Intentional internal iliac artery occlusion to facilitate endovascular repair of aortoiliac aneurysms

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Purpose: The safety of intentional occlusion of patent internal iliac arteries (IIAs) to facilitate the endovascular repair of aortoiliac artery aneurysms (abdominal aortic aneurysms [AAAs] and iliac aneurysms [IAs]) was evaluated.

Methods: We analyzed the techniques and clinical sequelae of selective occlusion of one or both IIAs in 103 patients and correlated these findings with the results of preoperative angiograms to identify vascular anatomy that may predict postoperative pelvic ischemia. To quantify the clinical presentation of pelvic ischemia, we developed these criteria: class 0, no symptoms; class I, nonlimiting claudication with exercise; class II, new onset impotence, with or without moderate to severe buttock pain, leading to physical limitation with exercise; class III, buttock rest pain, colonic ischemia, or both. IIA occlusion was achieved in 100% of the patients by means of either catheter-directed embolization or orifical coverage with a stent-graft. No patient in this study had angiographic evidence of significant visceral occlusive disease before the procedure. Sixty-four patients had isolated AAAs, 23 patients had AAAs and IAs, and 16 patients had isolated IAs. Ninety-two patients had one IIA selectively occluded, and 11 patients had both IIAs selectively occluded.

Results: After IIA occlusion, 12 patients were categorized in class I, 9 patients were categorized in class II, and 1 patient was categorized in class III, for a total of 22 patients (21%) with pelvic ischemia. Sixteen (17%) of 92 patients had unilateral IIA occlusions, and six (17%) of 11 patients had bilateral IIA occlusions. Five patients in class I improved and had no symptoms within 1 year, and one patient in class II was downgraded to class I because of improved symptoms. Two unique preoperative angiographic findings were identified in the remaining 16 patients (16%) with chronic pelvic claudication: (1) stenosis of the remaining IIA origin (> 70%) with nonopacification of more than three of the six IIA branches (63%); and (2) small caliber, diseased or absent medial and lateral femoral circumflex arteries ipsilateral to the side of the IIA occlusion (25%). One patient with class III ischemia died of cardiovascular collapse associated with colon infarction caused by either acute ischemia or particulate embolization.

Conclusion: The incidence of pelvic ischemia after IIA occlusion is 20% immediately after endovascular aortoiliac aneurysm repair. A total of 25% of patients had no symptoms within 1 year. Two preoperative radiologic findings may help identify patients who are at risk for pelvic ischemia: stenosis of the patent IIA and disease deep femoral ascending branches ipsilateral to the occluded IIA. The risk of colon ischemia appears to be small after selective IIA occlusion to facilitate endovascular AAA repair. (J Vasc Surg 2001;34:204-11.)

In 1991, Parodi1 reported the first endovascular abdominal aortic aneurysm (AAA) repair, igniting interest in the development of devices and techniques for less-invasive vascular therapy. Although the minimally invasive aspects of this technique are appealing, it was recognized early that the coexistence of a common iliac artery aneurysm would be a major limitation to accomplishing full exclusion of the aneurysm with the stent-graft. Two main adjunctive techniques deal with the internal iliac artery (IIA) when a common iliac artery aneurysm is present to circumvent this problem. Subsequently, Parodi2 described direct revascularization of the IIAs, followed by proximal ligation and transection of the vessel (Fig 1, A) to lengthen the distal anchoring site to a more distant site (external iliac artery). The second alternative is to simply occlude the IIA with catheter-based technology (Fig 1, B). The opponents of this approach to endovascular management of common iliac aneurysms argue that there may be major undesired consequences related to the occlusion of one or both patent IIAs after AAA repair, including colonic and pelvic ischemia.

In this study we analyzed the preoperative pelvic angiographic anatomy in patients who required IIA embolization and correlates specific vascular patterns with postoperative clinical outcome related to pelvic ischemia.

METHODS

Study design and therapeutic interventions. For 5 years, we analyzed the clinical sequelae of pelvic ischemia...
in 103 patients who had selective occlusion of one or both of their IIAs to ensure complete endovascular exclusion of aortoiliac aneurysms and correlated these findings with the results of preoperative pelvic angiograms. The patient population represented in this study is approximately 26% of the total endovascular aortic volume from this institution. Patient demographics, distribution of aneurysmal disease, and interventions are shown in Table I. All patients underwent preoperative aortography that included pelvic runoff. None of the patients in this study had preoperative angiographic evidence of significant visceral arterial occlusive disease, which was defined by the presence of a lesion of < 50% stenosis. Completion angiography in two planes was performed after each endovascular procedure. Patient follow-up included physical examination, duplex ultrasonography (3, 6, and 12 months, then annually), and spiral computed tomography scanning (3, 6, and 12 months, then annually). Supplemental angiography was performed in 28% of patients as a means of investigating endoleaks or evaluating chronic lower extremity or pelvic ischemia. The mean follow-up period was 21 months (range, 6-61 months). Four different types of endovascular aortic endografts were used as a means of treating the patients in this study (Table II). Device selection for a particular patient was made on the basis of aneurysmal morphology and the presence of severe medical comorbidities, in accordance with individual study protocols.

Methods of IIA occlusion. IIA occlusion was performed, at least 3 weeks before endovascular aneurysm repair, predominantly by means of selective catheter-directed coil embolization (Fig 2, A). Other occlusion devices (detachable balloons and “spider” thrombosis device) and direct orificial coverage of the vessel with an endovascular graft were used in a minority of patients \((n = 3)\). Three occlusion devices were used to accomplish IIA thrombosis and are illustrated in Fig 2. Most selective embolization procedures were performed in the radiology suite. A contralateral approach to the IIA was used in 62 patients (61%), whereas the ipsilateral approach was chosen in 33 patients (32%).

Stainless steel Gianturco coils with adherent fibers of polyester material, which ranged in size from 5 to 10 mm by 5 to 10 cm were used (Fig 2, A; Cook, Bloomington, Ind). An average of three to five coils were used to achieve angiographic thrombosis of the vessel. For large diameter

Fig 1. A, Direct revascularization of IIA. B, Sacrifice of IIA by embolization. Both methods allow a more distal deployment of stent-graft, with complete aneurysm exclusion from circulation.
Table I. Disease distribution and demographics

<table>
<thead>
<tr>
<th>No*</th>
<th>Age (y)</th>
<th>Primary disease and no. of patients</th>
<th>Iliac artery occlusion‡</th>
<th>AAA 0‡</th>
<th>RIA 0‡</th>
<th>LIA 0‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>103</td>
<td>76 ± 7</td>
<td>AAA 64 IAA 23 AAA and IAA 16</td>
<td>Unilateral 92</td>
<td>6.6 ± 0.9</td>
<td>4.8 ± 1.1</td>
<td>4.9 ± 1.6</td>
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</table>

Averaged data are expressed by their mean ± SD.
*Total number of patients with intentional internal iliac occlusion
†Number of IIAs occluded.
‡Transverse diameter expressed in centimeters by its mean and SD. AAA, Abdominal aortic aneurysm; IAA, internal iliac artery; LIA, left iliac artery; RIA, right iliac artery aneurysm.

Table II. Type of devices

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
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<tbody>
<tr>
<td>Aortouniiliac-femoral*†</td>
<td>76</td>
</tr>
<tr>
<td>Common iliac-external iliac*</td>
<td>17</td>
</tr>
<tr>
<td>Common iliac-femoral</td>
<td>1</td>
</tr>
<tr>
<td>Multimodular bifurcated‡</td>
<td>9</td>
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</table>

*Parodi custom-designed devices that have been described elsewhere.5
†Talent stent-graft.
‡Vanguard stent-graft (Boston Scientific, Natick, Mass) and Talent stent-graft (World Medical, Fort Lauderdale, Fla).

IIAs, an Amplatz vascular obstructing device or spider, 13 mm in diameter (Cook) and made of stainless steel, was used (Fig 2, B). This device typically required supplemental embolic coils, which were anchored to the spider to achieve vessel thrombosis. For ectatic IIAs, a detachable occlusion balloon made of a semipermeable membrane was delivered at the tip of a catheter that was used to inflate the balloon to an appropriate diameter within the vessel (Fig 2, C). The semipermeable nature of the device membrane, which is freely permeable to water, provides an unique property for achieving different balloon volumes and diameters by varying the osmolarity of the liquid used to inflate the balloon. If the liquid within the balloon is hyperosmolar, subsequent device distension should be predicted. Finally, IIA occlusion was achieved in a limited number of patients by deploying a stent-graft across the origin of the IIA, terminating the end of the graft in the external iliac artery (Fig 2, D). The unintentional coverage of the IIA origin was primarily caused by the usage of an oversized iliac limb graft in three patients.

Pelvic ischemia grading system. These criteria were used to quantify the clinical severity of pelvic ischemia after IIA occlusion: class 0, no symptoms; class I, nonlimiting claudication with exercise; class II, new onset impotence or moderate-to-severe buttock pain, leading to physical limitations with exercise; class III, buttock rest pain with or without skin necrosis and/or colonic ischemia.

Description of the pelvic anatomy. Each preprocedure and postprocedure arteriogram was analyzed for the presence of as many as nine discrete arterial collateral branches associated with the IIAs (Fig 3): (1) the lower lumbar branches, which collateralize through to the iliolumbar artery; (2) the inferior mesenteric artery anastomosing to the superior hemorrhoidal artery; (3) the middle sacral arteries coming from and leading to the lateral sacral branches; (4) the superior hemorrhoidal artery coming from and leading to the middle hemorrhoidal artery; (5) the superior gluteal artery to the lateral femoral circumflex artery; (6) the deep and superficial circumflex iliac arteries coming from and leading to the external iliac artery; (7) the obturator artery to the inferior epigastric artery; (8) the internal pudendal artery coming from and leading to the inferior rectal artery, which anastomoses with the deep femoral artery (medial femoral circumflex artery); and (9) the central anatomic system, which corresponds to the numerous collaterals between the sacral branches (superior, middle, and inferior sacral branches, middle rectal, inferior vesicle, ovarian and uterine arteries).

For the purpose of analysis, we divided the pelvic circulation in two sides. The IIA to be occluded was termed ipsilateral. Conversely, the IIA supplying the pelvic circulation was defined as the contralateral IIA, as contralateral to the occluded side. In addition, to document the presence of occlusive disease, we denominated each pelvic vessel caliber as normal caliber or ectatic vessels. Also, pelvic branches that crossed the pelvic midline to the contralateral pelvis were recorded from each angiogram studied.

Statistical methods. Two-tailed analysis of variance (ANOVA) with the Bonferroni method was used as a means of comparing subjects treated with different devices.

RESULTS

A total of 103 patients underwent selective IIA occlusion in this study, 22 (21%) of whom had symptoms of pelvic ischemia (15 with unilateral pelvic symptoms, 6 with bilateral symptoms, and 1 with evidence of colon ischemia). Five patients in class I with minimal clinical symptoms (23%) improved and had no symptoms within 1 year, and one patient from class II (5%) was downgraded to class I when symptoms improved. Table III summarizes the clinical outcome within 30 days of the procedure and at 1 year.

Each endovascular graft and technique for reconstruction of the aorta was analyzed in an attempt to identify whether a specific device had a greater predilection to cause pelvic ischemia than others (Table IV). Although, the aortouniiliac-femoral device appeared to produce an
increase in the incidence of pelvic ischemia, this was not statistically significant ($P = .43$ with ANOVA).

An analysis of the preoperative angiograms of the 22 patients in whom clinical symptoms of pelvic ischemia developed after IIA occlusion and aortic endografting revealed two consistent radiographic findings in 16 patients: (1) preoperative angiographic evidence of chronic pelvic ischemia manifested by the proximal stenosis of the remaining IIA origin and/or nonopacification of three or more named IIA branches and preoperative evidence of arterial collaterals (63%; Fig 4); and (2) small caliber, diseased, or absent medial and lateral femoral circumflex arteries (ascending deep femoral branches) ipsilateral to the side of the IIA occlusion (25%) (Fig 5). None of the six patients who temporarily experienced complaints of pelvic ischemia but went on to have complete resolution of their symptoms during a 1-year follow-up period had the two radiologic findings described.

One patient with class III ischemia had the right internal IIA successfully embolized 3 weeks before the defini-

![Fig 2. Various devices used as means of occluding IIA (upper row) accompanied by their angiograms (lower row). A, Coil embolization by means of Gianturco stainless steel stents. Completion angiogram showing thrombosis of the IIA. B, Amplatz vascular obstructing device (Spider) used as anchor to coil embolization stents, accompanied by angiogram. C, Detachable balloon occluder and its angiographic appearance. D, Iliac limb stent-graft deployed over origin of the IIA.](image)
tive aneurysm repair and had no complaints. During the operation, cardiovascular instability with low cardiac output developed in this patient. The subsequent postoperative period was complicated by circulatory collapse associated with colon ischemia. Like the other patients in this study, this patient had a normal superior mesenteric artery and celiac trunk, an occluded inferior mesenteric artery at its origin, and a large arcade of Riolan that was patent to the left colon, as revealed by means of the preoperative angiogram. This patient died of multisystem organ failure 5 weeks after the aforementioned event.

**DISCUSSION**

Many published reports describe the normal arterial circulation in the pelvis. Since the 1960s, intentional ligation of the IIA to reduce pelvic circulation and thereby minimize blood loss during gynecological procedures has been performed in young women with pelvic pathology.\(^\text{3}\) These maneuvers were often lifesaving in the management of uncontrollable hemorrhage from pelvic arterial collaterals. One series reported on more than 200 patients treated by means of IIA ligation, with no apparent short- or long-term sequelae of pelvic ischemia. Many of these interventions were performed to assist in the resection of neoplastic masses, and because of the nature of the underlying disease, extended follow-up was not reported.

Most pelvic end organs are spared the effects of atherosclerosis and ischemia and additionally have abundant arterial collaterals. Thus, clinical interest in the pelvic circulation has been minimal compared with that of other vascular beds. However, recent developments in endovascular surgery of aortic and iliac aneurysms, have created a need to exclude one or both IIAs to achieve aneurysm exclusion, thereby increasing concern for pelvic ischemia. Parodi,\(^\text{4}\) May,\(^\text{5}\) and Marin\(^\text{6}\) initially described the clinical feasibility of repairing complex multisegmental aortoiliac aneurysms with the aortouniiliac-femoral stent-graft. The emphasis of these preliminary reports was focused on the versatility and simplicity of the device in excluding complex aortoiliac aneurysms with the use of
only one device. In the initial studies, the adverse effect on the pelvic circulation when one or both of the IIAs were sacrificed appeared to be minimal. Data from conventional open operations, which preceded the advent of endovascular techniques, corroborate this by also revealing a low incidence of pelvic ischemia after aortoiliac reconstructions for aneurysmal and occlusive disease.7,8

Furthermore, there are other data from kidney transplant patients and IIA harvest for aortorenal bypass grafting procedures for the treatment of renovascular disease,9,10 substantiating the claim that IIA sacrifice carries little risk of significant pelvic ischemia. However, most of these procedures were performed in patients who were relatively younger than patients who usually undergo AAA repair. Conversely, although the overall number of patients is small, there are numerous reports of impotence, buttock claudications, anorectal necrosis, and even paralysis of the lower extremities as a result of acute ligation or thrombosis of a patent IIA during or after aortoiliac bypass grafting for aneurysmal disease.9,10

<table>
<thead>
<tr>
<th>Immediate postoperative period</th>
<th>Unilateral claudication†</th>
<th>Bilateral claudication†</th>
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<tr>
<td>Class I*</td>
<td>Class II*</td>
<td>Class III*</td>
</tr>
<tr>
<td>12 (55%)</td>
<td>9 (41%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>One-year postoperative period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 (50%)</td>
<td>8 (50%)</td>
<td>death</td>
</tr>
<tr>
<td>15 (68%)</td>
<td>6 (27%)</td>
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</table>
| Number of patients with clinical symptoms of pelvic ischemia. The percentages, incidence at 1 month, and prevalence at 1 year represent the distribution of patients with symptoms according to the severity of symptoms related to pelvic ischemia.

*Clinical classification of pelvic ischemia by symptoms: class I, nonlimiting claudication with exercise; class II, new onset impotence without moderate to severe buttock pain leading to physical limitations with exercise; class III, buttock rest pain or colonic ischemia.
†Location of pelvic symptoms: either unilateral or bilateral buttock pain.

1. Pelvic arterial inflow disease with evidence of preoperative chronic pelvic ischemia. This feature was manifested by stenosis of the contralateral IIA origin (≥70%) or nonopacification of three or more named IIA branches and the presence of newly developed collaterals (Fig 4).
2. Absence of ipsilateral vessels necessary for the development of collateral arteries. This was manifested by small caliber, diseased, or absent medial and lateral femoral circumflex arteries (ascending deep femoral branches) ipsilateral to the side of the IIA occlusion (Fig 5). Even with the potential growth of collateral arteries, these new vessels must have an end point vessel as outflow.

None of the six patients who temporarily experienced complaints of pelvic ischemia but went on to have complete resolution of their symptoms during a 1-year period had these two radiologic findings. These two preoperative radiologic findings, which potentially could be used as predictors of pelvic ischemia in patients who receive unilateral internal iliac occlusion, cannot be applied to the patients who underwent bilateral IIA occlusion. By means of the analysis of this group of 6 patients, it was revealed that 1 patient had a 90% stenosis of the orifice of 1 deep femoral artery, 4 patients had underdeveloped or absent branches of the deep femoral vessels, and 1 patient had poor quality imaging of these particular branches. Conversely, no particular pattern was
revealed by means of the angiographic features of the remaining five patients with no symptoms, although the deep femoral arteries appeared to be patent in these patients. Unfortunately, because of the lack of symptoms, there was no need to perform additional postoperative angiography, by means of which the new collateral pathways from the upper thigh to the pelvis might have been revealed. Therefore, no conclusions or predictive factors can be derived from such a small group of patients.

In most patients, the intricate network of collateral pelvic vessels usually compensates for the sacrifice of one of the IIAs. However, it is not prudent to justify the safety of random IIA occlusion in patients with aneurysmal disease on the basis of data by means of which an excellent outcome in young women undergoing bilateral IIA ligation for gynecologic procedures was revealed. If an aggressive approach is planned to treat complex aortoiliac aneurysms, careful preoperative imaging tests are recommended for assessing all possible sources of collateral vessels that can be recruited to provide perfusion to the pelvis from visceral, pelvic, and upper thigh circulations after sacrifice of one or both of the IIAs.

Because atherosclerosis in the pelvic circulation appears to impede the development of new collaterals and promotes the underdevelopment of the ipsilateral femoral circulation, on the basis of the findings of our study, we recommend good clinical judgment be exercised before the intentional occlusion of one or both of the IIAs.

The results of this study suggest that, despite the complexity of the pelvic arterial circulation, careful preoperative evaluation of the visceral, pelvic, and upper thigh circulations should be performed by means of bilateral delayed angiograms of the IIA and deep femoral branches before intentional embolization to search for signs of chronic pelvic ischemia. When bilateral IIA occlusions are planned, both deep femoral arteries must be studied and should be reconstructed when stenosis is present to maximize the inflow to the ascending collateral vessels to the pelvis. However, to virtually eliminate the probability of pelvic ischemia in patients with bilateral IIA occlusions, an iliac artery relocation or bypass should be performed to preserve blood flow to the pelvis, as described by Parodi. In the presence of a normal superior mesenteric and celiac artery anatomy, sacrifice of the IIA appears to be safe and does not represent a significant risk factor for ischemia of the colon. When the aforementioned guidelines are used, intentional IIA occlusion can be safely performed as an adjuvant intervention to endovascular exclusion of AAAs.

Three limitations were found in this study. First, a group of 22 patients with pelvic ischemic symptoms is a small sample and is most likely underpowered in the number of subjects enrolled in the study, because the amount of possible permutations within the numerous variations of pelvic collaterals on each side clearly outnumbers that of our patient population. Precise estimation of statistical power becomes difficult because of the lack of previous systematic studies of the pelvic circulation. Second, although 6 of the 11 patients who underwent bilateral IIA occlusions had symptoms of pelvic ischemia, the remaining 5 patients who had no symptoms were an inadequate number from which to derive any conclusions regarding the possible alternative collaterals used to perfuse the pelvis. Finally, the intravenous radiopaque injection used as a means of performing the angiogram was timed to study the aorta and the common iliac vessels, not the branches of the IIA. Thus, delayed contrast views may be a beneficial means of better assessing pelvic circulation to optimize visualization of the pelvic arterial branches, which are not usually seen on standard angiograms.

REFERENCES


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