Delayed Open Conversion after Endovascular Abdominal Aortic Aneurysm: Device-specific Surgical Approach

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WHAT THIS PAPER ADDS

Endovascular treatment of abdominal aortic aneurysms is nowadays performed in many centers at high and low volumes of activity. Often its failure can be treated only by surgical conversion. This work gives an overview of the causes and the possibility of surgical management of abdominal aortic aneurysms after endovascular treatment failure.

Objectives: Despite several advances in endoluminal salvage for failed endovascular abdominal aortic repair (EVAR), in our experience an increasing number of cases necessitate delayed open conversion (dOC).

Methods: EVAR patients requiring delayed (>30 days) conversion were prospectively collected in a computerized database including demographics, details of aortoiliac anatomy, procedural and clinical success, and postoperative complications.

Results: Between 2005 and 2011, 54 patients were treated for aortic stent-graft explantation. Indications included 34 type I and III endoleaks, 13 type II endoleaks with aneurysm growth, 4 cases of material failures, and 3 stent-graft infections. All fit-for-surgery patients with type I/III endoleak underwent directly dOC. Different surgical approaches were used depending on the type of stent-graft.

Overall 30-day mortality was 1.9%. Overall morbidity was 31% mainly due to acute renal failure (13 cases). Mean hospitalization was 6 days (range, 5–27 days). Overall survival at mean follow-up of 19 months was 78%.

Conclusions: In recent years, the use of EVAR has increased dramatically, including in young patients regardless of their fitness for open repair. dOC after endovascular abdominal aortic aneurysm seems to be a lifesaving procedure with satisfactory initial and mid-term results.

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INTRODUCTION

In the last two decades, endovascular aortic repair (EVAR) has been demonstrated to be a valid and safe alternative to open repair (OR) in the treatment of infrarenal abdominal aortic aneurysms, with reduced early morbidity and mortality rates. However, the "Achilles' heel" of EVAR remains its long-term durability, and lifelong surveillance is therefore mandatory.[1–3]

Secondary procedures are required in up to 27–30% of patients following EVAR independent of the type of stent-graft implanted, and are mainly carried out by endovascular means.[4,5] Delayed open conversion (dOC) with or without stent-graft explant is usually left for cases not amenable to endovascular techniques.

The aim of this study is to report the indications, technical aspects and outcomes of a single-center experience with dOC after EVAR.

METHODS

All EVAR patients who underwent delayed open conversion (dOC) between January 2005 and December 2011 were prospectively recorded in a computerized database. The database included demographics, comorbid conditions and aortoiliac anatomy (involvement of the abdominal aorta alone or of the aorto-iliac segment).

dOC was defined as total or partial stent-graft removal after 30 days from the initial EVAR procedure with prosthetic graft reconstruction of the aortic anatomy.

Indications for open conversion were the presence of an endoleak warranting treatment (not amenable to endovascular repair), stent-graft infection and graft failure (either limb thrombosis or stent-graft collapse). Patients

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with an asymptomatic type I or III endoleak that could not be treated by standard endovascular techniques (i.e. proximal aortic cuff, aorto-uniliac or bifurcated implant) due to inadequate anatomy, and resulted as low-risk surgical candidates, underwent directly dOC. Indication for treatment in the case of a type II endoleak was an aneurysm growth equal to or greater than 1 cm/year: dOC was performed only in patients fit for open surgery in whom endoluminal attempts had already failed. Advanced endovascular repair, in our daily clinical practice (fenestrated/branched stent-graft or chimney/periscope implant), is reserved for patients at high risk for open conversion and not amenable for standard endovascular repair.

Data of the index EVAR operation were recorded, with particular attention to the date of the initial EVAR, device type and any secondary endovascular operation performed during follow up. Intraoperative data such as cross-clamping site, the extent of stent-graft removal, reconstruction technique, operative and cross-clamping time were recorded.

Operative outcome was analyzed in terms of mortality and perioperative systemic morbidities (at 30 days) and any intraoperative complications related to the surgical operation. Classification, etiology, location, and clinical manifestations were reported according to the Society for Vascular Surgery Suggested Reporting Standards[1] and to the Society for Vascular Surgery/American Association for Vascular Surgery (SVS/AAVS) medical comorbidity grading system.[2]

Follow up was performed in the outpatient clinic at 3, 6 and 12 months, and then annually if not otherwise required.

Results are expressed as mean ± standard deviation for continuous variables and as frequency and percentage for categorical variables.

RESULTS

Between January 2005 and December 2011, 54 patients underwent dOC at our institution. Forty-seven patients were male (87%) and the mean age was 73 ± 5.6 years. Complete patient demographic data and comorbidities are presented in Table 1. Mean aneurysm size increased by 1.1 cm (range, −1.2 to 4.5 cm) between the time of initial EVAR and the time of surgical conversion. The average time from the index EVAR operation to dOC was 63 months (range 3−102 months). Five patients (9.2%) had their conversion within 12 months of stent-graft deployment. The initial EVAR was performed at our institution in 11 cases (20%).

The stent-graft removed was the AneuRx in 10, the Talent in 6 and the Endurant in 3 cases (Medtronic, Santa Rosa, CA, USA), the Excluder (W. L. Gore & Associates, Flagstaff, AZ, USA) in 13 cases, the Zenith (Cook, Bloomington, IN, USA) in 12, the Vanguard (Boston Scientific, Natick, MA, USA) in 4, the Anaconda (Vascutek, Inchinnan, UK) in 4, the Treovance (Bolton Medical, Sunrise, FL, USA) in 1 and the Ovation (TriVascular, Santa Rosa, CA, USA) in 1.

Indications

Indication for dOC was endoleak in 47 cases (87%), device failure in 4 (7.4%) and stent-graft infection in 3 (5.6%).

Table 1. Demographic data of patients undergoing conversion and type of stent-graft removed.

Cardiovascular risk factors	$N = 54$
Age	73 ± 5.6
Male sex	47 (87%)
Active smoking	15 (28%)
CAD	18 (33%)
COPD	14 (26%)
Hypertension	51 (95%)
Dyslipidemia	33 (61%)
Diabetes	15 (28%)
EVAR procedure details	
AAA original diameter (mm)	53 (42−71)
Time from EVAR to dOC (months)	63 (3−102)
AAA diameter at dOC (mm)	58 (45−83)
Stent-graft type	
Excluder	13 (24%)
Zenith	12 (22%)
AneuRx	10 (18%)
Talent	6 (12%)
Vanguard	4 (7%)
Anaconda	4 (7%)
Endurant	3 (6%)
Treovance	1 (2%)
Ovation	1 (2%)

CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; EVAR: endovascular aortic repair; dOC: delayed open conversion.

The endoleak group included 34 type I and III endoleaks and 13 type II with sac enlargement. Although a single patient might present with more than one endoleak only the most clinically relevant was considered as the indication for dOC.

There were five primary type I endoleaks (i.e. endoleak detected at the first computed tomography control after index EVAR), 19 newly detected type I endoleaks with aneurysm progression and 10 type III endoleaks (six limb disconnections, four stent fractures with fabric tear).

Before undergoing conversion, 27 patients (50%) were submitted to at least one secondary endovascular procedure. This group included all the type II endoleaks, nine type I and six type III endoleaks. Secondary endovascular procedures were 10 lumbar artery embolizations, one transcaval aneurysm sack embolization, two CT-guided embolizations and 15 cases of additional extension/stent-graft deployment. In all cases the procedures proved unsuccessful either immediately or at follow up. Three patients were submitted to a secondary surgical procedure before conversion: two cases of laparoscopic ligation of the inferior mesenteric artery and one case of aneurysm sac fenestration.

The device failure group included three cases of graft thrombosis and one case of stent-graft infolding with collapse, while in the infection group all three cases were related to erosion of the stent-graft into the duodenal wall.

An elective operation was performed in 47 patients (87%) while in seven cases the operation was urgent (Fig. 2). This group included two graft thromboses causing ischemia of the lower limbs and five aneurysm ruptures (four contained).

Indications with the total number of patients and extent of aortic involvement are summarized in Table 2.

Operative technique

A transperitoneal approach was used in all the cases. A midline incision was used in 47 cases (87%) while a bilateral subcostal incision with medial visceral rotation was used in 7 cases (13%). Proximal cross-clamping was supraceliac in 14 cases (26%), suprarenal in 15 (28%) and infrarenal in 25 (46%). In 10 cases of supraceliac clamping (18%), the renal arteries were perfused with a cold solution (4 °C Custodiol® Histidine—Tryptophan—Ketoglutarate solution). In 16 cases proximal cross-clamping was placed at the level of either the bare stent or of the first covered stents of the stent-graft (Fig. 3) while in 18 cases the iliac limbs were clamped. In 3 patients both the proximal and iliac segments of the stent-graft were clamped.

After incision of the aneurysm sack, complete removal of the stent-graft was performed in 17 cases (Fig. 2). These included all the cases of stent-graft infection. Special care was taken in the removal of the stent-grafts in the case of suprarenal fixation. To reduce the risk of dissection at the level of the renal artery ostia, the stent-graft was first pushed cranially and gently crushed to detach the proximal fixation hooks and barbs from the aortic wall. Only after this initial step was the stent-graft retracted.

Partial removal of the stent-graft was performed in the remaining 37 cases (Figs. 1 and 3). When possible, resection of the stent-graft was always done at the level of the fabric to reduce the risk that the cut stent struts would eventually damage the new graft or the suture line. In the case that the stent struts had to be cut, special attention was paid to avoid direct impingement of the leftover spikes against the new aortic tube-graft.

Reconstructions included 53 cases of in-situ prosthetic repair (11 cases with aorto-aortic bypass and 42 cases with aorto-bifemoral bypass) and 1 case of extra-anatomic bypass (axillo-bifemoral bypass) for an extensive infection of the stent-graft with disruption of the duodenal wall. All in-situ repairs were performed with a Dacron graft. In the case of infected stent-grafts, a silver-coated Dacron graft was used. The only case of extra-anatomic reconstruction was completed with an expanded polytetrafluoroethylene externally supported graft. The Dacron grafts were never anastomosed solely to a leftover segment of stent-graft (if present); a layer of aortic or iliac wall was always included in the anastomoses. This was done to fix the reconstruction and avoid further complications due to late migration of the remaining stent-graft.

Whenever possible, an aorto-aortic reconstruction was chosen (Fig. 1). The use of an aorto-bifemoral bypass was deemed necessary in all cases of iliac aneurysmal degeneration. In five cases the aorto-bifemoral reconstruction was used because of a damaged iliac wall after stent-graft limb removal. Overall, aorto-bifemoral reconstruction was preferred in the case of complete stent-graft explant while aorto-aortic reconstruction was performed in most cases of partial stent-graft explant: the association was not considered statistically significant (Fisher's exact test). Aorto-biiliac reconstruction was not used in this group because, during the operation, the iliac wall was found unsuitable for anastomosis due to fibrosis and thinning caused by the stent-graft limbs.

In one patient who had his iliac limbs completely removed, stenting of the common iliac was done before awakening due to the presence of a flow-limiting distal dissection (a weak femoral pulse was detected at the end of the intervention and control angiography was therefore performed).

Mean operative time was 154 ± 63 min, with aorto-aortic reconstruction with infrarenal clamping requiring the shortest operative time (mean, 118 ± 14 min).

Table 2. Indications with the total number of patients and extent of aortic involvement.

Indication	Elective treatment $N = 47$	Urgent treatment $N = 7$	Aneurysm extension
Endoleak $N = 47$	**43**	**4**	Aorta = 31 Aorto-iliac = 16
Type I	22	2	Aorta = 15 Aorto-iliac = 9
Type II	13	—	Aorta = 10 Aorto-iliac = 3
Type III	8	2	Aorta = 6 Aorto-iliac = 4
Infection $N = 3$	**2**	**1**	Aorta = 1 Aorto-iliac = 2
Device failure $N = 4$	**2**	**2**	Aorta = 3 Aorto-iliac = 1
Graft thrombosis	1	2	Aorta = 3 Aorto-iliac = 0
Graft infolding with collapse	1	—	Aorta = 0 Aorto-iliac = 1

Aorta = aneurysm limited to the aortic segment; aorto-iliac: aneurysm involving at least one common iliac artery.

Early outcomes

There was one case of perioperative death with an overall mortality rate of 1.9% (1/54). This patient presented at our Emergency Department with shock due to free rupture of an abdominal aortic aneurysm and was treated with an aortobifemoral bypass with supraceliac clamping (complete removal of the stent-graft). He died in the Intensive Care Unit on the first postoperative day due to multiorgan failure.

The overall systemic morbidity rate was 31% (17 cases). Acute renal failure was the most common comorbidity with 13 cases (24%). In three cases (5.5%), oliguria was detected at the end of the operation and was secondary to dissection of the renal artery ostia after removal of the stent-graft suprarenal fixation. All three cases were submitted to emergent angiography with rescue stenting. Complete revascularization of both kidneys was possible in two patients. The third patient had only one kidney revascularized and postoperative temporary hemodialysis was required. He was discharged with a mild impairment in renal function (S-creatinine 2.1 mg/dL). All other patients

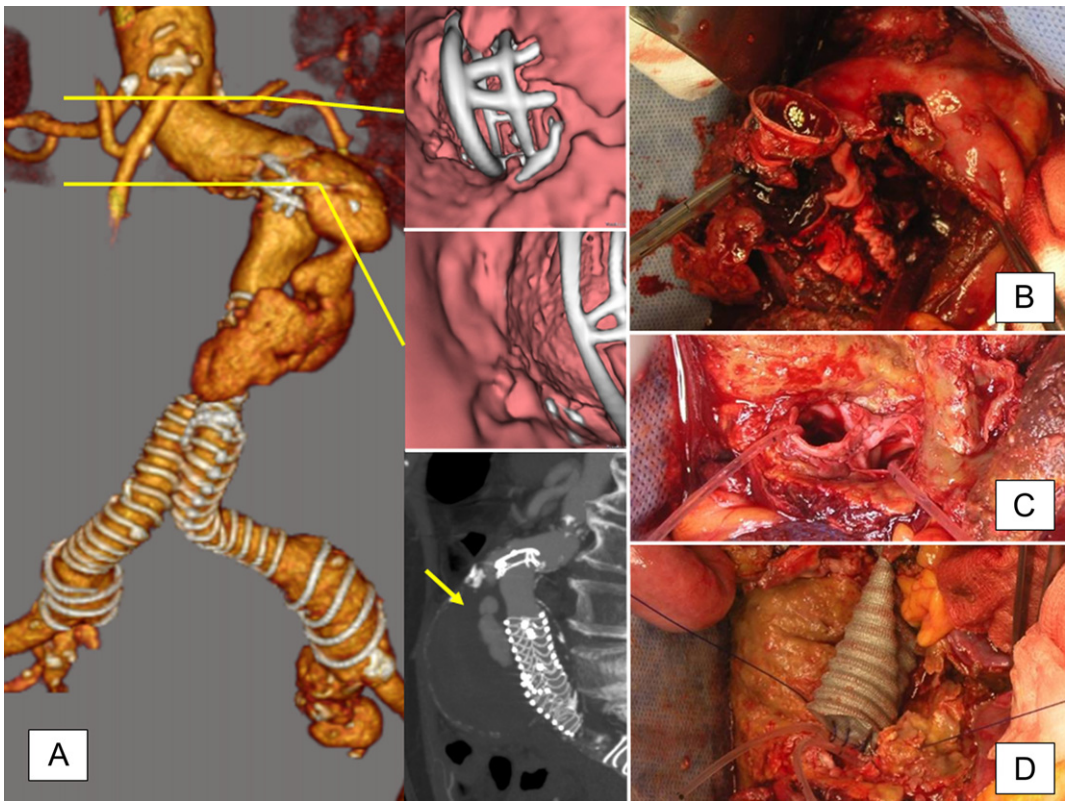

Figure 1. Preoperative CT scan with 3D and virtual angioscopy reconstruction showing distal migration of a bifurcated stent-graft with type I endoleak (A): of note, the aneurysm reperfusion (arrow) and stent-graft misalignment. Intraoperative images showing complete removal of the proximal component (B) with endoclamping of iliac branches (C) for distal component preservation and aortic reconstruction by means of a straight tube graft (D).

presented temporary acute renal failure with renal function normalization at discharge.

There was one case (1.9%) of perioperative acute myocardial infarction requiring emergent angioplasty and stenting. Three patients developed respiratory insufficiency (5.5%). This latter group included one patient who developed perioperative pneumonia and was discharged with home oxygen therapy.

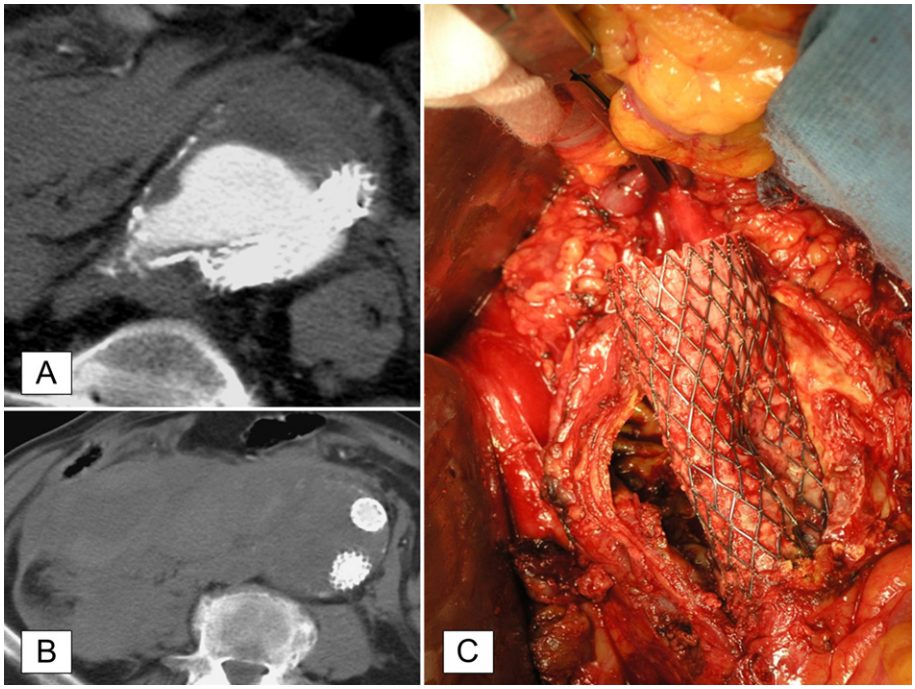

Figure 2. Preoperative CT scan of an urgent open conversion after EVAR with posterior rupture (A and B). Intraoperative image showing infrarenal aortic cross-clamping and complete stent-graft removal (C).

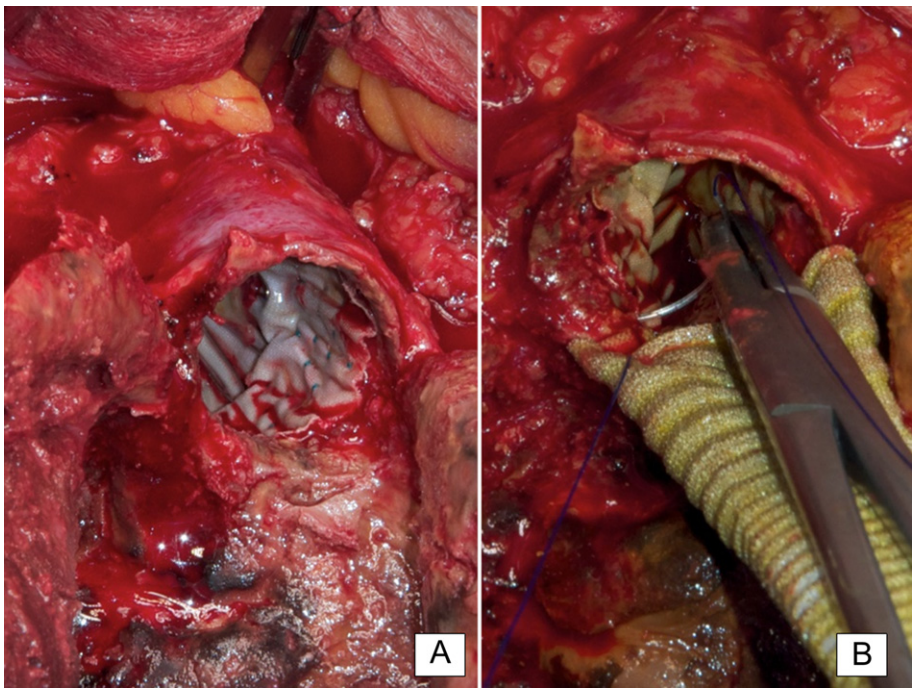

Figure 3. Intraoperative images showing proximal component management with stent-graft cross-clamping and partial stent-graft removal (A); of note proximal aortic reconstruction with end-to-end anastomosis between graft and stent-graft (B).

Perioperative surgical complications were registered in 9 cases (17%). There were one case of spleen lesion (1.9%) and two cases of bowel injury (3.8%). The first was treated with splenectomy with spleen slices reimplanted in an omental pouch while the second case required simple direct suture without the need for bowel resection. There were three cases of bleeding requiring operative revision (5.5%), with one case needing double revision for persistent bleeding from the proximal anastomosis. Three patients (5.5%) required emergent lower limb revascularization for acute limb ischemia. There were two cases of postoperative early iliac artery thrombosis that were treated with balloon thrombectomy and stenting of the common iliac. Both cases occurred in patients who had complete removal of the iliac limb of the stent-graft. The third case consisted of distal embolization at the level of the popliteal artery and was treated with embolectomy after surgical cutdown of the proximal popliteal artery.

Complete outcomes related to the device type and surgical technique are reported in Table 3.

Mean hospitalization was 6 days (range, 5—27 days) with 35 patients (65%) discharged to a center for cardiopulmonary rehabilitation and the remaining patients discharged home. No patient required admission to a long-term nursing facility.

Late outcomes and follow up

Six patients did not attend regular visits to the outpatient clinic and were lost to follow up. No other record could be found in the hospital archive and these patients could not be contacted by phone.

For the remaining 46 patients (85%) the overall survival at mean follow up of 19 months (range, 5—63) was 78% (37/47). There was one aortic related death: a patient who developed an aorto-enteric fistula 4 years after dOC for a type I endoleak and died with hemorrhagic shock before any operation could be attempted. The remaining deaths were due to cancer in three cases and myocardial infarction in four. For two patients the cause of death could not be assessed. All patients treated for an infected stent-graft did not show any recurrence of infection. The two patients treated with in-situ silver graft reconstruction were discharged with long-term antibiotic therapy.

DISCUSSION

Since its first report, two decades ago, EVAR has become a valid and safe alternative to OR for abdominal aortic aneurysms.[3—5] The principal objective of EVAR is to prevent death secondary to aneurysm rupture, but the goal is not always achieved: as shown in the EUROSTAR registry, aneurysm rupture occurs in 1.4% of patients in the first year after EVAR and in 0.6% of patients in the second year,[6] with a cumulative annual risk of 2% at 6 years.[7] Another concern is that secondary interventions, in order to achieve or maintain aneurysm exclusion and prevent aneurysm rupture, are proved to be more frequent in patients undergoing EVAR than OR.[8—10] For these reasons lifelong CT-scan surveillance is nowadays strictly recommended after EVAR.[11,12]

Although EVAR was initially performed only in high-risk patients with severe comorbidities and contraindication for OR, the indication range has since been expanded to include average risk patients, mostly in low volume centers.[13]

It is therefore redundant to say that young patients with good life expectancy require a longer follow-up than older

Table 3. Outcomes of open conversion related to device type and surgical technique.

Device type $N = 54$	Stent-graft partial preservation $N = 37$		Proximal clamping site			Aortic reconstruction			Perioperative outcome
	Proximal $N = 24$	Iliac limbs $N = 13$	SC $N = 14$	SR $N = 15$	IR $N = 25$	Ao-ao $N = 11$	Ao-bi $N = 42$	A.-bifem $N = 1$	
Excluder $N = 13$	4	3	2	4	7	2	11	—	3 ARFs, 1 AMI, 1 bleeding (double revision), 1 acute limb ischemia
Zenith $N = 12$	7	4	5	2	5	3	9	—	3 ARFs (2 renal arteries dissection, 1 RI, 1 acute limb ischemia
AneuRx $N = 10$	3	2	1	3	6	2	7	1	1 death, 2 ARF, 2 RI
Talent $N = 6$	4	1	2	2	2	1	5	—	2 ARFs (1 renal arteries dissection), 1 spleen injury, 1 bleeding
Endurant $N = 3$	2	1	1	1	1	1	2	—	1 bowel injury, 1 ARF
Vanguard $N = 4$	2	1	1	1	2	1	3	—	1 ARF, 1 bowel injury, 1 acute limb ischemia
Anaconda $N = 4$	1	1	1	1	2	1	3	—	1 ARF, 1 bleeding
Treovance $N = 1$	1	—	1	—	—	—	1	—	Uneventful
Ovation $N = 1$	—	—	—	1	—	—	1	—	Uneventful

SC: supraceliac; SR: suprarenal; IR: infrarenal; Ao-ao: aorto-aortic; Ao-bi: aorto-bifemoral; A.-bifem: axillo-bifemoral; ARF: acute renal failure; AMI: acute myocardial infarction; RI: respiratory insufficiency.

patients and we deduce that they probably will experience a secondary intervention during follow up. Furthermore, although most of the secondary procedures can be performed via percutaneous interventional routes, a significant number of them require open conversion.[6,7]

Early open conversion (<30 postoperative days) is usually the result of a technical misadventure such as iliac calcification or tortuosity, renal artery occlusion, technical problems during stent-graft deployment, or immediate post-procedure graft thrombosis.[14] dOC (>30 postoperative days) is most commonly due to aneurysm growth or rupture caused by endoleaks, stent-graft migration or material failure;[6,7,15] other indications for dOC include stent-graft infection and thrombosis.[14] In our experience, the risk of early open conversion has been reduced by accurate patient selection and technical improvement, resulting in only 2 cases and confirming that it represents a rare event.[16] On the contrary, as shown in recent literature, dOC occurs in up to 22% of patients following EVAR, with an overall rate of 1.9%.[15]

dOC presents several technical issues:

1. **Access:** median laparotomy or subcostal laparotomy in patients who often have already been operated can be complicated by the elevated risk of intestinal or ureteral injury;[17] in the case of proximal neck enlargement with visceral vessel involvement, transperitoneal medial visceral rotation is mandatory to obtain adequate exposure and proximal aortic control. Thoraco-phreno-laparotomy may help in the case of proximal aortic neck enlargement with visceral artery involvement, but it was not performed in this series of patients.
2. **Aortic cross-clamping:** suprarenal aortic cross-clamping is usually performed in the case of dOC with explantation of a suprarenal fixation stent-graft. Different authors have speculated that such a complication may be related to the dislocation of atherosclerotic debris from the pararenal aorta or because of distortion of the ostia of visceral vessels (especially the superior mesenteric artery) by the clamp: as Chong et al.[18] showed in their report, patients undergoing suprarenal aortic cross-clamping experience a higher rate of mesenteric ischemia secondary to visceral malperfusion compared to patients undergoing infrarenal clamping (2.3% vs 0.8%). Prolonged suprarenal or supraceliac aortic cross-clamping needed for complex dOC, especially in the case of a well incorporated free-flow and proximal stent, could be associated with increased morbidity and mortality: Lyden et al.[19] reported a 20% mortality rate in patients undergoing dOC with supraceliac cross-clamping. The risk of acute postoperative renal failure, especially in patients with preoperative impairment of renal function and glomerular filtration rate reduction, may be higher.[20,21] From our experience, in order to avoid mesenteric and renal ischemia, we prefer to perform an infrarenal cross-clamping as often as possible. When a suprarenal or supraceliac cross-clamping is needed, after stent-graft explantation, we usually move the

clamp position to the infrarenal aorta, limiting visceral ischemic injury. In a case where infrarenal cross-clamping is not possible, adequate renal protection with cold crystalloid perfusions can be applied routinely in order to reduce the damage caused by prolonged renal ischemia.[22]

3. **Stent-graft removal and aortic reconstruction:** paraphrasing Hamlet's verses we can nowadays say: "to explant or not to explant: that is the question". As the traditional approach for dOC entails aortic cross-clamping, stent-graft removal and aortic reconstruction with prosthetic grafts[23] (Fig. 2), it is generally burdened by high mortality and morbidity rates, as shown by May et al.[24] who reported a 17% mortality and 17% renal failure rate, and by Harris et al.[6] who reported, in the EUROSTAR registry, 24% mortality in patients undergoing elective dOC. Several techniques have been described to perform stent-graft explantation: Kelso et al.[23] advocate a traditional "clamp and pull" technique; Brinster et al.[25] perform routinely stent-graft removal also in the case of suprarenal fixation, using a wire cutter in a circumferential manner to release barbs from the main body of the stent-graft thus avoiding intimal injury (Fig. 3); Koning et al.[26] proposed to collapse the upper bare metal stent in a 20 mL syringe as a "home-made" introducer sheath; some authors proposed also that iced saline can be placed on nitinol elements to help collapse to the predeployment state.[23] Recently, several authors have argued for partial explant of the stent-graft or even for complete stent-graft preservation, presenting good results in terms of intraoperative morbidity and mortality,[27] likely attributable to less aortic dissection, shorter clamp time and lower incidence of visceral ischemia secondary to supraceliac cross-clamping. From our experience, we prefer to perform a complete explant as frequently as possible, depending on stent-graft features. In the case of complete explant, we perform an aorto-aortic end-to-end proximal anastomosis by a 2/0 or 3/0 polypropylene suture reinforced with a Teflon felt. If a suprarenal fixation stent-graft needed to be converted, we used to try a complete explant of the stent-graft with a temporary short suprarenal clamping. More recently, especially where a long proximal free-flow with barbs was encountered, we have performed a partial main body explant, by means of a circumferential wire cutter, of the first proximal covered stent. The proximal anastomosis is then performed between the stent-graft with the aortic wall and the aortic graft through a running 2/0 polypropylene suture reinforced with several Teflon pledgets (Fig. 3). Distal aortic anastomosis and iliac branch management is also an issue: we usually perform an aorto-aortic reconstruction with end-to-end anastomosis to the aortic bifurcation in the case of distal component partial explant (Fig. 1). On the other hand, an aorto-bifemoral reconstruction is preferred in the case of iliac branch complete explant; in these cases the aortic bifurcation is sutured by means of a 2/0 polypropylene running suture reinforced through a Teflon felt. We believe that complete stent-graft removal should be the aim of these kinds of procedure (Fig. 2), but we have observed that each patient deserves a "tailored treatment" depending on stent-graft characteristics, aortic disease, comorbidities and age.

This study has several limitations. First, the low incidence of dOC means that statistical significance is difficult to obtain, limiting the results and conclusions of the study. Second, this study evaluates patients who required dOC at our Institution, but not all patients who underwent EVAR at our Institution were reviewed: so we are unable, to date, to assess the real risk of dOC for patients who we have treated. Other potential confounding factors are that stent-graft materials have improved, and first generation stent-grafts are now no longer available which may affect the eventual conversion rates.

Last but not least, current clinical indications for EVAR have progressively expanded over the years and, with increased off-label use, anatomical suitability has been stretched and redefined: this should make us reflect on the fact that the incidence of dOC could change in the future.

CONCLUSION

In recent years, the use of EVAR has increased dramatically. The number of late complications has also increased and in our experience a growing number of stent-grafts have been explanted. dOC after endovascular abdominal aortic aneurysm seems to be a lifesaving procedure, with satisfactory initial and mid-term results, that is comparable to primary open repair even if it is technically more challenging. Long-term radiological surveillance is mandatory.

CONFLICT OF INTEREST/FUNDING

None.

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