Isolated iliac artery aneurysms: A contemporary comparison of endovascular and open repair

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Objective: **Iliac artery aneurysms are rare but associated with significant morbidity and mortality when ruptured. This study compares recent open and endovascular repairs of iliac aneurysms at a single institution.**

Methods: **Patients were identified and charts reviewed using ICD-9 and CPT codes for iliac artery aneurysm and open or endovascular repair performed between January 2000 and January 2006. Baseline characteristics, procedure-related variables, and follow-up data were retrospectively reviewed.**

Results: **A total of 71 patients were treated with isolated iliac artery aneurysms. There were 19 open and 52 endovascular repairs. Seven presented with acute ruptures and were treated by open (4) or endovascular (3) repair. Preoperative comorbidities were similar between the two groups. Major perioperative (30 day) complications included three deaths in the open group from cardiovascular complications, all after ruptured aneurysm repair, and one death in the endovascular group (after rupture; one additional perioperative death occurred after 30 days due to colonic infarction) (P = NS). Postoperative complications were less frequent in the endovascular group, although this did not reach statistical significance. The mortality was 50% in the open group and 33% in the endovascular group for patients presenting with a ruptured aneurysm (P = NS). Transfusion requirement was significantly higher in the open group (47%) than in the endovascular group (6%) (P = .03). The mean follow-up was 20 ± 5 months in the open group and 17 ± 2 months in the endovascular group (P = NS). Long-term complications included two limb thromboses following repair with a bifurcated stent graft that were treated with thrombolysis plus stenting or a fem-fem bypass. Three endoleaks were identified on postop CT scans, all of which were successfully managed with endovascular techniques. There were no postoperative ruptures or aneurysm-related death. The mean postoperative length of stay was 5.2 ± 2.3 days (open) and 1.3 ± 1.0 days (endovascular) (P = .04).**

Conclusions: **This is the first large, case control study comparing open vs endovascular repair of isolated iliac artery aneurysms. Endovascular repair of iliac artery aneurysms is safe and results in decreased length of stay, lower requirement for perioperative blood transfusion, and similar intermediate term outcomes as open repair. (J Vasc Surg 2008;47: 708-13.)**

Iliac artery aneurysms (IAAs) are uncommon and are frequently associated with coexisting abdominal aortic aneurysms (AAAs). Isolated iliac artery aneurysms are even less frequent, accounting for less than 2% of all intra-abdominal aneurysms,[1,2] and occur in less than 0.1% of the population as a whole.[3] Most IAAs are asymptomatic,[4] but patients may present with rupture, distal embolization, thrombosis, and symptoms of visceral or neurologic compression. The operative mortality of ruptured IAAs approaches 40% even with modern anesthetic and surgical care.[5] Therefore, the key to preventing IAA-associated mortality lies in identifying patients at risk of rupture and prophylactic repair.

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IAA size has been used most commonly as a surrogate for rupture risk, with repair recommended in those with IAAs >3 to 4 cm in diameter. Until recently, open surgical repair has been considered the gold standard. However, this is often technically challenging given the pelvic location of iliac aneurysms and the frequent history of prior AAA repair. This may account for the higher mortality associated with elective common iliac and hypogastric aneurysm repairs compared with AAA repair.[5,6]

Endovascular repair of isolated IAAs has recently emerged as a minimally invasive alternative to open repair. Using a combination of branch-vessel coil embolization and stent-grafting, this technique has the potential to reduce perioperative morbidity and mortality, especially in high-risk patients. While several recent series have demonstrated the feasibility of this approach,[7-9] they fail to contrast the endovascular experience to contemporary open repair of these aneurysms. The purpose of this study was therefore to use case control methodology to compare two large contemporary series of open and endovascular IAA repair performed at a single institution.

METHODS

Medical records for consecutive patients undergoing IAA repair between January 2000 and January 2006 were reviewed. No pseudoaneurysms or mycotic aneurysms

were included, and patients with aortic diameters >3.5 cm were excluded. Five patients with a prior open AAA repair were included (two in the open group and three in the endovascular group). Isolated IAAs were defined as either single or multiple aneurysms located only within the common, internal, or external iliac arteries. Patient characteristics, comorbidities, as well as presentation and symptoms were reviewed. Computed tomography (CT) with intravenous contrast was used to assess IAA location and diameter and to plan the repair. The decision to proceed with open vs endovascular repair was surgeon dependent and was affected by anatomy, comorbities, and the urgency of the repair. Preoperative angiography was selectively used for sizing purposes prior to endovascular repair or to evaluate the runoff vessels.

Operative data included type of repair, anesthetic technique, procedural time, estimated blood loss, intraoperative complications, graft type utilized, and need for hypogastric coil embolization. At the time of endovascular repair, bilateral femoral arterial access was obtained, percutaneously on the contralateral side and by cut-down on the ipsilateral side, or through bilateral femoral cut-down if a bifurcated device was to be used.

All patients underwent intraoperative aortic and pelvic angiography with a marker catheter for appropriate length measurement. A proximal and distal fixation zone of 15 mm was desirable for endovascular repair of common and external iliac artery aneurysms to obtain a good seal. Coil embolization of the origin of the internal iliac artery was performed to achieve an appropriate distal fixation zone in common iliac aneurysms extending into the external iliac artery and to avoid a type II endoleak. For aneurysms involving the hypogastric artery or for isolated hypogastric aneurysms, the distal branches of the hypogastric (anterior and posterior division) were coil-embolized, and the origin of the internal iliac was covered by a stent-graft extending to the external iliac artery. In cases of bilateral common IAAs or common IAAs without adequate proximal necks (<1.5 cm), bifurcated modular devices were used. In the majority of cases, at least one hypogastric artery was preserved. Open repair included aortoiliac reconstructions, iliac ligation with extra-anatomic bypass, ilioiliac bypass, iliofemoral bypass, and simple ligation.

Hospital stay data included ICU stay, length of stay, and early postoperative complications. Acute renal failure was defined as an increase of creatinine greater than 50% of the patient's baseline and >1.5; bowel ischemia was either endoscopically documented or clinically suspected based on elevated white blood cell count (WBC) and physical examination findings; myocardial infarction was identified by consulting cardiologists based on EKG changes and troponin values; wound infection was identified based on clinical factors and wound cultures.

On follow-up, late aneurysm-related and systemic complications were recorded, including the presence of claudication. All patients who underwent endovascular repair had a CTA at 1 month and 6 months postoperatively, and then yearly afterwards in uncomplicated cases to follow the aneurysm diameter and the presence of any endoleak. An increase in IAA short-axis diameter of >5 mm or attachment site endoleaks prompted further workup with angiography and possible secondary intervention.

Follow-up after open repair included physical examination at 2 weeks postoperatively and then yearly thereafter. Imaging was not routinely obtained but was used selectively to address specific clinical situations. Patients with a concomitant small AAA had yearly ultrasound or CTA. Rates of primary patency and freedom from secondary interventions were estimated using the Kaplan-Meier life-table method. Categorical variables were compared with the Fisher exact test, and means were compared using the Student *t* test. *P* values < .05 were considered significant.

Table I. Preoperative patient characteristics

Patient characteristic	*Open group N (%)*	*Endovascular group N (%)*	P *value*
Mean age (y ± SE)	68 ± 4	73 ± 2	NS
Gender (male)	15 (79%)	47 (90%)	NS
Smoking	7 (37)	35 (69)	.02
DM	2 (11)	8 (15)	NS
HTN	10 (53)	43 (81)	.01
CAD	8 (42)	31 (58)	NS
CHF	5 (26)	19 (37)	NS
COPD	1 (5%)	10 (19)	NS
Renal insufficiency	2 (11)	13 (25)	NS
PVD	5 (26)	17 (33)	NS
AAA < 3.5 cm	4 (21)	26 (49)	.03
Symptomatic	6 (32)	7 (14)	NS
Mean aneurysm size (cm ± SE)	5.4 ± 0.4	4.3 ± 0.1	.002
Elective	5.3 ± 0.6	4.2 ± 0.2	.02
Ruptured	6.4 ± 0.5	4.3 ± 1.0	NS
Symptomatic	5.5 ± 0.6	4.9 ± 0.3	NS
Mean follow-up (months ± SE)	20 ± 5	17 ± 2	NS

RESULTS

Patient and aneurysm characteristics

From January 2000 to January 2006, 71 patients (60 men), with a mean age of 71 years (68 ± 4 in the open group and 73 ± 2 in the endovascular group; *P* = NS) underwent endovascular or open repair of IAAs (Table I). This included 19 open repairs and 52 endovascular exclusions (Fig 1). Fifteen patients (21%) were symptomatic (seven in the open group and eight in the endovascular group) and presented with flank pain, claudication, distal embolization, or ureteral obstruction. Of these, seven patients presented with acute rupture and were treated by open (four patients) or endovascular (three patients) repair.

Among the 52 endovascular repairs, most aneurysms involved the common iliac artery (45/52; Table II). A total of seven patients had bilateral common iliac aneurysms—one treated with open repair and six with endovascular repair. Single segment aneurysms in the endovascular group involved the common iliac (including bilateral) in 39 repairs (75%) and the hypogastric in seven repairs (14%).

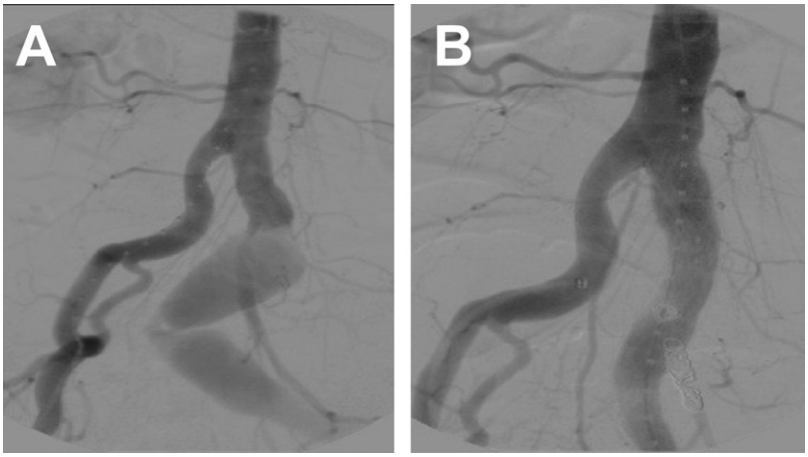

Fig 1. Endovascular repair of iliac artery aneurysm rupture (**A**) with endovascular stent exclusion and hypogastric embolization (**B**).

Table II. Iliac aneurysm distribution in the open and endovascular groups

Location	*Open group N (%)*	*Endovascular group N (%)*
Common iliac	13 (68)[a]	39 (76)[b]
External iliac	3 (16)	0 (0)
Internal iliac	3 (16)	7 (14)
Common/external	0 (0)	2 (4)
Common/internal	0 (0)	4 (6)

[a]One patient had bilateral common iliac aneurysms.
[b]Six patients had bilateral common iliac aneurysms.

Table III. Endovascular techniques used in repairing iliac aneurysms

Endovascular technique	*N (%)*
Unilateral stent	
Stent graft	33 (63)
Covered stent	6 (12)
Bifurcated device	13 (25)
None (coil embolization only)	1 (2)
Overall hypogastric embolization	34 (65)

There were no isolated external iliac aneurysms in this group. In the open repair group, 19 aneurysms involved the common iliac, while three each involved the external and internal iliacs as isolated aneurysms. The mean preoperative maximum IAA diameter was 4.3 ± 0.1 cm in the endovascular group and 5.4 ± 0.4 cm in the open group (P = .002). The average diameter of those aneurysms that ruptured was 5.5 cm although one of those aneurysms was only 2.3 cm. Two patients in the open group (10.5%) and three patients in the endovascular group (5.7%) had prior open AAA repair (P = NS).

All patients underwent CT with intravenous contrast before open or endovascular repair for planning and sizing. Preoperative diagnostic angiography was done as a separate procedure. In five of the latter cases, diagnostic angiography and ipsilateral internal iliac artery coil embolization were combined as one procedure, essentially staging the endovascular IAA repair with later stent-grafting.

Operative technique. All patients with open repair were treated with general anesthesia. In the endovascular group, local or regional anesthesia was used in 15 cases (29%) and the remaining 37 (71%) were treated under general anesthesia. A variety of endovascular techniques were utilized to manage these aneurysms (Table III). One isolated hypogastric aneurysm was managed with coil embolization alone, the remainder was managed with stent graft or covered stent exclusion (Fig 1). Those involving an inadequate proximal common iliac landing zone or with bilateral common iliac aneurysms were managed with bifurcated stent grafts (13/52). A total of 34/52 (65%) underwent concomitant or staged hypogastric embolization; two patients had staged bilateral hypogastric embolization without clinical sequela. There were no conversions to open repair. In the open group, there were ten ilioiliac bypasses, and three each of iliofemoral bypass, aortoiliac bypass, and ligation with extra-anatomic bypass (two femoral-femoral crossover and one axillary-bifemoral bypass).

Major perioperative and long-term complications included three deaths in the open group from cardiovascular complications, all after ruptured aneurysm repair, and four deaths in the endovascular group (one colonic infarction, two cardiovascular, and one directly related to rupture) (P = NS). The three former endovascular deaths following elective repair occurred after 30 days with one of these directly related to colonic ischemia that occurred after repair with a bifurcated graft and two additional remote deaths secondary to cardiac events were deemed unrelated to the repair. One patient undergoing open repair had a ureteral injury that was recognized and repaired intraoperatively. None of the patients with colonic ischemia (two, one of whom died) had been treated with hypogastric coil

Table IV. Postoperative complications

Complication	*Open group N (%)*	*Endovascular group N (%)*	P *value*
Renal failure	2 (11)	2 (4)	NS
MI	3 (16)	2 (4)	NS
Bowel ischemia	0 (0)	2 (4)	NS
Wound infection	2 (11)	1 (2)	NS
DVT	3 (16)	1 (2)	NS
Need for any transfusion	9 (47)	3 (6)	<.001
Total	19	11	

MI, Myocardial infarction; *DVT*, deep venous thrombosis.

embolization. The incidence of mortality related to elective open repair was therefore 0% in the open group and 1.9% in the endovascular group, although this patient expired 2 months following the initial surgery from complications related to colon resection.

Postoperative complications were less frequent in the endovascular group, although they did not reach statistical significance (Table IV). Re-exploration for bleeding was required in two patients in the open group. For those patients presenting with rupture, the mortality was 50% in the open group and 33% in the endovascular group (P = NS). The need for transfusion was significantly higher in the open group (44%) than in the endovascular group (6%) (P = .03). The mean postoperative length of stay was 5.2 ± 2.3 days (open) and 1.3 ± 1.0 days (endovascular) (P = .04).

Long-term complications included two limb thromboses following repair with a bifurcated stent graft, which were treated with thrombolysis plus stenting in one patient and a femoral crossover bypass in the other (Table V). Three endoleaks were identified on follow-up CT scan: two were treated by coil embolization (type II) and one by limb extension (distal type I). No patients presented with claudication following hypogastric coil embolization. Freedom from secondary interventions are detailed in Fig 2. Freedom from intervention were 100% and 87% at 1 and 2 years, respectively, in the open group and 91% and 81% in the endovascular group (P = NS). With a mean follow-up of 20 ± 5 months in the open group and 17 ± 2 months in the endovascular group, there were no postoperative ruptures or aneurysm-related deaths. In the endovascular group, 86% of patients had shrinkage (≥5 mm) of the aneurysm sac as measured by CT scan. The remainder had no change in vessel diameter.

DISCUSSION

Although iliac artery aneurysms represent a relatively unusual form of intra-abdominal aneurysm, they pose a unique challenge as traditional open surgical management has been hampered by a relatively high morbidity and mortality. Because iliac artery aneurysms are rare (especially in contrast to abdominal aortic aneurysms), proper management of these aneurysms has not been completely standardized. Since early reports documented the utility of endovascular approaches to this disease,[10-12] a number of other investigators have applied a similar approach with excellent midterm results.[13] The emphasis on endovascular repair of these aneurysms is clear with over half of the repairs in this series occurring in the latter third of the series. More recent reports have demonstrated the feasibility of branched endovascular grafts, which can preserve antegrade hypogastric artery flow.[14] Here we present the first report comparing open and endovascular repair in a modern era practice.

The management of iliac artery aneurysm is complicated by the technical challenge of operating deep within the pelvis as well as the uncertain consequence of compromising internal iliac flow to one or both vessels. Elective open management of IAAs has been marred by relatively high rates of complications with mortality ranging from 11%[1] to as high as 33%.[15] Endovascular management has offered the ability to deal with the challenges of these deep pelvic structures with minimal morbidity with contemporary series boasting perioperative mortality rates approaching 0%.[7,9,16]

Earlier reports on iliac aneurysms cited a relatively high percentage of symptomatic presentation.[5] In this study, only a minority of patients presented with symptoms. This is undoubtedly due to the increased number of aneurysms that are incidentally discovered on imaging. Some series, which have followed aneurysm size following endovascular exclusion, have failed to document significant shrinkage in aneurysm sac size[16] although this study and others have demonstrated significant sac shrinkage after repair.[7,8] Therefore, some symptomatic patients may still require open surgical resection to address the compressive etiology of their symptoms. This, however, is a much simpler and less hazardous procedure than de novo open aneurysm repair.

Iliac artery aneurysms are often multiple, and up to 23% to 71% of patients can present with multiple aneurysms.[1,17-19] Similar to other reports, the majority of the patients in this series were males presenting in their 70s.[20] The anatomic distribution of aneurysms treated in this series mirror those that are historically described: 70% in the common iliac, 20% in the internal iliac, and 10% in the external iliac.[21]

Unlike abdominal aortic aneurysms, the natural history of iliac aneurysms is not well defined. The recommended threshold size of 3 to 4 cm was suggested in the era of open surgical repair with its attendant increased morbidity.[5] This was based largely on relatively small numbers of patients who were observed nonoperatively due to the perceived morbidity of surgical repair. The true incidence of rupture and its correlation to size is unclear, with previous series reporting rupture rates ranging from 14% to 70%.[1,18,20] McCready et al demonstrated a mean aneurysm growth rate of 4 mm per year that is similar to AAA growth.[18] Given the unclear natural history of these aneurysms and the relatively high rate of morbidity in the setting of emergent repair (even with endovascular techniques), perhaps there are patients, especially those with favorable anatomy, that ought to be repaired at even smaller sizes. The mortal-

Table V. Complications following endovascular repair

Complication	*N*	*Days postop*	*Initial repair*	*Intervention*
External iliac dissection	1	30	Aortouniliac stent graft	Bare stent
Limb thrombosis	2	60, 150	Bifurcated device	Thrombolysis and stenting (1), femoral-femoral bypass (1)
Type II endoleak	2	30, 180	Unilateral stent graft	Observation (1), coil embolization (1)
Type I endoleak (distal)	1	180	Bifurcated device	Limb extension

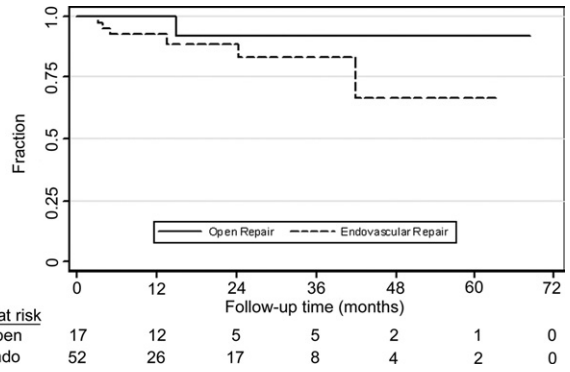

Fig 2. Kaplan-Meier estimate of freedom from secondary intervention.

ity rate in this and other series is on the order of 0% to 2% in the elective setting.

In a collective series of 367 open iliac aneurysm repairs,[5] the emergency mortality was 40% whereas elective mortality was only 7%, again emphasizing the importance of early recognition and repair. In our series, 3/4 patients who presented with rupture died after open repair, whereas only 1/3 patients treated with endovascular exclusion died. Although this can only represent a trend in our series, it may ultimately mimic some of the lower rates of mortality rates seen with endovascular aneurysm repair (EVAR) treatment of infrarenal AAA rupture.[22]

The need for secondary intervention in the setting of endovascular IAA repair appear to be similar if not somewhat less than conventional EVAR reintervention rates, which range from 12% to 28% of cases,[23-25] although it appears that the rate may be dropping with newer generation grafts.[26] Our reintervention rate at 2 years was 14%, which compares favorably with other reports.[7,27,28] Given the difficulties in performing sonography in this region, however, this reintervention rate would suggest that these patients should get yearly CT follow-up until less rigorous follow-up, perhaps with duplex, can be proven safe.

While patients treated with endovascular exclusion had statistically similar rates of complications, there were certainly trends that would suggest a decreased risk of renal failure, cardiovascular compromise, infections, DVTs, and death in the endovascular group. There was also a significantly decreased need for transfusion in these patients. There were no symptoms of pelvic claudication following hypogastric occlusion, which is similar to the reports of others.[29] No postoperative sexual complications were noted after either repair although the open repairs were complicated by one instance of ureteral injury. Whether or not repair of iliac aneurysms will mimic the sexual side-effects seen in EVAR and open repair of infrarenal AAAs is still unclear.[30]

While several series of endovascular management of isolated iliac artery aneurysms have been published, this contemporary series examines both open and endovascular results of iliac artery aneurysm repair. Endovascular repair is a safe and minimally invasive alternative to open repair and seems to be associated with fewer complications and a shorter length of stay in these patients. Given these results, perhaps it is reasonable to readdress the conventional approach of waiting until the iliac aneurysm exceeds 3 cm to repair it. Longer term follow-up, however, is needed to determine the durability of such repairs.

AUTHOR CONTRIBUTIONS

Conception and design: RC, SL, KK, JM
Analysis and interpretation: RC, JB, SL, MZ, KK, JM
Data collection: RC, SL
Writing the article: RC, JB, MZ, JM
Critical revision of the article: RC, JB, SL, MZ, JM
Final approval of the article: RC, JB, SL, MZ, KK, JM
Statistical analysis: SL, MZ
Obtained funding: KK, JM
Overall responsibility: JM

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APPENDIX, online only. Breakdown of procedures performed by year

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Open	3	2	1	4	5	2	2
Endovascular	6	5	5	9	14	13	0