Outcome after hypogastric artery bypass and embolization during endovascular aneurysm repair

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Background: Multiple strategies have been devised to extend the applicability of endovascular aneurysm repair (EVAR) in patients with common iliac artery (CIA) aneurysms. This study was designed to examine outcome in patients undergoing EVAR with either hypogastric artery embolization or common iliac artery bifurcation advancement by hypogastric bypass.

Methods: A retrospective review of all patients undergoing EVAR since the inception of our program (1997-2006) was performed. Patients with large common iliac artery aneurysms (≥20 mm) and patent hypogastric arteries not amenable to a cuff or “bell bottom” technique were treated with coil embolization (EMBO) and/or hypogastric revascularization (BYPASS). The perioperative and mid-term outcomes were compared with the larger group of patients undergoing EVAR that did not require either treatment (CTRL). Bilateral common iliac artery aneurysms were treated with unilateral coil embolization and contralateral bypass.

Results: Common iliac artery aneurysms were present in 137 (31%) of the 444 patients undergoing EVAR, but only 57 (42%) of 137 required direct management. This included hypogastric artery embolization alone (EMBO) in 31 or hypogastric artery revascularization (BYPASS) in 26, with and without contralateral embolization (both revascularization/embolization in 46%). The procedure length (CTRL, 159 ± 72 minutes; EMBO, 153 ± 39 minutes; BYPASS, 283 ± 75 minutes) and estimated blood loss (CTRL, 251 ± 313 mL; EMBO, 233 ± 158 mL; BYPASS, 400 ± 287 mL) were significantly greater (P < .05) in the BYPASS group. The incidence of any postoperative complication (CTRL, 26%; EMBO, 68%; BYPASS, 54%), any ischemic complication (CTRL, 6%; EMBO, 55%; BYPASS, 27%), and new-onset buttock claudication (CTRL, 3%; EMBO, 39%; BYPASS, 27%) were all significantly greater in the BYPASS and EMBO group relative to the control (CTRL) group (n = 387). The incidence of new-onset buttock claudication ipsilateral to the hypogastric bypass was 4%; the balance of the new onset claudication in the BYPASS group was due to the contralateral embolization. The primary hypogastric artery bypass patency was 91 ± 11% (SE) at 36 months by life-table analysis.

Conclusions: Despite its increased complexity, hypogastric artery bypass is an excellent alternative to embolization in terms of patency and freedom from ischemic symptoms for patients with large common iliac artery aneurysms undergoing EVAR. (J Vasc Surg 2006;44:1162-9.)

Common iliac artery aneurysms are found concomitant with abdominal aortic aneurysms in 18% to 25% of patients.1,2 These common iliac artery aneurysms may preclude or complicate endovascular aneurysm repair (EVAR) depending upon their size and extent. A variety of techniques have been described to extend the applications of EVAR in this setting. These techniques include embolization/occlusion of the ipsilateral hypogastric artery with extension of the graft limb into the external iliac artery,3-10 seating the endograft limb in the aneurysmal common iliac artery using aortic cuffs (ie, “bell bottom” technique),11-13 advancement of the common iliac artery bifurcation with hypogastric artery bypass/transposition,14-16 use of bifurcated endografts with extension of the limbs into the hypogastric/external iliac arteries,17-19 and use of an aortouniiliac endograft with crossover femorofemoral bypass in combination with a retrograde endovascular external-hypogastric artery bypass.20-22 Hypogastric artery embolization/occlusion and the “bell bottom” technique are the most commonly used but are limited by their ischemic complications and concerns about long-term durability, respectively. Indeed, ipsilateral thigh/buttock claudication and sexual dysfunction have been reported in up to 40% and 20% of patients, respectively, after hypogastric embolization.3-10,23 and case reports have documented bowel infarction,24 paraplegia,25 and gluteal compartment syndrome.26 Advancement of the common iliac artery bifurcation by re-siting the origin of the hypogastric artery overcomes many of these limitations. The overall experience with this approach is limited, however, and the long-term durability uncertain.14-16 This study was designed to examine the perioperative and mid-term outcome in patients undergoing EVAR with either hypogastric artery bypass or coil embolization, or both.

METHODS

Experimental design. All patients undergoing endovascular repair of their aortoiliac artery aneurysms at the
University of Florida College of Medicine between August 1997 and December 2005 were identified by retrospective review of a prospectively maintained EVAR database. Patients requiring direct management of their common iliac artery aneurysms with either hypogastric artery embolization alone (EMBO) or hypogastric artery bypass with or without contralateral hypogastric artery embolization (BYPASS) were further identified in the database. The perioperative and mid-term outcomes were compared between these two subsets of patients and the larger group of patients undergoing EVAR that did not require hypogastric embolization or bypass (CTRL). Data obtained from the database were confirmed by review of the complete medical record. Patients with isolated common iliac artery aneurysms treated with a bifurcated endograft were included in the study, but those with isolated hypogastric artery aneurysms were specifically excluded. The study was approved by the Institutional Review Board at the University of Florida College of Medicine and the Malcolm Randall Veterans Affairs Medical Center.

Clinical practice. Patients were evaluated and treated by a group of seven board-certified vascular surgeons at a tertiary-care university medical center or an affiliated Veterans Affairs Medical Center. The primary preoperative imaging modality was a spiral computed tomography (CT) angiogram with three-dimensional reconstructions, including surface-shaded renderings and multiplanar reconstructions. Conventional preoperative arteriography was used infrequently and only during the initial experience. A variety of endografts were used, including the Excluder (W. L. Gore & Associates, Flagstaff, Ariz), AneuRx (Medtronic Vascular, Santa Rosa, Calif), Zenith (Cook Medical Inc, Bloomington, Ind), Ancure (Guidant, Menlo Park, Calif), Vanguard (Boston Scientific, Natick, Mass), and the TriVascular device (TriVascular, Santa Rosa, Calif). Stent choice was contingent upon availability, anatomic suitability, and surgeon preference. All procedures were performed in the operating room. General endotracheal anesthesia and a portable fluoroscopic unit (GE-OEC, Salt Lake City, Utah) were used during the first half of the experience, and continuous spinal anesthesia and a fixed imaging system (Infinix, Toshiba American, New York, NY) were used during the latter part. All patients, regardless of whether they underwent retroperitoneal exposure for hypogastric bypass, were admitted to the general care ward postoperatively after observation in the postanesthesia care unit. Patients were discharged when they were able to ambulate independently and tolerate a general diet. They were seen in the outpatient clinic 2 to 4 weeks postoperatively as dictated by their wound care and imaging requirements. Initially, patients underwent a four-view abdominal series and thin-cut, triple-phase spiral CT scan with delayed images at 1 month and 6 months postoperatively and at 6-month intervals thereafter. More recently, patients received an abdominal series and spiral CT during the first month postoperatively and a CT scan at 6 months, 12 months, and yearly thereafter, depending upon the measurements of the aneurysm, the presence of an endoleak, and the configuration of the device. Remedial procedures and interventions were performed for all type I and III endoleaks detected during follow-up and for select type II endoleaks when there was evidence of significant (>5 mm) aneurysm sac enlargement. Remedial procedures and interventions were also performed for inadequate fixation, device failure (eg, fabric tear), and graft limb thrombosis.

Patients with common iliac artery aneurysms (>20 mm) without a suitable landing zone (ie, length >20 mm, diameter-device dependent) for the standard iliac graft limb were treated preferentially with an aortic cuff or the “bell bottom” technique. Those not amenable to this approach were treated with either hypogastric artery occlusion/embolization and extension of the endograft limb into the external iliac artery or advancement of the common iliac artery bifurcation by hypogastric bypass/transposition. The choice was contingent upon the patient’s anatomical suitability, hypogastric circulation, comorbidities, and presence of any factors that would complicate the bypass procedure from a technical standpoint, such as morbid obesity or prior retroperitoneal procedures. Bilateral hypogastric embolizations were not performed. Flush occlusion (ie, flush coverage of the hypogastric orifice with the endograft limb), proximal embolization, and distal embolization of the hypogastric artery were all used, with the distal embolization technique accounting for most of the cases, despite our preference for the others. The extension of the common iliac artery aneurysm to its bifurcation and any dilatation/aneurysmal involvement of the hypogastric artery precluded the flush occlusion and proximal embolization, respectively. Briefly, the proximal hypogastric artery or distal branches were occluded with a suitable number of appropriately sized coils until the flow within main artery was arrested altogether or significantly reduced with the anticipation that the vessel would thrombose after deployment of the endograft across its orifice. During our initial experience, the coil embolization was performed as a separate procedure before EVAR, but in later cases was performed simultaneously as part of the endograft placement. Hypogastric artery thrombosis was confirmed on the first postoperative CT scan.

Hypogastric bypass. A 15-cm curvilinear skin incision was made halfway between the umbilicus and symphysis pubis, and the anterior rectus sheath was incised along its lateral border (Fig 1, A). The ipsilateral rectus muscle was retracted medially to access the retroperitoneal space. The visceral structures were reflected superiorly/medially with a self-retaining Buckwalter retractor, and the iliac vessels were dissected free, including a sufficient length on the hypogastric artery (ie, internal iliac) to facilitate vascular clamp application and the anastomosis. The distal anastomosis to the hypogastric artery was performed first using an 8-mm Dacron graft. The proximal anastomosis was then sited on the inferior aspect of the external iliac artery a sufficient distance from the original bifurcation of the common iliac artery to provide an appropriate distal landing zone (Fig 1, B). In the presence of severe distal external iliac occlusive disease (ie, diameter <7 mm), an 8-mm Dacron conduit was anastomosed to the anterolateral aspect of the
proximal eternal iliac artery (>2 cm distal to the hypogastric orifice) and tunneled to the groin beneath to the inguinal ligament. After deployment of the endograft, the conduit was used for the hypogastric bypass. In a few cases, redundant hypogastric arteries were mobilized and transposed directly onto the inferior aspect of the external iliac artery.

**Database.** All patient data were prospectively gathered in a dedicated aortic endovascular database that included standard demographics, cardiovascular risk factors, aneurysm measurements, intraoperative procedural details, and postoperative outcomes. Preoperative cardiovascular risk factors included any history of hypertension, coronary artery disease (angina, coronary artery bypass, percutaneous coronary angioplasty), peripheral arterial occlusive disease (claudication, ankle-brachial index <0.9, prior lower extremity revascularization), chronic obstructive pulmonary disease, diabetes mellitus, chronic renal insufficiency (serum creatinine >1.3 mg/dL), congestive heart failure (New York Heart Association class II or greater), and cerebrovascular occlusive disease (transient ischemic attack, stroke, carotid endarterectomy/angioplasty). Preoperative risk stratification was based on the American Society of Anesthesiologists (ASA) Physical Status Classification system. Postoperative data collected included detailed records of all complications and device-related secondary procedures. The complications were classified as wound, bleeding, cardiac, pulmonary, neurologic, ischemic, gastrointestinal, renal, death, or other. An electronic schedule of each patient’s pending clinic follow-up was maintained, and all patients that missed their clinic appointments were contacted. Attempts were made to determine the date and probable cause of each death. A single author (W. A. L.) reviewed all the perioperative imaging studies.

**Statistical analyses.** The perioperative and mid-term outcomes were compared among the treatment groups. All categoric data were compared using the χ² test, and the continuous data were compared using analysis of variance. Patient survival and freedom from secondary procedures were determined by the Kaplan-Meier method and compared with the log-rank test. Patency of the hypogastric revascularization was determined using the life-table method. All values, unless otherwise specified, were reported as mean ± standard deviation, and P < .05 was accepted as significant.

**RESULTS**

During the study period, 444 consecutive patients underwent EVAR of their aortoiliac aneurysms at our institution, of whom 137 (31%) had common iliac artery aneurysms (diameter ≥20 mm), although only 57 (42%) of these required direct management. The direct strategies included hypogastric artery embolization (EMBO) in 31 with extension of the endograft limb into the external iliac artery or common iliac artery bifurcation advancement by hypogastric artery revascularization in 26 (BYPASS), and aortic cuffs were used to treat 80 of the 387 control (CTRL) patients. Among the patients undergoing hypogastric revascularization, 12 (46%) also required contralateral hypogastric embolization.

The aneurysm diameters, patient demographics, and comorbidities for the three treatment groups are shown in Table I. The patients in the BYPASS group were significantly younger than those in either of the other two groups. The maximal abdominal aortic aneurysm diameters, breakdown by gender, ASA classification, and comorbidities were all similar, however. The diameter of the common iliac artery aneurysms in the CTRL group were significantly smaller than those treated by the direct means in the other two groups (CTRL, 28 ± 11; EMBO, 32 ± 11; and BYPASS, 33 ± 10; P = .019).

The details of the operative procedure for the three groups are summarized in Table II. The total operative
time and estimated blood loss were significantly greater in the BYPASS group, although the fluoroscopy time and quantity of contrast agent administered were similar. Excluding the hypogastric bypass and coil embolizations, a comparable number of adjunctive procedures were performed in each group, with the overwhelming majority associated with the access vessels (eg, iliac angioplasty, iliac conduit, common femoral patch angioplasty). The incidence of intraoperative complications was also similar among the three groups, with most again related to the access vessels (eg, iliac artery dissection/avulsion, common femoral artery dissection and avulsion).

The perioperative and mid-term outcomes for the three groups are summarized in Table III. Eight patients in the CTRL group died within the first 30 days for an overall mortality rate of 2%. Deaths were due to cardio-pulmonary causes in 4, colorectal/pelvic ischemia in 2, and stroke in 1; 1 death occurred intraoperatively due to a profound coagulopathy. Notably, one of the patients with colorectal/pelvic ischemia underwent an uneventful EVAR with preservation of both hypogastric arteries, whereas inadvertent occlusion of one of two patent hypogastric arteries occurred in the other. The mean postoperative follow-up (months) was longer for the BYPASS group (CTRL, 21 ± 18; EMBO, 18 ± 9; BYPASS, 30 ± 17; \( P = .03 \)). The likelihood of a postoperative complication developing was significantly greater in the EMBO and BYPASS groups than in the CTRL group. Similarly, the incidence of any ischemic complication developing (ie, claudication, graft thrombosis, pelvic ischemia) was also greater in the EMBO and BYPASS groups. Notably, 39% and 27% of the patients in the EMBO and BYPASS groups respectively developed new onset buttock claudication immediately after EVAR. This new onset claudication accounted for all of the ischemic complications in the BYPASS group while 4 patients in the EMBO group had a graft limb thrombosis and 1 patient developed a lumbar plexopathy. The early onset claudication resolved after 6 months in 2 patients in the EMBO group (claudication \( \geq \) 6 mos: EMBO – 33%, BYPASS – 27%). Further breakdown of the BYPASS group demonstrated that only 1 patient (4%) developed buttock claudication ipsilateral to the hypogastric bypass (cause - immediate graft thrombosis); the balance of the new onset claudication resulted from the hypogastric embolization performed contralateral to the bypass. The primary patency rate for the hypogastric bypass was 91% ± 11% (SE) at 36 months (Figure 2). The incidence of secondary procedures, the freedom

### Table I. Aneurysm diameter, patient demographics and comorbidities

<table>
<thead>
<tr>
<th>Variables</th>
<th>CTRL ( n = 387 ) (%)</th>
<th>EMBO ( n = 31 ) (%)</th>
<th>BYPASS ( n = 26 ) (%)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA diameter (mm)</td>
<td>59 ± 12</td>
<td>57 ± 12</td>
<td>54 ± 12</td>
<td>.12</td>
</tr>
<tr>
<td>CIA aneurysm</td>
<td>21</td>
<td>100</td>
<td>100</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>73 ± 8</td>
<td>74 ± 9</td>
<td>68 ± 10</td>
<td>.008</td>
</tr>
<tr>
<td>Male</td>
<td>89</td>
<td>87</td>
<td>96</td>
<td>.47</td>
</tr>
<tr>
<td>ASA ≤ III</td>
<td>72</td>
<td>71</td>
<td>73</td>
<td>.98</td>
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<tr>
<td>Diabetes mellitus</td>
<td>13</td>
<td>16</td>
<td>15</td>
<td>.86</td>
</tr>
<tr>
<td>Hypertension</td>
<td>66</td>
<td>58</td>
<td>73</td>
<td>.48</td>
</tr>
<tr>
<td>CAD</td>
<td>47</td>
<td>35</td>
<td>54</td>
<td>.36</td>
</tr>
<tr>
<td>CHF</td>
<td>10</td>
<td>6</td>
<td>15</td>
<td>.54</td>
</tr>
<tr>
<td>COPD</td>
<td>28</td>
<td>23</td>
<td>35</td>
<td>.60</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>15</td>
<td>29</td>
<td>15</td>
<td>.13</td>
</tr>
<tr>
<td>CVOD</td>
<td>17</td>
<td>23</td>
<td>15</td>
<td>.73</td>
</tr>
<tr>
<td>PAOD</td>
<td>16</td>
<td>19</td>
<td>15</td>
<td>.90</td>
</tr>
</tbody>
</table>

CTRL, Control; EMBO, embolization; AAA, abdominal aortic aneurysm; CIA, common iliac artery; ASA, American Society of Anesthesiologists Physical Status Classification; CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVOD, cerebrovascular occlusive disease; PAOD, peripheral arterial occlusive disease.

### Table II. Operative procedural details

<table>
<thead>
<tr>
<th>Variable</th>
<th>CTRL ( n = 387 ) (%)</th>
<th>EMBO ( n = 31 ) (%)</th>
<th>BYPASS ( n = 26 ) (%)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent repair</td>
<td>9</td>
<td>6</td>
<td>0</td>
<td>.27</td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>159 ± 72</td>
<td>153 ± 39</td>
<td>283 ± 75</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Estimated blood loss (mL)</td>
<td>251 ± 313</td>
<td>233 ± 158</td>
<td>400 ± 287</td>
<td>.048</td>
</tr>
<tr>
<td>Fluoroscopy time (min)</td>
<td>26 ± 13</td>
<td>26 ± 10</td>
<td>28 ± 12</td>
<td>.81</td>
</tr>
<tr>
<td>Contrast (mL)</td>
<td>93 ± 34</td>
<td>98 ± 34</td>
<td>99 ± 45</td>
<td>.76</td>
</tr>
<tr>
<td>Adjunct procedures</td>
<td>20</td>
<td>13</td>
<td>27</td>
<td>.42</td>
</tr>
<tr>
<td>Intraoperative complications</td>
<td>14</td>
<td>3</td>
<td>12</td>
<td>.23</td>
</tr>
</tbody>
</table>

CTRL, Control; EMBO, embolization.
DISCUSSION

The results of the study suggest that hypogastric bypass can safely and effectively extend the application of EVAR in patients with large common iliac artery aneurysms. The incidence of ipsilateral ischemic complications after hypogastric bypass was minimal, and the associated graft patency rates were excellent. However, hypogastric bypass is technically challenging, increases the complexity of the EVAR, and may extend the hospital length of stay. The significance of our findings is underscored by the fact that, to our knowledge, the current report represents the single largest experience in the literature.

The observed risks and benefits associated with hypogastric bypass are consistent with the other reports in the literature. Indeed, the associated patency rates are not particularly surprising given the diameter and length of the bypass. Faries et al\(^{18}\) reported their experience with hypogastric bypass/transposition during EVAR in 11 patients and documented 100% patency at a mean followup of 10 months. Notably, there were no deaths in their series and no patients developed postoperative buttock claudication, pelvic ischemia or erectile dysfunction. Arko et al.\(^{14}\) compared hypogastric embolization and bypass during EVAR in a small series of patients and documented a 50% incidence of early claudication after embolization, but no claudication after bypass with an overall mean followup of 15 months. Furthermore, they did not see any difference in mortality, morbidity, blood loss or length of stay. Similarly, Johansen\(^{30}\) reported his experience with direct hypogastric revascularization in 8 patients with symptomatic pelvic ischemia during the pre-EVAR era and documented excellent long-term success. Our findings documenting the increased magnitude of the operative procedure are consistent with our early report encompassing all retroperitoneal procedures during EVAR.\(^{31}\) In that study, the retroperitoneal approach was associated with a greater blood loss (almost 3-fold higher), a longer procedure time (82% increase), a longer hospital stay (1.5 additional days), and higher complication rate (almost 2-fold greater).

The risks associated with hypogastric embolization are well documented, and our findings are within the collective experience. The incidence of buttock claudication and sexual dysfunction are very consistent and, indeed, predictable. A significant proportion of the buttock claudication will improve with time, although this was not seen in the current study. Interestingly, Lee et al\(^{4}\) reported that no patients with symptoms returned to their baseline state after hypogastric embolization, despite significant improvement in their disability score. Not surprisingly, Lin et al\(^{5}\) reported that hypogastric embolization caused a significant decrease in the penile-brachial index, but no change in the ankle-brachial index. The magnitude and clinical significance of the buttock claudication and sexual dysfunction from a patient perspective are clear. Wolpert et al\(^{32}\) reported that 87% of their patients undergoing EVAR with hypogastric embolization had \textit{prooperative} erectile dysfunction, whereas Lee et al\(^{4}\) reported that all the patients in their series volunteered that they would undergo the same procedure despite the 39% incidence of early buttock claudication.

The other ischemic complications associated with hypogastric embolization, such as colon ischemia, glutal compartment syndrome, and paraplegia, are relatively un-

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### Table III. Perioperative and mid-term outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>CTRL n = 387 (%)</th>
<th>EMBO n = 31 (%)</th>
<th>BYPASS n = 26 (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day mortality</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>.55</td>
</tr>
<tr>
<td>Length of stay (days)</td>
<td>3 ± 5</td>
<td>3 ± 3</td>
<td>5 ± 12</td>
<td>.09</td>
</tr>
<tr>
<td>Any postoperative complication</td>
<td>26</td>
<td>68</td>
<td>54</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Any ischemic complication</td>
<td>6</td>
<td>55</td>
<td>27</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>New postoperative claudication</td>
<td>3</td>
<td>39</td>
<td>27</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Secondary procedures</td>
<td>13</td>
<td>26</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Freedom secondary procedures (24 mos)(\dagger)</td>
<td>84 ± 2</td>
<td>74 ± 9</td>
<td>82 ± 6</td>
<td>.09</td>
</tr>
<tr>
<td>Survival (24 mos)(\dagger)</td>
<td>79 ± 3</td>
<td>91 ± 6</td>
<td>87 ± 7</td>
<td>.94</td>
</tr>
</tbody>
</table>

CTRL, Control; EMBO, embolization.
\(\dagger\)Kaplan-Meier estimates ± the SEM.

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![Hypogastric Bypass - Primary Patency](image)

Fig 2. The life-table curve for the primary patency of the hypogastric bypass is shown with the negative standard error bars. The dotted lines denote a standard error >10%. The time intervals (months) and the number of patients at risk are shown in the inset table.
common, but unfortunately, the remedial treatment options are poor or nonexistent. Because of these concerns, we have been unwilling to perform bilateral hypogastric embolizations despite reports documenting its safety.\textsuperscript{6,32-34} Regardless, it is important to assess the status of the pelvic circulation before unilateral or bilateral embolization, because occlusive disease in the hypogastric and ipsilateral profunda femoris arteries has been identified as a predictor of complications.\textsuperscript{5,10} Finally, flush occlusion of the hypogastric artery or embolization of only its proximal part (vs distal embolization) may confer an advantage in terms of the associated ischemic complications.\textsuperscript{10} These approaches are, however, usually not an option when the common iliac artery aneurysm extends to its bifurcation or there is a dilatation of the hypogastric artery, as noted in the Methods section.

The observations in the current study pose the difficult question about the optimal management of patients with aneurysmal involvement of the common iliac artery that extends to its bifurcation, particularly in those patients with bilateral involvement. Our current initial approach using larger diameter iliac limbs or aortic cuffs to seat the graft in the aneurysmal vessel still seems reasonable for patients with suitable anatomy, despite the concerns about long-term durability. The excellent outcomes associated with hypogastric bypass have lowered our threshold for the procedure (i.e., extended its indication) in properly selected patients. Indeed, the clinical decision for patients with unilateral common iliac artery aneurysms requiring direct repair is often whether to recommend hypogastric bypass or embolization with the ultimate decision based upon the individual patient preference. We counsel the patients extensively and outline the associated risks and benefits, although most patients that elect for EVAR (vs open repair) prefer a complete endovascular approach. In patients with large bilateral common iliac artery aneurysms that require direct repair, we have opted for embolization/bypass or open repair. The embolization/bypass approach facilitates EVAR and avoids bilateral hypogastric embolization (and the potential ischemic complications). However, the incidence of claudication ipsilateral to the embolization is sobering and the magnitude of the procedure significant; it is likely irrelevant from a patient perspective that the claudication is only unilateral. It is conceivable that the commercial availability of a bifurcated or branched iliac graft will make these debates irrelevant. The equivocal survival benefits of the Dutch Randomised Endovascular Aneurysm Management (DREAM)\textsuperscript{35} and EVAR\textsuperscript{36} trials comparing open and EVAR have further confounded this issue. Specifically, it is unclear how many additional procedures or modifications are indicated and justified to facilitate EVAR (and to avoid the patient’s fear of an open operation) given the lack of a survival benefit beyond 1 year. In light of these concerns, we do not believe that there is any role for bilateral hypogastric bypass and would simply favor open aneurysm repair.

Several technical points concerning the hypogastric bypass merit further comment. The procedure itself is challenging given the anatomic location of the hypogastric artery and further complicated in obese patients and those with very large common iliac artery aneurysms. The common trunk of the hypogastric artery is quite short, although there is usually sufficient length to apply a vascular clamp. The hypogastric artery and the proximal external iliac artery are often quite calcified, and indeed, this may preclude successful bypass. In contrast to most arterial bypasses, the distal anastomosis should be performed first. This simplifies the procedure/exposure given its deep anatomic location. The proximal anastomosis is performed to the underside of the external iliac artery, and this can be facilitated by externally rotating the vessel with the vascular clamps. Finally, marking the oversewn proximal hypogastric artery with a large hemostatic clip can help identify the proper landing site for the stent graft deployment.

The major limitation of the study is its retrospective design. Inherent in this approach is a significant selection bias that, unfortunately, limits the strength and applicability of the results. As noted in the Methods section, patients were selected to undergo hypogastric bypass based upon their ambulatory status, hypogastric circulation, comorbidities, and the presence of any factors that might complicate the bypass from a technical standpoint. The patients’ preferences and choices were also factored into the decision. The ultimate choice (i.e., clinical judgment of the attending surgeon) reflected the aggregate of these concerns, but patients were specifically selected to do well.

CONCLUSION

Patients with large common iliac artery aneurysms and patent hypogastric arteries can undergo EVAR with either hypogastric embolization or common iliac artery bifurcation advancement by hypogastric bypass. However, the ischemic complications associated with embolization are significant. Despite its increased complexity, hypogastric artery bypass is an excellent alternative to embolization in terms of patency and freedom from ischemic symptoms.

AUTHOR CONTRIBUTIONS

Conception and design: WAL, PRN, SAB, JMS, TSH
Analysis and interpretation: WAL, PRN, SAB, JMS, TSH
Data collection: WAL, PRN, TSH
Writing the article: WAL, TSH
Critical revision of the article: WAL, PRN, SAB, JMS, TSH
Final approval of the article: WAL, PRN, SAB, JMS, TSH
Statistical analysis: WAL, TSH
Obtained funding: Not applicable
Overall responsibility: TSH

REFERENCES


Submitted Jun 4, 2006; accepted Aug 17, 2006.

DISCUSSION

Dr David Calcagno (Camp Hill, PA). I had a question about your method of embolization. Were these coils placed into the distal hypogastric and its branches, or were you occluding these at the origin of the internal, such as is done with the Amplatzer Plug? We found that when we placed an Amplatzer Plug in the proximal internal iliac, thus preserving the distal collateral communication, that the occurrence of buttock claudication was less than when we placed conventional coils in the branches of the internal iliac.

Dr W. Anthony Lee. I am glad you asked that question, because that debate has been going on for some time. Whenever possible, we try to do a truncal embolization. We have not used the Amplatzer plug until very recently in our practice. And on occasion