patients with aortic aneurysms or dissections.
Key words: aortic aneurysm, aortic arch aneurysm, aortic dissection, stent-graft.

Streszczenie

Wstęp: Tętniaki aorty piersiowej są jednostką chorobową obciążoną dużą śmiertelnością i wciąż stanowią duże wyzwanie dla chirurgów. W ostatnich latach stenty wewnątrznaczyniowe coraz częściej są używane do leczenia szerokiego zakresu patologii aorty.
Materiał i metody: W poniższej pracy prezentujemy 2 przypadki patologii aorty piersiowej, które były leczone metodą łączoną – za pomocą operacji i zabiegu wszczepienia protezy wewnątrznaczyniowej. Pierwszy przypadek opisywany w naszej pracy to 71-letni pacjent, który trafił do szpitala z nasilonym bólem w klatce piersiowej 3 tyg. po przeprowadzonej operacji OPCAB ze wszczepieniem 2 żylnych pomostów aortalno-wieńcowych i lewej tętnicy piersiowej wewnętrznej. Badanie tomografii komputerowej (CT) wykazało rozwarstwienie w aorcie wstępującej. Drugi chory to 74-letni mężczyzna z tętniakiem łuku aorty o średnicy ponad 7 cm. Wykonywane u chorego w ostatnich latach badania CT wykazały postępujące powiększanie się średnicy tętniaka z przyrostem rocznym ponad 1 cm. Poza wiekiem pacjent charakteryzował się obciążającym wywiadem chorobowym.
Wyniki: W obu przypadkach z powodzeniem zastosowano stentgrafty. W przypadku pierwszego chorego pod kontrolą TEE wprowadzono stent, umieszczając go w aorcie wstępującej tuż powyżej odejścia proksymalnych zespoleń żylnych. To pozwoliło na zbliżenie do siebie warstwy wewnętrznej i środkowej ściany aorty. Przepływ w pomostach żylnych został zachowany, a rzekome światło rozwarstwionej aorty zostało zamknięte, co potwierdzono w badaniu TEE. W przypadku drugiego pacjenta wykonano transpozycję wielkich naczyń łuku aorty, a w drugim etapie pod kontrolą radiologiczną założono stent-graft do łuku aorty, zamykając ujście lewej tętnicy podobojczykowej.
Wnioski: Stentowanie aorty wstępującej i łuku może być skuteczną metodą leczenia u wybranych chorych z rozpoznaniem tętniaka aorty.
Słowa kluczowe: tętniak aorty, tętniak łuku aorty, rozwarstwienie aorty, stentgraft.

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Introduction

Thoracic aortic aneurysms are life-threatening and continue to challenge surgeons. Surgical repair with a prosthetic vascular graft is the traditional therapy for patients with thoracic aortic aneurysms. Although there have been remarkable improvements in treatment as a result of technical advances and improved prosthetic grafts, operative mortality remains high [1-3].

The conventional operation is still associated with substantial morbidity, chiefly related to major thoracotomy, use of cardiopulmonary bypass, and postoperative complications including bleeding, paraplegia, stroke, renal insufficiency, and need of prolonged ventilatory support [4].

The success of the first use of endovascular stent-graft placement in an abdominal aortic aneurysm [5] prompted investigation into the feasibility of thoracic aortic aneurysm repair with transluminally placed endovascular stent-grafts for a variety of descending aortic pathological conditions such as complicated type B dissections, aortic rupture, and penetrating ulcers [6, 7].

Recently, combined repair of aortic arch aneurysms by sequential transposition of the supraaortic branches and consecutive endovascular stent-graft placement has been reported [8]. Furthermore, percutaneous stent-graft placement in the ascending aorta as primary treatment for an intramural hematoma of the ascending aorta has been described [9, 10]. We report herein on two cases of thoracic aortic pathologies that have been treated with a combined surgical and endovascular procedure.

Case 1

A 71-year-old man was admitted for severe chest pain 3 weeks after off-pump triple coronary bypass grafting (LIMA – LAD, SVG – OM1, SVG – DIAG, 2 proximal anastomoses). The electrocardiogram showed no symptoms of coronary ischemia or myocardial infarction. Furthermore, all biochemical markers such as CK, CK-MB and Troponin were within the normal range at the time of admission. A spiral computed tomographic (CT) scanning (Figure 1) of the chest was performed, demonstrating a dissection confined to the ascending aorta. The entry tear was identified in the proximal ascending aorta starting right above the level of the proximal vein anastomoses. There was no blood in the mediastinum and pericardium.

Because of the overall reduced physical status and multiple co-morbidities such as hepatic cancer, hypertension and diabetes, the patient was deemed to be at high risk for ascending aortic replacement in profound hypothermic circulatory arrest. Therefore the decision was made to place a stent into the ascending aorta and after written informed consent was obtained, the patient was admitted to the hospital the same day under hemodynamically stable conditions.

The procedure was performed in the operating theater, as there is no interventional radiology department in our hospital. With the patient under general anesthesia and after administration of 5000 IU of heparin, the right common carotid artery was exposed and tangentially clamped. Thereafter, an 8 mm Dacron-graft was sutured end-to-side to the vessel. Attempts were made to place a guide wire under transesophageal echo (TEE) control through this graft into the ascending aorta. However, this approach was unsuccessful, with the guide wire going repeatedly down the descending aorta. For this reason, the Dacron-graft into the carotid artery was ligated, the wound closed, and a second attempt was made through the ascending aorta. After a repeat median sternotomy and removal of all adhesions from the first surgical procedure the ascending aorta was partially clamped just below the level of the two proximal vein anastomoses at an area not affected by atherosclerosis and the 8 mm Dacron-graft was sutured end-to-side to the ascending aorta. The only stent available at this time in our hospital for this procedure was an uncovered Gianturco Vena Caval Z-Stent (Cook, Bloomington, IN, US, Figure 2).

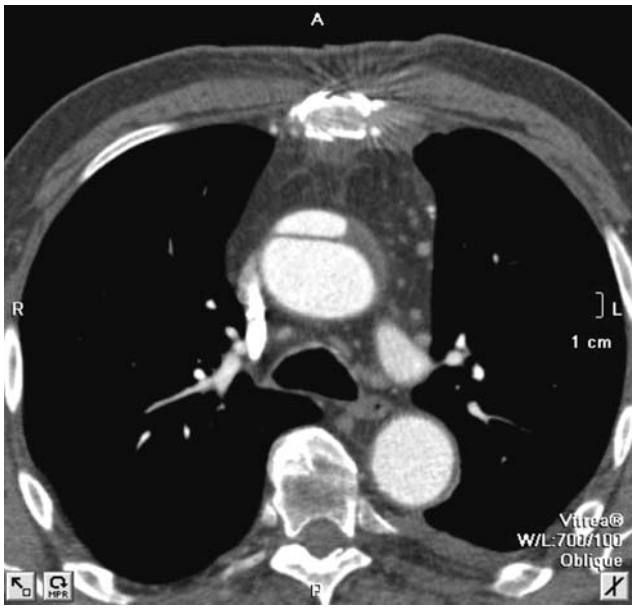

Fig. 1. Preoperative CT scan demonstrating type A dissection

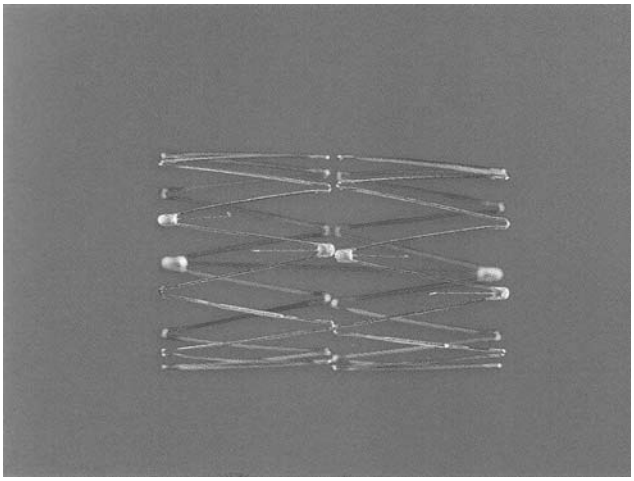

Fig. 2. Postinterventional CT scan demonstrating proper position of the stent

This stent was introduced through the Dacron-graft and deployed under transesophageal echocardiography (TEE) control in the ascending aorta, right above the two proximal vein anastomoses. This led to the reapproximation of the intimal and medial layer. Blood flow to the bypass veins was unaffected and flow in the false lumen could be stopped as confirmed by TEE.

The patient recovered in the intensive care unit and was extubated one day after the procedure. He was transferred to the regular ward on postoperative day 3 and discharged from the hospital 6 days later. A follow-up spiral CT angiogram showed a regular stent position in the ascending aorta between the ostia of the vein-grafts and the brachiocephalic trunk (Figure 3).

Case 2

A 74-year-old male patient was admitted to our Department with an aortic arch aneurysm 7 cm in diameter. Annually performed CT-scans revealed a rapid progression of the aneurysm with a growth rate of over 1 cm in the last year (Figure 4). Besides his age, the patient had significant comorbidities such as diffuse coronary artery disease with consecutively low left ventricular ejection fraction and hypertension. Accordingly, conventional surgical repair of this aortic arch aneurysms during deep hypothermic circulatory arrest was deemed unsuitable in this high-risk patient.

Preoperative evaluation and surgical approach

Preoperative evaluation was made by multisclice computed tomographic scans to exclude major occlusive disease of the supra-aortic branches as well as the aorto-iliac axis for later arterial access of stent-graft insertion and also to be sure that a sufficient proximal neck of at least 2 cm along the lesser curvature of the aortic arch would be available after double transposition. A median sternotomy approach was used and the pericardium was opened. After systemic heparinization with 10,000 IU, the ascending aorta was partially clamped and a bifurcated prosthesis was sewn end-to side to the ascending aorta. The tangential clamp was removed and placed above the performed anastomosis. Then the left common carotid artery was dissected free and clamped. The first leg of the bifurcated graft was sewn end-to-side to the left common carotid artery. The vessel was then transversely divided and the proximal portion was closed with a 4-0 Prolene running suture (Ethicon, Inc, Somerville, NJ). Blood flow was reestablished through this graft after deairing. Consecutively, the brachiocephalic trunk was partially clamped, and the second leg of the bifurcated graft was anastomosed end-to-side to the brachiocephalic trunk. Blood flow was reinstalled after flushing and removal of air (Fig.5) Due to the large extent of the aneurysm, the left subclavian artery was hard to reach and we decided not to transpose this vessel to the left carotid artery. After chest tube insertion, the wound was closed in layers.

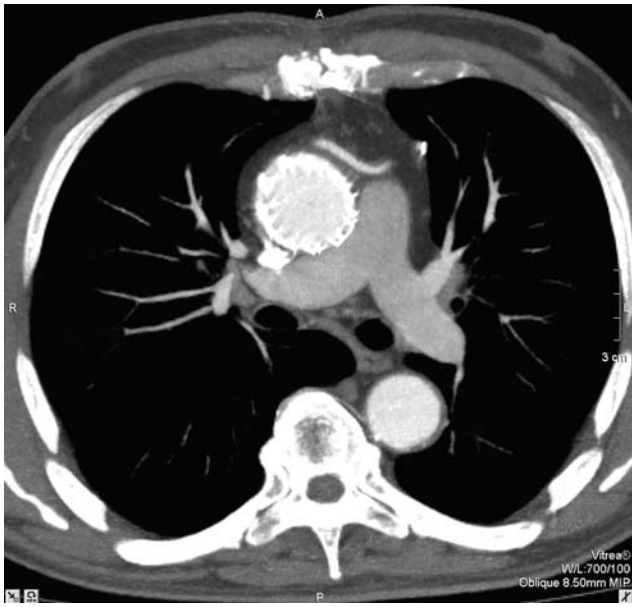

Fig. 3. Zenith stent

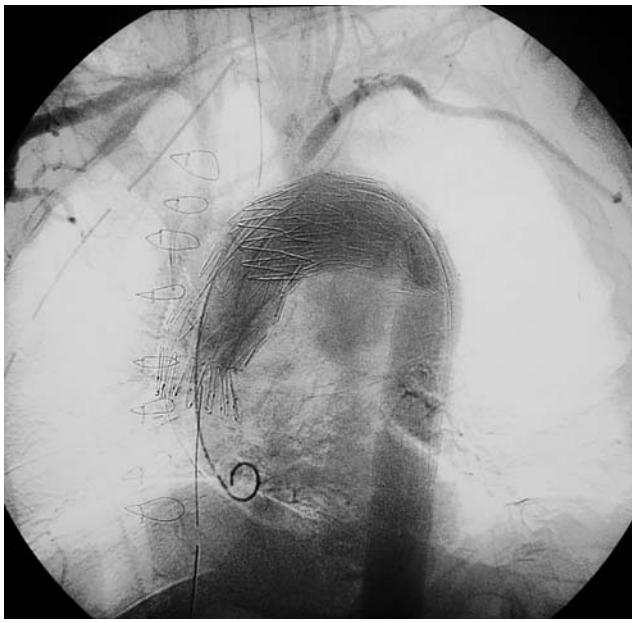

Fig. 4. Preoperative CT scan

Stent-graft placement

After the surgical procedure was completed, the patient was taken immediately into the interventional radiology suite. Vascular access was made through the right common femoral artery. Initially a 5 French pigtail catheter was advanced through the right brachial artery into the aortic arch to reconfirm characterization of the morphology and the extent of the aneurysm. After systemic heparinization with 5,000 IU, an arteriotomy was performed, and the delivery system was advanced under fluoroscopic guidance. In this case, a Zenith TX2 TAA endovascular stent (15cm in length, 42 mm in diameter) was used. Afterwards, the stent-graft was inserted into the aortic arch and deployed

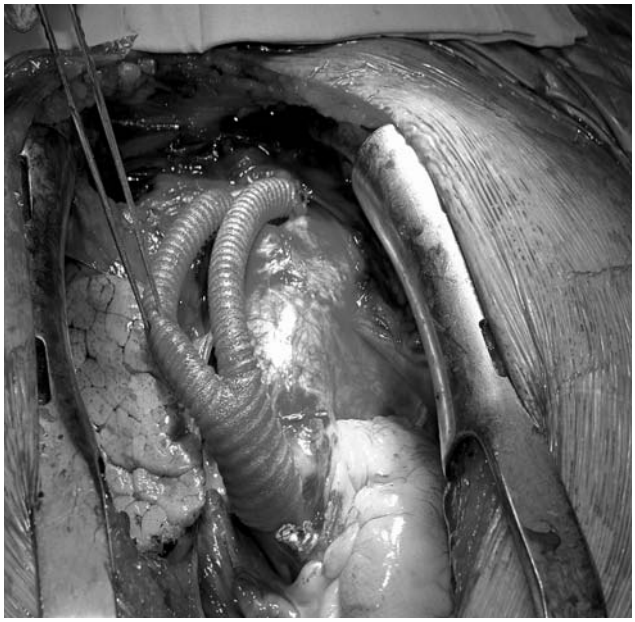

Fig. 5. Intraoperative picture

Fig. 6. Angio after stent-graft placement

overstenting the left subclavian artery. The post procedural performed angio showed no sign of endoleak and the patient recovered uneventfully without any signs of transient or permanent neurologic injury in the intensive care unit (Figure 6). He also showed no signs of left arm ischemia. Five days after the intervention, a three-dimensional computed tomographic scan was performed to confirm regular perfusion of the arch vessels. The patient was discharged from the hospital on day seven.

Discussion

To our knowledge, case number one is the first report of treating an iatrogenic acute Stanford type A dissection by means of a stent. The standard treatment for acute type A dissection remains emergent surgical intervention to prevent cardiac tamponade. Stent-graft placement in the descending aorta has evolved as a treatment modality for a variety of pathological conditions in the past decade, especially for high risk patients. Here, we report the first successful treatment of an iatrogenic acute type A dissection by means of a stent placed in the ascending aorta. This approach was chosen because of the high risk associated with a second large operation within a short time frame in a patient with a reduced health status and several co-morbidities. The patient had undergone lobar resection of the liver due to a malignant tumor 6 months prior to coronary bypass surgery. At referral he was in Canadian Cardiovascular Society Class III and had undergone off-pump coronary bypass surgery due to symptomatic ischemic heart disease. Because of the reduced status and the heavily calcified aorta, off-pump bypass surgery was performed. Since no anastomotic device is available in our department, the ascending aorta had to be tangentially clamped for the proximal vein anastomoses. This was done in an area where the aorta was soft and the anastomoses could be performed without difficulties.

Early postoperative acute aortic dissection (AOD) has not been described with any frequency in the literature. Chavanon and colleagues have performed a retrospective analysis of acute ascending aortic dissections complicating coronary artery bypass grafting surgery in 3,031 patients and found an increased risk of aortic dissection in OPCAB [11]. We performed off-pump coronary surgery with careful manipulation of the aorta with single side-clamping and tight control of the arterial pressure in order to minimize aortic trauma. Despite the precautions taken our patient developed AOD. The rationale for our approach was that stenting of the ascending aorta with the goal of sealing the entry tear by simple mechanical reapproximation of the intima and media was the last resort for the treatment of this patient. This particular uncovered stent was used, since no other type of stent-graft was available in this emergency situation. The early result in our case is very encouraging. Together with the two reports in the medical literature, our case could set the stage for a wider application of endoluminal stent treatment for acute type aortic dissections.

The second case confirms that sequential transposition of the left common carotid artery and the brachiocephalic trunk can be performed safely with consecutive stent-graft placement to exclude an aortic arch aneurysm in patients not suitable for conventional surgical repair. The main advantage of this approach is that it is a less invasive procedure without the need of cardiopulmonary bypass and profound hypothermic circulatory arrest. However, several technical aspects have to be considered. Type 1 endoleak formation in this highly shear-stress exposed area has to be closely monitored. In addition, backbone fracture of the stent-graft must be kept in mind in this anatomically distinct position due to the severely curved pathway. This new approach itself is associated with further potential risks. Central manipulation of supra-aortic vessels may cause a cerebral injury by embolization of atherosclerotic debris. In addition, partial clamping of the innominate artery without any collateral cerebral perfusion may have significant morbidity if the duration of the

anastomosis exceeds the time frame of cerebral ischemic tolerance. Incorrect estimation of the proximal neck length may lead to insecure proximal fixation of the stent-graft with early type 1a endoleak formation. Therefore it is essential to determine the length of the proximal neck along the lesser curvature of the aortic arch.

In conclusion, we do believe that this combined approach for arch aneurysms will extend the indications in this delicate anatomic region. Actually a variety of adjunctive techniques to enable stent-graft placement in patients with arch aneurysms is now available. Therefore, an extended application of these techniques will enable safe and effective treatment of this highly selected subgroup of patients with aortic aneurysms by avoiding conventional arch aneurysm repair in deep hypothermia and circulatory arrest.

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