Published in final edited form as:

Ann Vasc Surg. 2017 July ; 42: 162–168. doi:10.1016/j.avsg.2016.10.052.

HYBRID EVAR: PRESERVATION OF PELVIC PERFUSION WITH EXTERNAL TO INTERNAL ILIAC ARTERY BYPASS

Neel A. Mansukhani, MD^a, George E. Havelka, MD^a, Irene B. Helenowski, PhD^b, Heron E. Rodriguez, MD^a, Andrew W. Hoel, MD^a, and Mark K. Eskandari, MD^a

^aDivision of Vascular Surgery, Northwestern University, Chicago, IL USA

^bDepartment of Surgery, Northwestern University, Chicago, IL USA

Abstract

Introduction—Diminished pelvic arterial flow as a result of intentional coverage/embolization of internal iliac arteries (IIA) during isolated endovascular common iliac artery aneurysm (CIAA) repair or endovascular repair of abdominal aortic aneurysms (EVAR) may result in symptomatic pelvic ischemia. While generally well tolerated, in severe cases pelvic ischemia may manifest as recalcitrant buttock claudication, vasculogenic impotence, or perineal, vesicle, rectal, and/or spinal cord ischemia. Branched graft technology has recently become available; however, many patients are not candidates for endovascular repair with these devices. Therefore, techniques to preserve pelvic arterial flow are needed. We reviewed our outcomes of isolated endovascular common iliac artery aneurysm repair or EVAR in conjunction with unilateral external-internal iliac artery bypass.

Methods—Single center, retrospective review of 10 consecutive patients who underwent hybrid endovascular abdominal aortic aneurysm (AAA) or common iliac artery aneurysm (CIAA) repair with concomitant external-internal iliac artery bypass between 2006 and 2015. Demographics, index procedural details, post-operative symptoms, hospital length of stay (LOS), follow-up imaging, and bypass patency were recorded.

Results—The cohort of 10 patients was all men with a mean age of 71 years (range of 56–84). Hybrid repair consisted of contralateral IIA coil embolization followed by EVAR with external iliac artery- internal iliac artery (EIA-IIA) bypass. All EIA-IIA bypasses were performed via a standard lower quadrant retroperitoneal approach with a prosthetic bypass graft. Technical success was 100% and there were no peri-operative deaths. One patient developed transient paraplegia, one patient had buttock claudication on the side of his hypogastric embolization contra-lateral to his iliac bypass, and one developed post-operative impotence. 20% of patients sustained long term complications (buttock claudication and post-operative impotence). Mean LOS was 2.8 days (range 1–9 days). Post-operative imaging was obtained in 90% of patients and mean follow-up was 10.8 months (range 0.5–36 months). All bypasses remained patent.

Corresponding Author: Mark K. Eskandari, MD, Division of Vascular Surgery, 676 N St. Clair, Suite 650, Chicago, IL 60611, Office: 312-926-7775, Fax: 312-695-4955, meskanda@nm.org.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusion—While branched graft technology continues to evolve, strategies to maintain adequate pelvic circulation are necessary in order to avoid the devastating complications of pelvic ischemia. We have demonstrated that a hybrid approach combining EVAR or isolated endovascular common iliac artery exclusion with a unilateral external-internal iliac bypass via a retroperitoneal approach is well tolerated with a short LOS and excellent patency rates.

Keywords

abdominal aortic aneurysm repair; endovascular aneurysm repair; iliac artery aneurysm; hybrid EVAR

1. Introduction

Abdominal aortic aneurysm repair remains a common operation, and since 2005 endovascular repair has eclipsed open surgical repair for elective cases.[1] Iliac artery aneurysms (IAA) are repaired with similar techniques of open surgical repair or endovascular aneurysm repair using Food and Drug Administration approved endovascular devices. When treated with endovascular aortic aneurysm repair (EVAR) devices, intentional endovascular coverage or coil embolization and exclusion of both internal iliac artery ostia of aneurysmal common iliac arteries may result in pelvic ischemia. While generally well tolerated, pelvic perfusion should be maintained to avoid complications such as buttock claudication, vasculogenic impotence, and perineal, vesicular, colonic, rectal or spinal cord ischemia. Branched endovascular devices exist to maintain internal iliac artery perfusion when standard EVAR devices would otherwise occlude the IIA ostia. However, not all patients are candidates for branched IIA devices, and these devices have only recently become available outside of clinical trials.[1–4] In addition to branched graft technology, physician modified endografts and parallel graft techniques can maintain pelvic perfusion, but these techniques are outside the devices' indications for use and require advanced endovascular training and skill.[5–8] Additionally, long-term patency of novel endovascular stent graft techniques is not known.

The purpose of this study is to describe a hybrid technique with open surgical external to internal iliac artery bypass to preserve internal iliac artery flow and pelvic perfusion with endovascular coverage of the internal iliac artery ostia during EVAR. We reviewed our outcomes of unilateral external-internal iliac artery bypass for patients with isolated unilateral and bilateral common iliac artery aneurysms, and patients with concomitant aortic aneurysm. We show that external to internal iliac artery bypass is a safe and durable technique to maintain pelvic perfusion, and present the technique, outcomes, and complications of this procedure in our single center experience.

2. METHODS

2.1 Study Design

This study is a retrospective review of 10 patients who underwent unilateral external to internal iliac artery bypass for treatment of unilateral or bilateral common iliac artery aneurysm with or without concomitant abdominal aortic aneurysm. The goal of therapy was

to successfully exclude aneurysmal segments of the abdominal aorta and common iliac arteries while preserving flow to one IIA. All patients were evaluated at a single tertiary referral center, and treated by the same vascular surgery group practice by board certified vascular surgeons. All patients underwent pre-operative axial imaging with computed tomography studies, and pre-operative cardiac risk stratification. Primary outcomes are 30-day morbidity, mortality, and procedure related complications; secondary outcomes are endoleak, colonic ischemia, pelvic ischemia, bypass patency, and bypass patency related complications. Approval for the study was granted by the Northwestern University Institutional Review Board. Patient consent was waived.

2.2 External to Internal Iliac Artery Bypass

External to internal iliac artery bypass was performed in conjunction with or prior to endovascular aneurysm repair as a staged procedure. Contralateral or bilateral CIAAs were treated with EIA to IIA bypass, ipsilateral proximal IIA ligation, and an EVAR device with distal extension limb(s) and contralateral IIA coiling. The operations were performed under general anesthesia in the supine position. The retroperitoneum was exposed in the left or right lower quadrant. In some cases, depending on operator preference, a midline skin incision with a paramedian fascial incision was used to gain access to the retroperitoneum. After the external, internal, and common iliac arteries were dissected and encircled with vessel loops, the proximal internal iliac artery was oversewn. Next, a prosthetic conduit (6 or 8mm) was sewn end-to-end to the distal internal iliac artery proximal to the anterior-posterior divisional bifurcation. The graft was then sewn end-to-side to the external iliac artery, thus re-creating the iliac bifurcation at a more distal location (iliac advancement) (Figure 1).

2.3 Follow Up

Patients are seen in the outpatient clinic within the first month after discharge with computed tomography angiogram (Figure 2). Following their first post-surgical visit, patients are seen annually. Information gathered at patient interviews and by imaging studies at follow up is used to measure technical success, and post-operative complications related and unrelated to the procedure. Technical success by symptoms is evaluated prior to discharge from the index procedure, short term success is evaluated within the first 4 weeks post op, and mid-term success is evaluated at one year post procedure.

2.4 Statistical analysis

Continuous data are presented as mean values with ranges. Categorical data were summarized as frequencies and percentages. Patency was estimated via the Kaplan-Meier method. Analyses were conducted in SAS v9.4.

3. RESULTS

In total, ten patients were treated with external to internal iliac bypass with endovascular exclusion of common iliac artery aneurysm from November 2006 to January 2015. The mean patient age was 71 years old (range 56–84). The most common patient comorbidities were hypertension, hyperlipidemia, and chronic obstructive pulmonary disease at 80%, 50%,

and 50% respectively. For the full list of patient comorbidities see Table I. All patients were evaluated with pre-operative CT angiogram. Six (60%) patients had concomitant aortic aneurysm, 7 (70%) patients had unilateral iliac artery aneurysm, and 3 patients (30%) had bilateral iliac artery aneurysm. Eight patients (80%) were treated with standard EVAR, and 2 patients (20%) required complex EVAR with branches/fenestrations to treat the visceral aortic segment. Mean iliac artery aneurysm size was 3.69cm (range, 3.2–4.0cm; Table I).

Perioperative technical success was achieved in 100% of patients. Five (50%) patients underwent single stage procedure, and five (50%) patients underwent a multi-stage procedure. Mean length of stay was 2.8 days (range, 1–9 days). Major adverse outcomes were 30%. One patient developed transient paraplegia, one patient had buttock claudication on the side of his hypogastric embolization contra-lateral to his iliac bypass, and one developed post-operative impotence. Overall 30 day morbidity was 40% with one patient sustaining a post-operative urinary tract infection.

Mean follow up time was 10.9 months (range, 0–36 months). The long term complication rate was 20%. One patient has new onset impotence, which has failed to resolve. One patient has new onset buttock claudication, which continues to improve but has not yet resolved at 9 months post procedure. In follow up, 3 (30%) patients were found to have a stable type II endoleak, which did not require intervention. In two patients, the type 2 endoleak was due to a lumbar artery and in one patient the type 2 endoleak was due to a patent inferior mesenteric artery and an accessory renal artery. There are no bypass patency related complications and no patients sustained post-operative colonic ischemia or incisional hernia (Figure 3). One patient was lost to follow up prior to his first post-operative visit. (Table II)

4. DISCUSSION

Many centers and patients do not have access to, nor are capable of, totally endovascular repair of common iliac artery aneurysms. We have demonstrated that a hybrid approach: combining EVAR with an open surgical unilateral external-internal iliac bypass via a retroperitoneal approach with or without contralateral internal iliac ligation or coil embolization is well tolerated with a short LOS and excellent patency rates. In this series there was no short term mortality. Thirty-day morbidity was experienced by two patients immediately following the procedure on the same admission. This was due to post-operative urinary tract infection and transient paraplegia, which resolved prior to discharge. The patient who experienced transient paraplegia underwent branched repair of an extent II thoracoabdominal aneurysm with coverage of the entire descending thoracic and abdominal aorta. In follow up, one patient experienced new onset buttock claudication, which continues to improve, and one patient has experienced new onset impotence. There were no instances of bypass patency compromise, bowel ischemia, or incisional hernia. Three patients have stable type 2 endoleak (two from lumbar arteries, one from a patent inferior mesenteric artery and accessory renal artery) and are being monitored with serial imaging for aneurysm sac expansion; the aneurysm sac size is stable in all patients.

As advancements in endovascular devices continue and minimally invasive therapy options increase, we show that the external to internal iliac artery bypass remains a safe, feasible,

and relevant operation for the current treatment of common iliac artery aneurysms to preserve pelvic perfusion. Due to the unproven long term success of endovascular branched graft technology and the lack of anatomic suitability in some patients, there remains a need for open pelvic revascularization, which can readily be performed without difficulty by practicing vascular surgeons.

The technique and feasibility of external to internal iliac artery bypass with concomitant EVAR was first described by Drs. Parodi and Ferriera in 1999. In their report they highlight the strategy of “distalization” of the iliac artery bifurcation, either by bypass grafting and occlusion of the IIA ostia or by ligation and distal re-implantation of the internal iliac artery to facilitate adequate landing zones for EVAR while maintaining pelvic perfusion.[9] As EVAR gained popularity and indications were expanded to include treatment of common iliac artery aneurysms, Lee et al showed that approximately 1 in 4 patients who have iliac artery occlusion with EVAR will experience symptoms of pelvic ischemia, no patients were affected by bowel ischemia, and of patients who were symptomatic, approximately half will resolve by follow up. [10] In 2001 Faries et al examined the mid-term outcomes of external to internal iliac artery bypass in patients who had undergone EVAR with bilateral internal iliac artery coverage. At 10 months follow up, no patients had buttock claudication, erectile dysfunction, or colonic or pelvic ischemia, and ten month survival was 100%. [11] In a similar study by Arko et al in 2004, hypogastric bypass was compared to hypogastric embolization during EVAR for abdominal aortic aneurysm (AAA) and concomitant common iliac artery aneurysm (CIAA). Fifty percent of patients whose internal iliac arteries were embolized developed buttock claudication, compared to patients who underwent EIA-IIA bypass of which zero patients developed buttock claudication. 88.9% of EIA-IIA bypass grafts in this study were patent at 6 months follow up. [12] There have been two subsequent case series demonstrating safety and feasibility of EIA-IIA bypass with contralateral hypogastric embolization during EVAR with coverage of the bilateral IIA ostia. [13, 14] (Table III)

With advancements in endovascular devices and technology, branched iliac endografts began to be described in the literature by 2001 by Bergami et al who showed feasibility of aortouniiliac endografts with ipsilateral hypogastric artery coiling, femorofemoral bypass, and contralateral external to internal iliac artery endograft for repair of aortic and bilateral common iliac artery aneurysm. [15] More recently a case report by Riesenman demonstrated feasibility of a physician modified endograft with off-label use of commercially available endograft components to maintain perfusion in an internal iliac artery during EVAR for treatment of aortic and bilateral common and internal iliac artery aneurysms. [16] Wu et al have corroborated Riesenman’s findings with a case series of five patients who underwent EVAR with unilateral hypogastric artery coiling and unilateral physician modified iliac branched devices for treatment of CIA aneurysms with and without AAA. Physician modified iliac branched grafts had 100% patency at 2 years, and patients had no signs of pelvic ischemia, aneurysm rupture, or death. [6] While these advancements are promising, they require a high degree of endovascular skill, innovation, and a broad range of devices.

Although common iliac artery aneurysm that extends to the iliac bifurcation is a contraindication to standard endovascular aortic/iliac aneurysm repair, new endovascular

devices such as the Cook Preserve-Zenith Iliac Branch System and Gore Excluder Iliac Branched Endoprosthesis allow for endovascular repair of these CIAAs.[1–3] While these iliac artery branched graft devices are newly commercially available, 65% of patients are not candidates for such devices according to the manufacturer published inclusion and exclusion criteria.[4, 17–19] Off label use of devices to repair common iliac artery aneurysms that extend to the iliac bifurcation, such as the parallel graft and sandwich techniques, and physician modified devices have been recently described as well. [5–8, 20, 21] However, long term patency rates and outcomes of such techniques and devices are not yet known, and the overall cost of these devices may be prohibitively expensive, effectively limiting access to such technology in certain centers. Until iliac artery branch graft technology is applicable to the entire patient population, techniques to preserve pelvic arterial flow are needed. Hybrid endovascular abdominal aortic aneurysm repair (EVAR) with standard open surgery for repair of common iliac aneurysms is a durable and useful technique for patients who are not candidates for iliac branched graft devices, or where such devices or expertise are not readily available.

Limitations exist with this study. This is a small retrospective single center case series review of a single procedure. As the Cook and Medtronic commercially constructed branched internal iliac artery grafts were not available at our institution, the patients treated totally endovascularly were all with physician modified endografts or with off-label use of commercially available devices. These patients were not included in this series. As such, these are observational data only, and there is no group to which outcomes are compared. The average follow up time was only 10.8 months, and longer follow up data is required to more accurately determine bypass patency rates and patency related complications.

5. CONCLUSIONS

While branched graft technology continues to evolve, strategies to maintain adequate pelvic circulation are necessary in order to avoid the devastating complications of pelvic ischemia. This study demonstrates hybrid EVAR with external to internal iliac artery bypass as a safe, effective, and useful procedure for the treatment of common iliac artery aneurysms. Short term outcomes are excellent with no mortality and low morbidity. For patients for whom iliac artery branched grafts are not available or appropriate, vascular surgeons must be able to perform open pelvic revascularization procedures to maintain perfusion to the pelvis and abdominal viscera. This procedure is an excellent adjunct to endovascular common iliac aneurysm repair with short length of stay, low complications, and high patency rates.

Acknowledgments

The authors would like to thank and acknowledge Dr. Kyle Miller (Northwestern University Department of Surgery) for his professional illustrations of the figures within this manuscript, and Ms. Janet Goldstein for her editorial and administrative assistance.

Author NM is partially supported by National Institutes of Health Grant (2T32HL094293-06). Author HR has received honoraria from W. L. Gore & Associates, Trivascular Inc, and Abbott as a speaker/consultant. Author ME has received honoraria from Prairie Education and Research Cooperative (Bard) for service on the LEVANT 2 clinical events committee; from Silk Road Medical, Inc. for service on the Roadster clinical events committee; and from W. L. Gore & Associates for as a TEVAR course director. None of these entities in any way influenced the

design and conduct of the study; collection, management, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript.

The primary investigator and senior author had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

Abbreviations

(IIA)	Internal iliac artery
(CIA)	common iliac artery
(EIA)	external iliac artery
(EVAR)	endovascular aneurysm repair
(LOS)	length of stay
(AAA)	abdominal aortic aneurysm
(CIAA)	common iliac artery aneurysm

References

1. Kent KC. Clinical practice. Abdominal aortic aneurysms. *N Engl J Med*. 2014; 371(22):2101–8. [PubMed: 25427112]
2. Cook Medical. Zenith® Branch Endovascular Graft- Iliac Bifurcation with the H&L-B One-Shot™ Introduction System: Instructions for Use. 2015. https://www.cookmedical.eu/data/IFU_PDF/IFU-IBE_V10.PDF accessed 4/26/16
3. Gore. GORE® EXCLUDER® Iliac Branch Endoprosthesis. 2015. <https://www.goremedical.com/cms/excluderibeeu.jsp> accessed 4/26/16
4. Pearce BJ, Varu VN, Glocker R, Novak Z, Jordan WD, Lee JT. Anatomic suitability of aortoiliac aneurysms for next generation branched systems. *Ann Vasc Surg*. 2015; 29(1):69–75. [PubMed: 25194549]
5. Nykamp M, Anderson J, Remund T, Santos A, Laurich C, Schultz G, et al. Use of physician-modified endografts to repair unilateral or bilateral aortoiliac aneurysms. *Ann Vasc Surg*. 2015; 29(7):1468–74. [PubMed: 26122416]
6. Wu WW, Lin C, Liu B, Liu CW. Using a surgeon-modified iliac branch device to preserve the internal iliac artery during endovascular aneurysm repair: single-center experiences and early results. *Chin Med J*. 2015; 128(5):674–9. [PubMed: 25698203]
7. Greenberg RK, West K, Pfaff K, Foster J, Skender D, Haulon S, et al. Beyond the aortic bifurcation: branched endovascular grafts for thoracoabdominal and aortoiliac aneurysms. *J Vasc Surg*. 2006; 43(5):879–86. discussion 86–7. [PubMed: 16678676]
8. Lepidi S, Piazza M, Scrivere P, Menegolo M, Antonello M, Grego F, et al. Parallel endografts in the treatment of distal aortic and common iliac aneurysms. *Eur J Vasc Endovasc Surg*. 2014; 48(1):29–37. [PubMed: 24846490]
9. Parodi JC, Ferreira M. Relocation of the iliac artery bifurcation to facilitate endoluminal treatment of abdominal aortic aneurysms. *J Endovasc Surg*. 1999; 6(4):342–7. [PubMed: 10893136]
10. Lee CW, Kaufman JA, Fan C-M, Geller SC, Brewster DC, Cambria RP, et al. Clinical outcome of internal iliac artery occlusions during endovascular treatment of aortoiliac aneurysmal diseases. *J Vasc Interv Radiol*. 2000; 11(5):567–71. [PubMed: 10834486]
11. Faries PL, Morrissey N, Burks JA, Graveriaux E, Kerstein MD, Teodorescu VJ, et al. Internal iliac artery revascularization as an adjunct to endovascular repair of aortoiliac aneurysms. *J Vasc Surg*. 2001; 34(5):892–9. [PubMed: 11700492]

12. Arko FR, Lee WA, Hill BB, Fogarty TJ, Zarins CK. Hypogastric artery bypass to preserve pelvic circulation: improved outcome after endovascular abdominal aortic aneurysm repair. *J Vasc Surg.* 2004; 39(2):404–8. [PubMed: 14743144]
13. Hosaka A, Kato M, Kato I, Isshiki S, Okubo N. Outcome after concomitant unilateral embolization of the internal iliac artery and contralateral external-to-internal iliac artery bypass grafting during endovascular aneurysm repair. *J Vasc Surg.* 2011; 54(4):960–4. [PubMed: 21621367]
14. Lee WA, Nelson PR, Berceli SA, Seeger JM, Huber TS. Outcome after hypogastric artery bypass and embolization during endovascular aneurysm repair. *J Vasc Surg.* 2006; 44(6):1162–8. discussion 8–9. [PubMed: 17145415]
15. Bergamini TM, Rachel ES, Kinney EV, Jung MT, Kaebnick HW, Mitchell RA. External iliac artery-to-internal iliac artery endograft: A novel approach to preserve pelvic inflow in aortoiliac stent grafting. *J Vasc Surg.* 2002; 35(1):120–4. [PubMed: 11802142]
16. Riesenman PJ, Ricotta JJ 2nd, Veeraswamy RK. Preservation of hypogastric artery blood flow during endovascular aneurysm repair of an abdominal aortic aneurysm with bilateral common and internal iliac artery involvement: utilization of off-the-shelf stent-graft components. *Ann Vasc Surg.* 2012; 26(1):109. e1–5.
17. ClinicalTrials.gov. PRESERVE-Zenith® Branch Endovascular Graft-Iliac Bifurcation. 2015. <https://clinicaltrials.gov/ct2/show/NCT02475798> accessed 4/26/16
18. ClinicalTrials.gov. PRESERVE-Zenith® Iliac Branch System Clinical Study. 2015. <https://clinicaltrials.gov/ct2/show/NCT01208415?term=preserve-zenith&rank=1> accessed 4/26/16
19. ClinicalTrials.gov. Evaluation of the GORE® EXCLUDER® Iliac Branch Endoprosthesis. 2015. <https://clinicaltrials.gov/ct2/show/NCT01883999?term=gore+excluder&rank=4> accessed 4/26/16
20. Lobato AC. Sandwich technique for aortoiliac aneurysms extending to the internal iliac artery or isolated common/internal iliac artery aneurysms: a new endovascular approach to preserve pelvic circulation. *J Endovasc Ther.* 2011; 18(1):106–11. [PubMed: 21314358]
21. Lobato AC, Camacho-Lobato L. The sandwich technique to treat complex aortoiliac or isolated iliac aneurysms: results of midterm follow-up. *J Vasc Surg.* 2013; 57(2 Suppl):26S–34S. [PubMed: 23336852]

Figure 1. Surgical approach and exposure (A). Hybrid EVAR with EIA-IIA bypass and ipsilateral IIA ligation; end to side anastomosis on the EIA, and end to end anastomosis on the IIA (B).

Figure 2. EVAR and left internal iliac artery coiling (A), completion angiogram after EVAR and patent EIA-IIA bypass(B) and post-operative CT angiogram showing patent left EIA-IIA bypass (C).

Figure 3.
Kaplan-Meier curve with 100% EIA-IIA bypass patency.

Table I

Patient demographics, aneurysm size and morphology (n=10)

Demographic	mean	range
Age	71.1	56–84
Aneurysm size (cm)	3.69	3.2–4.0
	n	%
Male sex	10	100
Hypertension	8	80
Coronary artery disease	4	40
Smoking (current or significant previous)	5	50
Hyperlipidemia	6	60
Atrial fibrillation	1	10
Chronic renal insufficiency	1	10
Diabetes	0	0
Aortic aneurysm involvement	6	60
Bilateral iliac aneurysm	3	30
Unilateral iliac aneurysm	7	70

Table II

Perioperative details and postoperative outcomes

	mean	range
Estimated blood loss (cc)	440	150–1200
OR time (minutes)	303	188–520
Length of stay	2.8	1–9
Follow up time (months)	10.9	0.5–36.0
	n	%
Technical success	10	100
Single stage procedure	5	50
Multi stage procedure	5	50
Standard EVAR	8	80
Complex EVAR	2	20
30-day morbidity	4	40
30-day mortality	0	0
30-day procedure related complications	3	30%
Endoleak	3	30
Impotence	1	10
Buttock claudication	1	10
Bypass patency related complication	0	0
Colonic ischemia	0	0
Incisional hernia	0	0

Table III

Summary of hybrid EVAR with EIA-IIA bypass literature

Author	Year	N	Conclusions
Faries et al [11]	2001	10	100% patency, survival, and freedom from buttock claudication, erectile dysfunction, colonic and pelvic ischemia at mean 10-month follow up.
Arko et al [12]	2004	21 (9 bypass, 12 embolization)	88.9% patency of EIA-IIA bypass at 6-month follow up No buttock claudication in EIA-IIA bypass group compared to hypogastric embolization (50% reported ipsilateral buttock claudication) during EVAR.
Lee et al [14]	2006	26	91% primary patency at 36 months, higher postoperative complications, ischemic complications, and buttock claudication in EIA-IIA bypass and EIA-IIA bypass with contralateral embolization than control EVAR group.
Hosaka et al [13]	2011	11	100% primary patency at 15.7-month mean follow up time, no graft related complications, 9% with buttock claudication—both on occluded IIA side, contralateral to EIA-IIA bypass
Mansukhani et al [current study]	2016	10	100% technical success, 0% 30-day mortality or procedure related complication, 100% primary patency at 10.8-month mean follow up time, 20% post-operative impotence and buttock claudication