Eur J Vasc Endovasc Surg (2016) 51, 38—42

Obliterative Endoaneurysmorrhaphy with Stent Graft Preservation for Treatment of Type II Progressive Endoleak

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WHAT THIS PAPER ADDS

Type II endoleak (EL II) is a recurrent problem after endovascular aneurysm repair. Although most EL II are benign, some lead to aneurysm sac enlargement with a risk of rupture. Endovascular embolization techniques are classically used to treat EL II, but the results are not always convincing. Conversion to open repair with stent graft (SG) explantation, used as a rescue procedure, is often associated with high peri-operative morbidity and mortality. Herein, an alternative option is proposed for EL II repair, combining sacotomy with ligation of the patent back bleeding vessels and preservation of the SG. This option is particularly useful after failure of embolization in frail patients.

Objective/Background: Persistent type II endoleak (EL II) with sac enlargement after endovascular repair of abdominal aortic aneurysm requires treatment to prevent rupture. Embolization is not always effective. Conversion to open repair with stent graft (SG) explantation is a high risk option. The aim of this study was to evaluate the feasibility and immediate results of an alternative technique combining obliterative endoaneurysmorrhaphy (OEA) with SG preservation.

Methods: The open surgical technique combined sacotomy, ligation of all patent back-bleeding vessels and SG preservation. The aneurysmal shell was tightly closed over the SG to protect it from the intestines. An intra-aortic occlusion balloon was used when clamping was required.

Results: Twelve patients were treated with the OEA technique at Amiens University Hospital. All 12 procedures were successful. Four patients had previously undergone unsuccessful transarterial or translumbar embolization. Aortic clamping was performed in four cases. No SG migration or graft dislocation was observed. Follow up computed tomography scan at a median of 12 months showed shrinkage of the aneurysm sac with stable diameters and no recurrence of EL II in all cases.

Conclusion: The OEA technique is an alternative option for the treatment of progressive EL II, which can be particularly useful after failure of embolization.

Article history: Received 29 December 2014, Accepted 8 July 2015, Available online 18 August 2015

Keywords: Endoaneurysmorrhaphy, EVAR, Sac enlargement, Stent graft explantation, Type 2 endoleak

INTRODUCTION

Type II endoleak (EL II) is a recurrent problem after endovascular repair (EVAR) of abdominal aortic aneurysm (AAA). Although most EL II are benign,[1] some lead to aneurysm sac enlargement with a risk of rupture.[2] Endovascular embolization techniques are classically used to treat EL II, but the results are not always successful.[3] Laparoscopic repair is technically challenging, even for experienced surgeons, because of the dense periaortic inflammation after EVAR.[4] Conversion to open repair with stent graft (SG) explantation, used as a rescue procedure, is a challenging procedure, often associated with significant peri-operative morbidity and mortality.[5] Herein, an alternative open option for EL II repair, combining sacotomy with ligation of the patent back bleeding vessels and preservation of the SG, is described.

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1078-5884/
http://dx.doi.org/10.1016/j.ejvs.2015.07.013

MATERIALS AND METHODS

Indication

Obliterative endoaneurysmorrhaphy (OEA) with SG preservation is performed, at Amiens University Hospital, to treat EL II associated with aneurysm enlargement in three main situations: (i) after failure of embolization techniques; (ii) in the presence of complex EL II involving several collateral vessels; and (iii) when the endoleak origin remains unclear on imaging.

Culprit collaterals and SG position in the aneurysm sac were studied pre-operatively on 1 mm computed tomography (CT) with contrast enhancement.

Surgical details

The first step of the procedure consists of endovascular control of the supraceliac aorta. A 6-F introducer is placed in a femoral artery after percutaneous puncture via a retrograde approach or after surgical exposure. A 0.035″ hydrophilic guide wire (Terumo Europe, Leuven, Belgium) is advanced into the SG and thoracic aorta under fluoroscopic guidance. The OEA procedure is then performed. A trans- or retro-peritoneal approach is used, depending on the aneurysm morphology and the surgeon's usual practice. Cautious dissection of the dense inflammatory tissue surrounding the abdominal aorta is then performed. The aneurysm sac is opened very slowly to avoid damaging the SG and to evaluate bleeding from the sac. In the absence of major bleeding, the thrombus is removed to identify back bleeding vessels that are then ligated under direct vision using 2/0 polypropylene suture material (Prolene; Ethicon, Brussels, Belgium).

When clamping is required, a straight catheter is used to replace the guidewire with a stiff Lunderquist guidewire (Cook Medical, Bloomington, IN, USA) and the 6-F introducer is replaced by a 12-F/40 cm introducer. An intra-aortic occlusion balloon (Coda; Cook Medical) is inserted, advanced, and placed in the supraceliac aorta above the suprarenal stent (Fig. 1).

In the case of a fenestrated SG, the aortic occlusion balloon is placed in the thoracic aorta via a left axillary approach when possible, to avoid catheters crossing the arch vessel origins.

In the presence of major lumbar bleeding, the intra-aortic occlusion balloon is inflated to provide temporary hemostasis. It is sometimes necessary to mobilize iliac limbs cautiously in order to reach the lumbar or median sacral ostia. After careful examination to rule out type III or IV endoleak, the SG is finally left in place (Fig. 2).

The aneurysm shell is then partly resected and tightly closed over the SG to decrease sac diameter and dead space, using 2/0 polypropylene running sutures. Wrapping of the aneurysm shell around the SG also allows separation of the SG from the intestines.

Endovascular material is removed at the end of the procedure and the femoral artery is surgically sutured when exposed or closed percutaneously with the Perclose Proglide (Abbott Vascular, Santa Clara, CA, USA) suture mediated

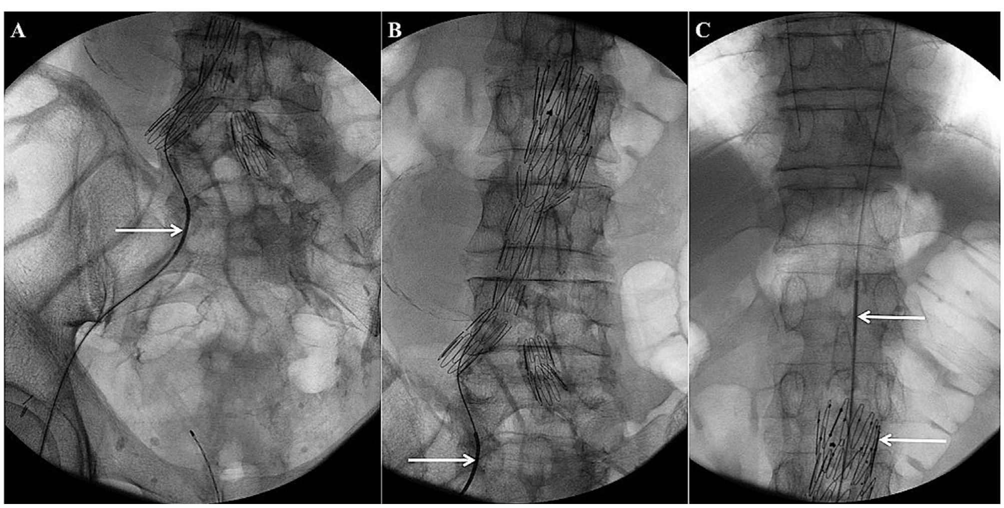

Figure 1. After placing a stiff Lunderquist guide wire in the thoracic aorta, an aortic occlusion balloon (arrow) is inserted via (A) the femoral artery and advanced into (B) the stent graft. (C) The balloon is finally positioned in the low thoracic aorta (upper arrow), above the bare suprarenal stent (lower arrow).

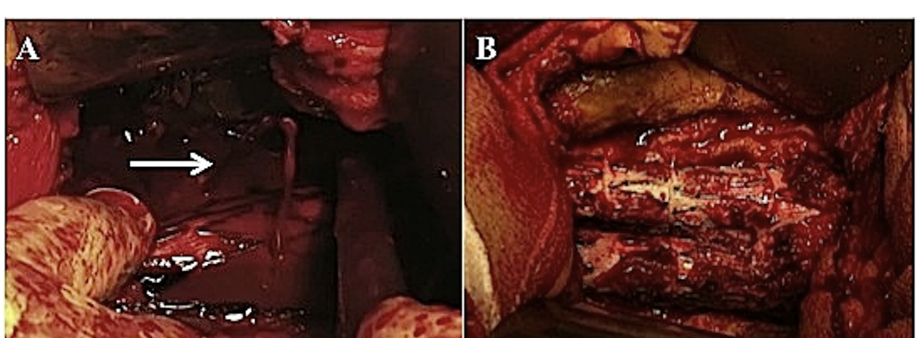

Figure 2. (A) Intra-operative view showing major lumbar back bleeding after sac opening (arrow). (B) Preservation of the stent graft after elimination of type III or IV endoleak.

closure system. The puncture site is closed with the Femoseal closure device (St. Jude Medical, St. Paul, MN, USA) when an aortic balloon is not used.

Data analysis

The study was conducted in accordance with the Declaration of Helsinki. The French ethics committee approved the protocols. Data were collected prospectively. Written informed consent for the procedure was obtained from each patient. Results for continuous variables are expressed as mean ± SD or median ± interquartile range. Categorical variables are expressed in percentages.

RESULTS

From January 2007 to December 2014 a total of 278 patients underwent an EVAR procedure at Amiens University Centre. Twelve patients with sac enlargement were successfully treated with the OEA technique. The median age of the patients was 77 years (range 60—88 years) and the median American Society of Anesthesiologists' score was 3. Patients' baseline characteristics are detailed in Table 1.

A bifurcated SG with suprarenal fixation was implanted in six patients, a bifurcated SG without suprarenal fixation was implanted in two patients, and a fenestrated SG was implanted in one patient. An aorto-uni-iliac SG with suprarenal fixation was deployed as an emergency for ruptured aneurysm in three patients. All patients had regular follow up after EVAR, with an annual CT scan.

Table 1. Characteristics of the study population.

Baseline characteristics	Number of patients (%)
Male sex	12 (100)
Hypertension	7 (58)
History of smoking	6 (50)
Diabetes mellitus	2 (17)
Ischemic heart disease	2 (17)
Congestive heart failure	1 (8)
Cardiac arrhythmias	5 (42)
Stroke	3 (25)
Renal dysfunction	1 (8)
Chronic obstructive pulmonary disease	2 (17)

During follow up, transarterial embolization was performed in four patients with sac enlargement related to clearly identified EL II (two coil embolizations of a patent inferior mesenteric artery and two coil embolizations of patent lumbar arteries). None of these procedures eradicated the leak or stopped sac expansion. Translumbar embolization was performed in one patient after failure of repeated unsuccessful transarterial embolization. The OEA procedure was then performed after failure of embolization.

Two patients with endoleak of undetermined origin on imaging examinations and four patients with complex EL II with multiple origins were treated directly by OEA.

Two patients presented sac enlargement with no visible endoleak on CT scan.

Median aneurysmal diameter was 70 mm (range 54—100 mm) at the time of EVAR and 86 mm (range 67—130 mm) at the time of OEA representing a 25% mean increase in diameter, with a mean follow up of 20 months between the two procedures (Table 2).

Surgical access was obtained in 10 cases via a midline transperitoneal approach and in two cases via a left retroperitoneal incision. Clamping with intra-aortic occlusion balloon was performed in four cases (to eliminate occult proximal type I endoleak or to reduce lumbar bleeding). Mean aortic occlusion time was 7 ± 4 minutes. No type I endoleak was identified intra-operatively. EL II were identified in 10 patients, mostly involving lumbar, inferior mesenteric, and median sacral vessels. One to six vessels were ligated (Table 3). One patient presented with EL II associated with a type III endoleak, which was treated by endovascular SG reinforcement. One patient presented true endotension without retrograde perfusion of the sac, treated by tight closure of the aneurysm shell over the SG.

No SG plication, disjunction, or migration was observed during the procedures.

Mean operating time was 120 ± 35 minutes and mean blood loss was 505 ± 385 mL.

Table 2. Evolution of diameter during follow up after endovascular aneurysm repair (EVAR).

Patient	EVAR diameter (mm)	OEA diameter, mm (increase)	Diameter increase (%)	Length (mo)
1	60	80 (+20)	33	36
2	55	80 (+25)	45	11
3	80	120 (+40)	50	49
4	55	67 (+12)	22	44
5	60	85 (+25)	42	8
6	100	130 (+30)	30	30
7	100	105 (+5)	5	8
8	100	105 (+5)	5	8
9	54	71 (+17)	31	17
10	60	72 (+12)	20	12
11	80	90 (+10)	13	10
12	80	88 (+8)	10	12
Mean/median[a]	70 (54—100)	86 (67—130)	25 ± 13	20 ± 13

Note. OEA = obliterative endoaneurysmorrhaphy.
[a] Mean ± SD; median (range).

Table 3. Details of intra-operative data.

Patient	Pre-operative imaging data	Intra-operative diagnosis	Number and type of ligated vessels	Associated procedure
1	EL undetermined	EL II	2 (L)	—
2	EL II (L, IM)	EL II	4 (L, IM, MS)	—
3	EL undetermined	EL II	2 (L)	—
4	EL II (L, IM)	EL II	3 (L, IM, MS)	—
5	No visible leak	EL II	1 (IM)	—
6	No visible leak	Endotension	0	—
7	EL II (L)	EL II	5 (L, IM)	—
8	EL II (IM)	EL II	3 (L, IM)	—
9	EL II (L, IM)	EL II	5 (L, IM, MS)	—
10	EL II (L, IM, MS)	EL II	6 (L, IM, MS)	—
11	EL II (L, IM)	EL II + type III	2 (L, IM)	SG reinforcement
12	EL II (L)	EL II	2 (L)	—

Note. EL = endoleak; EL II = endoleak type II; L = lumbar; IM = inferior mesenteric; MS = median sacral; SG = stent graft.

No post-operative death was observed. Non-fatal major complications occurred in two patients (pneumonia and heart failure), resolving in response to medical treatment. Median hospital stay was 8 days (range 5—15 days).

With a median follow up of 12 months (range 6—39 months), control CT scan showed shrinkage of the aneurysm sac with stable diameters in every case. No missed EL II, no recurrence, and no SG migration or dislocation were observed (Fig. 3).

DISCUSSION

In the experience of the authors, OEA with SG preservation for the treatment of progressive EL II was always feasible with excellent immediate results.

EL II is an ongoing problem after EVAR. Although EL II are present in nearly 15% of cases during the early post-operative period, up to 40% closing spontaneously during the first year of follow up.[1,2] While some authors have reported that conservative management of EL II is a safe option,[6,7] others have shown that EL II increase the risk of rupture.[8,9] According to current guidelines, treatment is recommended for persistent EL II associated with sac enlargement.[10]

Transarterial, transcaval, and translumbar embolization have been described for EL II repair with controversial results.[3,11,12] The systematic review by Sidloff et al. showed that translumbar embolization had a higher success rate and a lower risk of complications than transarterial embolization.[13] Laparoscopic repair is technically challenging because of the dense periaortic inflammation after EVAR.[4] Surgeons experienced in laparoscopic aortic surgery have recently described access to the lumbar and median sacral arteries in the plane of the anterior longitudinal ligament.[14] Voûte et al. described laparoscopic clipping of side branches and aneurysm sac fenestration with significant rates of conversion or additional procedures for persistent EL II.[15] Open repair with SG removal is a complicated surgical procedure associated with high morbidity and mortality rates in frail patients.[5] A few cases of sacotomy with ligation of back bleeding vessels have been reported,[16,17] but this technique has not yet been specifically described.

Initial placement of an intra-aortic occlusion balloon allows (i) a limited dissection of the abdominal aorta to be performed, as the supraceliac aorta is not surgically cross clamped; (ii) immediate inflation to clamp the aorta in the case of an occult proximal type I endoleak; and (iii) temporary hemostasis to limit blood loss in the case of major collateral back bleeding. No case of type I endoleak was observed in this study. When lumbar bleeding was profuse, inflation of the intra-aortic occlusion balloon led to a significant decrease in flow thereby limiting blood loss.

Surgical dissection of the aorta should be limited to be just sufficient to provide adequate access to the sac, close to the origin of the patent aortic side branches detected on pre-operative CT scan. Sacotomy allows visual identification

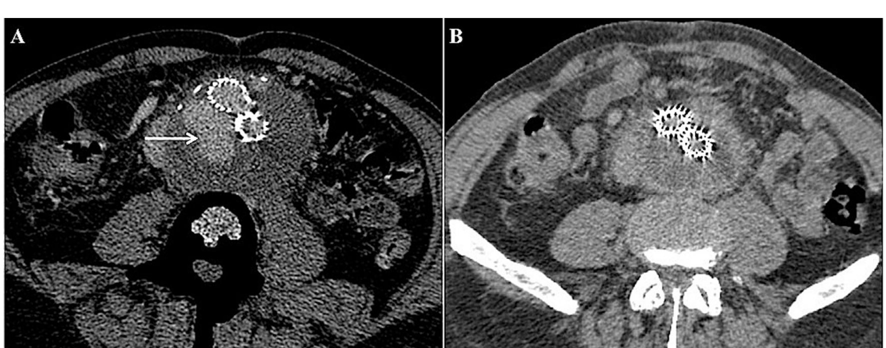

Figure 3. (A) Axial pre-operative computed tomography scan showing a large type II endoleak (arrow). (B) Sac retraction and absence of endoleak at 6 month follow up.

of back bleeding vessels and associated endoleaks not detected on pre-operative imaging that can then be repaired at the same time. In this study, one patient with visible EL II on pre-operative CT scan presented with EL II from lumbar, inferior mesenteric, and median sacral origins, associated with a type III endoleak not detected pre-operatively. As shown in Table 3, the OEA procedure allowed the diagnosis of EL II in two patients with endoleak of undetermined origin and in one patient with no visible leak. Endotension with no patent back bleeding vessel was observed in one patient with no visible leak on pre-operative CT. The lack of sensitivity of helical CT for visualization of EL II has been described previously,[18] but this examination currently remains the most accessible imaging modality for patient follow up.

During the procedure, access to either proximal lumbar arteries in the neck or distal lumbar and median sacral arteries close to the aortic bifurcation can be difficult. If necessary, the SG can be very carefully mobilized avoiding graft damage or displacement. In the present experience, it was always possible to ligate lumbar and median sacral ostia from inside the aorta and the SG main body or limbs did not have to be removed. It is important to plicate the aneurysm sac over the SG to prevent contact and erosion of bowel on the graft. This wrapping also avoids SG migration or dislocation.

Few post-operative complications were observed and were always related to comorbidities. This report is limited by its observational design and by the small number of patients. Although OEA with SG preservation is feasible and gave good immediate results, more patients and a longer follow up are required to confirm this technique as a safe and lasting treatment for progressive EL II.

CONCLUSION

This technique can be considered to be an alternative to SG removal in the case of persistent EL II with aneurysm sac enlargement after failed embolization. By avoiding extensive dissection for surgical aortic cross clamping, minimizing hemodynamic changes, reducing blood loss, and operating time, this procedure can be performed even in patients initially considered unfit for surgery.

CONFLICT OF INTEREST

None.

FUNDING

None.

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