Endovascular abdominal aortic aneurysm repair significantly decreases operative morbidity rates and enhances patient recovery.1-4 Exclusion of patients with abdominal aortic aneurysms that extend to the bifurcation bilaterally may be avoided by using a custom-made stent graft in the external iliac artery. The contralateral common iliac artery aneurysms were excluded by a custom-made stent graft (n = 2) from the external iliac artery to the internal iliac artery, which preserved pelvic inflow via retrograde perfusion from the femorofemoral bypass. Mean length of stay was 3.5 days. One patient had hip claudication. Follow-up (mean 10 months, range 6 to 17) demonstrated exclusion of the abdominal aortic aneurysm and common iliac artery aneurysms with no endoleak and patent external iliac artery–to–internal iliac artery endografts in all patients.

**Conclusion:** Patients with bilateral common iliac artery aneurysms that extend to the bifurcation may be excluded from endovascular abdominal aortic aneurysm repair because of concerns regarding pelvic ischemia after occlusion of both internal iliac arteries. External iliac artery–to–internal iliac artery endografting is a feasible alternative to maintain pelvic perfusion and still allow endograft repair of the abdominal aortic aneurysm in these patients. (J Vasc Surg 2002;35:120-4.)

Endovascular abdominal aortic aneurysm repair significantly decreases operative morbidity rates and enhances patient recovery.1-4 Exclusion of patients with abdominal aortic aneurysms for endovascular repair is commonly due to inadequate anatomy of the proximal aortic neck or iliac arteries. Twenty percent of patients with abdominal aortic aneurysms have common iliac artery aneurysms.5 Endovascular repair of abdominal aortic aneurysms with an adequate proximal aortic neck and common iliac artery aneurysms (grade IIB6 or IIC7) is more challenging because of difficulties in obtaining an adequate distal seal of the iliac limb(s) to prevent endoleak while maintaining adequate pelvic perfusion.

Open and endovascular techniques have been developed to achieve successful endovascular repair in patients with abdominal aortic aneurysms and common iliac artery aneurysms that extend to the bifurcation (Fig 1). Endovascular methods include coil embolization of the external iliac artery or endograft coverage of a patent internal iliac artery.8 An open laparoscopic retroperitoneal approach to ligate the internal iliac artery has also been performed.9 The major criticism of these methods was that they occlude flow to the internal iliac artery and impair pelvic perfusion. Complications of interruption of internal iliac artery flow include hip claudication, ischemic colitis, neurologic deficits, bowel or bladder dysfunction, and impotence. Although interruption of one or both internal iliac arteries can usually be safely performed, preservation of flow to at least one internal iliac artery is recommended if at all possible.10,11

Open and endovascular techniques to preserve internal iliac artery perfusion for endovascular repair of grade IIB or IIC abdominal aortic aneurysms have also been developed. Parodi and Ferreira12 reported an open retroperitoneal approach to relocate the external iliac artery and internal iliac artery bifurcation by either direct reanastomosis or with a bypass graft, permitting endograft seal in the external iliac artery proximal to the new bifurcation. This open retroperitoneal approach has been criticized because of its complexity and difficulty.13 Endovascular methods that

External iliac artery–to–internal iliac artery endograft: A novel approach to preserve pelvic inflow in aortoiliac stent grafting

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**Purpose:** To describe four patients with abdominal aortic aneurysm and bilateral common iliac artery aneurysms repaired by coil embolization of the ipsilateral internal iliac artery, aortouniiliac endograft extended to the ipsilateral external iliac artery, femorofemoral bypass grafting, and a contralateral external iliac to internal iliac stent graft to preserve pelvic perfusion.

**Methods:** Four patients with multiple risk factors, abdominal aortic aneurysm (mean diameter, 6.6 cm), and bilateral common iliac artery aneurysms were evaluated with contrast-enhanced computed tomography scanning, arteriography, and intravascular ultrasonography. Aortobiiliac endovascular abdominal aortic aneurysm repair was not feasible because of extension of the common iliac artery aneurysms to the iliac bifurcation bilaterally.

**Results:** The abdominal aortic aneurysms were repaired with an aortouniiliac endograft. The ipsilateral common iliac artery aneurysms were treated by coil embolization of the internal iliac artery and extension of the endograft to the external iliac artery. The contralateral common iliac artery aneurysms were excluded by a custom-made stent graft (n = 2) or a commercial stent graft (n = 2) from the external iliac artery to the internal iliac artery, which preserved pelvic inflow via retrograde perfusion from the femorofemoral bypass. Mean length of stay was 3.5 days. One patient had hip claudication. Follow-up (mean 10 months, range 6 to 17) demonstrated exclusion of the abdominal aortic aneurysm and common iliac artery aneurysms with no endoleak and patent external iliac artery–to–internal iliac artery endografts in all patients.

**Conclusion:** Patients with bilateral common iliac artery aneurysms that extend to the iliac bifurcation may be excluded from endovascular abdominal aortic aneurysm repair because of concerns regarding pelvic ischemia after occlusion of both internal iliac arteries. External iliac artery–to–internal iliac artery endografting is a feasible alternative to maintain pelvic perfusion and still allow endograft repair of the abdominal aortic aneurysm in these patients. (J Vasc Surg 2002;35:120-4.)
obtain a seal in the common iliac artery while maintaining flow to the internal iliac artery include the use of the bell-bottom technique, coil embolization of the common iliac artery, or a contralateral common iliac occluder. However, these techniques are recommended only in ectatic iliac arteries less than 20 mm in diameter that are not aneurysmal. This report describes a novel approach to preserve pelvic perfusion during endovascular abdominal aortic aneurysm repair in patients with bilateral common iliac artery aneurysms extending to the iliac bifurcation.

**METHODS**

Patients/anatomy. Four male patients, average age 75 (range 70 to 79), underwent endovascular repair of a grade IIIC abdominal aortic aneurysm with coil embolization of the ipsilateral internal iliac artery, aortouniiliac endograft extended to the ipsilateral external iliac artery, femorofemoral polytetrafluoroethylene bypass graft (W. L. Gore & Associates, Flagstaff, Ariz), and contralateral external iliac artery–to–internal iliac artery endograft to preserve pelvic perfusion at Baptist Hospital East from December 1999 to November 2000. These procedures were performed under an investigator-sponsored study that was approved and monitored by the investigational review board at Baptist Hospital East, Louisville, Ky. The size of the abdominal aortic aneurysm was an average of 6.5 cm (range, 6-8 cm). The common iliac artery aneurysm size was an average of 2.5 cm (range, 2-3.5 cm). Two (one bilateral and one unilateral) of the four patients had common femoral artery aneurysms as well that were repaired at the time of the procedure with an interposition polytetrafluoroethylene bypass graft (W. L. Gore & Associates). All patients had fusiform aneurysms that were asymptomatic (stage I) and underwent elective repair with no signs of rupture. Three patients had palpable pedal pulses, and 1 patient had moderate ischemia caused by femoropopliteal occlusive disease.

All patients had two or more risk factors increasing the risk for standard open surgical repair as suggested by the Society for Vascular Surgery and the American Association for Vascular Surgery Standards for Reporting on Arterial Aneurysms. The comorbid risk factors included coronary artery disease in 4 patients, hypertension in 3 patients, tobacco use in 3 patients, chronic obstructive pulmonary disease in 2 patients, and congestive heart failure in 1 patient. All patients had fixed defects, and 1 patient had a small periinfarct reperfusion defect on adenosine thallium stress testing. One patient had an ejection fraction less than 30%. One patient had sleep apnea, and one patient received warfarin (Coumadin). None of the patients had hyperlipidemia, carotid artery occlusive disease, diabetes mellitus, or chronic renal insufficiency. The American Society of Anesthetist Risk Classification was III for all patients.

All patients underwent preoperative contrast-enhanced computed tomography (CT) scanning, arteriography, and intravascular ultrasound scanning to determine artery diameters, wall structure, seal zone lengths, angulation, and the length of the endograft. The proximal abdominal aortic aneurysm neck was suitable for endografting in all patients (length ≥1.5 cm, no significant tortuosity or grade III angulation). All four patients had bilateral common iliac aneurysms that extended to the bifurcation with no adequate distal seal zone. The internal iliac arteries and external iliac arteries were not aneurysmal and had no significant stenosis or tortuosity. The internal iliac artery and external iliac artery were 7 mm to 10 mm in diameter, with ≥2 cm seal zone length. The angle between the external iliac artery and internal iliac artery was between 60 and 120 degrees. The treatment method and endograft type and size were determined by the results of these studies.

**Endograft device.** All patients had repair of their abdominal aortic aneurysms with an aortouniliac endograft. The aortouniliac endograft was custom-made from a polytetrafluoroethylene graft (Impra, Inc, Tempe, Ariz) sutured to a Gianturco Z-stent endoskeleton (Cook, Inc, Inamed, Bloomington, Minn).
The contralateral internal iliac artery was accessed for coil embolization with the use of a Cobra catheter (Boston Scientific). The ipsilateral internal iliac artery was accessed for coil embolization with the use of a Cobra catheter (Boston Scientific) or an angled Berenstein catheter (Boston Scientific). An 8F 45-cm Arrow sheath (Arrow International Inc, Reading, Pa) was used if a crossover iliac approach was used. The Cobra or Berenstein catheter was exchanged for a 4F or 5F glidecath (Boston Scientific) for delivery of the 6-mm to 10-mm Gianturco coils (Cook, Inc) at the origin of the internal iliac artery. The glidewires were exchanged for an Amplatz Super Stiff (Boston Scientific) for endograft deployment. The self-expanding aortouniiliac endografts were deployed through 24F Desilet-Hofman sheaths (Cook, Inc). The endograft was extended to the external iliac artery, covering the coiled internal iliac artery. Contrast arteriography and intravascular ultrasound scanning were performed to ensure no technical problems and proper endograft placement in relation to the renal and iliac arteries and endoleak.

The contralateral internal iliac artery was accessed for placement of the external iliac artery–to–internal iliac artery endograft. An angled glidewire with the aid of a Cobra, Sos-Omni (Boston Scientific) or angled Berenstein catheter was used to access the internal iliac artery from the external iliac artery. The glidewire was placed in the distal portion of a branch of the internal iliac artery. The glidewire was then exchanged for an Amplatz Super Stiff or Rosen guide wire (Boston Scientific). The 12-mm to 14-mm by 30-cm sheath (Cook, Inc) was softened in hot water. The sheath was then passed over the wire from the external iliac artery to the proximal portion of the internal iliac artery for deployment of the endograft. The dilator was then removed, and contrast arteriography was performed through the sheath to confirm proper positioning for placement of the endograft. The endograft was deployed just proximal to the branches of the anterior and posterior trunks of the internal iliac artery. The endograft was sealed proximally in the internal iliac artery, looped in the common iliac artery aneurysm, and sealed distally in the external iliac artery. Contrast arteriography and intravascular ultrasound scanning were performed to ensure no technical problems or endoleak (Fig 2).

**Postoperative follow-up.** All patients were monitored with serial clinical examination, color-flow duplex scanning, and contrast-enhanced CT scanning at 1 month and at 3-month to 6-month intervals to assess for endograft patency and endoleaks. No patients were lost to follow-up.

**RESULTS**

From September 1995 to December 2000, 222 patients underwent endovascular abdominal aortic aneurysm repair...
at Baptist Hospital East. The four patients with abdominal aortic and bilateral common iliac artery aneurysms extending to the iliac bifurcation in this report underwent endovascular repair between December 1999 and November 2000. There were no failed attempts at an external iliac artery–to–internal iliac artery endograft. Before December 1999 patients with grade IIC abdominal aortic aneurysms with bilateral common iliac aneurysms underwent open repair.

All four patients undergoing aortouniliac abdominal aortic aneurysm repair with contralateral external iliac artery–to–internal iliac artery endograft to preserve pelvic perfusion during this time period were successfully performed. The estimated blood loss was an average of 1525 mL (range, 500-3800 mL). The patients received an average of 188 mL packed red blood cells (range, 0-500 mL) and 500 mL Cell saver (COBE Cardiovascular, Arvada, Colo) (range, 0-1250 mL). The average operating time was 320 minutes (range, 240-480 minutes). One of the patients had an intraoperative endoleak after placement of a custom-made external iliac artery–to–internal iliac artery endograft. An additional custom-made endograft was immediately placed to resolve the endoleak. The second patient with a custom-made endograft had a stenosis along the endograft corrected with the placement of a Wallstent (Boston Scientific) or Smart stent (Fig 3). The estimated blood loss was an average of 188 mL packed red blood cells (range, 0-500 mL) and 500 mL Cell saver (COBE Cardiovascular, Arvada, Colo) (range, 0-1250 mL). The average operating time was 320 minutes (range, 240-480 minutes). One of the patients had an intraoperative endoleak after placement of a custom-made external iliac artery–to–internal iliac artery endograft. An additional custom-made endograft was immediately placed to resolve the endoleak. The second patient with a custom-made endograft had a stenosis along the endograft corrected with the placement of a Wallstent (Boston Scientific) or Smart stent (Fig 3). The average length of hospital stay was 3.5 days (range, 1-7 days). There were no postoperative complications or deaths.

Average patient follow-up was 10 months (range, 6-17 months). One patient had bilateral hip claudication that persisted at 6 months of follow-up. There were no other complications related to pelvic perfusion. All four patients underwent follow-up color-flow duplex scanning and contrast-enhanced CT scanning. The abdominal aortic aneurysm decreased ≥1 cm in diameter in two patients and did not significantly change in the other two patients. All four external iliac artery–to–internal iliac artery endografts remain patent. There were no endoleaks or deaths in follow-up.

DISCUSSION

External iliac artery–to–internal iliac artery endografting is a feasible technique with good short-term results. All endografts remained patent with no endoleaks or aneurysm rupture. This endovascular method maintains pelvic perfusion in patients with grade IIC abdominal aortic aneurysms that have bilateral common iliac artery aneurysms extending to the bifurcation. Pelvic perfusion is retrograde from the femorofemoral graft and contralateral aortouniliac endograft. This technique has several advantages over current open and endovascular methods.8,9,12,14,15 The common iliac artery can be aneurysmal, thrombus laden, and >20 mm in diameter. Endovascular catheter and guide wire techniques are used to perform the procedure, avoiding the difficulty of exposure of the iliac arteries and morbidity of the retroperitoneal approaches.13 The endograft seals in normal arteries, the internal iliac artery proximally and external iliac artery distally. This method was performed via groin incisions only, maintaining the advantages of the less invasive aortouniliac endovascular abdominal aortic aneurysm repair.4,15

The external iliac artery–to–internal iliac artery endograft maintains pelvic perfusion in only 1 of the 2 internal iliac arteries of these patients with bilateral common iliac artery aneurysms. Preserving pelvic perfusion to both internal iliac arteries could be achieved in patients with grade IIC abdominal aortic aneurysms with standard open abdominal aortic aneurysm repair, bilateral retroperitoneal approaches for relocation of the right and left iliac artery bifurcations with endovascular abdominal aortic aneurysm repair, or with the use of an endograft with a bifurcated iliac limb to the external iliac artery and internal iliac artery. Before this series of patients all of our patients underwent standard open abdominal aortic aneurysm repair. To maintain the advantages of the endovascular repair4,15 and with no access to endografts with bifurcated iliac limbs, we chose to use the external iliac artery–to–internal iliac artery endograft to preserve pelvic perfusion.

All patients in this series had occlusion of the internal iliac artery on the side of the aortouniliac endograft and contralateral placement of the external iliac artery–to–internal iliac artery endograft. Severe ischemic complications of unilateral internal iliac artery coil occlusion are infrequent. Hip and buttock complications are the most common, occurring in approximately one third of patients, but subsiding in two thirds of these patients within 1 year.10 Symptomatic ischemic colitis occurs in 2% to 5% of patients.10,11 Buttock necrosis and peripheral neurologic deficits are rarely reported. Preservation of internal iliac artery collateral vessels by occlusion at the origin, avoiding distal embolization, preventing hypotension, and preserving one internal iliac artery were believed to be important to minimize complications. Bilateral internal iliac artery occlusion has been associated with an increased frequency of ischemic colitis11 and impotence.10 Preservation of flow to 1 internal iliac artery was recommended to minimize the risk of these severe ischemic complications.8,10-12 We performed the external iliac artery–to–internal iliac artery endografting to avoid bilateral internal iliac artery occlusion during endovascular repair of these grade IIC abdominal aortic aneurysms with bilateral common iliac artery aneurysms. Larger experience with longer follow-up is needed to determine the benefits of preservation of pelvic inflow with the external iliac artery–to–internal iliac artery endograft versus bilateral internal iliac artery coil occlusion.

To our knowledge this is the first report of endovascular repair of abdominal aortic aneurysms with bilateral
common iliac aneurysms by use of aortouniiliac endograft with a contralateral external iliac artery–to–internal iliac artery endograft. Even though novel to the endovascular repair of grade IIC abdominal aortic aneurysms, the technique of external iliac artery–to–internal iliac artery endograft is not original. This endovascular method has been reported by Derom et al16 to repair residual bilateral common iliac artery aneurysms after successful repair of ruptured abdominal aortic aneurysms and aortobifemoral bypass grafting. The patient underwent bilateral external iliac artery–to–internal iliac artery placement of a Hemobahn endograft (W. L. Gore & Associates) via a superficial femoral artery approach with a 12F sheath. The authors used a 13 mm × 10 cm endograft on the left and a 11 mm × 10 cm endograft on the right. Bilateral patency of the endografts and no endoleak was reported with 18 months of follow-up. Potential advantages of the Hemobahn endograft over our custom-made endograft and the Wallgraft include the flexibility of the nitinol stent easing passage around the angle from the external iliac artery to the internal iliac artery and the ultrathin expanded polytetrafluoroethylene permitting the use of smaller sheaths. More flexible endografts delivered through smaller sheaths may minimize the risk of distal embolization of common iliac aneurysm thrombus and injury to the internal iliac artery and external iliac artery. The availability of this endograft may have avoided the intraoperative use of additional stents to resolve endograft stenosis and intimal irregularities in our patients.

Certain anatomic characteristics must be present to consider the use of this technique. The proximal aortic neck of the abdominal aortic aneurysm must be suitable for endograft placement. Both common iliac arteries must have aneurysms greater than 20 mm in diameter that extend to iliac bifurcation. Standard aortobifemoral endograft or aortouniiliac endograft with a contralateral occluder should be used if both or one of the distal common iliac arteries has an adequate seal zone length of greater than 1 cm and diameter less than 20 mm. The extension of the common iliac artery aneurysm to the bifurcation creates a broad neck between the origin of the external iliac artery and internal iliac artery. This broad neck allows a smooth curve of the external iliac artery–to–internal iliac artery endograft within the common iliac artery aneurysm. The origins of the external iliac artery and internal iliac artery must be normal or suitable for balloon angioplasty. These arteries must not be aneurysmal or contain thrombus. The diameter of these arteries must be adequate to accept a 12F to 14F sheath. Collateral vessels from the internal iliac artery and external iliac artery must be patent and believed to be adequate to maintain pelvic perfusion.

This early experience with the use of the external iliac artery–to–internal iliac artery endograft with the aortouniiliac endograft in patients with grade IIC abdominal aortic aneurysms was encouraging. Longer follow-up and further developments in endograft technology will determine the safety and future role of this technique in the treatment of patients with abdominal aortic aneurysms and bilateral common iliac aneurysms.

REFERENCES


