Outcome after concomitant unilateral embolization of the internal iliac artery and contralateral external-to-internal iliac artery bypass grafting during endovascular aneurysm repair

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Objective: **Despite improvement of devices, endovascular aneurysm repair (EVAR) is still challenging in cases with associated aneurysmal involvement of the iliac arteries. This study examined the safety and efficacy of EVAR with concomitant unilateral embolization of the internal iliac artery (IIA) and contralateral external-to-internal iliac artery bypass grafting, with bilateral endograft limbs extended into the external iliac arteries (EIAs).**

Methods: **The study included 22 consecutive patients (mean age, 74 years) who underwent elective endovascular repair of aortoiliac or iliac aneurysms, with concomitant coil embolization of the unilateral IIA and contralateral EIA-to-IIA bypass in the same operative setting. Five patients had a unilateral IIA aneurysm, and eight had bilateral IIA aneurysms. EIA-to-IIA bypass grafting was performed through the retroperitoneal approach. The perioperative and midterm outcome of the procedure was assessed.**

Results: **The procedure was successfully performed in all cases. Eleven patients underwent IIA embolization at the main trunk, and the other 11 cases required IIA occlusion at distal branches. There was no perioperative death or severe complication. The mean follow-up period was 15.7 ± 7.8 months, ranging from 2 to 32 months. The bypass remained patent in all cases, and there was no occurrence of graft-related complication. Enlargement of aneurysms or development of type I endoleak was not observed. Persistent mild buttock claudication occurred in two patients (9%) ipsilaterally to the occluded IIA; one patient after IIA occlusion at the main trunk and the other at distal branches. No other pelvic ischemic manifestation was observed.**

Conclusions: **EVAR with simultaneous unilateral IIA embolization and contralateral EIA-to-IIA bypass grafting is feasible, with a relatively low risk of complications. It can be a useful treatment option in cases with complex aortoiliac aneurysms, including those with bilateral IIA aneurysms. (J Vasc Surg 2011;54:960-4.)**

Endovascular aneurysm repair (EVAR) has gained growing importance in the treatment of abdominal aortic aneurysm (AAA). However, coexistent aneurysmal involvement of the common iliac arteries (CIAs) is seen in approximately 20% to 30% of patients with AAA,[1-4] sometimes additionally associated with internal iliac artery (IIA) aneurysms. In some cases, a short CIA hinders stable fixation of the endograft. EVAR is still challenging under these conditions despite improvement of the devices.

Embolization of IIA and extension of the endograft limb into the external iliac artery (EIA) can broaden the indications for EVAR. Although unilateral occlusion of IIA followed by EVAR is a relatively safe technique,[5-7] bilateral IIA embolization can lead to severe ischemic complications such as ischemic colitis or neurologic deficit.[8,9] Thus, in patients in whom stent graft limbs need to be extended into the bilateral EIAs, various attempts have been made to revascularize at least unilateral hypogastric flow to preserve pelvic perfusion.[10-14]

We have simultaneously performed EVAR with unilateral IIA embolization and contralateral EIA-to-IIA bypass grafting in these cases. In the present study, we examined the perioperative and midterm outcome of the procedure and evaluated its safety and efficacy as a treatment option.

METHODS

The study included 22 consecutive patients (20 men and 2 women) who underwent elective endovascular repair of aortoiliac or iliac aneurysms, with concomitant coil embolization of the unilateral IIA and contralateral EIA-to-IIA bypass in the same operative setting, during the period between March 2008 and November 2010. All patients required extension of the endovascular graft to the bilateral EIAs because of aneurysmal involvement of the iliac arteries or short CIAs insufficient for stent graft fixation. The decision on which IIA should be revascularized was made preoperatively based on imaging findings, including contrast-enhanced computed tomography (CT), magnetic resonance imaging (MRI), and Duplex echography, taking into consideration the suitability for bypass grafting and the

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Table. Clinical characteristics of the patients

Age (years)	74 ± 7
Sex (male/female)	20/2
Body mass index	23.7 ± 2.3
Comorbidity (n)	
Hypertension	16
Hyperlipidemia	8
Coronary artery disease	6
Cerebrovascular disease	5
Chronic obstructive pulmonary disease	8
Diabetes mellitus	0
Chronic renal insufficiency	2
Patent inferior mesenteric artery (n)	19
Aneurysmal involvement of internal iliac arteries (n)	
None	9
Unilateral	5
Bilateral	8

degree of aneurysmal involvement of the vessel. The clinical characteristics of the patients are summarized in the Table. Patients were assumed to have hypertension, hyperlipidemia, or diabetes mellitus if they were on corresponding medication. Coronary artery disease was diagnosed from a history of interventional or surgical treatment of the disease, and cerebrovascular disease from a medical history of stroke. The diagnosis of chronic obstructive pulmonary disease was confirmed by respiratory function tests showing the forced expiratory volume in 1 s <70% of forced vital capacity. Chronic renal insufficiency was defined as serum creatinine level >1.5 mg/dL. The patency of the inferior mesenteric artery was determined by preoperative imaging study.

The procedure was performed under general anesthesia as follows. The common femoral artery (CFA) was exposed through an oblique skin incision parallel to the inguinal ligament on the side on which coil embolization of the IIA was to be performed. The contralateral EIA and IIA were exposed and mobilized for bypass grafting through the retroperitoneal approach, as described by Lee et al.[4,15] A linear skin incision of about 10 cm in length was made in the lower abdomen along the lateral rim of the rectus muscle. The anterior rectus sheath was incised, the rectus muscle was displaced medially, and the retroperitoneal space was exposed. The distal part of the EIA was dissected as the access site for the endovascular procedure and the proximal anastomosis of subsequent EIA-to-IIA bypass. The IIA was exposed at the main trunk close to the iliac bifurcation, if there was no aneurysmal change of the artery, or at the distal end of the IIA aneurysm, carefully preserving branches of the IIA, if the patient had a coexistent IIA aneurysm.

After systemic heparinization, coil embolization of the IIA was first performed via the contralateral EIA or ipsilateral CFA. In patients who did not have aneurysmal disease of the targeted IIA, the artery was embolized at its main trunk. If there was aneurysmal involvement of the vessel, branches originating from the IIA were embolized, to prevent postoperative retrograde collateral blood flow into the IIA aneurysm. After coiling of the IIA, EVAR was performed by the standard technique via the ipsilateral CFA and contralateral EIA, extending the bilateral endograft limbs into the EIAs at least 2 cm distally to the iliac bifurcations. Subsequently, EIA-to-IIA bypass was performed on the contralateral side to the embolized IIA, using a 6-mm expanded polytetrafluoroethylene (ePTFE) or 6- to 8-mm knitted Dacron prosthesis in accordance with the size of IIA. The proximal side of the IIA was ligated or oversewn, and anastomosis between the graft and IIA was performed in an end-to-end or end-to-side fashion at a site where no aneurysmal involvement was observed. Finally, the graft was sutured to the EIA in a side-to-end manner. Proximal control of the EIA was achieved by clamping it between the distal end of the stent graft limb and the anastomosis site (Fig).

Clinical examination was performed to identify postoperative pelvic ischemia and buttock claudication. Regular surveillance using either contrast-enhanced CT or Duplex echography was performed 4 to 6 days after the surgery, and every 3 to 6 months thereafter. Charts were reviewed and patients were contacted to gain additional follow-up information if necessary.

Data are presented as mean ± SD unless otherwise stated.

RESULTS

Three patients were treated with a Zenith AAA Endovascular Graft (Cook Medical, Bloomington, Ind), and 19 patients with a GORE Excluder AAA Endoprosthesis (W. L. Gore & Associates, Flagstaff, Ariz). IIA was occluded at the main trunk in 11 patients and at its distal branches in 11 patients. For bypass grafting, a 6-mm prosthesis was used in 19 patients, and an 8-mm prosthesis in three patients. IIA revascularization was performed on the left side in 11 patients, and on the right side in 11 patients. A stenosis at the anastomosis between the graft and IIA was observed in three patients intraoperatively, which was treated with subsequent deployment of a self-expanding nitinol stent at the site. In two patients, stenosis was associated with bilateral IIA aneurysms; the dissection at the distal end of the IIA aneurysm was observed intraoperatively and seemed to be the likely cause of the anastomotic stenosis. The other patient had bilateral IIAs located deep within the pelvis; therefore, suturing was technically difficult, which might have lead to the stenosis at that site. Stent placement at the anastomosis site was successful for all patients, without remarkable bleeding from the suture line. Mean operative time was 329 ± 76 min, and blood loss was 371 ± 289 mL. Eleven patients received blood transfusions.

The average amount of contrast medium used during the procedure was 104 ± 38 mL, excluding a case in which EVAR was performed without angiography, using only intravascular ultrasound because of chronic renal insufficiency. Immediate technical success, meaning exclusion of the aneurysm without type I or III endoleak at the first postoperative imaging surveillance on days 4 to 6, was achieved in all cases. The mean length of postoperative

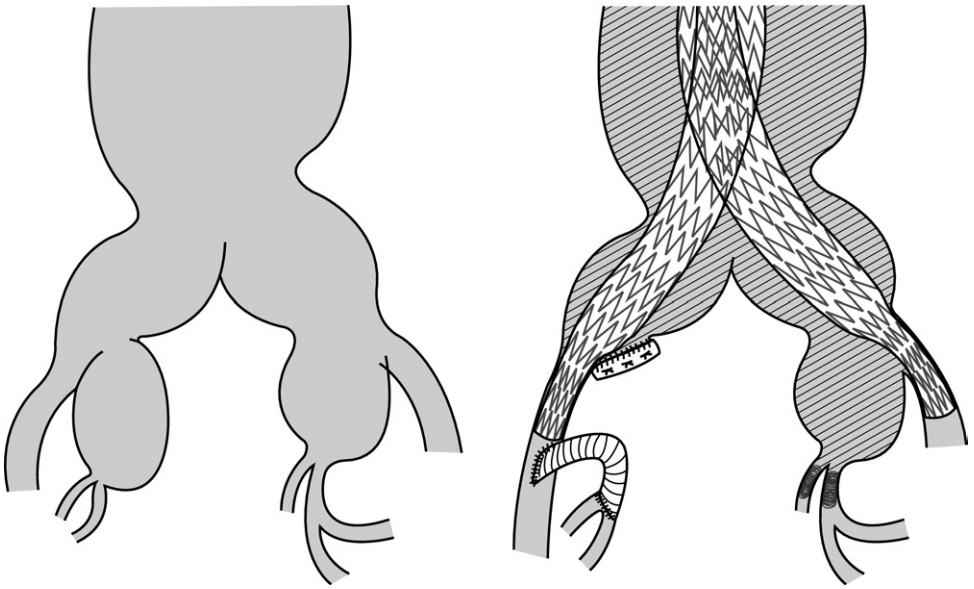

Fig. Endovascular aneurysm repair (EVAR) with concomitant unilateral internal iliac artery (IIA) coil embolization and contralateral external iliac artery (EIA)-to-IIA bypass grafting. IIA embolization was first performed. Then, EVAR was completed with the standard technique, extending the bilateral endograft limbs into the EIAs. EIA-to-IIA bypass grafting was finally performed.

hospital stay was 13.2 ± 8.5 days. At the time of discharge, all the patients had recovered to the preoperative level of activity. No patient died within 30 days postoperatively. Two patients developed perioperative complications. Partial splenic and renal infarction was detected in one patient on day 4 by regular postoperative CT scanning, which was clinically asymptomatic and was treated conservatively. Another patient suffered minor cerebral lacunar infarction in the right internal capsule, which was diagnosed by MRI on day 22 and was presumably not related to the endovascular manipulation. It improved without sequelae, and the patient was discharged on day 46.

The mean follow-up period was 15.7 ± 7.8 months, ranging from 2 to 32 months. One patient died of a cause unrelated to the aneurysm or the procedure at 15 months postoperatively. The bypass was patent in all cases during the follow-up, and no graft-related complication occurred. Aneurysm enlargement or development of type I endoleak was not observed in any of the patients. Persistent mild buttock claudication occurred in two patients (9%) ipsilaterally to the occluded IIA; one patient had undergone IIA occlusion at the main trunk, and the other at distal branches. Transient buttock claudication was observed in one patient, whose IIA was embolized at distal branches. This had resolved completely by 2 months postoperatively without any additional treatment. The inferior mesenteric arteries of the three patients who developed buttock claudication were patent preoperatively, and their branches remained patent during follow-up after the procedure. There was no delayed onset of buttock claudication. Other pelvic ischemic manifestations such as ischemic colitis, neurologic deficit, or skin necrosis did not occur.

DISCUSSION

The results of the present study indicate that the procedure consisting of EVAR with simultaneous unilateral IIA coil occlusion and contralateral EIA-to-IIA bypass can be safely performed with minimal peri- and postoperative complications. Severe ischemic events in the pelvic and hypogastric regions did not occur, and the bypass was patent in all of the patients during the follow-up period, suggesting the usefulness of the strategy as a treatment alternative in patients with iliac aneurysms.

Interruption of the bilateral IIAs during open surgery can cause severe pelvic complications due to an abrupt decrease of blood supply, including gluteal and perineal necrosis, visceral ischemia, and spinal cord or peripheral nerve injury.[16-19] Therefore, revascularization of at least the unilateral IIA is recommended in performing open repair of AAA. On the other hand, coil embolization of the bilateral IIAs in EVAR has been considered safer compared with their ligation during open surgery.[20-23] However, it has been documented that it can lead to ischemic colitis[8] or persistent spinal cord deficiency,[9] and buttock claudication is a major complication with a reported incidence of up to 63%.[24] Unno et al[13] examined the intraoperative penile and gluteal blood flow during EVAR with unilateral IIA occlusion and contralateral IIA revascularization. They demonstrated that pelvic blood flow was significantly decreased when bilateral IIA blood flow was interrupted, while it recovered to the preoperative level after unilateral IIA reconstruction. Thus, it is recommended to preserve blood flow to IIA at least unilaterally as well during EVAR in some manner, and bilateral IIA occlusion should be performed in

limited cases.[8,20,24] If both IIAs appear equally suitable for revascularization, preservation of the left IIA might be beneficial for increasing collateral flow to the left colon;[25] however, the results of the present series did not reveal any difference with regard to the side of the reconstructed IIA.

Several approaches have been devised to maintain arterial perfusion to the unilateral IIA in cases requiring extension of endograft limbs into the bilateral EIAs. Aortouniiliac endografting with subsequent femorofemoral bypass and retrograde contralateral EIA-to-IIA stent grafting has been demonstrated to be a useful treatment method.[10-12] This technique has the advantage that it can be completed through bilateral groin incisions. On the other hand, it cannot be adopted in cases with an insufficient landing zone in the bilateral IIAs due to aneurysmal involvement on both sides. In addition, postoperative occlusion of the femorofemoral bypass might lead to severe ischemia of the pelvis and unilateral lower limb. Leon et al[14] introduced EVAR with antegrade endograft extension into the unilateral IIA and femorofemoral bypass grafting. Their method ensures sufficient antegrade IIA perfusion. However, as mentioned in their article, there are limitations because the technique cannot be performed when the brachial arteries are too small to insert a sheath of adequate diameter.

Recently, the results of clinical application of iliac branched devices (IBDs) have been reported.[26-32] The technical success rate has been demonstrated to be between 85% and 100%, showing relatively high feasibility of the devices, while the indication for usage of IBDs is limited by various morphologic factors of the targeted iliac arteries. Aneurysmal involvement or stenosis at the orifice of IIA or severe tortuosity or calcification of iliac arteries hampers successful implantation of the devices.[32] Postoperative branch occlusion could occur in up to 26% of cases treated with IBDs.[28] Further improvement of the devices is required to effectively apply them in broader clinical conditions.

Adjunctive surgical IIA revascularization in patients undergoing EVAR has been reported as a safe alternative to preserve hypogastric perfusion.[4,15,25,33,34] The procedure is advantageous in that it can be performed simultaneously with EVAR and in cases with various anatomical conditions, even in patients with aneurysmal involvement of the bilateral IIA. Concurrent unilateral embolization and contralateral bypass grafting to IIA extensively broadens the therapeutic potential of EVAR. Faries et al[25] reported a good outcome of their strategy, which includes coil embolization of the unilateral IIA 3 to 5 weeks prior to EVAR and EIA-to-IIA bypass. They set an interval of several weeks between IIA coiling and the subsequent procedure, to promote the development of collateral vessels within the pelvic circulation network. On the other hand, several reports have demonstrated the safety and effectiveness of concomitant IIA embolization compared with staged interventions.[7,8] The present study revealed the feasibility and efficacy of unilateral IIA embolization followed by EVAR and contralateral EIA-to-IIA bypass grafting at the same operation, with a relatively low rate of perioperative morbidity. This strategy might be convenient for patients because the treatment is completed during one hospitalization, and it avoids the risk of aneurysm-related complications between the staged procedures.

In cases requiring IIA embolization, it is generally recommended that it should be performed at the main trunk of IIA rather than at distal branches to preserve collateral blood flow. Previous reports have demonstrated that ischemic complications occurred in more than half of patients after distal embolization of IIA compared with 10% to 16% of cases after proximal interruption.[6,8,9] However, it is often necessary to occlude its distal branches, especially in cases with associated IIA aneurysms. Indeed, 13 patients (59%) had IIA aneurysms in our series, and distal embolization was required in 11 cases (50%). The present study showed that postoperative buttock claudication was observed in one patient (9%) after coiling of the main trunk compared with two patients (18%) after distal embolization, including one with transient symptoms, and there were no other severe ischemic complications. We consider that occlusion of distal branches of IIA can be carefully performed if necessary, with a relatively low risk of severe ischemia during EVAR, which might broaden the indications for treatment of aortoiliac aneurysms.

In this study, we did not perform standardized quality of life assessments or determine the status of potency before or after the procedure. Further studies involving these evaluations are essential for elucidating the effectiveness of this procedure.

CONCLUSIONS

EVAR with simultaneous unilateral IIA embolization and contralateral EIA-to-IIA bypass grafting is feasible with a relatively low risk of complications. The technique can be applied in a broad range of cases associated with aneurysmal involvement of the iliac arteries and is a potentially useful treatment alternative for patients with complex aortoiliac aneurysms.

AUTHOR CONTRIBUTIONS

Conception and design: AH, MK, IK, SI, NO
Analysis and interpretation: AH, MK, NO
Data collection: AH, MK
Writing the article: AH, MK
Critical revision of the article: MK, IK, SI, NO
Final approval of the article: AH, MK, IK, SI, NO
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