Preservation of internal iliac artery during endovascular repair of abdominal aneurysmal disease

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Abstract:

Objective: The overstenting of the internal iliac artery (IIA) in patients with concomitant aortic and common iliac artery (CIA) aneurysm has been sometimes associated with significant complications. The aim of this study was to report a single center experience during a 7 years period on preservation of IIA during endovascular aneurysm repair (EVAR).

Methods: From January 2006 till Jun 2014, all patients who underwent a revascularization additive procedure, open or endovascular, for IIA preservation during EVAR were registered in a prospectively maintained database and included in this study. Aneurysm morphology and the need for revascularization were determined on preoperative computed tomography angiography. During follow-up all patients were interviewed for the presence of symptoms, while occurrence of endoleak and the evolution of the aneurysms were recorded.

Results: A total of 11 patients (10 males, mean age 73.5±5.6 years) underwent an adjunctive revascularization procedure for IIA preservation during EVAR. Mean maximum CIA diameter at the side of revascularization was 40.6±15.6 mm, while at the contralateral side was 44.3±18.3 mm. In nine patients IIA revascularization was performed to preserve at least the patency of one IIA, one patient underwent bilateral IIA preservation, while in one patient the CIA was accidentally covered during the deployment of the contralateral limb. Three patients underwent an IIA transposition, while 2 patients had an external iliac artery-IIA by-pass. In three patients an iliac branch device was deployed, while in three the "sandwich technique" was applied. The overall 30-day mortality was null. During a mean follow-up of 48±21.7 months early buttock claudication was observed in 1 patient (9.1%) at the contralateral side from the preservation that was resolved three months after. Two occlusions, one IBD and one sandwich, occurred. Both occlusions were asymptomatic and no reinterventions were needed. The cumulative free from reintervention rate was 100%.

Conclusion: Preservation of one or both hypogastric arteries can be accomplished through various open or endovascular techniques. These techniques represent a significant improvement in the treatment of aortoiliac aneurysms by allowing preservation of pelvic flow. A trend towards more endovascular procedures for IIA preservation has been noted during the last years. However considering the lack of long-term data, therapeutic strategy should be tailored for each individual patient, according to anatomical criteria and the presence of significant comorbidities.

INTRODUCTION

A significant proportion (up to 40%) of patients with abdominal aortic aneurysm have an ectatic or aneurysmal common iliac artery (CIA).[1-7] The presence of concomitant iliac artery aneurysm has been associated with worse outcome regarding type I endoleak, limb thrombosis and aneurysm rupture.[8] Whenever possible the CIA may serve as a distal landing zone, thus avoiding coverage of the internal iliac artery (IIA) during endovascular aneurysm repair (EVAR). However only iliac limbs up to 28mm are commercially available, that can be used for iliac aneurysms up to 24 mm, according to manufacturer's instructions.[9]

In cases of larger iliac aneurysms, EVAR requires exclusion of one or both internal iliac arteries (IIA) and extension of the stent graft to the external iliac artery. In a proportion of these patients embolization of one or both IIAs is often required. The overstenting of the IIA has been sometimes associated with significant complications including buttock claudication, gluteal necrosis, ischemic colitis, erectile dysfunction and spinal cord injury.[2] The group of patients at increased risk for such complications has not been well defined. Coverage of a single IIA is generally well tolerated, although an incidence up to 28% of buttock claudication has been reported.[3, 4] Reports of bilateral IIA embolization show that bilateral IIA overstenting might be safe for the majority of patients, although there is an increased risk of serious life-threatening consequences.[2-4] Clearly some patients at high risk for developing adverse complications might benefit from preservation of IIA perfusion and therefore most physicians attempt to preserve flow at least to one IIA whenever possible.[5,6]

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ISSN 1106-7237/ 2019 Hellenic Society of Vascular and Endovascular Surgery Published by Rotonda Publications

Several open and endovascular techniques have been described to maintain pelvic perfusion during EVAR. The aim of the present study was to report our single center experience in preservation of IIA and analyze technical and clinical outcome.

METHODS

Study population: From January 2006 till Jun 2014, all patients who underwent a revascularization additive procedure, open or endovascular, for IIA preservation during EVAR were registered in a prospectively maintained database and included in this study. We also retrospectively reviewed all EVAR procedures to identify cases in which overstenting of the IIA and perhaps embolization occurred and defined their frequency.

All patients underwent preoperative computed tomography angiography (CTA) to determine anatomical suitability for endovascular treatment and evaluate the need for a revascularization procedure for IIA preservation. All procedures were performed in a fully equipped operating room with the patient under general or regional anesthesia. All patients were treated by the same surgical and anesthesiology team. Every effort was made to follow the selection criteria recommended by the manufacturer of the device. However, the decision as to which device to use was based on surgeon's critical preference, according to the anatomic characteristics of the proximal neck, the iliac configuration, and the presence of thrombus or calcification. The grafts deployed were Excluder (W. L. Gore & Associates, Flagstaff, Ariz), Talent and Endurant (Medtronic Corp, Minneapolis, Minn), Zenith (Cook Inc, Bloomington, IN, USA). The choice of the revascularization procedure for IIA preservation was based on anatomical criteria as depicted from the preoperative CTA as well as on the surgeon's preference. The decision on the best approach when IIA preservation was considered was tailored to each patient specifically. There were patients that could be treated successfully by different therapeutic options, open or endovascular. An endovascular-first strategy was considered in every patient, while an open approach was followed in patients that could not be treated endovascular or in accidental coverage of the IIA. The use of an iliac branched device is restricted by certain anatomic properties inside the instructions of use for each endograft mostly regarding the length of the common iliac artery and the distal landing zone of the IIA. The sandwich technique can be applied in patients with a short CIA that cannot be treated with an IBD.

Description of procedures performed (Figures 1-4):

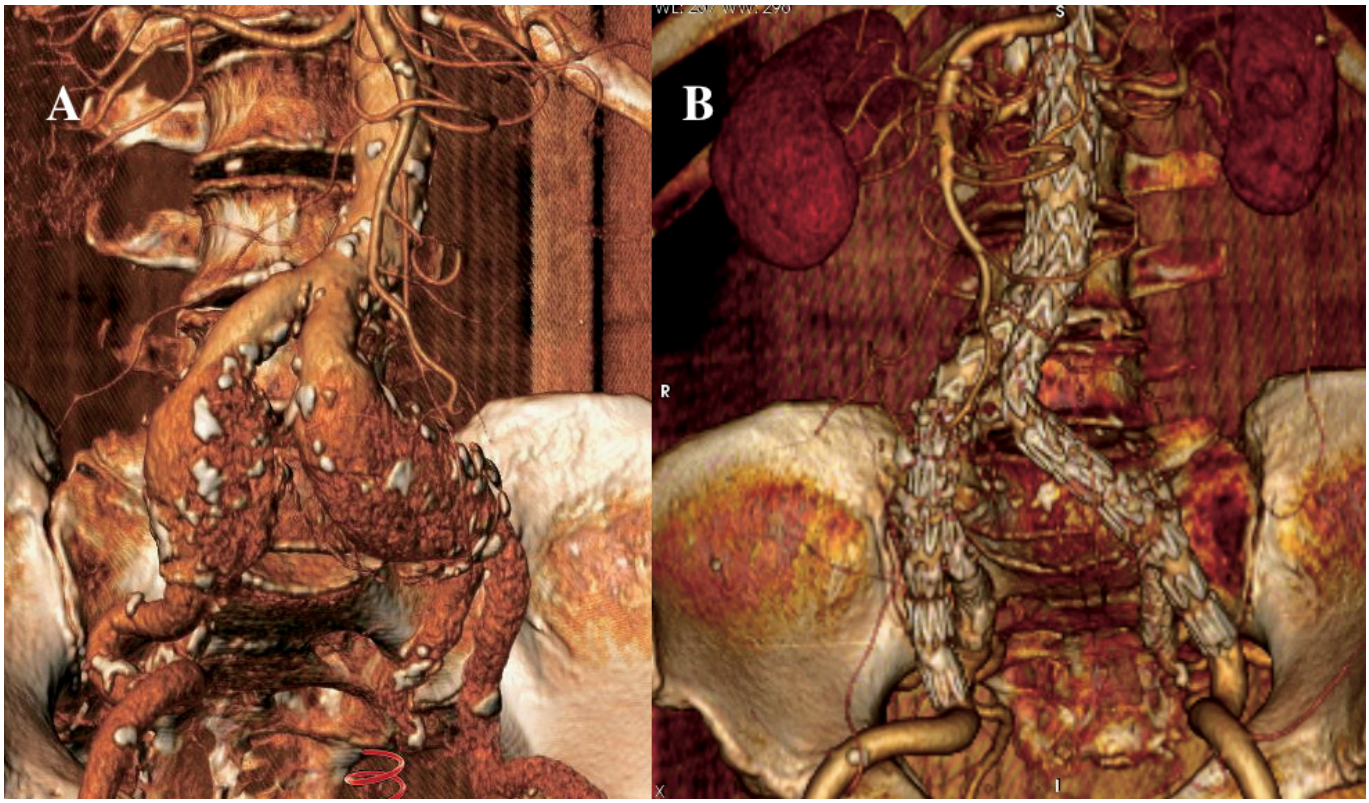

Figure 1. A. CTA showing large bilateral iliac artery aneurysms, B. CTA at 1 year after the deployment of bilateral IBDs showing patency of both IIAs and complete exclusion of both aneurysms

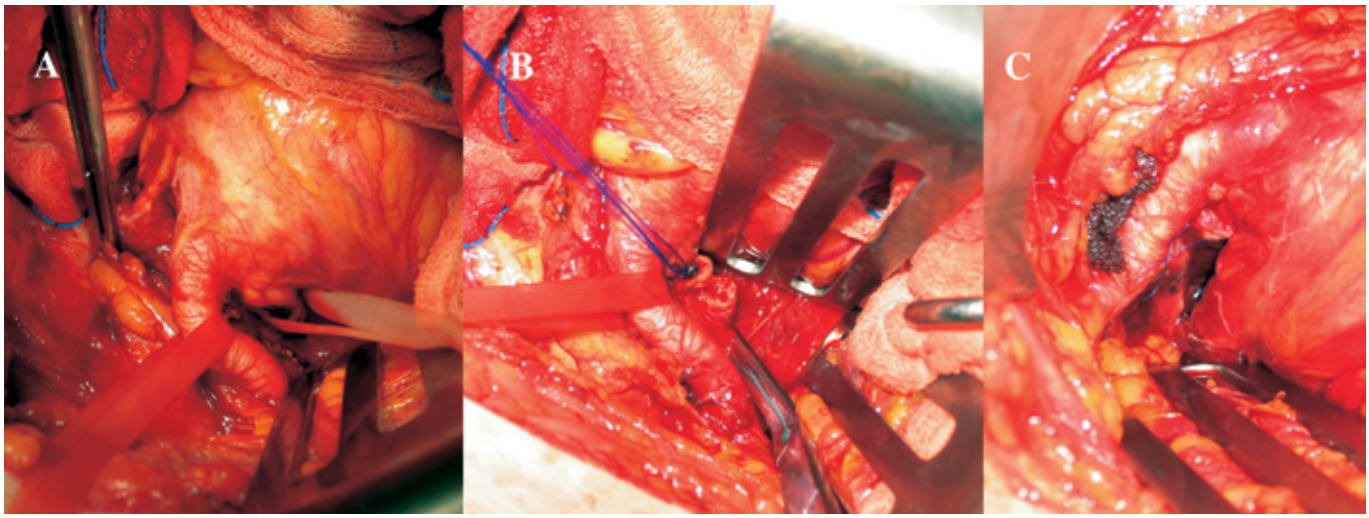

Figure 2. A. Exposure of the iliac bifurcation in a patient with a large CIA aneurysm, B,C. Preservation of the IIA by transposition to the ipsilateral IIA

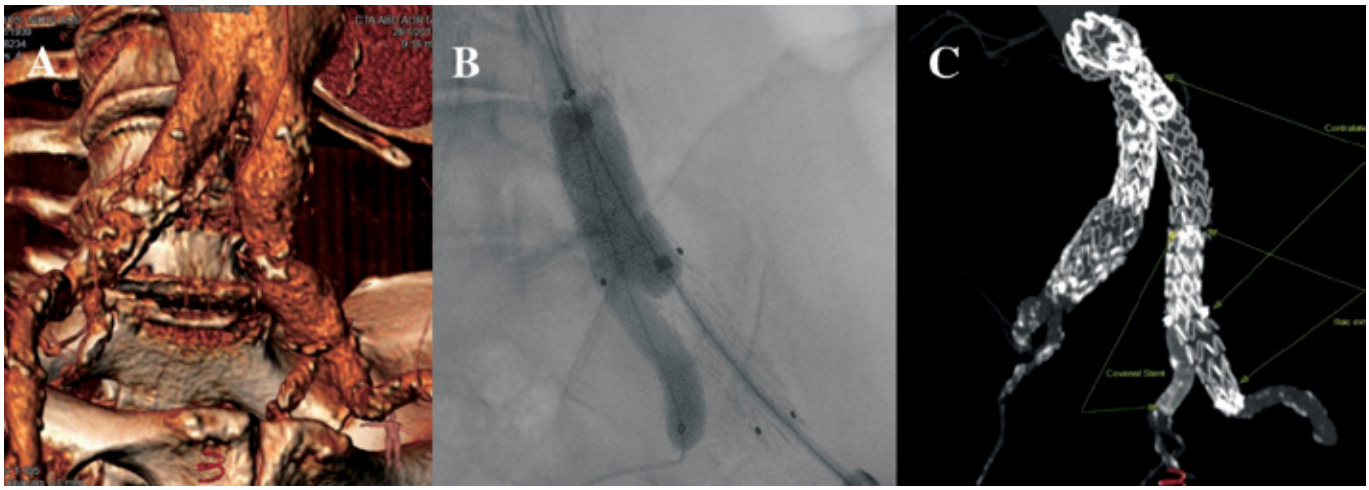

Figure 3. A. CTA showing a large Lt CIA aneurysm with insufficient landing zone, B. Intraoperative image showing the kissing-balloning during the sandwich technique, C. CTA at 2 years after the procedure showing the endografts' configuration after the sandwich technique

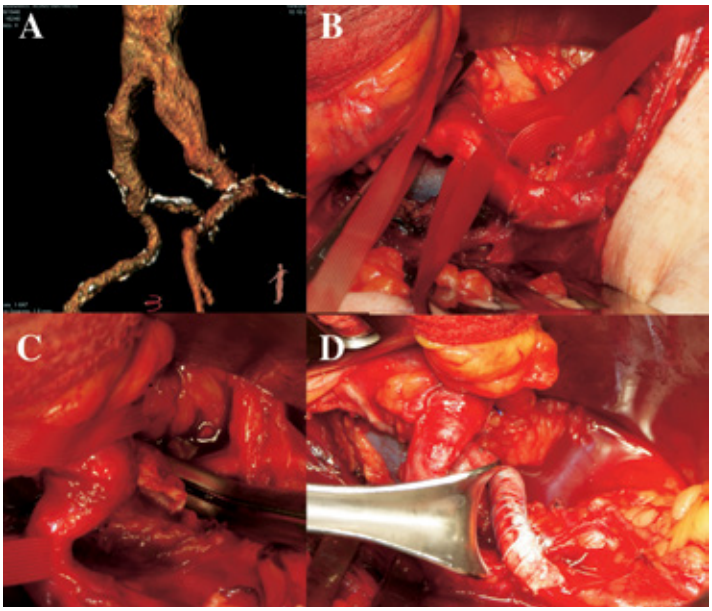

Figure 4. A. CTA showing a patient with CIA aneurysms, B,C,D. Intraoperative images showing the exposure of the iliac bifurcation and the completion of an EIA to IIA by-pass

IIA bypass/transposition: Standard surgical techniques were used to accomplish retroperitoneal exposure of the CIA, IIA and EIA via a relative short oblique incision in the lower quadrant of the abdomen. The level of iliac bifurcation was identified and the IIA was carefully exposed and controlled a few cm from its origin. The proximal anastomosis of a 6 mm PTFE graft to the IIA was accomplished at a first step, followed by the distal anastomosis to the distal part of the EIA in an end to side fashion. The IIA was ligated proximally to avoid retrograde filing of the aneurysm sac after endovascular repair. Alternatively, the IIA after being transected close to its origin was transpositioned on the EIA and directly anastomosed in an end-to-side fashion.

Sandwich-technique: A detailed description of this technique has been reported elsewhere.[10,11] Using an ipsilateral femoral approach the main body of a bifurcated stent graft was deployed with the distal end of the iliac limb positioned 1 cm above the iliac bifurcation. The ipsilateral IIA was cannulated using a left brachial access and a self-expandable covered stent was deployed at least 1 cm inside the nondiseased IIA, with at least 5 cm overlapping into the iliac limb extension. The iliac limb extension was positioned 1 cm below the covered stent proximal end, deployed and accommodated with a balloon prior to deploying the covered stent.

Iliac Branched Device: One IBD stent graft model was used (Cook Inc, Bloomington, IN, USA). This model comes with a preloaded indwelling catheter and guidewire through the side branch. This guidewire was snared from a contralateral or brachial approach and guides the introduction of a sheath that will enter the main body of the device and exit through the side branch. The IIA was catheterized and a bridging covered stent was deployed, connecting the side branch to the IIA and excluding flow into the sac of the CIAA.

In open IIA revascularization single antiplatelet therapy was given during and after the procedure. In endovascular procedures for IIA preservation, the patient was given dual antiplatelet therapy (aspirin plus clopidogrel) after the procedure and for at least one month during follow-up. After the first month the patient remained on single antiplatelet therapy.

All patients underwent a postoperative surveillance protocol, which included physical examination, blood pressure measurement, and CTA at 1, 6, and 12 months postoperatively and yearly thereafter.

Statistical analysis: Data are expressed as mean±standard deviation, except for non-Gaussian parameters, which are presented as median (range). Categorical data are represented by number (n) and percentage (%). Kaplan- Maier analysis was used to estimate survival rates. Statistical analyses were performed using SPSS 20.0 statistics software (SPSS Inc, Chicago, Ill). A p value of $<.05$ was considered as statistically significant.

RESULTS

During a time period of 7 years 380 patients underwent EVAR with modular devices in our institution. Concomitant unilateral iliac aneurysms were found in 125 (33.1%) patients, while 63 (16.7%) had bilateral iliac aneurysms. Exclusion of one IIA with the extension of the stent graft to the external iliac artery was performed in 53 (14%) patients, while embolization of the IIA in 23 (6%) patients. 124 patients were treated with a wide iliac limb landing on the common iliac artery (bell-bottom technique). Eleven of the patients that had the IIA overstented had an IIA aneurysm. None of these patients needed any IIA preservation procedure and were treated with an endograft landing on the EIA.

Our study population consisted of a total of 11 patients (10 males, mean age 73.5±5·6 years, range 64-82 years) who underwent an adjunctive revascularization procedure for IIA preservation during EVAR. Patients' demographics and preoperative and postoperative data are shown in Table I, and a summary of all cases reported herein is delineated in Table II. None of these patients were operated on emergency setting. Mean maximum abdominal aortic diameter was 60±19 mm (range 26-99 mm). Three patients had no abdominal aortic aneurysm, but a bifurcated endovascular graft was deployed due to inadequate CIA landing zone. Ten patients had bilateral CIA aneurysms above 3cm, while 1 patient had a unilateral CIA aneurysm >3cm. Mean maximum CIA diameter at the side of revascularization was 40.6±15.6 mm.

Variables	No. (%)
Age, years	73.5±5.6
Gender (male)	9 (81.8)
Risk factors	
Hypertension	11 (100)
Hyperlipidemia	8 (72.7)
Coronary artery disease	5 (45.5)
Chronic Obstructive Pulmonary Disease	6 (54.5)
Diabetes mellitus	3 (27.3)
Cardiac insufficiency	3 (27.3)
Smoker	5 (45.5)
Abdominal aorta maximum diameter, cm	6±1.9
Time to discharge, median/days	5

Table 1. Patient demographics and comorbidities

No	Year	Age	Gender	AAA (mm)	RCIA	LCIA	IIA occlusion	IIA embolization	IIA preservation	Procedure	Follow-up	Complications
1	2008	67	F	50	31	12	RIIA		LIIA	Transposition	62	
2	2008	70	M	65	32	36	LIIA		RIIA	By-pass	58	
3	2009	73	M	28	70	55	LIIA		RIIA	Transposition	46	
4	2010	64	M	98	38	50		LIIA	RIIA	By-pass	38	
5	2011	69	M	59	35	33	RIIA		LIIA	Transposition	27	
6	2012	79	M	53	36	93		LIIA	RIIA	IBD	15	Thrombosis at 1st month
7	2012	82	M	26	41	73			RIIA-LIIA	IBD	12	
8	2013	76	M	64	39	44		LIIA	RIIA	"Sandwich"	6	
9	2013	74	M	72	32	36			LIIA	"Sandwich"	6	
10	2013	74	M	71	36	25			RIIA	"Sandwich"	3	Thrombosis at 1st month
11	2013	80	F	73	37	42		LIIA	RIIA	IBD	3	

No: number, F: Female, M: Male, AAA: abdominal aortic aneurysm, RCIA: Right common iliac artery, LCIA: Left common iliac artery, IIA: Internal iliac artery, IBD: iliac branch device

Table 2. Summary of all cases undergoing internal iliac artery preservation during endovascular aneurysm repair.

Indications: In nine patients IIA revascularization was performed to preserve at least the patency of one IIA. One patient underwent bilateral IIA preservation. This patient had large bilateral CIA aneurysms (4.1 and 7.3 cm respectively) and severe atherosclerosis of the whole aortic tree. Bilateral IIA preservation was deemed appropriate for paraplegia prevention. In one patient the IIA was accidentally covered during the deployment of the contralateral limb and since the other IIA was deliberately covered with a limb extending to the EIA, preservation of the contralateral IIA was necessary.

Procedures: Six patients underwent an endovascular procedure for IIA preservation, while in 5 patients an open procedure was performed. Three patients underwent an IIA transposition, while 2 patients had an EIA-IIA by-pass. In three patients the iliac branch device (IBD) (Cook Medical Inc, Bloomington, IN, USA), in two unilateral and one bilateral, was deployed, while in three patients the "sandwich technique" was applied. IIA revascularization was accomplished successfully in all cases and no reoperation was required in the postoperative period. The overall 30-day mortality was null. The median hospital stay was 5 days (range, 4-7 days).

During a mean follow-up of 48±21.7 months (range 15-90 months; median, 26 months) early buttock claudication was observed in 1 patient (9.1%) at the contralateral side from the preservation that was resolved conservatively three months after the procedure. There were no cases of ischemic colitis, buttock necrosis or late buttock claudication. Two occlusions occurred during the follow-up period, both found at the first month visit after the procedure. One IBD was occluded, probably as a result of severe atherosclerotic disease and very poor outflow. One sandwich was also thrombosed, due to significant compression of the iliac limb extension. Both occlusions were asymptomatic and were found incidentally at the 1st month follow-up visit. No reinterventions were needed for these occlusions. The cumulative free from reintervention rate was 100%.

DISCUSSION

The clinical impact of IIA overstenting with or without embolization has been controversial. Complications predominantly comprise buttock claudication and erectile dysfunction but may even involve spinal, bowel ischemia or buttock necrosis.[4] Papazoglou et al reported a 13% incidence of buttock claudication after IIA coverage that was significantly ameliorated or resolved within the first 6 months postoperatively in all patients.[12] However, a recent review identified the development of buttock claudication in 29.2% of patients after unilateral IIA embolization prior to EVAR, while new onset erectile dysfunction was evident in 12.7% of the male population.[4] Bilateral IIA occlusion has been associated with a higher incidence of buttock claudication as well as other presentations of pelvic ischemia.[4] These complication rates should be interpreted cautiously, since several complications after IIA interruption might be underreported leading to significant publication bias.[3] Although current data are coming mostly from retrospective not randomized case series, these relatively high complication rates after single or bilateral IIA sacrifice raises certain questions about the necessity for IIA preservation even when unilateral coverage is involved.

Current evidence regarding the subset of patients that may benefit from an IIA revascularization procedure during EVAR has not been well defined. The presence of certain circumstances, as contralateral IIA occlusion, large inferior mesenteric artery or the need for concomitant thoracic endograft, may exert the need for a revascularization procedure; although not enough data exist.[1-10] Furthermore, the presence of severe atherosclerosis resulting in significant stenosis of the contralateral IIA's orifice consist an indication that has to be considered. Therefore in such cases it is of utmost importance always to evaluate meticulously both IIAs during the preoperative planning. In our practice we try to preserve the flow to at least to one IIA, if possible.

The bell-bottom technique has been proven safe and effective in treating common iliac aneurysm of moderate size over a long-term period.[1] However, this technique, although is easy to perform even in emergency situations, is limited by the commercially available sizes of iliac limbs (28mm) and the high risk of secondary procedures. Various techniques, open or endovascular, have been developed to exclude the CIA and minimize the risk of a type IIa endoleak from the IIA without raising the chance for pelvic ischemia.[2-4]

An open surgical procedure for IIA revascularization was used in nearly half of our patients. Open interventions, as it is shown from our report, was the first choice in the early years of EVAR, when IIA maintenance was deemed necessary. They can be safely and successfully applied in emergent setting, as in one of our patients, in case of inadvertent coverage of the IIA. Lee et al by retrospectively studying patients treated with an hypogastric by-pass found only 4% of new onset buttock claudication ipsilateral to the hypogastric by-pass, while they also reported a 90% patency rate at 36 months.[2] In our series there were no ischemic complications while both bypasses were patent at 3 years. These excellent associated results should not come to any surprise given the relatively large diameter and short length of the by-pass. However, the procedure itself is technically demanding given the anatomic location of the IIA, especially in obese patients and those with large aneurysms.

Furthermore, the transposition of the hypogastric artery was performed in three of our patients and consist a good alternative therapeutic option, though an adequate length of IIA is mandatory. Nevertheless, the exposure of the CIA bifurcation and the isolation of the proximal segment of the IIA through a small lower quadrant incision, especially in obese individuals, require a high-level of surgical training, considering the limited and deep surgical field.[13,14]

A trend towards more endovascular procedures for IIA revascularization during EVAR in recent years is evident.[4] This shift was also evident in our practice. In half of the patients an iliac branch device was deployed, while in the other half the "sandwich technique" was applied. Iliac branch devices (IBD) extend from a conventional bifurcated stent-graft into the EIA whilst preserving flow into the ipsilateral IIA using a side branch.[3] This procedure can be performed with high technical success rate and have been associated with encouraging mid-term results, very low endoleak rate, although a significant reocclusion rate (10%) that required reintervention has been reported.[3] In our series one IBD was occluded, though no reintervention was needed.

The sandwich endograft technique involves deployment of two parallel endografts side by side into an existing iliac limb to create a bifurcated iliac component.[15] This technique allows for iliac preservation by using commercially available grafts in an off label manner. Lobato et al by studying 40 patients undergoing "sandwich technique" for treatment of complex aortoiliac or isolated iliac aneurysms reported a 100% and 93.8% technical success and primary patency rate respectively.[16] There were three occlusions, occurring early in the study probably, as the authors stated, because of the technique's learning curve. Nevertheless, the lack of long-term data and the potential risk for type III endoleak and limb thrombosis should be acknowledged. In our practice we always deploy the bridge stent graft through a brachial access, that has enable a successful catheterization in all cases. Furthermore, in this technique an overlap of at least 40mm is considered mandatory to avoid undesirable endoleaks and succeed the best sealing. Therefore, we always use the Viabahn stent graft, due to its flexibility and length (available in length >100mm).

Several other endovascular techniques have been proposed over the past decade for IIA revascularization during EVAR. Minion et al used two bifurcated endovascular prostheses to preserve IIA patency.[17] However the need for a large enough aortic diameter to fit the three limbs and the high cost of a second bifurcated graft has limited the applicability of the procedure. External iliac-to-internal iliac artery "cross stenting" has also been recommended.[18] This technique however warrants further investigation, considering the potential high risk of graft kinking and the lack of adequate literature data.

A very important issue with IIA preservation is the cost, particularly as the overall budget of the endovascular procedure is compared with AAA open repair. Stroupe et al recently by studying the 881 patients of the Open Versus Endovascular Repair (OVER) Veterans Affairs (VA) Cooperative Study reported a lower cost for EVAR when compared with open repair after the initial hospitalization, which eventually became not significantly different after the first two years.[19] It has been reported that IIA embolization can be achieved at a cost of approximately $470.[20] Undoubtedly, all the endovascular interventions for IIA preservation performed in our series raise the total cost of the procedure. The use of Zenith bifurcated Iliac Side device (Cook Inc, Bloomington, IN) adds $6000 to the cost of standard EVAR, without taking into account the additional cost of the bridging stent graft.[3] The sandwich technique consists a more economic option; though the cost of the iliac extension limb and the bridge cover stent should be acknowledged. Open surgical procedures for IIA revascularization seem to consist the most economic solution, however the logistic impact of certain parameters as the perioperative morbidity and the hospital stay prolongation have not been evaluated. The cost-effectiveness of IIA preservation during EVAR remains open to question and certainly a formal cost-effectiveness appraisal is mandatory.

In conclusion, the option of unilateral or bilateral internal iliac artery occlusion during EVAR may have a significant risk of complications in certain patients. Preservation of one or both hypogastric arteries can be accomplished through various open or endovascular techniques. These techniques represent a significant improvement in the treatment of aortoiliac aneurysms by allowing preservation of pelvic flow. A trend towards more endovascular procedures for IIA preservation has been noted during the last years. However considering the lack of long-term data, therapeutic strategy should be tailored for each individual patient, according to anatomical criteria and the presence of significant comorbidities.

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