Internal iliac artery revascularization as an adjunct to endovascular repair of aortoiliac aneurysms

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Purpose: Endovascular repair of aortoiliac aneurysms may be limited by extension of the aneurysm to the iliac bifurcation, necessitating endpoint implantation in the external iliac artery. In such cases the circulation to the internal iliac artery is interrupted. Bilateral internal iliac artery occlusion during endovascular repair may be associated with significant morbidity, including gluteal claudication, erectile dysfunction, and ischemia of the sigmoid colon and perineum. We have employed internal iliac artery revascularization (IIR) to allow endograft implantation in the external iliac artery while preserving flow to the internal iliac artery in patients with aneurysms involving the iliac bifurcation bilaterally.

Methods: A total of 11 IIR procedures were performed in 10 patients undergoing endovascular abdominal aortic aneurysm (AAA) repair (9 men, 1 woman; mean age, 74 years). IIR was accomplished via a retroinguinal incision in 9 cases and a retroperitoneal incision in 2 cases. Six-mm polyester grafts were used for external-to-internal iliac artery bypass in 10 cases and internal iliac artery transposition onto the external iliac artery was used in one case. Endovascular AAA repair was performed using a modular bifurcated device (Talent-LPS, Medtronics, Minneapolis, Minn) after IIR. Bypass graft patency was determined immediately after the surgery, at 1 month, and every 3 months thereafter, using duplex ultrasound scanning and computed-tomography angiography. Mean aneurysm diameters were as follows: AAA, 6.4 ± 0.7 cm; ipsilateral common iliac, 3.7 ± 1.0 cm; contralateral common iliac, 3.9 ± 0.8 cm.

Results: Successful IIR and endovascular AAA repair were accomplished in all cases. No proximal, distal, or graft junction endoleaks occurred. Two patients demonstrated retrograde aneurysm side-branch endoleaks originating from the lumbar arteries. One thrombosed spontaneously within 3 months. One perioperative myocardial infarction occurred. Reduction in aneurysm size was documented in 5 aortic, 5 ipsilateral iliac, and 3 contralateral iliac aneurysms. Gluteal claudication, erectile dysfunction, colon and perineal ischemia, and mortality did not occur. All IIRs have remained patent during a follow-up period of 4 to 15 months (mean, 10.1 months).

Conclusions: IIR may be used with good short-term to intermediate-term patency to prevent pelvic ischemia in patients whose aneurysm anatomy requires extension of the endograft into the external iliac artery. This may allow endovascular AAA repair to be performed in patients who might otherwise be at risk for developing complications associated with bilateral internal iliac artery occlusion. (J Vasc Surg 2001;34:892-9.)

Endovascular treatment of arterial aneurismal disease has gained increasingly widespread application. The experience gained with the increased use of endovascular techniques for abdominal aortic aneurysm (AAA) repair has demonstrated it to be a safe treatment in properly selected patients. Endovascular AAA repair has also proven to be effective in preventing aneurysm expansion and rupture. Successful endovascular treatment of AAAs requires that areas of undilated artery that are relatively free of disease be present proximal and distal to the aneurysm. These undiseased arterial sites are required for the fixation of the endovascular prosthesis to the arterial wall. Tight apposition and fixation is necessary to achieve exclusion of the aneurysm from the arterial circulation.

Aneurysm confirmation rarely permits the use of the distal aorta for implantation of an endograft. The use of a bifurcated prosthesis is required when an aortic aneurysm extends to the aortic bifurcation. Bifurcated endovascular grafts are employed in nearly 90% of AAAs currently treated by using endovascular techniques. Extension of the aneurysm to the bifurcation of the common iliac artery necessitates deployment of the distal aspect of the endovascular graft in the external iliac artery. This in turn results in interruption of arterial flow to the ipsilateral internal iliac artery. In addition, when the internal iliac artery exhibits significant aneurismal dilatation, perfusion must be arrested to prevent rupture.

The effects of internal iliac artery occlusion vary greatly in their severity and are dependent on the circumstances in which occlusion occurs. These effects range from asymptomatic occlusion to the development of significant pelvic and spinal ischemia. Complications resulting from unilateral internal iliac artery occlusion associated with endovascular aneurysm repair have been observed in 12% to 45% of cases. Bilateral internal iliac artery occlusion may be a relatively innocuous event.
with limited sequelae. However, the occlusion of both internal iliac arteries appears to be associated with a greater likelihood of development of an ischemic complication. The purpose of this study was to determine the feasibility of internal iliac artery revascularization (IIR) to preserve the pelvic arterial circulation during endovascular repair of aortoiliac aneurysms and to assess the effectiveness of revascularization in preventing the development of ischemic complications.

PATIENTS AND METHODS

Patient demographics and database. A consecutive series of 437 patients whose AAA were treated with endovascular grafts between December 1996 and February 2001 was studied. All data regarding each patient, procedure, and follow-up were entered prospectively in a vascular registry. During this time, 10 patients with aortoiliac aneurysms extending to the level of the common iliac artery bifurcation bilaterally whose arterial anatomy was suitable for IIR were identified. In these patients, extension of the endovascular prosthesis across the origin of both internal iliac arteries was required. IIR was performed in each of these patients (11 total procedures). During this period, two additional patients required extension of the endovascular graft to the external iliac artery; however, severe atherosclerotic occlusive disease precluded revascularization in these patients. All procedures were performed under protocol approved by the Institutional Review Board of the Mount Sinai School of Medicine and approved for an Investigational Device Exemption by the Food and Drug Administration. All patients had extensive concomitant medical conditions that rendered standard open surgical repair high risk (average, 5.2 comorbid conditions/patient). The average age was 74 years. Nine patients were male and one was female; 9 had symptomatic coronary artery disease; 5 had chronic obstructive pulmonary disease impairing baseline pulmonary function; 7 were hypertensive; 2 had diabetes mellitus; and 4 suffered from congestive heart failure with an ejection fraction less than 30%.

Preoperative management. Preoperative assessment included standard contrast arteriography and helical computed tomography (CT) scan with intravenous contrast and images acquired at 3-mm intervals. These studies were used to determine suitability for endovascular repair and to prepare the specifications of the endovascular graft. Maximum aortic diameter ranged from 5.8 to 7.8 cm (mean, 6.4 ± 0.7 cm). Maximum common iliac artery
diameter on the side of IIR ranged from 2.4 to 5.3 cm (mean, 3.7 ± 1.0 cm). Embolization of the internal iliac artery contralateral to the planned IIR was performed 3 to 5 weeks preoperatively using Gianturco embolization coils (5 mm × 5 cm, 15 mm × 15 cm) (Cook, Inc, Bloomington, Ind). The maximum diameter of the common iliac artery aneurysm on the side of internal iliac artery embolization was 3.9 ± 0.8 cm (range, 2.0-5.0 cm).

**Internal iliac artery revascularization.** During surgery the IIR procedure was performed first to allow deployment to the distal aspect of the endovascular graft in the external iliac artery without interrupting perfusion to the pelvic circulation (Fig 1). IIR was followed by endovascular repair of the aortoiliac aneurysm performed at the same operative setting. Two exposures, retroinguinal (9 procedures) and retroperitoneal (2 procedures), were used to achieve IIR. The retroinguinal approach was used preferentially. The retroperitoneal approach was used when the patient’s body habitus precluded adequate exposure through the retroinguinal incision. Selection of which internal iliac artery to use for revascularization was based on the absence of occlusive or aneurismal disease involvement. If both internal iliac arteries appeared adequate for revascularization, the left artery was used in an effort to maximize collateral flow to the left colon. All revascularization procedures were performed in the operating room under epidural anesthesia.

**Description of surgical procedure for retroinguinal exposure.** A transverse incision is created in the skin at the level of the inguinal ligament.23 The inguinal ligament is dissected and mobilized along its entire length to provide adequate access to the retroperitoneum. The inguinal ligament is then elevated using a mechanical self-retaining retractor (Omni-tract, Minnesota Scientific, Inc, Minneapolis, Minn) (Fig 2). The common femoral artery is identified as it passes under the inguinal ligament, and dissection is carried out proximally to isolate and control the external iliac artery in the retroperitoneum. The level of the iliac bifurcation is identified and the internal iliac artery is isolated and controlled 3 to 6 cm from its origin with careful preservation of the distal branches. The anastomosis to the internal iliac artery is created first by using a 6-mm polyester graft (Hemashield, Boston Scientific Corp, Natick, Mass). The graft is then anastomosed to the external iliac artery, and the internal iliac artery is ligated proximally at its origin to prevent retrograde perfusion of the aneurysm sac after endovascular graft deployment. Alternatively, the internal iliac artery may be transected at its origin and translocated onto a medial arteriotomy in the external iliac artery with a direct anastomosis being performed in an end-to-side fashion. Metallic hemoclips are then placed at the level of the external iliac artery anastomosis to aid in its identification during the endovascular procedure. Endovascular aneurysm repair is then carried out by using a distinct arteriotomy site in the common femoral artery for arterial access.

**Endovascular aortoiliac aneurysm repair.** Endovascular aneurysm repair was performed in the operating room under fluoroscopic guidance. Epidural anesthesia was used for all operative procedures. Aortoiliac aneurysm exclusion was performed using the bifurcated Talent-LPS endovascular grafting system (Medtronic, Minneapolis, Minn) in all 10 cases. The endovascular device was deployed via access in the common femoral artery. Transrenal positioning of the proximal uncovered stent of the aortic graft was performed in all cases. Distal implantation of the iliac limbs was performed in the external iliac artery in all cases; extension iliac endoprostheses were required in two cases.

**Postoperative surveillance.** Flexible sigmoidoscopy was performed on the first postoperative day to assess the viability of the mucosa of the descending and sigmoid colon. Duplex ultrasound scanning was performed to assess IIR patency immediately after the surgery and at 1 month, 3 months, 6 months, and 12 months postoperatively and annually thereafter. CT was performed with intravenous contrast to assess adequacy of the endovascular repair within 1 month of surgery and then at 3 months, 6 months, 12 months, and annually thereafter with aneurysm-size determination performed by using video image analysis. Selective arteriography was also performed if abnormalities were identified by duplex scan or CT. 

**Statistical analysis.** All figures are represented as the mean ± standard deviation. Continuous variables were compared with a Student t test. Significance was assumed at P < .05.

**RESULTS**

**Pelvic arterial circulation.** IIR was successfully accomplished in all cases. Unilateral revascularization was performed in nine patients and bilateral revascularization in one (Fig 3). Follow-up ranged from 4 to 15 months (mean, 10.1 months). All grafts remained patent throughout the follow-up period without need for intervention. On postoperative flexible sigmoidoscopy, the colonic mucosa appeared normal and well-perfused in all patients. There were no symptoms of colonic claudication. A history of sexual function was obtained in eight patients. Seven patients experienced no change in sexual function and one patient noted improved ability to maintain penile erection of greater duration. There were no other symptoms of internal iliac artery ischemia, including no neurologic deficits and no pelvic ischemia or gangrene.

**Aneurysm repair.** All endovascular grafts were successfully deployed with transrenal fixation and distal implantation in the external iliac artery in each of the 10 patients. No attachment-site endoleaks (type I) or endograft junctional endoleaks (type III) occurred (Fig 4). Two patients had retrograde perfusion of the aneurysm sac through patent lumbar or iliolumbar vessels (type II). One of these endoleaks thrombosed spontaneously within 3 months. The other endoleak remained patent on CT scan performed 6 months after surgery. The vessel of origin of the endoleak was the right L4 lumbar artery, as confirmed by arteriography. AAA diameter has decreased from 6.6 to 6.3 cm despite persistence of the retrograde
Fig 3. Digital subtraction arteriogram of aortoiliac aneurysm. A, The patient experienced a previous dissection of the aorta extending from the aortic valve to the iliac bifurcation and underwent replacement of the entire thoracic aorta. Subsequent aneurismal degeneration of the infrarenal aorta occurred and endovascular repair with bilateral IIR was planned. B, Revascularization of the left internal iliac artery (I) was performed using a 6-mm polyester graft (arrow) from the external iliac artery (E). C, Transposition of the internal iliac artery (I) onto the external iliac artery (E) was able to be performed on the right.

Preoperative and postoperative aneurysm size for patients followed for ≥6 months (N=7)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P value</th>
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<tbody>
<tr>
<td>AAA diameter*</td>
<td>6.12 ± 0.33 cm</td>
<td>5.52 ± 0.59</td>
<td>.015</td>
</tr>
<tr>
<td>Ipsilateral CIA diameter†</td>
<td>3.83 ± 1.15 cm</td>
<td>3.42 ± 0.79</td>
<td>.046</td>
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<tr>
<td>Contralateral CIA diameter‡</td>
<td>3.88 ± 0.82 cm</td>
<td>3.20 ± 1.13</td>
<td>NS</td>
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*Maximum aortic diameter.
†Maximum diameter of common iliac artery ipsilateral to IIR.
‡Maximum diameter of common iliac artery contralateral to IIR.
CIA, Common iliac artery.
Mass), and flow was reestablished to the right lower extremity. No spinal cord ischemia or neurologic events occurred in this study. Postoperative sigmoidoscopy verified that no colonic ischemia was present. No patient died, and no aneurysm rupture occurred in the perioperative period or in subsequent follow-up.

DISCUSSION

A greater range of aortoiliac aneurysm anatomic configurations is currently being treated using endovascular techniques. Endovascular treatment of iliac artery aneurysms that extend to the level of the iliac bifurcation has resulted in the interruption of antegrade arterial perfusion to the internal iliac artery. The effect of sacrifice of the internal iliac artery in the setting of endovascular aneurysm repair has been characterized by several investigators.19-23 When internal iliac artery embolization is performed unilaterally, the most frequent complication is the development of claudication of the gluteal musculature. Frequently, this claudication is self-limited, resolving spontaneously within 6 months. More significant adverse results of unilateral internal iliac artery occlusion occur more rarely. However, colonic ischemia, impotence, and minor neurologic deficits of the lower extremity have all been reported.19,21 The development of these significant complications may be associated with other confounding factors, such as profound hypotension or evidence of embolization.16,18,25,26 Because these complications appear to be multifactorial, the contribution of the interruption of only one internal iliac artery is difficult to distinguish.

The results of several series indicate that interruption of the circulation to both internal iliac arteries is more likely to result in significant morbidity than is unilateral interruption. The incidence of gluteal claudication appears to be increased.20,22 When symptoms occur, they are frequently more severe with greater limitation of walking being more commonly observed.22,23 The incidence of bilateral gluteal claudication is also increased, as would be expected.23 Symptoms of sexual dysfunction, particularly the new development of impotence in male patients, is also reported to occur more commonly in patients with bilateral internal iliac artery interruption.19,20 In addition, some reports suggest that the incidence of colonic ischemia may also be increased.21 However, it should be noted that other reports have highlighted a more innocuous outcome of bilateral internal iliac artery occlusion and have not demonstrated an increase in ischemic complications as compared with unilateral occlusion.19

These observations have led investigators to advocate preservation of antegrade perfusion of at least one internal iliac artery during endovascular aortoiliac aneurysm repair.21,22 Direct revascularization of the internal iliac artery during aortic surgery has been examined extensively before the advent of endovascular treatments. In several large series and in prospective trials, revascularization of the internal iliac artery was associated with a reduced incidence of neurologic complications and colonic ischemia.27,28 A procedure for IIR performed in conjunction with endovas-

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Fig 4. CT angiogram of aortoiliac aneurysm treated by using an endovascular graft in conjunction with right IIR. A, Arterial flow is seen within the bypass graft (arrow). The bypass graft originates from the external iliac artery (E). B, The internal iliac artery anastomosis (I) and perfusion of the pelvic branches (arrow) are seen.
Aortic aneurysm size remained unchanged in the other 7 patients who were followed for at least 6 months. Treating the aortic or iliac aneurysmal disease. Following decrease the effectiveness of the endovascular procedure in conjunction with contralateral internal iliac embolization in 9 patients. Embolization proceeded surgery by 3 to 5 weeks in all cases to allow development of collateral vessels within the pelvic circulation. The selection of which internal iliac artery on which to perform revascularization was based on previously established criteria indicating maximal pelvic perfusion. Additional consideration was given to the technical suitability of the internal iliac vessel for bypass, particularly the absence of aneurismal involvement or significant atherosclerotic occlusive lesions.

One patient underwent bilateral IIR. That patient had experienced previous aortic dissection that had involved the entire aorta from the aortic root to the iliac bifurcation bilaterally. Subsequent aneurismal deterioration of the aorta had necessitated replacement of the ascending, transverse, and descending thoracic aortic segments. As a result, collateral perfusion to the spinal cord was impaired. When replacement of the infrarenal aorta and iliac arteries with the attendant loss of the lumbar perfusion to the spinal cord became necessary, both internal iliac arteries were preserved in an attempt to maximize collateral spinal cord perfusion. In addition, this patient received cerebrospinal fluid drainage to maintain an intrathecal pressure ≤10 mm Hg during surgery and in the immediate postoperative period. Endovascular repair was successful in excluding the aortoiliac aneurysm, and the patient experienced no neurologic sequelae or other complications.

Both the standard retroperitoneal and a modified retroinguinal approach were used to expose the iliac vessels for revascularization. Currently, the retroinguinal approach is used preferentially. This approach involves significantly less dissection with reduced trauma to the abdominal wall musculature and less postoperative patient discomfort. The only significant complication, a clinically silent myocardial infarction, occurred in a patient treated with the retroperitoneal approach. In patients with extensive comorbid medical illnesses, such as those described in this study, the retroinguinal approach may be expected to result in less morbidity while being equally efficacious in preserving pelvic perfusion and preventing ischemic complications.

Revascularization of the internal iliac artery did not decrease the effectiveness of the endovascular procedure in treating the aortic or iliac aneurysmal disease. Following endovascular repair, aortic aneurysm size decreased in 5 of the 7 patients who were followed for at least 6 months. Aortic aneurysm size remained unchanged in the other two patients. Common iliac aneurysm size also either remained stable or decreased during the follow-up period in these patients. Although the average diameter reduction was small, 0.6 cm in aortic aneurysms and 0.4 cm in iliac artery aneurysms, it is nevertheless suggestive of effective elimination of pressure from the aneurysm sac and protection against aneurysm rupture.

In conclusion, during the treatment of aortoiliac aneurysms that involve the iliac bifurcation, interruption of the internal iliac artery circulation may be associated with the development of significant ischemic complications. Although these ischemic complications may result from several factors, the absence of antegrade arterial flow in the internal iliac artery is likely to contribute significantly. Revascularization of the internal iliac artery and the resultant preservation of pelvic perfusion appear to be an effective means of preventing pelvic ischemia in these patients. Further follow-up of these patients will be necessary to determine the long-term effectiveness of this procedure.

We gratefully acknowledge the efforts of Joseph Samet, medical photographer, in the preparation of the figures for the manuscript.

REFERENCES


**DISCUSSION**

Dr Kim J. Hodgson (Springfield, Ill). I would like to congratulate Dr Faries and the Sinai group on another excellent presentation of their work. I have several questions for you.

Clearly you have demonstrated the feasibility of maintaining antegrade hypogastric artery flow, at least unilaterally, in patients in whom you are performing aortoendografting. It still is a question in my mind, however, whether or not this is absolutely necessary in all patients. In our experience, even unilateral hypogastric embolization, which was performed in all but one of your patients, leads predictably to better outcomes. In these patients, the most common form of pelvic ischemia that we see. The question is, in your patients who were getting these unilaterally hypogastric embolizations, do you think that they really fared any better than if they had undergone bilateral hypogastric loss, since unilateral buttck claudication alone is the likely limiting factor in their ambulatory distance?

Second, I would ask you, in your manuscript you refer to the iliac artery aneurysm sizes on the side that was embolized ranging anywhere from 2 to 1 believe somewhere around 5 cm in diameter. Iliac arteries in the 2-cm range are of the size that we majority were at least 3 cm in diameter, and I think that is major disease in that internal iliac artery circulation would also preclude its use for bypass grafting. If all factors are absolutely equal, consideration may be given to the revascularization on the better, we can only compare them to the published literature and our historical controls. In your own published series, the incidence of significant colon ischemia was significantly increased in patients who had bilateral occlusion of the internal iliac arteries. There is other evidence in the literature that suggests bilateral occlusion is of greater consequence than unilateral occlusion particularly with regard to the severity of buttck claudication and the incidence of more severe complications, though certainly unilateral occlusion is not optimal. Our patients who underwent internal iliac bypass fared better compared to those patients in whom we had performed bilateral embolizations, particularly with regard to bilateral buttck claudication. We saw no patients who developed that in this study, and buttck claudication in those who have undergone unilateral embolization seems to be more limited in terms of its duration. In addition, they did fare better than those reported in the literature who have had bilateral embolizations.

In terms of the size of iliac aneurysms treated, there was one patient whose maximum common iliac diameter was 2 cm. The majority were at least 3 cm in diameter, and I think that is reflected by the average size, which is well over 3 cm in those patients. I think at 2 cm you certainly could consider using a bell-bottomed graft. We have done that in patients of that size. I think 2 cm is probably a reasonable threshold for considering embolization or revascularization and extension of the graft into the external iliac artery.

In terms of the decision as to which side to embolize and which side to bypass, it is really determined based on predominantly anatomic considerations. If there is aneurysmal involvement of the internal iliac artery that would preclude its use as a bypass graft, certainly this would favor the selection of the opposite side. Other anatomic considerations such as significant occlusive disease in that internal iliac artery circulation would also preclude its use for bypass grafting. If all factors are absolutely equal, consideration may be given to the revascularization on the
left side as was pointed out by Dr Parodi in his initial description of this procedure, since the collateralization into the inferior mesenteric artery seems to be greater from the left internal iliac.

**Dr Peter Gloviczki** (Rochester, Minn). I enjoyed your paper very much, too. My question concerns the approach to the internal iliac artery. You mentioned that in two cases you went through transmuscular higher approach and in the remaining you went through the groin. I am wondering, which is the one that you recommend at this point, and was maybe the lower approach responsible for the high incidence of retrograde thigh hematomas where you did not have a good visualization, and maybe that is why you had more problems. Did you have any long-term consequences of dividing the inguinal ligament?

**Dr Faries.** In fact, the inguinal ligament is not divided but it is retracted intact to allow posterior exposure of the retroperitoneal space, so there were no adverse consequences in that regard.

The hematoma formation seems to be fairly evenly distributed regardless of approach. I think it is really more a reflection of surgical procedure in that region. I think if you were to perform CT scans on every kidney transplant that was performed using the same dissection and approach, you might find a similar incidence of asymptomatic hematoma.

Currently, in terms of the approach that we favor, we have moved predominantly to the retroinguinal approach. This seems to involve less patient morbidity. There is no muscle splitting in the incision. The patients seem to tolerate this better. They are able to walk and be more mobile at an earlier time point postoperatively. The one patient who did experience a myocardial infarction had a retroperitoneal approach. Of course, there were significant comorbid illnesses in that patient; nevertheless, the additional stress and discomfort of that muscle splitting incision may have contributed to the myocardial infarction. For that reason, we have favored the retroinguinal approach. I think these factors have all led us to consider that as our principle or primary approach.

**Dr Alan Dardik** (Baltimore, Md). Just to follow up on that last point that you mentioned, are these incisions that you use for this bypass the same as one would need to pass the endovascular device? If it is not, how do you explain these incisions to the patients that we are hoping to avoid additional incisions in surgery?

**Dr Faries.** The device deployment is carried out through these incisions either retroperitoneal or retroinguinal. It is more difficult technically to deliver the device through that retroperitoneal exposure, but still quite feasible. Since these approaches are planned preoperatively it is explained to the patient what will be taking place and even though retroperitoneal incision is more extensive than an inguinal incision, it still seems to be associated with less morbidity than standard operative repair of abdominal aortic aneurysm.

**Dr Frank Criado** (Baltimore, Md). I congratulate you on a good paper as well. I think it is important to document the fact that bilateral interruption can be performed safely. This was presented at this society recently. We have done bilateral hypogastric embolization in twice as many patients, always staged, so these patients end up with three procedures, and we have not had any serious ischemic complications. Furthermore, we have found that buttock claudication is the same whether it is unilateral or bilateral, but your statement is true: the claudication in the bilateral patients tends to be more severe and longer lasting. I would like to hear your comments about that.

**Dr Faries.** I appreciate your thoughts on that matter. It is clear that there is some variance in the literature as far as the development of ischemic complications with regard to unilateral and bilateral embolizations. Clearly, there are patients who will tolerate bilateral embolization. This may be in some way related to more adequate collateral circulation from circumflex iliac vessels and other deep femoral collateral branches. I think further study in this area will be important in delineating which patients can tolerate embolization more readily from those who might be more likely to require a revascularization procedure.

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