Endovascular management performed percutaneously of isolated iliac artery aneurysms

Florian Wolf*, Christian Loewe, Manfred Cejna, Maria Schoder, Thomas Rand, Joachim Kettenbach, Albert Dirisamer, Johannes Lammer, Martin Funovics
Medical University of Vienna, Clinical Department of Cardiovascular and Interventional Radiology, Waehringer Guertel 18-20, A-1090 Vienna, Austria
Received 10 October 2006; received in revised form 28 February 2007; accepted 4 April 2007

Abstract
Purpose: To report about the endovascular treatment of isolated iliac artery aneurysms (IIAA) with stentgraft placement and transluminal or CT-guided embolization of the internal iliac artery or the combination of these methods.
Methods and materials: Over a period of 5.6 years, 36 interventions were performed in 20 patients with 23 IIAAs. In a retrospective analysis patient records were reviewed. The CT-angiography follow-up was evaluated for the presence of re-perfusion of the IIAA and for change of aneurysm diameter.
Results: Primary success was achieved in 15/23 aneurysms (65%), and secondary success in 21/23 aneurysms (91%). In 5/23 cases two interventions and in 1/23 cases three interventions were necessary to achieve secondary success. Embolization alone, as a therapy for aneurysms involving only the internal iliac artery, had a success rate of 27%. No procedure-related minor or major complications occurred.
Mean decrease of aneurysm size during a mean observation period of 14.1 months was 6.9% which was not significant (p = 0.3; 95% confidence interval +7–21%).
Conclusion: Endovascular therapy of isolated iliac artery aneurysms performed percutaneously has become a treatment alternative to open surgical repair. This method is feasible and safe with low procedure-related morbidity and mortality. However, on average more than one intervention has to be performed to achieve successful permanent exclusion of the aneurysm and embolization alone in isolated internal iliac artery aneurysms is not sufficient.
© 2007 Elsevier Ireland Ltd. All rights reserved.
Keywords: Iliac aneurysm; Therapeutic embolization; Stent; Computed tomography scanner; X-ray; Interventional radiology

1. Introduction
The prevalence of isolated iliac artery aneurysms ranges from 0.03 to 0.1% according to autopsy studies from both North America and Europe [1,2]. Isolated iliac artery aneurysms, as incidental intraoperative findings in vascular surgery patients, are also rare with a reported frequency of fewer than 2% [3].
Some authors have reported that isolated iliac artery aneurysms carry a risk of spontaneous rupture [4] of up to 40% [5] with an associated mortality rate of up to 80% [6,7].
Open surgical repair of IIAAs is a major procedure, which is associated with considerable procedure-related morbidity and mortality rates. This retrospective analysis reports technical details, clinical success rates and the mid-term results of endovascular treatment of isolated iliac artery aneurysms.

2. Methods and materials
2.1. Study group
Over a period of 5.6 years in 20 patients (18 male, 2 female) endovascular treatment of 23 isolated iliac artery aneurysms (IIA) was performed. Mean aneurysm size was 54 mm (range 20–115 mm). Three of these patients suffered from bilateral IIAAs.
All the patients were considered at high operative risk, due to high age and/or high co-morbidity, and therefore endovascular treatment was favoured.
Mean patient age was 69 ± 8.9 years (range 35–85 years). The majority of patients (15/20, 75%) had no symptoms and
the aneurysm was detected incidentally in imaging studies (CT or ultrasound), which were performed for other reasons. The other five patients were symptomatic and had pelvic pain \((n = 3)\) or signs of hydronephrosis due to ureteral compression \((n = 2)\).

In 12/20 patients (60%) the underlying cause for the presence of IIAA was general atherosclerosis. Three patients (15%) had multiple aneurysms of unknown etiology. Three patients (15%) suffered from Marfan syndrome and one patient (5%) from Ehlers Danlos syndrome. One patient (5%) developed IIAA 17 years following a venous patch.

After approval of institutional review board patient records were retrospectively analyzed, and the radiographic documentation of the therapeutic intervention and all re-interventions, as well as all follow-up control investigations were re-evaluated. The findings of this review represent the basis of this retrospective study.

2.2. Imaging

In all patients with proven IIAAs considered for an endovascular treatment a pre-interventional CT-angiography (1996–1999 Siemens Somatom plus spiralCT and 1999–2002 Siemens Somatom IV Volume Zoom multislice-CT, Erlangen, Germany) was performed. The volume of contrast medium (300 mg/ml iodine concentration) varied between 90 and 150 ml with biphasic flow rates of 3–12 ml/s \([8]\). Transverse images were reconstructed with a section thickness of 1.25 mm and were reconstructed in 0.7 mm intervals. In the post-interventional examinations a delayed scanning protocol for both scanners to visualize eventual enhancement of the aneurysm sac included scanning in craniocaudal direction after completion of the arterial phase scan (with a delay of 30–40 s).

According to the findings of these CT examinations aneurysms were classified \([12]\) into four types (Table 1) in consensus (M.C., M.F., M.S., J.K., T.R. and J.L.).

Aneurysms involving the common iliac artery (Fig. 1) with a neck to aortic bifurcation of more than 1.5 cm were classified as type I (5/23, 22%), aneurysms involving the internal iliac artery as type II (10/23, 44%), aneurysms involving both the common and internal iliac artery as type III (4/23, 17%), and aneurysms involving the external iliac artery together with or without the common and/or internal iliac artery as type IV (4/23, 17%). In two cases the common and external iliac artery was involved, in one case only the external iliac artery was involved and in one case the internal and proximal external iliac artery was involved. On a CT-viewing workstation the lesser diameter of the elliptical vessel was measured on the axial sections for evaluation of the maximum cross-diameter of each aneurysm.

<table>
<thead>
<tr>
<th>Type I (5/23, 22%)</th>
<th>Nr. of interventions per aneurysm including re-interventions</th>
<th>Nr. of aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stentgraft placement</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Embolization and Stentgraft</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type II (10/23, 44%)</th>
<th>Nr. of interventions per aneurysm including re-interventions</th>
<th>Nr. of aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Embolization</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Embolization, Stentgraft</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Embolization, CT-guided Embolization</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2 x Embolization, CT-guided Embolization</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Embolization and Stentgraft</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type III (4/23, 17%)</th>
<th>Nr. of interventions per aneurysm including re-interventions</th>
<th>Nr. of aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Embolization and Stentgraft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Embolization, Stentgraft</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4 x Embolization, Stentgraft, CT-guided Embo</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type IV (4/23, 17%)</th>
<th>Nr. of interventions per aneurysm including re-interventions</th>
<th>Nr. of aneurysms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Embolization and Stentgraft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Stentgraft</td>
<td>1</td>
</tr>
</tbody>
</table>
2.3. Therapeutic decision

Implantation sites, i.e. necks, were considered suitable for use of stentgraft when 1.5 cm long or longer. Whenever the internal iliac artery was aneurysmatic, or involved in the aneurysms of the common or external iliac artery, its orifice was crossed with a stentgraft. If retrograde perfusion could be expected because of strong side-branch vascularization, (Fig. 2) the internal iliac artery was embolized by selective catheterization and application of coils or application of a cyanoacrylate/lipiodol mixture, or a combination of coils and glue (see Table 2). Embolization alone could be considered in type II aneurysms, when only the distal portion of the internal iliac artery was involved in the aneurysm.

For digital subtraction angiography a Siemens Polygraph angiography unit (Siemens, Erlangen, Germany) was used. For embolization, sheath size was 6 French, for stentgraft application, sheath size was between 8 and 12 French. All stentgrafts (mean diameter $14.1 \pm 3.17$ mm, range $10–22$ mm; mean length $90 \pm 18.6$ mm, range $60–120$ mm) were oversized by 10–20% relative to neck diameters as measured on CT. Different stentgrafts were used (see Table 2) and after balloon angioplasty within the stentgraft completion angiography was performed to document complete stentgraft deployment and patency and to exclude major type 1 endoleaks. The detection of small endoleaks and insufficient exclusion of IIAAs is not possible angiographically and CT-angiography has to be performed after the intervention.

Embolization of the internal iliac artery and its primary and strong secondary branches was performed after selective catheterization using between 2 and 19 macrocoils (Cook Europe, Denmark, length 2–15 cm, diameter 3–20 mm) and between 3 and 40 microcoils (Fiber coils,
treatment.

for 6 weeks, and 100 mg ASA once daily for long-term

75 mg, Sanofi-Synthelabo Inc., USA) was given once a day

(Lovenox 40 mg, Bracco, Milano, Italy) was given subcu-

tional units) was given intra-arterially. In the post-interventional

a single dose. During intervention heparin (5000 interna-

branches.

If stentgraft placement or CT-guided direct puncture of an

amoxicillin i.v., GlaxoSmithKline, Europe) was applied as a

diameter of 2–6 mm).

2.4. Follow-up

Follow-up CT-angiography studies were performed before

hospital discharge and at 3, 6 and 12 months after the inter-

vention in the arterial and venous phases, as already described.
The diameter of the aneurysm sac was compared with the first

post-interventional CT-angiography and the respective previous

investigation.

The aneurysm sac was carefully reviewed for evidence of any

leaks.

2.5. Re-interventions

Patients were scheduled for a secondary intervention if a leak

or retrograde perfusion of the aneurysm was detected in any

follow-up CT or increasing diameter of the aneurysm sac was

recognized.

In type I endoleaks (re-perfusion of the aneurysm sac origin-

ated at the proximal or distal end of stentgraft) either balloon

angioplasty or insertion of additional stentgrafts was performed.

In type II endoleaks (re-perfusion of the aneurysm sac origin-

ated from branches of the internal or external iliac artery)

feeding branches of the internal iliac artery system and the

aneurysm were selectively catheterised. Then, micro- and/or

macrocylinders or 1–2 ml of a mixture (1:4) of cyanoacrylate and

lipiodol were injected into the feeding. In cases where either

this treatment was ineffective or there was a substantial increase

in the diameter of the aneurysm sac, the aneurysm sac was

punctured directly under CT guidance with a 18-gauge Chiba

needle (Cook Europe, Denmark). If supplying branches of the

aneurysm could be catheterised through the Chiba needle

with a microcatheter (FasTracker, Boston Scientific, MA, USA),
microcoils (Fiber coils, Boston Scientific Target Vascular, USA) were applied. Additionally, cyanoacrylate and

lipiodol (1:2) was directly applied into the immediate vicinity

of the ostia of the suspected supplying branches of the

aneurysm sac in order to promote retrograde thrombosis of these

branches.

2.6. Medication

If stentgraft placement or CT-guided direct puncture of an

aneurysm sac was performed, antibiotic prophylaxis (2.2 g

amoxicillin, GlaxoSmithKline, Europe) was applied as a

dose. During intervention heparin (5000 international units) was
given intra-arterially. In the post-interventional period after stentgraft placement, low molecular weight heparin

(Lovenox 40 mg, Bracco, Milano, Italy) was given subcu-
taneously every 12 h for 3 days, clopidogrel 75 mg (Plavix

75 mg, Sanoﬁ-Synthelabo Inc., USA) was given once a day
for 6 weeks, and 100 mg ASA once daily for long-term treatment.

2.7. Study definitions

The endpoint of this study was the time and number of

interventions needed to establish primary or secondary suc-

cess. Primary success was defined as complete exclusion of

the aneurysm verified by contrast-enhanced CT after one inter-

vention without the need for re-intervention during observation

period. If a secondary leak, retrograde perfusion, or substantial

increase of diameter of the aneurysm was detected at follow-

up CT, re-intervention (stentgraft placement, embolization of

the internal iliac artery, or CT-guided embolization) was per-

formed. Substantial increase of aneurysm diameter was defined

as either increase in diameter of more than 3 mm compared to the

first post-interventional measurement or increase of more than

3 mm compared to the retrospective previous measurement if the

aneurysm sac had initially shrunken and then grown again. These

comparisons were always carried out on CT scans acquired with

identical slice thickness and contrast media parameters and on

identical slice positions.

Secondary success was defined as complete exclusion of the

aneurysm after one or more re-intervention verified by CT-

angiography.

2.8. Statistical analysis

Data are presented as mean value and median values when

necessary and the standard deviation (S.D.). Continuous vari-

ables are compared by paired Student’s t-test (baseline and

follow-up). A value of $p < 0.05$ was considered statistically

significant.

3. Results

In 20 patients with 23 IIAAs 36 interventions were performed
(Table 1), a mean of 1.6 interventions (range 1–6, median 1
intervention per aneurysm) were performed on each aneurysm.

The primary success rate for complete exclusion of the

aneurysm as determined by contrast-enhanced follow-up CT

was 65% (15/23 aneurysms).

The secondary success rate was 91% (21/23 aneurysms). In

5/23 cases two interventions and in 1/23 cases three interventions

were necessary to achieve secondary success.

In 2/23 lesions (9%), there was still a leak despite two and six

interventions, respectively. First patient had a type III aneurysm

(common iliac artery 4 cm, internal iliac artery 2.2 cm). After

embolization of the main branches of the internal iliac artery

and the internal iliac artery aneurysm itself, in a second inter-

vention the internal iliac artery was overstented and the common

iliac artery aneurysm excluded. A stentgraft was implanted
(Talent Stentgraft, diameter 16 mm, length 95 mm, World Medical

Systems, Sunrise, FL, USA). Two months later, a proximal type

I endoleak was found at CT. Since the size of the aneurysm sac

remained stable, no intervention was performed. However, this

patient was lost to follow-up.

The second patient suffered from an internal iliac artery

aneurysm with a diameter of 8 cm combined with an com-

mon iliac artery aneurysm with 2 cm diameter. Two attempts
to embolize the main branches of the internal iliac artery with micro- and macrocoils and the proximal internal iliac artery with macrocoils that failed to prevent retrograde perfusion of the aneurysm sac. As the aneurysm grew to 11 cm in diameter—two stentgrafts (Talent Stentgraft, diameters 18 and 22 mm, lengths 110 and 105 mm) were implanted from the common to the external iliac artery with exclusion of the common iliac artery aneurysm across the ostium of the internal iliac artery. Due to persistent perfusion from branches taking off from the deep femoral artery, three additional embolization attempts were performed—two trans-catheter and the other under CT-guidance and direct puncture as previously described without success. At the 15-month CT follow-up, following the initial intervention, the aneurysm remains stabled at 11 cm diameter with a persistent perfusion.

Regarding aneurysm type, the success rates were as follows: therapy of type I (n = 5) and type IV (n = 4) aneurysms had a primary success rate of 100%. Therapy of type II (n = 10) aneurysms had a primary success rate of 40% and a secondary success rate of 100%, and therapy of type III (n = 4) aneurysms had a primary and secondary success rate of 50%. For detailed information about therapy of each aneurysm type see Table 1.

Stentgraft deployment (n = 3) and the combination of stentgraft deployment and embolization (n = 9) as primary interventions had a primary success of 100%. Embolization alone as the primary intervention had a primary success of 27% (3/11). In the other eight cases, secondary embolization (n = 2), secondary stentgraft placement (n = 5), or both (n = 1) had to be performed after primary embolization.

All 36 interventions were completed without clinically evident minor or major complications.

In 20/23 patients embolization of internal iliac artery branches was performed. 4/20 patients (20%) developed mild claudication of the buttocks after the intervention. After 7/36 interventions (20%) a leak was detected in the follow-up CT examination although the procedure was terminated successful. Re-interventions were required.

Pre-treatment aneurysm size ranged from 20 to 115 mm (mean 54 ± 29). In 12 cases measurement of aneurysm size was possible after a mean follow-up time of 14.1 months. The change of aneurysm size was not significant with a mean decrease of 6.9% (p = 0.3; 95% confidence interval −7 to −21%).

4. Discussion

Because of their pelvic localization, IIAAs produce symptoms typically late when they have reached an advanced size and are often incidental findings on imaging studies performed for other indications. Elective surgical treatment is indicated in the majority of patients for aneurysms larger than 3 cm in diameter [6]. Surgical reconstruction with aneurysm resection and graft interposition is a relatively complex procedure with the possibility of severe complications like injury of adjacent veins during surgical procedure [9]. Perioperative mortality for elective operations is 7–13% [10–12], whereas mortality approaches 30% in cases of ruptured iliac aneurysms [10,13].

In this series, primary therapeutic success of endovascular therapy for type I (n = 7) and type IV (n = 4) aneurysms was 100%. Primary therapeutic success for type II (n = 10) aneurysms was 40%, with 100% secondary success. In type III aneurysms (n = 4), primary and secondary success rate was 50%. Therapy of type II and type III aneurysms seems to be more complicated than therapy of type I and IV aneurysms. The reason for that is the involvement of the internal iliac artery. Retrograde perfusion by side branches of the internal iliac artery is a frequent cause of a secondary leak.

Embolization alone without stentgraft placement as the primary therapeutic approach was performed in 11 cases with a primary success in only 3 cases (27%). These three aneurysms were type II aneurysms and showed a proximal neck to the common iliac artery of more than 1.5 cm. The other eight aneurysms were either type II aneurysms (n = 6) as well, or type III aneurysms (n = 2) and required more than one embolization (n = 2) or the additional placement of a stentgraft (n = 6). Embolization alone was unsuccessfully attempted in two type III aneurysms (small aneurysm of the common iliac artery and large aneurysm of the internal iliac artery) and should not be considered as a viable treatment option. The primary therapeutic approach for type III aneurysms should be the combination of stentgraft placement and embolization of the internal iliac artery.

Stentgraft placement alone was performed in type I aneurysms in four cases and in type IV aneurysms in one case. Primary success rate was 100%. In both cases the neck to the internal iliac artery was more than 1.5 cm. These results are similar to the results of Scheinert et al. [14], when the successful treatment of common or external iliac artery aneurysms by stentgraft placement was described with a technical success of 97.9% (47 of 48 cases). If embolization of the internal iliac artery was necessary, these patients were excluded from their study. Scheinert concluded that the critical selection of patients with regard to the suitability for an endovascular aneurysm repair without embolization is very important. There must be a sufficient proximal and distal neck of greater than 1.5 cm and the internal iliac artery should not be involved. If the proximal neck to the aorta is smaller than 1.5 cm, application of a bifurcated stentgraft would be therapy of choice [15].

Stentgraft placement and embolization is the primary method of choice for type II aneurysms, if it is obvious that embolization alone will not be sufficient because the aneurysmatic internal iliac artery reaches the common iliac artery. In this series the combined approach was successful in nine cases with a primary success of 100% (types I and IV: n = 3; type III: n = 2; type II: n = 1).

CT-guided puncture of the aneurysm sac with a Chiba needle and following embolization was successful in two of three aneurysms. In all three cases, the internal iliac artery was involved and one or more endoluminal embolizations of all internal iliac artery branches had been performed previously. For puncture of the aneurysm sac, at our institution steel needles are generally preferred to 4F or 5F sheaths due to their smaller diameter (to minimize bleeding complications in case of high pressure in the sac), and due to their high stiffness and better...
guidance. The risk of cutting the microcatheter during retraction is controlled by simultaneously retracting needle and microcatheter, thereby avoiding kinking of the microcatheter near the needle tip. Reports about this kind of therapy are very rare in the literature [16,17] and embolization is performed with different kinds of tissue adhesive (mixture of thrombin, fibrinogen, and aprotinin, and a combination of thrombin and cyanoacrylate). CT-guided percutaneous embolization should be considered as therapeutic option for repair of internal iliac artery aneurysm if there are no other therapeutic options left, and if embolization of all internal iliac artery branches was done before without successful exclusion of the aneurysm.

After 7/36 interventions (20%) a leak was detected in the follow-up examinations although the procedure was terminated successful. Re-interventions were required. Procedural success with absence of a leak in the control angiography immediately after the intervention does not exclude a small re-perfusion (type II) endoleak. For that reason, a contrast-enhanced CT should be performed after the intervention.

Procedure-related complications such as death, major bleeding, distal embolization, and transient bowel ischemia, which have been reported in single cases by Marin et al. [18], Cardon et al. [19], and Sanchez et al. [20] were not observed in this study. In this study in 20/23 aneurysms (87%) the internal iliac artery was embolized alone or in combination with stentgraft placement. Nevertheless, in the follow-up period in only 4/20 cases (20%) mild claudication of the buttocks was found. Similar results were found by Cormier et al. [21]. Although some authors [22,23] found high complication rates of 26–41% after embolizing the internal iliac artery and there are some discussions [24] about the accurate use of this method, embolization of the internal iliac artery is crucial in the majority of cases if the aneurysm involves the internal iliac artery or if the internal iliac artery is overstented with a stentgraft.

In this study, there was a mean decrease of the maximum aneurysm diameter of 6.9% (p = 0.3, 95% confidence interval −21 to +7 %) in the 12 cases with follow-up. These results are similar to the results of Scheinert et al. [14], who also found no significant decrease of aneurysm diameter in 48 aneurysms. Sahgal et al. [25] conclude in their study about diameter changes in IIAAs 1–6 years after endovascular graft repair that properly treated aneurysms decrease in size 0.5 ± 0.1 cm/year.

The major limitation of this study is that it is a retrospective analysis with a heterogenous patient group with very different types of aneurysms. However, randomized trials comparing endovascular versus open repair by now cannot be justified. Another limitation is the relative short follow-period of mean 14.1 months with a large range from 3 to 56 months.

5. Conclusion

In this study it was shown that endovascular therapy of isolated iliac artery aneurysms has become a treatment alternative to open surgical repair, especially for patients with severe comorbid conditions.

The methods applied are technically feasible and safe with low procedure-related morbidity.

In the majority of cases, embolization of the internal iliac artery is inevitable in order to obtain complete exclusion of the aneurysm.

The absence of a re-perfusion leak on angiography immediately after the intervention is not a predictor of successful exclusion of the aneurysm. For that reason, follow-up examinations with CT (in particularly during arterial and late venous phase) are necessary to discover possible leaks.

References


