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Endovascular Repair of Isolated Iliac Artery Aneurysms

Andreas Chemelli, MD[1]; Beate Hugl, MD[2]; Josef Klocker, MD[2]; Michael Thauerer, MD[1]; Alexander Strasak, PhD[3]; Werner Jaschke, MD[1]; Peter Waldenberger, MD[4]; and Iris Eva Chemelli-Steingruber, MD[1]

Departments of [1]Radiology, [2]Vascular Surgery, and [3]Medical Statistics, Informatics and Health Economics, Innsbruck Medical University, Innsbruck, Austria. [4]Department of Radiology, St. Vincent Hospital, Linz, Austria.

Purpose: To retrospectively evaluate a 12-year experience with endovascular repair of isolated iliac artery aneurysm (IAA).

Methods: From August 1997 through July 2009, 91 patients (81 men; mean age 71 years, range 31–90) underwent endovascular treatment for isolated IAA at our department. Of these, 77 patients received stent-grafts either alone or in combination with coils or an Amplatzer vascular plug (n=2); 1 patient received a Smart stent combined with coils, and 13 patients were treated with coil embolization only. The aneurysms were classified according to location: type I=common iliac artery (CIA), type II=internal iliac artery (IIA), type III=CIA and IIA, and type IV=external iliac artery with/without CIA and/or IIA involvement.

Results: Primary technical success was 90.1% for all aneurysm types and 93.6%, 80%, 88.8%, and 93.3% for types I, II, III, and IV, respectively. Secondary technical success was 96.7% for all types and 97.8%, 95%, 100%, and 93.3%, respectively, for each type. Clinical success was 93.4% for all types and 97.8%, 85%, 100%, and 86.7%, respectively, by type. Complications in 18 (19.8%) patients included 7 type I endoleaks, 3 type II endoleaks, 2 enlarged aneurysm sacs (incomplete embolization), 5 cases of buttock claudication, and 2 stent-graft thromboses. Two patients were converted to open surgery; 10 underwent secondary interventions. Mortality rates were 1.1% (n=1) at 30 death days and 23.1% (n=21) over a mean follow-up of 45.9 months (no aneurysm-related death). Cumulative overall survival was 97.7% at 1 year and 47.6% at 10 years. Freedom from aneurysm-related complications was 88.6% at 1 year and 83.5% at 5 years.

Conclusion: Endovascular repair of isolated IAA is a safe and minimally invasive alternative to surgery. However, it may be associated with several complications and must, therefore, be carefully planned.

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Key words: isolated iliac artery aneurysm, endovascular aneurysm repair, stent-graft, coil embolization, Amplatzer vascular plug

Iliac artery aneurysm (IAA) occurs in 10% to 20% of patients with abdominal aortic aneurysm (AAA).[1] Isolated IAAs are rare, with an estimated prevalence of 0.008% to 0.03%. The most common cause for IAA is atherosclerosis, followed by trauma, infection, and collagen diseases,[2] but they may also develop at anastomotic sites after surgical reconstruction for arterial diseases[3,4] or at the proximal and/or distal ends of stent-grafts.[5] More than 65% of IAAs are asymptomatic and are found incidentally. However, they may cause neu-

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Address for correspondence and reprints: Iris Eva Chemelli-Steingruber, University Hospital Innsbruck, Radiology, Anichstr. 35, A-6020 Innsbruck, Austria. E-mail: *iris.chemelli-steingruber@uki.at*

rological, urological, and gastrointestinal symptoms.[6] If left untreated, they carry the risk of progressive expansion and rupture, which is associated with high mortality rates.[6]

Adequate and early treatment can improve survival. As open surgery of IAA is associated with high morbidity and mortality rates,[7] endovascular repair has gained wide acceptance as a minimally invasive alternative, with lower morbidity and mortality rates.[8] Endovascular modalities include stent-grafting, various embolization techniques, or a combination of both methods. The decision on the type of endovascular repair depends on vessel anatomy, aneurysm location, and morphology. Results of endovascular repair of IAAs are encouraging.[6,8,9] However, most studies had comparatively small patient populations and short observation times.

The purpose of this retrospective study was to evaluate the long-term outcome of endovascular repair of isolated IAAs based on a large patient population treated over a 12-year period.

METHODS

Patient Population

From August 1997 through July 2009, 91 patients (81 men; mean age 71 years, range 31–90) underwent endovascular treatment of 109 isolated IAAs at our department (Table 1). Young patients and those in good medical condition were referred for surgical repair, as were patients with bilateral internal iliac artery (IIA) aneurysms. The lesions treated at our department included 52 common iliac artery (CIA) aneurysms with a mean diameter of 33 mm (range 15–82), 20 IIAs with a mean diameter of 34 mm (range 15–78), and 11 external iliac artery (EIA) aneurysms with a mean diameter 29 mm (range 10–60). Nine patients presented with both CIA and IIA aneurysms and 4 patients had IIA and EIA aneurysms.

The majority of patients (79, 86.8%) were asymptomatic, and the diagnosis of IAA was made incidentally during computed tomography (CT) or ultrasound imaging for other reasons. Of the 12 symptomatic patients, 10 presented with pelvic pain arising from neurological, urological, or gastrointestinal symptoms caused by the growing IAA (n=8) or rupture (n=2). Two patients suffered from leg ischemia. One of the patients had a para-anastomotic aneurysm repaired surgically 9 years earlier, with an anastomotic site in the left femoral artery and another in the right iliac artery. In this patient, the IAA occurred at the anastomotic site in the right CIA and in the left CIA and IIA due to retrograde perfusion of the left native EIA. The youngest patient (age 31 years) developed IAA after explantation of a kidney transplant. Despite his young age, he was not considered a candidate for surgical repair because he had previously undergone multiple surgical interventions.

TABLE 1
Comorbidities and Etiologies of Isolated Iliac Artery Aneurysm (IAA) in 91 Patients

Comorbidities	
Hypertension	57
Congestive heart failure	23
Coronary artery disease	39
Diabetes	15
Malignancy	22
Peripheral artery occlusive disease	31
Chronic obstructive disease	23
Chronic renal insufficiency	15
Chronic venous insufficiency	5
Hyperthyroxinemia	2
Hyperlipidemia	34
Hypercholesterolemia	15
Hyperuricemia	10
Obesity	19
Tobacco use	22
IAA etiology	
Atherosclerosis	59
After aortobi-iliac bypass surgery for AAA or stenosis	16
After aortomonoiliac bypass surgery	7
After transarterial endarterectomy	3
After explantation of a kidney transplant	1
After surgical repair of the hip	1
After arterial infection (mycotic)	2
Just distal to an aortomonoiliac stent-graft	1
Just distal to a bifurcated stent-graft	1

AAA: abdominal aortic aneurysm.

Diagnostic Workup

The diagnosis of IAA was established on the basis of CT and/or angiography and/or clinical examination. In each patient, contrast-enhanced helical CT with 3-dimensional reconstruction from the apex of the thorax down to the groin was obtained immediately after admission; diagnostic angiography was done at the time of the endovascular repair. These studies provided the needed information on the exact location, morphology, length, and diameter of the iliac lesions, the anatomy of the affected vessels, and the anatomy of the vessels used for access.

Up to May 1999, CT examinations were performed using a single-slice CT scanner; from May 1999 to June 2006, a 4-row multidetector scanner was used, and since June 2006, data have been acquired from a 64-row multidetector CT scanner (VCT; GE Medical Systems, Milwaukee, WI, USA) using a slice thickness of 0.625 mm with a pitch of 0.98 in the standard reconstruction kernel. Scans were obtained using 120 to 150 mL of a nonionic contrast agent (Ultravist; Schering, Berlin, Germany) administered at a concentration of 300 to 370 mg I/mL and a flow rate of 4 mL/s. The raw data were transferred to an independent workstation (Sun Ultra 60; Sun Microsystems, Mountain View, CA, USA) running the Advantage Windows software (version 4.0; GE Medical Systems) for the 3D reconstructions.

Technique

Prior to the endovascular repair, informed consent was obtained from all patients. All procedures were performed by a team of experienced radiologists, anesthesiologists, and vascular surgeons in an angiographic suite (Integris BV 3000; Phillips, Eindhoven, The Netherlands) equipped for fluoroscopic guidance. Sixty patients were treated under local or regional anesthesia, 26 under general anesthesia, and 5 with epidural anesthesia. In 60 patients, the procedure was performed percutaneously; 9 patients required open common femoral artery exposure, while 22 patients had both approaches. All patients received short-term antibiotic prophylaxis with cephalosporin. Five thousand units of heparin were given intravenously during the intervention.

The IAAs were treated using various endovascular techniques, including stent-grafting, coil embolization, or a combination of both methods. These modalities have been described in detail previously.[6,10] A healthy aneurysm neck $\geq$1.5 cm was considered long enough to serve as an anchoring site for stent-graft placement. If one or both of the proximal landing zones were too short, a bifurcated or aortomonoiliac stent-graft was placed. If the distal landing zone was too short, the limb of the stent-graft was extended to the EIA. If the IIA was aneurysmal or involved in the CIA or EIA aneurysm, its orifice was crossed with the stent-graft. If retrograde perfusion of the aneurysm via the IIA or its side branches was suspected, these arteries were embolized. Embolization alone was performed when the proximal part of the IIA was not involved.

Stent-grafts. The dimensions of the grafts were determined on the basis of the preinterventional CT scans and angiograms. During primary interventions, 72 patients received 89 iliac stent-grafts of various types (Table 2), including Talent (Medtronic Vascular, Sunrise, FL, USA); Excluder, Hemobahn, Viabahn (W.L. Gore and Associates, Inc, Flagstaff, AZ, USA); Fluency (Bard, Karlsruhe, Germany); Wallgraft and Passenger (Boston Scientific, Natick, MA, USA); Zenith (Cook Medical, Bloomington, IN, USA); and Jostent (Abbott, Abbott Park, IL, USA). One stent-graft was implanted in 56 patients, 2 stent-grafts in 13 patients, and 3 devices in 1 patient. Two patients had single devices implanted bilaterally. Twenty-six patients were treated using stent-grafts alone.

In addition, 2 patients with acute aneurysm underwent an aortomonoiliac stent-graft procedure with crossover bypass. Three patients received a bifurcated stent-graft, 2 of them because of additional infrarenal AAAs with diameters of 4.1 and 4.2 cm, respectively. The third patient had bilateral CIA aneurysms that required a bifurcated device because neither of the CIAs offered an adequate proximal landing zone.

Stents. Three patients received stents, including 2 60-mm-long Smart stents (Cordis Corporation, Miami Lakes, FL, USA) with diameters of 10 to 12 mm and a 6$\times$28-mm

TABLE 2
Types, Sizes, and Numbers of Stent-Grafts Used in 91 IAA Patients

	Number	Length, mm	Diameter, mm
Talent	23	75–100	10–36
Excluder	2	100–120	12–16
Fluency	8	60–100	8–13.5
Wallgraft	26	50–100	10–14
Zenith	9	70–105	12–24
Passenger	10	60–100	10–14
Hemobahn and Viabahn	8	50–150	8–10
Jostent	3	28–60	12–14

Wallstent (Boston Scientific). One Smart stent was implanted for primary repair of a small eccentric EIA aneurysm and the other for repair of a short dissection following endovascular repair of a left CIA aneurysm during the same session. The Wallstent was implanted during primary intervention to treat stenosis of the EIA distal to a stent-graft.

Coils and Amplatzer vascular plug. In all, 61 patients has coil embolization; 45 had coils inserted in addition to stent-grafts, 2 in addition to an aortoiliac stent-graft, and 1 in addition to a stent. Thirteen patients were treated using coils only. Pushable 5- to 15-mm-diameter macrocoils (MWCE; Cook Medical) were inserted through a diagnostic catheter using a Benson 0.035-inch guidewire in 56 cases, while 3- to 10-mm-diameter detachable microcoils (IDC, Boston Scientific) were used in 3. Two patients received both kinds of coils.

In 12 of the 61 patients, a liquid embolic material (Ethibloc; Ethicon, Norderstedt, Germany) was additionally applied to activate thrombosis. Two patients received an Amplatzer vascular plug (AGA Medical Corporation, Golden Valley, MN, USA) instead of coils in addition to stent-graft placement to occlude the orifice of the IIA (Fig. 1). In one of them, a bifurcated stent-graft was combined with this device to occlude the left IIA. The second patient, who presented with a right CIA aneurysm involving the orifice of the IIA, was treated with iliac stent-graft placement and an Amplatzer vascular plug to occlude the IIA.

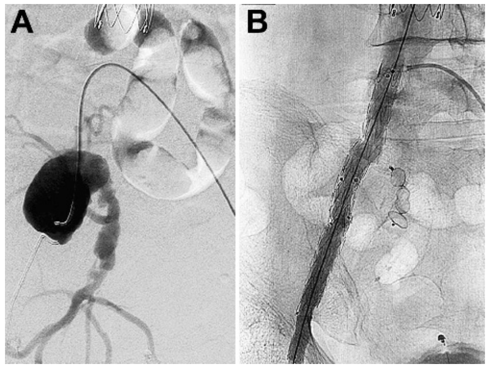

Figure 1 ◆ (**A**) Diagnostic angiography shows a large CIA aneurysm in a 67-year-old patient. (**B**) Completion angiography demonstrates successful endovascular repair with correct position of the stent-grafts and occlusion of the proximal IIA by an Amplatzer Vascular Plug.

Medication. After the procedure, 15,000 units of heparin were given for 24 hours to prevent early stent-graft thrombosis. The same dose was given to patients treated with coils alone to prevent thrombosis of the CIA and/or EIA originating from the embolized IIA. In addition, lifelong antiplatelet therapy with a daily dose of 100 mg acetylsalicylic acid was prescribed. Clopidogrel was not used routinely after iliac artery stent-grafting because the risk of thrombosis is low due to the comparatively large diameter of the affected vessels.

Follow-up Protocol

All patients underwent completion angiography at the end of the procedure and contrast-enhanced CT scans after the procedure. After discharge, the follow-up protocol included clinical examination and contrast-enhanced CT scans at 6 and 12 months and as needed thereafter. Additional scans and/or digital subtraction angiography were performed as needed to address specific problems. In addition, the patients were questioned on their state of health and possible complaints, such as buttock claudication or sexual impairment.

IAA Classification and Definitions

Aneurysms affecting the CIA were classified as type I, those affecting the IIA were type II, those affecting both the CIA and IIA were type III, and those affecting the EIA with or without involvement of the CIA and/or IIA were type IV. Type I aneurysms with a proximal neck <1.5 cm were treated by aortomonoiliac or bifurcated stent-grafts.[8,11]

Primary technical success was defined as successful exclusion of the aneurysm at the first intervention and its maintenance for 30 days. Secondary technical success was defined as complete exclusion of the aneurysm during a subsequent reintervention. Clinical success was defined as successful exclusion of the aneurysm without procedure-related mortality, rupture, gluteal claudication, stent-graft occlusion, or need for surgical reconstruction.

Statistical Analysis

Cumulative rates of survival and freedom from aneurysm-related complications were evaluated by means of Kaplan-Meier estimates. All statistical analyses were conducted using SPSS statistical software (version 15.0; SPSS, Chicago, IL, USA).

RESULTS

Primary technical success was 90.1% (82/91) including 2 patients who were treated by additional stent placement during primary interventions. One of them received a stent to treat a short dissection after endovascular repair of a left CIA aneurysm and the second one to treat stenosis of the EIA distal to an iliac stent-graft. The only perioperative death (1.1%) occurred in a patient who died of cerebral trauma due to an accident 4 days after the intervention. The other 8 failures at 30 days were 6 early endoleaks (3 type I and 3 type II), 1 acute stent-graft thrombosis, and 1 reperfused aneurysm.

Secondary technical success was 96.7% (88/91). Ten patients needed secondary endovascular interventions to treat 6 endoleaks (5 type I and 1 type II) in 5 patients, 2 cases of aneurysm enlargement (insufficient embolization), 1 stent-graft thrombosis, and 2 contralateral IIA stenoses in patients with buttock claudication. Secondary clinical failures included 2 patients who were converted to

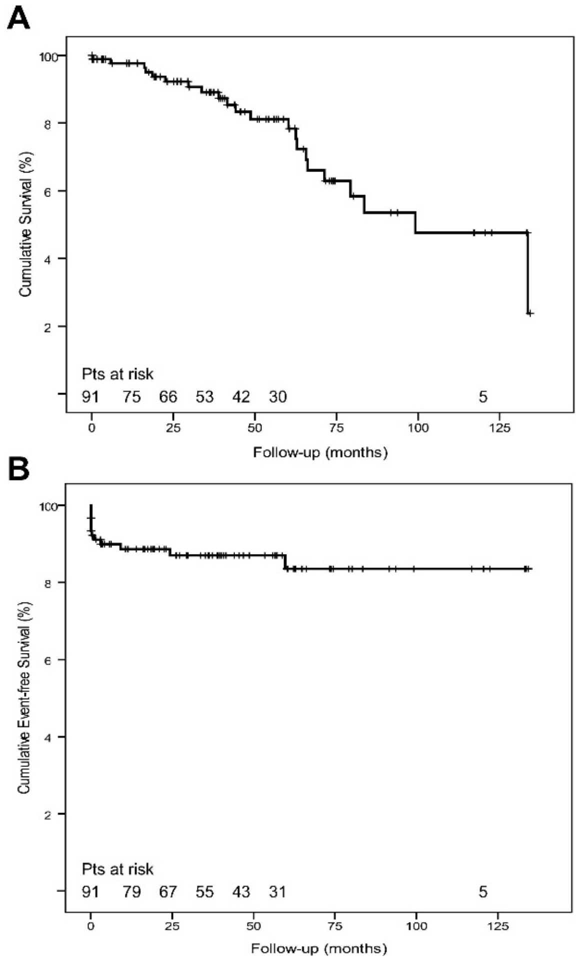

Figure 2 ◆ (**A**) Cumulative overall survival rates (standard error 0.97% at 10 years). (**B**) Freedom from aneurysm-related complications (standard error 0.49% at 10 years).

open surgery due to an early type I endoleak and a late stent-graft thrombosis, respectively, and 1 patient with an early type I endoleak who refused treatment. Clinical success was 93.4% (85/91), including 3 patients who suffered from persistent buttock claudication.

Mean follow-up was 45.9 months (range 0.1–134). Twenty-one (23.1%) deaths occurred after the 30-day period. However, none of these deaths was related to the intervention. Cumulative overall survival (Fig. 2A) was 97.7% at 1 year [standard error (SE) 0.16%], 92.3% at 2 years (SE 0.3%), 89.1% at 3 years (SE 0.37%), 83.3% at 4 years (SE 0.47%), 81.2% at 5 years (SE 0.51%), and 47.6% at 10 years (SE 0.97%). Freedom from aneu-

TABLE 3
Success Rates and Treatment Modalities According to Aneurysm Classification

	Type I (n=47)	Type II (n=20)	Type III (n=9)	Type IV (n=15)
Success rates				
Primary technical	44 (93.6%)	16 (80.0%)	8 (88.9%)	14 (93.3%)
Secondary technical	46 (97.9%)	19 (95.0%)	9 (100.0%)	14 (93.3%)
Clinical	46 (97.9%)	17 (85.0%)	9 (100.0%)	13 (86.7%)
Treatment modalities				
Stent-graft+vascular plug	1	0	0	0
Only coils	0	13	0	0
Stent-graft+coils	28	7	8	2
Stent-graft only	14	0	0	12
AMI or bifurcated stent-graft or stent	4	0	1	1

AMI: aortomonoiliac.

rysm-related complications (Fig. 2B) was 88.6% at 1 and 2 years (SE 0.37%), 87.0% at 3 and 4 years (SE 0.37%), and 83.5% at 5 and 10 years (SE 0.49%).

Complications According to the IAA Classification (Table 3)

Type I aneurysm (n=47). One early proximal type I endoleak was seen in a patient who was treated by iliac stent-graft placement combined with macrocoils. However, the stent-graft was undersized (34-mm vessel diameter and a 36-mm proximal stent-graft diameter); the leak was recognized at the postinterventional CT and was closed 2 months after the intervention by coil embolization using a crossover approach. One late type I endoleak occurred in a patient who received 3 10×60-mm iliac stent-grafts; CT at 24 months showed a distal endoleak type I due to vessel elongation and stent-graft migration. The leak was closed by additional stent-graft implantation.

One type II endoleak was seen on completion angiography, but the AAA was stable so no treatment was required. One patient developed both an early type II endoleak and a late type I endoleak. He had been treated for a ruptured CIA aneurysm using a 30–14×170-mm aortomonoiliac stent-graft combined with a crossover bypass. The postinterventional CT scans and angiogram showed type II endoleak, which was fed by the iliolumbar artery. Five months later, a distal type I endoleak was detected coming from enlargement of the distal anchoring zone caused by the type II endoleak. Both leaks were treated by placement of an additional iliac stent-graft and coil embolization of the iliolumbar artery, respectively.

Two stent-graft thromboses were encountered in this group. One acute thrombosis occurred 3 days after endovascular repair of a CIA aneurysm using a Zenith stent-graft in a patient who had undergone transarterial endarterectomy in 1990. A preexisting stenosis of the EIA, which was obvious on completion angiography, was not treated because its significance was underestimated. As a consequence, the patient developed stent-graft thrombosis. However, blood flow was restored by successful stent-graft lysis, intensified anticoagulation, and subsequent balloon dilation of the EIA. In the second patient, thrombosis occurred 9 months after Wallgraft placement for bilateral CIA aneurysm due to intimal hyperplasia. Recanalization was not successful, and the patient had to be converted to open surgery.

Type II aneurysm (n=20). Early proximal type I endoleak occurred in 1 patient who was treated using an iliac stent-graft in combination with microcoils. In this patient, the stent-graft had slipped down into the aneurysm because the anchoring zone was too short and angulated. The leak was recognized on the postinterventional CT. However, the patient had to be converted to open surgery 2 months after the intervention because he developed an inguinal abscess making further endovascular manipulation impossible.

Late type I endoleak occurred in 2 patients 50 and 59 months after endovascular repair, respectively. One of them had been treated using macrocoils. Follow-up CT showed proximal endoleak type I, which was retrospectively attributed to insufficient coil embolization of the IIA aneurysm neck, although completion angiography did not show any residual aneurysm perfusion. The leak was closed by redo embolization. The second patient, who had a 12×50-mm stent-graft with macrocoils, developed a type I endoleak distal to the stent-graft due to aneurysmal dilatation of the adjacent arterial segment. Distal extension with an additional stent-graft was successful.

Aneurysm reperfusion occurred in 1 patient who was treated by macrocoils only. Completion angiography showed complete occlusion of the aneurysm, but postinterventional CT showed proximal coil compaction. In this patient, the neck was wide (1.5 cm) and short (1 cm), and coil compaction could have been prevented by using coils combined with stent-graft placement. To stop reperfusion, redo coil embolization had to be performed at 2 months and a second redo coil procedure combined with stent-graft implantation 25 months after the primary intervention.

Bilateral buttock claudication occurred in a patient in whom both IIAs were occluded. His right IIA and lumbar arteries had been occluded during surgical repair of an AAA 10 years earlier, and the other IIA had to be embolized because of aneurysmal dilatation by placing coils into the proximal, middle, and distal segments of the IIA. The symptoms resolved almost completely and were only present during stair or mountain climbing. Three patients developed unilateral buttock claudication, although only one of the IIAs was occluded. In 2 of them, the coils were placed into the middle segment and in the middle and distal segments of the IIA in the other one. In 2 of these patients, claudication was due to stenosis of the contralateral branch of the IIA. After balloon dilation of the stenosed artery, the symptoms resolved. In the third patient, claudication was still present at the last clinical examination.

Type III aneurysm (n=9). Type II endoleak was noticed on completion angiography in 1 patient, but the AAA was stable, so no treatment was required. One patient showed sac enlargement (Fig. 3) after being treated using stent-grafts and coils. Completion angiography demonstrated successful endovascular repair with correct position of the stent-grafts. The proximal part of the IIA aneurysm had been embolized using macrocoils. However, the aneurysm could not be excluded because the distal part of the IIA was not embolized. The patient was closely monitored and at 28 months after the intervention, angiography showed significant enlargement of the distal part of the IIA due to retrograde perfusion from the obturator artery. Successful occlusion was achieved by placing microcoils into the IIA, the proximal part of the obturator artery, and the inferior gluteal artery.

Type IV aneurysm (n=15). Early type I endoleak was seen in 1 patient (Fig. 4) who was treated for a small, eccentric EIA aneurysm located immediately distal to the orifice of the IIA. A stent combined with macrocoils was placed into the distal CIA and proximal EIA to maintain perfusion to the IIA. It was intended to cover the aneurysm with the stent and insert the coils through the struts of the stent into the aneurysm sac. However, this maneuver failed, and the patient developed type I endoleak because of coil compaction. The endoleak was not treated because the patient refused any further therapy. He is alive 50 months after the intervention.

Buttock claudication was observed in 1 patient in whom coils were placed into the proximal and middle segments of the IIA. In this patient, the symptoms resolved almost completely and were only present during stair or mountain climbing.

DISCUSSION

IAAs usually produce symptoms late because of their pelvic location. Most of them are asymptomatic at the time of diagnosis.[6,12] However, if they expand to an advanced size, they often cause urological (in 54%), neurological, or gastrointestinal symptoms. They

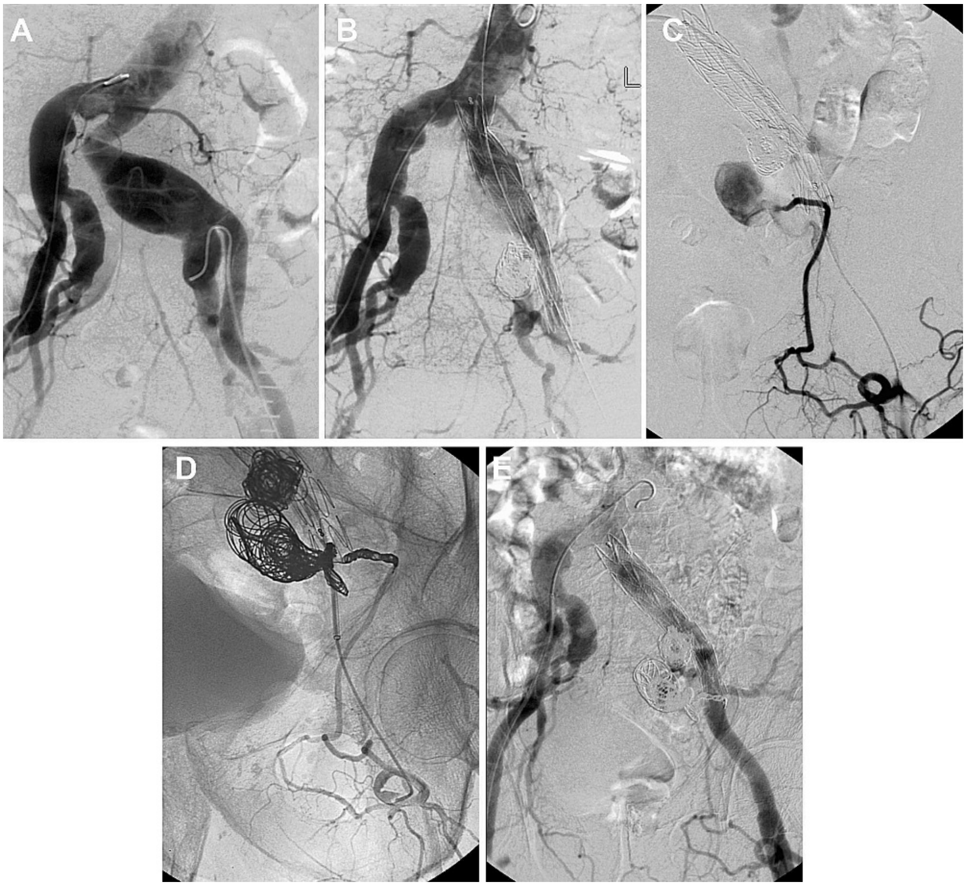

Figure 3 ◆ (**A**) Diagnostic angiography in an 82-year-old patient shows a large CIA aneurysm and a smaller IIA aneurysm. (**B**) Completion angiography demonstrates successful endovascular repair with correct position of the stent-grafts and macrocoils placed into the proximal IIA aneurysm. However, technical failure occurred because the distal part of the IIA aneurysm was not embolized. (**C**) Angiography 28 months after endovascular repair shows substantial enlargement of the distal IIA due to retrograde perfusion from the obturator artery. (**D**) Angiography shows microcoils placed in the distal IIA and the proximal obturator and inferior gluteal arteries. (**E**) Completion angiography demonstrates occlusion of about 95% of the IIA aneurysm.

carry a risk of rupture that proves fatal in 50% to 100% of cases.[6,13] Therefore, elective treatment is indicated for IAAs ≥3 cm in diameter.

Elective surgical reconstruction of IAAs is a complex procedure, with mortality rates ranging from 7% to 13%. For many years now, endovascular techniques have become a widely accepted alternative for the treatment of IAA. Several authors have reported promising and encouraging results.[4,6,8,9,14,15] However, most studies presented comparatively small patient populations and short follow-up periods.[2,6,8,9,16] The 2 largest studies presented 52 patients with a mean follow-up of 20±5 months[17] and 45 patients with a mean follow-up of 22 months.[4] Our study presents a population twice as large and with a mean follow-up more than twice as long. Our results are promising and comparable to those of other reports.[6,9]

Para-anastomotic aneurysm is an infrequent but challenging complication after open surgical graft reconstruction.[3,18–20] Continuous expansion may lead to rupture, which is associated with high mortality (67% to 100%).[19] In our patient population, 22 aneurysms occurred at the anastomotic site after graft placement. As our experience demonstrated, this complication can be effectively

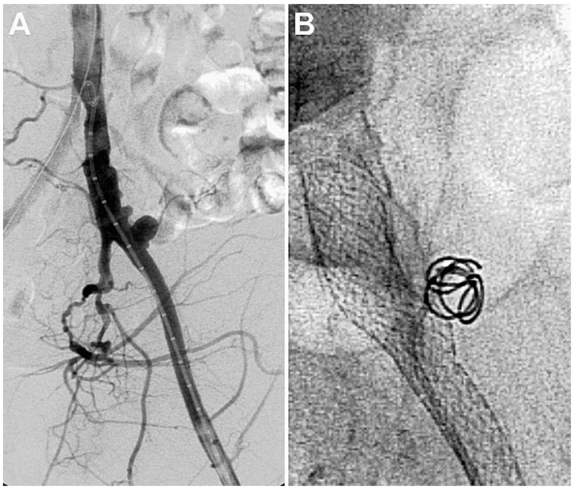

Figure 4 ◆ (**A**) Diagnostic angiography shows an eccentric EIA aneurysm in a 74-year-old patient. (**B**) Fluoroscopy demonstrates stent-assisted coil embolization of the EIA aneurysm to preserve antegrade perfusion of the IIA. The tip of the catheter is placed in the aneurysm and coils are delivered through the stent struts.

and safely treated by endovascular repair.[19,21] However, IAAs may also occur just distal to aortomonoiliac or bifurcated stent-grafts, as we encountered in 2 patients suffering from aneurysm disease. As this disease cannot be stopped, stent-grafting only displaces the problem further downward. This is underlined by the observation that true aneurysmal changes at para-anastomotic sites are rarely seen in the setting of previous aortic bypass for aortoiliac occlusive disease.[19]

Despite encouraging results, several serious complications, such as buttock claudication or sexual impairment, have been associated with endovascular repair of isolated IAAs. Intentional bilateral occlusion of the IIA is a matter of particular debate. Buttock claudication after bilateral IIA occlusion has been reported in up to 57% of patients.[22–25] Some authors postulate that this maneuver is well tolerated when pelvic collateral perfusion from the external iliac or femoral arteries is preserved.[2] Others recommend that perfusion of at least one of the IIAs should be preserved in order to prevent buttock claudication.

It is our policy to avoid occlusion of both IIAs, if possible. However, it may be necessary in patients with bilateral IIA aneurysms who are at high surgical risk or who underwent previous vessel surgery and developed para-anastomotic IAA. In our patient population, 5 patients developed buttock claudication, but only one had bilateral IIA occlusion. Buttock claudication may also develop when the ipsilateral IIA has to be occluded and the contralateral IIA is narrowed by atherosclerotic disease, as seen in 2 of our patients. Fenestrated stent-grafts, which have recently become available, can help to preserve pelvic perfusion. Power et al.[26] used them in 11 patients with promising short-term results. However, if the orifice of the IIA is also involved in the aneurysm, they cannot be used, and there is no guarantee of freedom from claudication or reocclusion of the IIA.[27] In our department, we have no specific strategy for preserving pelvic perfusion in case both IIAs have to be sacrificed, as we try to avoid bilateral occlusion whenever possible.

Another problem is distal embolization of the IIA. Cynamon et al.[28] and Zander et al.[29] reported increased incidences of buttock claudication if the coils were placed in the distal part of the IIA or in one of its subsegments. In contrast, if coils were placed strictly in the main IIA, the chance of gluteal claudication was only 10%. Zander et al.[29] also stated that it did not make any difference whether the IIA was proximally embolized or covered by a stent-graft, as long as the distal network remained untouched. This is supported by our results. If the coils were placed into the proximal IIA, no buttock claudication was observed. If the coils were placed in the main IIA, buttock claudication occurred in 6.5% (3/46) of the patients, but it occurred in 11.8% (2/17) of the patients in whom the distal IIA was embolized. Therefore, we concur that distal embolization should be avoided if possible. However, sometimes it has to be performed, as was the case in one of our patients who showed significant enlargement of the distal part of the IIA due to retrograde perfusion from the obturator artery.

To avoid distal coil embolization, Zander et al.[29] first placed a short, oversized coil proximal to the IIA subsegments; smaller coils were then inserted to form a nest. This technique is very efficient; however, in our limited experience, the same result can be achieved more easily, faster, and safer using an Amplatzer vascular plug. This device has been applied to treat arteriovenous fistulas and vascular malformations,[30–33] but reports of its use in the setting of IAA are scarce. In our series, the Amplatzer vascular plug device was used in 2 patients presenting with type III aneurysm. In our view, this device might in the future replace coils or be used in combination with coil embolization in patients with IIA aneurysm. We are aware that the number of patients with buttock claudication in our series is too small to allow us to draw firm conclusions, and further investigations in this area of application would be of great interest.

Type I endoleak is another serious complication associated with endovascular repair of IAAs. In our study, it was the main reason for failure and was caused by stent-graft migration, aneurysmal dilatation of the segments adjacent to the stent-graft, insufficient packing of the coils resulting in recanalization and coil compaction, and stent-graft undersizing. However, type I endoleak can be successfully treated using stent-grafts and/or coils, as was seen in our series; only 1 patient had to be converted to open surgery due to type I endoleak.

The use of coils alone to treat IIA aneurysm carries the risk of coil compaction and recanalization. To avoid this problem, the coil nest should be protected by covering the orifice of the IIA with a stent-graft following embolization. Coil compaction and recanalization are well known complications in the setting of cerebral aneurysm repair and are seen in as many as 40% of these patients. Higher packing density has been suggested to reduce both coil compaction and recanalization.[34–36] However, higher packing with macrocoils is difficult because they are very stiff and hard to insert into the aneurysm. This difficulty may be avoided by using an Amplatzer vascular plug.

Vessel elongation and stent-graft migration despite correct sizing of the stent-graft and aneurysmal dilatation of the arterial segment adjacent the stent-graft represent serious problems. Nevertheless, endovascular repair often remains the only option in patients with diffusely diseased arteries, as they usually are in poor medical condition and therefore at high surgical risk.

Stent-graft stenosis/thombosis is a well known and serious complication after endovascular repair. In our series, the 98% patency rate is very favorable and comparable to rates presented by others.[2,4,6,37] Tsilimparis et al.[2] reported 2 cases of endograft thrombosis in the right limb of a bifurcated stent-graft. They suspected that the occlusions were due to the small diameter of the arteries and stent-graft extensions, which measured 8 and 12 mm, respectively. To avoid this problem, we use tapered stent-grafts, if possible. In our series, stent-graft thrombosis was caused by an untreated EIA stenosis distal to the stent-graft and by intimal hyperplasia in another one. In the first patient, more careful analysis of the completion angiogram by performing an oblique projection may have permitted early recognition of the problem and immediate treatment of the EIA stenosis. In our experience, intimal hyperplasia such as seen in the second patient cannot be prevented.

Analysis of our results shows that some of the complications could have been avoided by adapting treatment modalities and matching stent-grafts more carefully to vessel anatomy, aneurysm location, and morphology. It also is obvious that treatment of aneurysms with IIA involvement is most challenging, especially when there is no adequate proximal and/or distal aneurysm neck. Wolf et al.[8] reported 11 patients with type II aneurysm who were treated using macrocoils alone.[8] Primary technical success was achieved in only 3 patients in whom the aneurysm neck was >1.5 cm. They concluded that stent-graft placement combined with embolization is the method of choice in type II aneurysm when there is no adequate neck. In our study, 13 patients with IIA involvement were treated using macrocoils alone; 2 who were treated for type II aneurysm showed coil compaction. In one of these patients, the neck was wide (1.5 cm) and too short (1 cm), so coil compaction could have been prevented by using coils combined with stent-graft placement. In the second patient, the neck was long enough, but technical failure occurred because only part of the neck was embolized, which led to coil compaction and aneurysm reperfusion.

Conclusion

Endovascular repair of isolated IAA is a safe and minimally invasive alternative to surgical treatment. However, it has been associated with several serious complications and must therefore be carefully planned on the basis of diagnostic CT and angiography. The decision as to the type of endovascular repair depends on vessel anatomy, aneurysm location, and morphology. Surgical repair should be considered in patients who are in good medical condition and in whom both IIAs are affected because it ensures the revascularization of one or both arteries.

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