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Endovascular management of iliac artery aneurysms

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***Abstract*---**Purpose: The aim is to evaluate the role of endovascular interventions in treatment of iliac artery aneurysms with one year follow up. Patients and methods: our study included 20 patients with iliac artery aneurysms defined as (iliac artery with a diameter >3cm) with adequate proximal and distal landing zone. Patients with anastomotic aneurysms, infected aneurysms or with severe renal impairment (GFR <30ml/min/1.73m2) were excluded. FOR ISOLATED ILIAC ANEURYSM: access used through either: 1) Retrograde ipsilateral common femoral artery puncture. 2) Contralateral femoral puncture and performing a crossover technique. Under fluoroscopy, the stent graft devices were advanced into the iliac axis up to the planned graft deployment site, Embolization of the IIA was performed in cases where backflow from the IIA was expected to result in a type II endoleak. For Aorto-Iliac Aneurysms: Bilateral femoral access is needed to place endografts and can be performed via surgical femoral cut down. Once vascular access is established and landmarks for positioning the device are obtained with aortography, the main device is positioned with particular attention paid to the location of the opening for the contralateral iliac limb ("contralateral gate"). Once the contralateral guide wire is positioned within the main body of the endograft, the deployment of the endograft at the neck of

the aneurysm is completed followed by deployment of the contralateral, then ipsilateral iliac artery limbs (depending on the type of graft). Results: mean Patients' age was 77.3 years, male to female ratio 19:1. The access: bilateral femoral cut-down was performed in 18 patients, while percutaneous puncture was performed in two patients. Sixteen patients needed infrarenal stent grafts, while stent grafts for coverage of only the iliac arteries were needed in two patients. Iliac Branched Device was used in two patients, while coiling of the IIA was performed in eight patients. Technical success achieved in all patients (100%). No mortalities occurred during the 1 year follow up. Conclusion: Symptomatic or large iliac aneurysms greater than 3 cm in diameter can be electively repaired safely with endovascular techniques.

***Keywords*---**endovascular, iliac artery, aneurysm.

Introduction

Iliac artery aneurysms (IAAs) occur much more rarely than abdominal aortic aneurysms (AAAs). A distinction can be made between true and anastomotic IAAs. True IAAs are most frequently atherosclerotic and localized in the common iliac artery (CIA), solitary or in combination with an AAA.(1) Solitary IAAs were found to occur with an incidence of 0.03% in a large autopsy study.(2)

As a result of the ongoing evolution in imaging techniques, asymptomatic IAAs are now being diagnosed more frequently than they were before. They can become symptomatic as a result of compression on or erosion of adjacent structures. The most devastating complication is rupture of the aneurysm, which is difficult to diagnose because usually no pulsatile mass is palpable. To prevent these complications, isolated IAAs with a diameter of >3 cm are recommended for elective repair.(1,4)

Open repair of an IAA is a major intervention. The mortality is comparable to that of elective repair of open AAA and increases up to 33% for emergent interventions. The close anatomic relation of veins and ureters with the iliac arteries in the pelvic region results in a risk of damage to these structures, contributing to the morbidity of the procedure.(1,3,4) Minimally invasive endovascular repair with a stent-graft may be a good alternative treatment for open repair, with less associated mortality and morbidity.(4)

Patients & Methods

This is a prospective study that included 20 patients with iliac artery aneurysms who underwent endovascular treatment in the period from March 2017 to March 2018. The aim of this study was to assess the role of endovascular treatment (technical success and clinical outcome after one year) in those patients.

Inclusion Criteria:

Patients with iliac artery aneurysm defined as (iliac artery diameter > 3 cm) with adequate proximal and distal landing zone.

Exclusion Criteria:

- Patients with anastomotic aneurysms.
- Patients with infected aneurysms.
- Patients with severe renal impairment (GFR <30ml /min/1.73m2)

All patients will were evaluated by:

1-History Taking:

- Age.
- Gender.
- Comorbidity: diabetes mellitus, hypertension, ischemic heart disease, renal impairment, previous CVS event, other comorbidity.
- History of smoking.
- presenting symptom.

2- Clinical examination:

- Blood pressure measurements in both upper limbs.
- Peripheral pulsations and carotid pulsation.
- Groin examination (scar,hematoma,infection,thrill, other aneurysms)

3- Pre procedural investigations*:*

a) Routine laboratory tests: complete blood count, kidney and liver functions, coagulation profile, fasting blood sugar and lipid profile.
b) All patients had 1 mm cut slice CT angiogram of their full aorta and iliac arteries down to the arterial tree of both L.Ls to assess suitability for endovascular management and 3d axial reconstruction images.
c) Echocardiography.

<u>For Isolated Iliac Aneurysm</u>

All patients signed an institutional approved informed consent and were made fully aware about the procedure benefits, risks, alternative interventions and possible complications.

Preprocedural medications:

- Patients received 300 mg of acetylcysteine bid, and hydration with normal saline at rate of 0.5-1 ml /kg/h (the night before the procedure).

Technique:

- All patients were admitted one day before the procedure.
- Position: supine position
- Preparation: both groins were prepared using antiseptic solution povidone iodine 10%.
- Anesthesia: under local anesthesia (xylocaine 2%: 3-5mg/kg).

- Equipment: all procedures were done in an angio suite; C-arm image intensifier with road mapping capability was used.

Arterial access:

- This was planned after reviewing of the pre-operative imaging.

The IAA was accessed through either:

1) Retrograde ipsilateral common femoral artery puncture.
2) Contralateral femoral puncture and performing a crossover technique.

The choice out of the above options depended on the anatomy and operator preference.

B) Angiography:
After gaining access a 6F sheath is inserted and free arterial flow is allowed to confirm the right position of the sheath. Systemic anticoagulation with heparin infusion (80-100 IU/kg). Angiography is done to confirm data obtained by preoperative investigations using nonionic low osmolar dye diluted to 50% with normal saline. Under fluoroscopy, the stent graft devices were advanced into the iliac axis up to the planned graft deployment site. The optimal apposition of the graft was secured with post deployment stent graft dilation by using balloon catheters when needed.

Device selection criteria were the suitability of the specific aneurysm's anatomy and especially the length and diameter of the proximal and distal necks. Embolization of the IIA was performed in cases where backflow from the IIA was expected to result in atype II endoleak. In cases where embolization of the IIA was needed, it was performed at the origin of the IIA to preserve flow in the distal branches. It was performed during the same procedure, immediately preceding the endovascular repair.

When the procedure is completed, the arterial access sheath is removed immediately, when more than 5000 IU of heparin is given, we delay sheath removal until aPTT normalizes, ACT< 180. Hemostasis achieved by manual compression. Digital compression was held proximal to the skin puncture site for 15-20 minutes and mobilization was delayed for 6-12 hours.

Post procedure care:
Most patients were discharged on the second day following the procedure after receiving instructions on risk factors control and treatment including:

- Acety salislic acid (Aspirin) 150 mg /day for 1week.
- Paracetamol 500mg PRN.

For Aorto-Iliac Aneurysms
Pre-operative assessment protocol:

All patients have been preoperatively through cardiac, pulmonary, and renal evaluation. Using myocardial perfusion scan, pulmonary functions test, check of kidney functions, clotting profile and full blood count followed by formal anaesthetic assessment based on American Society of Anesthesiology Scoring (ASA).The ASA score is a subjective assessment of a patient's overall health that is based on five classes (I to V).

I. Patient is a completely healthy fit patient.
II. Patient has mild systemic disease.
III. Patient has severe systemic disease that is not incapacitating.
IV. Patient has incapacitating disease that is a constant threat to life.
V. A moribund patient who is not expected to live 24 hour with or without surgery.

Decision for suitability for endovascular option taken through discussion on multi-disciplinary meeting of the vascular unit. Counselling with the patient and family prior to gain the informed consent for the intervention to insure patient understanding of the risks associated with endovascular repair as well as the lifelong follow up necessity post procedure. In addition to likelihood of re-intervention. Planning done with Ozyrex software, by vascular surgeon and based on the IFU of the device and sizing worksheet.

Patients undergoing aortoiliac aneurysm repair are considered to be at moderate to high risk for deep venous thrombosis and thromboprophylaxis is indicated. The procedure can be performed under general anaesthesia, regional anaesthesia depending on fitness and cooperation level of the patient. Prior to endograft placement, antibiotic prophylaxis is administrated within 30 minutes of the skin incision. Another single dose of antibiotics is given prior to removal of urinary catheter to guard against potential UTI and sepsis which may lead to graft infection. Bilateral femoral access is needed to place endografts. Endovascular repair of aortoiliac aneurysm can be performed via surgical femoral cut down.

Prior to device insertion, systemic anticoagulation is initiated, typically using a weight-based intravenous heparin dose of 80 to 100 units/kg. The goal is an activated coagulation time (ACT) of 200 seconds or greater Graft deployment: Once vascular access is established and landmarks for positioning the device are obtained with aortography, the main device is positioned with particular attention paid to the location of the opening for the contralateral iliac limb ("contralateral gate"). The aortic neck is imaged; a slight degree of craniocaudal and left anterior oblique angulation may improve imaging of the renal ostia. With the proximal radiopaque markers of the graft positioned appropriately below the lowest renal artery, the body of the graft is deployed to the level of the contralateral gate.

A guidewire is advanced through the contralateral access site into the contralateral gate. Gate cannulation is confirmed by placing a pigtail catheter over the guidewire into the main body of the graft, removing the guidewire and confirming that the pigtail catheter rotates freely within the main body of the

graft; if it does not, the catheter is assumed to be in the aneurysm sac. Once the contralateral guidewire is positioned within the main body of the endograft, the deployment of the endograft at the neck of the aneurysm is completed followed by deployment of the contralateral, then ipsilateral iliac artery limbs (depending on the type of graft). Once the endograft components are in place, the attachment sites and endograft junctions are gently angioplastied with a compliant or semi-compliant balloon.

Completion aortography is performed to evaluate the patency of the renal arteries and evaluate for endoleak. Guidewire access is maintained throughout the procedure but is particularly important when removing the main graft body device sheath since disruption of the access vessels by an oversized sheath may not become apparent until after sheath has been removed. Following endovascular repair of aortoiliac aneurysm, patients can be transferred to a regular ward once they have recovered from anaesthesia for regular observations (Vital signs,groin haematoma,limb perfusion,neurological events and urine output).

First day post operatively, patients were clinically assessed for groin haematoma/pseudoaneurysm, peripheral pulses/perfusion, skin radiation burn, kidney functions and abdominal symptoms. The majority of patients can be discharged home within 24 hours on single antiplatelet therapy (unless there is indication for anticoagulation) following endovascular repair, provided no complications have occurred and proper physiotherapy assessment to ensure adequate ambulation. Follow up protocol includes duplex ultrasound scans done at 2 weeks, 3 months, 6 months and 1 year to exclude endoleak and check for sac size.

Definitions:

Technical success:

- Was defined as successful placement of the stent graft without any endoleak.

Clinical success:

- Was defined as
    - Improvement of the pain and/ or edema if present
    - Shrinkage of the aneurysmal sac size

Major complications:

Procedure related mortality, renal failure, the need for emergency surgery due to arterial perforation, major bleeding or acute thrombotic occlusion.

Minor complications:

Puncture site complication including hematoma (not requiring surgical evacuation or blood transfusion), pseudoaneurysm, arteriovenous fistula, peripheral embolization (without significant ischemia).

Primary outcome parameters:

1) - Technical success proved by completion angiogram.
2) – 30 day aneurysm related mortality & morbidity.

Secondary outcome parameters:

1) Improvement of the pain and/ or edema if present
2) Shrinkage of the aneurysmal sac size
3) aneurysm related re- interventions and mortality at 1 year.

Follow up:

- All patients were re-examined after one week to check for access site complications and to confirm patency.
- All patients were followed for 12 months with regular visits at 3,6 and 12 months or when new complaints arise.
- Follow up consisted of clinical examination, imaging study (duplex ultrasoud).

Data collection and statistical analysis:

Data were statistically described in terms of mean ± standard deviation (SD), median and range, or frequencies (number of cases) and percentages when appropriate. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

Results

This study involved 20 patients who underwent endovascular repair of iliac artery aneurysm between February 2017 to February 2018.

Age:

The age of the patients in this study ranged from 68 to 88 years old with mean age of 77.3

Sex:

Majority of the patients were males (19 patients) in proportion to only 1 female. (Chart 1).

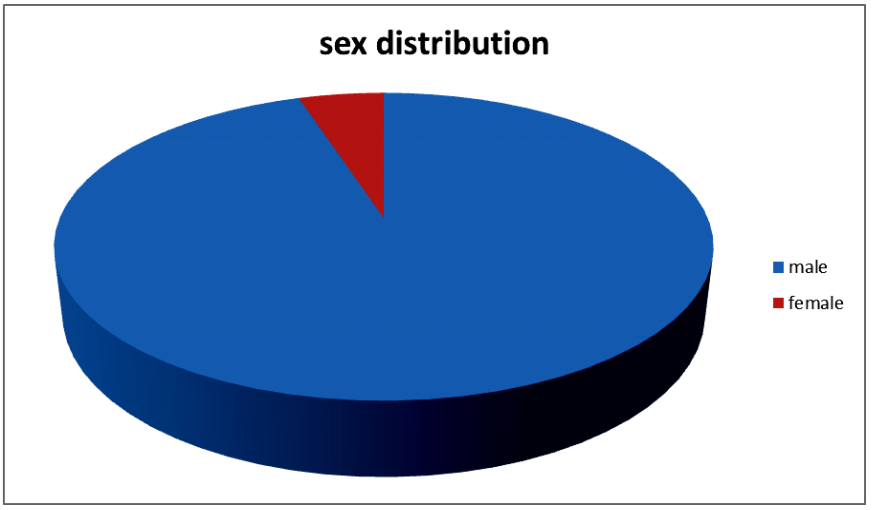

Chart 1: Sex distribution

Risk Factors:

Most of the patients included in this study were hypertensive (18 patients), followed by ischemic heart disease (16 patients), 15 patients were smokers, 6 patients had COPD and 5 patients with diabetes mellitus. (Chart 2)

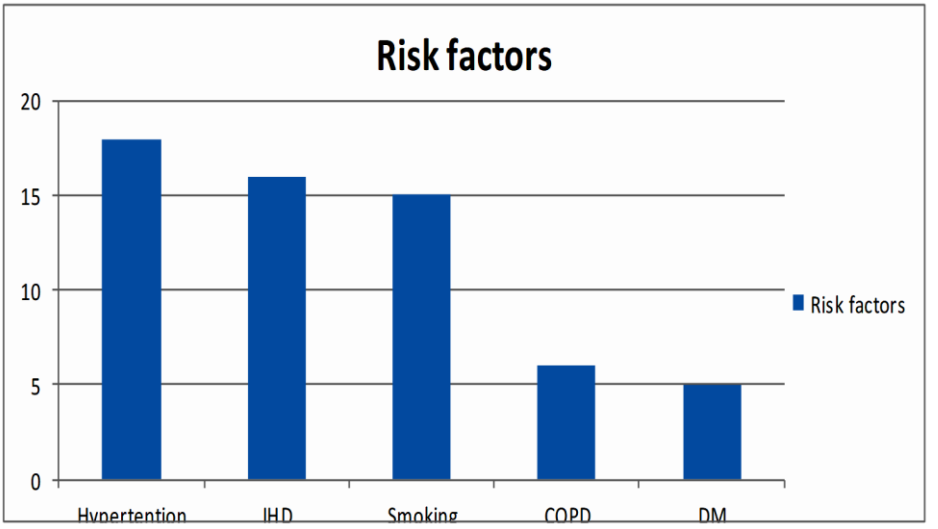

Chart 2: Risk Factors

Iliac Aneurysm Morphology:
Eighteen patients had common iliac artery aneurysm (11 patients had unilateral aneurysm and 7 patients had bilateral aneurysm) six of them also had internal iliac artery aneurysm. Two patients have isolated internal iliac artery aneurysm. (Chart 3). Fourteen patients have associated infrarenal AAA.

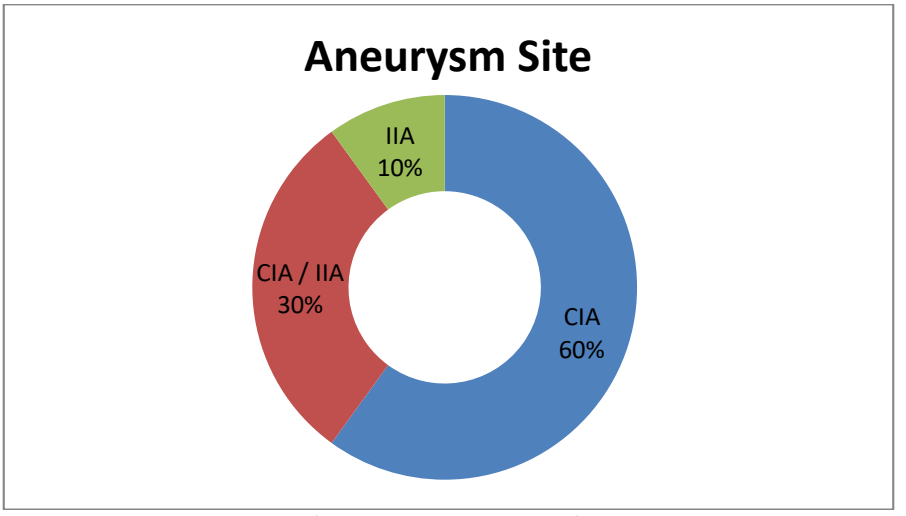

Chart 3: Aneurysm site

The sac size ranging from 35 mm to 71 mm with mean of 48mm. The proximal neck length ranges from 13 to 40 mm with mean of 28.5mm. Proximal neck diameter ranges from 15 to 22 mm with mean of 18 mm.

Access:
Bilateral femoral cut-down was performed in 18 patients, while percutaneous puncture was performed in two patients.

American Society of Anesthesiology Scoring (ASA) :
ASA score was used as a standard anesthetic risk stratification for our patients, majority of the patients in the study were scoring ASA 2 and 3 and only 2 patients were scoring ASA 4 (Table 1)

Table 1: ASA grade

ASA Grade	No of Patients
2	9
3	9
4	2

Anesthesia:
Eighteen patients had their procedures under general anesthesia, while 2 patients were done under local anesthesia.

Type of intervention:

Sixteen patients needed infrarenal stent grafts (fourteen patients with infrarenal AAA with CIA aneurysm and two patients with CIA aneurysm without adequate proximal landing zone) , while stent grafts for coverage of only the iliac arteries were needed in two patients(with adequate proximal landing zone). Iliac Branched Device was used in two patients, while coiling of the IIA was performed in eight patients. (Table 2)

Table 2: Types of intervention

Type of intervention	No. of patients
Infrarenal bifurcated stent graft	16
Stent graft	2
Coiling of IIA	8
IBD	2

Complication:

Immediate (Intra-procedural) complications:
The significant intra-procedural complications (Table 3) during this study included 1 patients with type 1 endoleak, 2 patients with type 2 endoleak, and one had dissection of the access. Managed as follows:

Table 3: Immediate (Intra-procedural) complications

Immediate Complication		No of Patients	Management	Fate
Endoleak	Type 1	1	Ballooning of the proximal neck	Resolved
	Type 2	2	Conservative	Resolved
Access Complication	Dissection	1	Needed femoral endarterectomy and vein patch closure	Intact distal pulses

Early Complications (30 days post-operative):

One patient stayed for 11 days following the procedure for developing hospital acquired pneumonia on a background of COPD which required admission to Intensive surgical unit for 6 days followed by intensive chest physiotherapy for 3 days. One patient had neurological event in the form of minor left hemispheric stroke for which stayed 7 days under the care of the stroke team for physiotherapy and neuro-rehabilitation. One patient stayed for 9 days for the management of post procedure contrast induced acute kidney injury which required 3 sessions of hemodialysis. One patient developed buttock claudication (who did bilateral coil embolization) which improved with time.

Late Complications:
Mean follow up for the patients included in this study was 1 year, looking at late complications and mid-term outcome. No short or mid-term graft infection, aorto-enteric fistula, device migration, limb occlusion or kink or late rupture.

Follow up:

- The follow up showed the following:
- Sac size: Decreased in 9 patients
- Static in 11 patients

Hospital Stay:
The mean hospital stay for the patients was 2 days. (Table 4)

Table 4: Hospital stay

	Min	Max	Mean
Post-operative stay (in days)	2	11	2

Mortality:
During the follow up period there were no intervention related mortalities, no early (30 days post-operative) mortalities and no mortalities occurred during the 1 years follow up.

Discussion

Iliac artery aneurysms present as either isolated disease, in 0.03% of the population, or in conjunction with abdominal aortic aneurysm, in approximately 20% to 25% of cases. Rupture rates have been reported to range from 15% to 70%, but there have been no reported ruptures in aneurysms 3 cm in diameter. Thus, elective repair for an isolated common iliac artery aneurysm is generally not undertaken for an aneurysm less than 3 cm in diameter, unless they are associated with an abdominal aortic aneurysm. **(Richardson, Greenfield, 1998)**

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. **(Fleming, Whitlock, Beil et al., 2005).**

Proper management of iliac artery aneurysms has not been completely standardized. Since several reports documented the utility of endovascular approach, a number of endovascular techniques have been applied either preserving (bell bottom, transposition/bypass, external to internal endografting) or sacrificing (simple coverage, coil embolization of hypogastric artery) hypogastric flow **(Lederle, 2012).**

In our study we tried to evaluate the role of endovascular intervention in treating patients with IAAs. It included 20 patients with iliac artery aneurysms with the mean age 77.3 years, confirming data from epidemiological studies suggesting increased incidence of aneurysm disease in aging population **(Fleming, Whitlock, Beil et al., 2005).**

Like age, there is evidence of gender difference with higher male prevalence **(Fleming, Whitlock, Beil et al., 2005).** In our study the majority of patients were males (95%). Cigarette smoking is by far the strongest predictor of AAA in both men and women, with reported odds ratios ranging from 3.0 to 12.0. **(Richardson Greenfield, 1998).** In our study about 75% of the patients were smokers.

A number of studies have demonstrated an apparent protective effect, with a decreased incidence of aneurysm disease in diabetics as well as decreased aneurysm growth and rupture rates **(Eur Vasc Endovasc Surg, 2012)**. In our study only 25% of the patients were diabetics, confirming the negative association observed between diabetes mellitus and aneurysm disease.

The prevalence of the aneurysm disease in a given population depends on the presence of risk factors associated with AAAs, including older age, male gender, white race, positive family history, smoking, hypertension, peripheral vascular occlusive disease, and coronary artery disease (CAD) **(Richardson Greenfield, 1998).** In our study most of our patients were hypertensive (90%) and had IHD (80%).

IAAs usually occur in the common iliac artery (89%). Internal iliac aneurysms account for only 10% and external iliac artery aneurysms are very rare (1%). Iliac aneurysms are bilateral in a quarter of cases. **(Gilmore et al., Isolated iliac artery aneurysms. Surgery, 1983).** In our study most of our patients had CIA aneurysm (90%), while (30%) had IIA aneurysm, and bilateral aneurysms were found in (35%) of the patients.

Despite good midterm results, with low morbidity/mortality rates, a number of drawbacks, such as endoleak, disconnection, iliac occlusion, and risk of pelvic ischemia are still unsolved issues, limiting the generalization of the procedures. However, literature data show that approximately one-third of patients with unilateral hypogastric occlusion and 80% of patients with bilateral hypogastric occlusion have symptoms of pelvic ischemia; buttock claudication is fortunately the most common, occurring in about 80% of symptomatic patients, with impotence in about 10% and colonic ischemia in 6% to 9% of all the pelvic ischemic complications **(Plate, Hollier, O'Brien et al., 1985)**.

Our study of iliac artery aneurysm treated by EVAR, showed trend toward lower in-hospital mortality and lower risk of systemic complications; No short or mid-term graft infection, aorto-enteric fistula, device migration, limb occlusion or kink or late rupture.

In our study, both the IBD procedure and coil hypogastric embolization with EIA extension were effective in the med-term, because no patients had persistent type 1 endoleak, junction endoleak, or bowel ischemia. However, some advantages were observed in the IBD procedure, including no cases of occurrence of buttock claudication, no impotence (vs one after coil embolization), and no patients had type 2 endoleak (vs two patients from hypogastric reperfusion after coil embolization). These data could suggest that IBD is more effective in both ensuring distal sealing with aneurysm exclusion and preserving adequate pelvic flow.

Long-term results of iliac artery aneurysms treated by endovascular repair are not yet fully understood. However, unlike for AAA, the natural history of iliac aneurysm is not well defined and the true incidence of rupture and its correlation with size is still unclear **(Wahlgren, Malmstedt, 2008).**

A recent study comparing long-term outcomes with newer and older stent grafts demonstrated similar perioperative and long-term mortality. On the other hand, late conversion rates, secondary procedures, and aneurysm sac expansion were significantly lower when using the newer-generation stent grafts. Thus, progression of stent graft durability might be beneficial to patients suitable for EVAR. Still, the long-term survival rates did not indicate a harmful effect of secondary procedures on overall survival **(Verzini et al., 2014)**.

Conclusions

- Isolated iliac artery aneurysms are uncommon lesions, usually recognized incidentally during imaging procedures indicated for other reasons.

- Symptomatic or large iliac aneurysms greater than 3cm in diameter can be electively repaired safely with endovascular techniques.
- Endovascular repair is associated reduced incidence of in-hospital morbidity and mortality along with reduced length of stay
- Successful endovascular repair is highly dependent on precise, preoperative high-resolution cross-sectional imaging for detailed case planning.
- Short- and midterm outcomes for complete endovascular repair using new stent graft devices that maintain flow to both the external and internal iliac artery are promising, with acceptable initial technical success rates and durability as compared to techniques involving unilateral or bilateral internal iliac artery occlusion.
- Knowledge of all current devices and techniques allows for predictably excellent outcomes for almost any patient, regardless of anatomic limitations, when these are applied in a creative and innovative fashion.

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