Management of ectatic, nonaneurysmal iliac arteries during endoluminal aortic aneurysm repair

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**Purpose:** Most endografts for an endoluminal AAA repair cannot achieve an adequate hemostatic seal in ectatic common iliac arteries larger than 14 mm. The extension of the endograft into the external iliac artery can alleviate this problem but requires sacrifice of the internal iliac artery. We have used the larger diameter aortic extension cuff to obtain adequate endograft-to-arterial wall apposition in patients with ectatic, nonaneurysmal common iliac arteries. Because of the resultant flared configuration of the iliac limb, the technique is termed *bell-bottom*. However, it is unknown whether subsequent enlargement of these ectatic common iliac arteries that will lead to endoleaks or endograft migration will occur.

**Methods:** The records of all 96 patients who have undergone endoluminal abdominal aortic aneurysm repair at our institution were reviewed. Fourteen patients were identified in whom aortic extension cuffs were placed into 18 ectatic (>14 mm, but <20 mm) common iliac arteries. The mean follow-up time was 14 months (range, 6-24 months). The maximal diameter of the common iliac artery on computed tomography scan before endograft placement was compared with the maximal diameter at the most recent follow-up. The incidence of endoleaks, ruptures, and endograft migration related to the “bell-bottom” technique were recorded.

**Results:** The mean preoperative common iliac artery diameter was 18 mm (range, 15-20 mm). Aortic extension cuffs of 20-mm diameter and 24-mm diameter were used in 14 and 4 common iliac arteries, respectively. The diameter did not change in 11 common iliac arteries (61%), increased by 1 mm in 4 common iliac arteries (22%), and decreased by 1 mm in 3 common iliac arteries (17%). No endoleaks, ruptures, or endograft migration related to this technique were identified.

**Conclusion:** The use of aortic extension cuffs for ectatic common iliac arteries expands the number of patients who can be treated endoluminally without sacrifice of the internal iliac artery. Most common iliac arteries do not increase in diameter. When enlargement occurs, the degree of dilation is minimal. Therefore, the “bell-bottom” technique appears to be an acceptable option in the management of large, nonaneurysmal iliac vessels during endoluminal abdominal aortic aneurysm repair. (J Vasc Surg 2001;33:S33-8.)

Endoluminal abdominal aortic aneurysm (AAA) repair is becoming an acceptable alternative to open surgical repair.1,2 However, because of anatomic constraints, not all patients are amenable to an endoluminal approach. Although much attention has been focused on aortic neck anatomy, the common iliac artery (CIA), which serves as the distal implantation site for the endograft, must be of suitable diameter to achieve an adequate endograft-vessel wall apposition and hemostatic seal. Most available endografts cannot achieve a hemostatic seal in CIAs larger than 14 mm. Extension of the endograft into the smaller diameter external iliac artery (EIA) can alleviate this problem but requires the sacrifice of the internal iliac artery (IIA) to prevent retrograde flow that results in a type II endoleak. However, occlusion of the IIA has been associated with hip and buttock claudication, impotence, and colon ischemia3-5; therefore, it is preferable to avoid IIA embolization.

To maintain IIA flow in patients with enlarged but nonaneurysmal CIAs, we have used the larger diameter aortic extension cuff component to achieve an adequate hemostatic seal in these enlarged CIA segments. Although designed for use in the aortic neck, the aortic extension cuff can be inserted into the distal portion of the iliac limb of the standard bifurcated endograft, which results in a flared iliac limb or “bell-bottom” configuration. However, it is not known whether subsequent enlargement of these ectatic CIAs will occur. Small changes in diameter may lead to failure of the hemostatic seal and result in...
endoleaks, endograft migration, and potential rupture. The purpose of this study was to evaluate patients who have been treated with the bell-bottom technique, to determine the incidence of CIA enlargement during the follow-up period, and to determine the incidence of endoleaks and endograft migration related to the bell-bottom technique.

METHODS

All patients who have undergone an endoluminal repair of an infrarenal AAA at our institution were retrospectively reviewed. All repairs were performed with the Ancurex device (Medtronic AVE, Santa Rosa, Calif) under Food and Drug Administration-approved and Institutional Review Board-approved prospective phase II and phase III clinical trials with proper informed consent. The endograft is a bifurcated, self-expanding, modular device fully stented along its entire outer length with self-expanding nickel-titanium stent rings and is lined with a thin-wall polyester graft material. At least 1 cm length of CIA with a diameter of 14 mm or less served as the distal implantation site for the endograft.

CIAs of more than 2.0 cm were considered aneurysmal. Aneurysmal CIAs were excluded from the arterial circulation. When an adequate segment of CIA that was distal to the aneurysm existed, the endograft was terminated proximal to the IIA orifice. If the aneurysm encroached on the IIA orifice, the endograft was extended into the EIA, and coil embolization of the ipsilateral IIA was performed to prevent retrograde flow. Patients with bilateral CIA aneurysms that would require bilateral IIA embolization underwent open surgical repair.

CIAs with a diameter of more than 14 mm but less than 20 mm were considered ectatic. If an adequate distal implantation site existed in the CIA proximal to the ectatic segment, the endograft was terminated at this site. Similarly, if an adequate distal implantation site existed distal to the ectatic segment but proximal to the IIA orifice, the endograft was terminated in this segment. If the ectasia was present to within 1 cm of the IIA orifice, a “bell-bottom” approach was used (Figs 1-3). An aortic extension cuff (available in diameters of 20, 22, 24, 26, and 28 mm) was selected on the basis of the diameter of the CIA. The cuff was oversized by 10% to 20% compared with the native arterial diameter and was positioned with at least 1-cm overlap into the distal iliac limb of the bifurcated endograft and at least 1-cm overlap in the native CIA, proximal to the IIA orifice. Thrombus within an ectatic CIA suggests aneurysmal change and was considered a contraindication to a bell-bottom approach. These patients were treated by endograft extension into the EIA and coil embolization of the ipsilateral IIA.

All patients underwent preoperative anatomic evaluation with the use of contrast-enhanced spiral computed tomography (CT) scan with 2-mm axial slices. Measurements of the CIA were obtained with the use of geometric calipers at the maximum diameter perpendicular to the vessel axis. Preoperative maximal CIA diameter and the diameter of the aortic extension cuff used in each patient was recorded. Procedural complications were noted.

All patients were evaluated after operation with serial CT scans and plain abdominal radiography at the time of discharge, 1 month, 6 months, 12 months, and yearly thereafter. The incidence of endoleaks on CT scan and endograft migration on CT scan or abdominal radiograph was documented. Repeat measurements of the maximal CIA diameter on the most recent CT scan obtained for

Table I. Comparison of CIA diameter before aortic endografting and at most recent follow-up

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<th>Patient</th>
<th>Preoperative CIA diameter (mm)</th>
<th>Most recent CIA diameter (mm)</th>
<th>CIA diameter change (mm)</th>
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each patient were performed. The CIA diameter at the most recent follow-up was compared with the diameter obtained before endoluminal AAA repair.

RESULTS

Between June 1997 and July 1999, 96 patients underwent endovascular AAA repair by vascular surgeons at our institution. There were 83 men and 13 women, with an average age of 74 years. The average AAA diameter was 5.6 cm.

Fourteen patients (14.6%) had ectatic CIAs and were treated with aortic extension cuffs. There were 13 men and one woman in this group of patients, with an average age of 73 years and an average AAA diameter of 5.5 cm. Bilateral ectatic CIAs were present in four patients (29%); therefore, a total of 18 CIAs were evaluated. There were no failed attempts at a bell-bottom approach.

The mean maximal CIA diameter in these 18 CIAs was 18 mm (range, 15–20 mm). Aortic extender cuffs with a diameter of 20 mm were used in 14 CIAs. Four CIAs required aortic extender cuffs with a diameter of 24 mm. All patients achieved hemostatic seals at the CIA-endograft junction after endograft deployment. Six of the 14 patients (43%) with one ectatic CIA had a contralateral CIA aneurysm (average diameter 25 mm) that required endograft extension into the EIA and ipsilateral IIA coil embolization.

Two patients experienced arterial trauma during the aortic endografting procedure, which was treated with a common femoral artery interposition graft in one patient and a WallStent (Boston Scientific Vascular, Natick, Mass) across a flow-limiting EIA dissection in the other patient. Neither complication could be directly attributed to placement of the aortic extension cuff component.

Average follow-up was 14 months (range, 6–24 months). All patients underwent CT scan at the required intervals. No patient died or was lost to follow-up. The results of CIA diameter measurements before operation and at the most recent follow-up are presented in Table I. The mean maximal CIA diameter at most recent follow-up was 18 mm (range, 15–20 mm). The CIA diameter remained unchanged in 11 CIA segments (61%), decreased by 1 mm in three CIA segments (17%), and increased by 1 mm in four CIA segments (22%).

At the 1-month CT scan, three patients had endoleaks, none of which appeared to be related to the distal endograft implantation site. One endoleak spontaneously sealed by the 3-month CT scan, and the remaining two patients underwent diagnostic angiography. Both patients were found to have endoleaks that were related to retrograde flow through patent lumbar arteries. No late or delayed endoleaks were seen. There were no cases of endograft migration or endoleaks as evaluated by abdominal radiography and CT scan. No aneurysm ruptures occurred in this series.

DISCUSSION

Most bifurcated endografts for the repair of infrarenal AAAs are manufactured with standard iliac limb diameters that are dependent on the size of the aortic portion of the endograft. For the AneuRx device, the available sizes for the bifurcated segment are 20 mm aortic/12 mm iliac, 22 mm aortic/13 mm iliac, 24 mm aortic/14 mm iliac, 26 mm aortic/15 mm iliac, and 28 mm aortic/16 mm iliac. The largest available contralateral iliac limb component and iliac extension cuff components are 16 mm in diameter. The endografts must be precisely chosen for the corresponding vessel diameter to avoid inadequate apposition, which would fail to exclude the AAA from the native arterial circulation and place the patient at risk for
rupture. Indeed, most manufacturers recommend that the endografts be oversized by 10% to 20% to assure an adequate hemostatic seal. We feel that a 10% to 20% oversizing of the endograft is important, not only at the proximal implantation site in the aortic neck but also at the distal implantation sites in the CIAs. Therefore, we did not treat patients with CIA diameters larger than 14 mm, using the standard 16-mm iliac limbs.

Patients with ectasia of the CIA that extends to within 1 cm of the IIA orifice require a modification of the standard endoluminal repair because of the size constraints of the endograft. In the setting of ectasia, the endograft can be extended into the smaller diameter EIA, but this requires embolization of the ipsilateral IIA to prevent retrograde flow into the CIA and possibly into the AAA, which results in an endoleak. However, sacrifice of the IIA is not without consequence. We have found that 36% of patients experience hip and buttock claudication, although this is temporary in most instances. In addition, colon ischemia, impotence, paraplegia, and pelvic necrosis can occur.

To avoid occlusion of the IIA in patients with ectatic but nonaneurysmal CIAs, we have used the aortic extension cuff to achieve an adequate endograft to CIA apposition. The aortic extension cuff is available in diameters of 20, 22, 24, 26, and 28 mm, which corresponds to the aortic component of the bifurcated graft. These components were designed for placement in the aortic neck, but we have placed these components into the distal segment of the iliac limb, leading to a flared or bell-bottom configuration of the endograft (Figs 1-3). This bell-bottom technique has been a useful option in aortic endografting because a significant number of patients with AAAs have ectasia of the CIAs. In one study, the mean CIA diameter of patients in need of endoluminal AAA repair was 17 mm. At our institution, almost 15% of the patients who underwent an endoluminal AAA repair had ectatic (15-20 mm) CIAs, which necessitated a bell-bottom approach to avoid sacrifice of the IIA. In addition, six of the 14 patients had a contralateral CIA aneurysm that required extension of the endograft into the EIA and coil embolization of the IIA. Therefore, these six patients would have required bilateral coil embolization of the IIA if a bell-bottom approach was not used in the ectatic CIA. It has been our practice to avoid bilateral IIA occlusion because of the high incidence of colon ischemia; therefore, these patients would have likely undergone open surgical repair.

Although achieving a complete hemostatic seal at the “bell-bottom” site was possible in all patients, the long-
term durability of this approach is unknown. Even a small-diameter enlargement of the CIA may lead to failure of the hemostatic seal between the aortic extension cuff and the vessel wall. However, there have been several reports of iliac artery ectasia in patients who undergo open surgical repair of AAAs that have demonstrated no iliac dilation over time.6-8 Lavee et al6 evaluated tube-graft AAA repair in 20 patients with ectatic CIAs that measured to twice the diameter of the normal distal vessel. At a mean follow-up of 4 years, no patient experienced subsequent enlargement of the ectatic CIA. An absence of CIA enlargement at 3 to 5 years follow-up was also noted by Provan et al7 in a review of nine patients with CIA diameters to 3 cm at the time of tube graft AAA repair. Similarly, reports that focus on iliac artery aneurysms rather than ectasia have shown that CIA aneurysms less than 3 cm in diameter can be safely observed.10-12 Expansion rates of 1 mm or less per year have been documented for CIA aneurysms of less than 3 cm in size.10 Nevertheless, if this degree of expansion occurs in patients with ectatic CIAs that are treated with a bell-bottom technique, after several years, failure of the hemostatic seal may occur.

In our series of 18 ectatic CIAs, four patients (22%) demonstrated CIA enlargement at an average follow-up of 14 months. The four cases of enlargement were seen at 12 months and 18 months after operation, and the degree of enlargement was only 1 mm, which is within the range of intraobserver and interobserver variability.13,14 There were no late endoleaks or cases of endograft migration in these patients. In addition, there was no apparent relationship between initial CIA or AAA diameter and subsequent enlargement although it did appear that the patients whose ectatic CIA decreased in size during follow-up had smaller AAAs (average diameter, 5.2 mm). We did note that in all cases of CIA enlargement, the contralateral CIA was either ectatic and treated with a bell-bottom technique or aneurysmal and treated by endograft extension into the EIA. However, this bilateral disease was not unique to the group of patients in which CIA enlargement occurred because two of the three patients who demonstrated decreased CIA size also had contralateral CIA ectasia or aneurysmal disease. Unfortunately, a meaningful statistical analysis of risk factors for dilation of ectatic CIAs could not be performed because of the small number of patients in our series.

Another limitation of our analysis is the possible inaccuracy of CT scan as a means of evaluation of CIA diameters. Diameter measurements with CT scans and geometric calipers are subject to intraobserver and interobserver variability of 1 to 2 mm.13,14 In addition, the diameter may be overestimated if the artery is tortuous and not perpendicular to the plane of the tomographic section. If it were possible to obtain a true transverse image of the artery on each axial slice, independent of angulation in the anteroposterior and lateromedial direction, measurement error would be reduced.14 Volume measurement had been found to be most sensitive in detecting size changes and may be a more appropriate method for determining subtle changes in AAA and CIA diameters.15

There are other available methods for the measurement of arterial diameters. Duplex ultrasonography can be used but is operator-dependent and has been associated with higher rates of interobserver variability.16 In addition, postoperative surveillance for endoleaks with the use of color-flow duplex scan has been associated with a low sensitivity, specificity, and accuracy in our vascular laboratory. Therefore, we use CT scans for postoperative endoleak detection and arterial diameter determinations. Intravascular ultrasound has also been used to obtain arterial diameter measurements before aortic endografting and correlates well with measurements obtained by CT scan or directly from pathologic specimens.17,18 However, its utility for monitoring diameter changes after operation is limited mainly by the need for arterial puncture, and although visualization of intraluminal characteristics is excellent, intravascular ultrasound scanning cannot optimally visualize the excluded aneurysm.17 Therefore, we will continue to use CT scan for patient follow-up evaluation.

With close postoperative surveillance, diameter changes of the CIA and related endoleaks and endograft migration can be identified. If an endoleak at the distal iliac implantation site occurs, the endograft can be extended into the EIA. This would require embolization of the IIA, which had been avoided initially by the use of the bell-bottom approach. Nevertheless, IIA occlusion is generally well tolerated and used in a significant number of patients to treat CIA aneurysms.3 Revascularization of the IIA through a retroperitoneal incision could be performed if the patient were at high risk of complications related to the IIA occlusion. Endograft migration may also be amenable to an endovascular repair by the placement of an additional endograft component distally. However, the threat of CIA expansion and endoleaks may never be realized in the population of patients who undergo endoluminal AAA repair because of the significant comorbidities that limit life expectancy in these patients.

In conclusion, we have shown that the use of aortic extension cuffs for ectatic CIAs expands the number of patients who can be treated endoluminally without sacrifice of the IIA. Most CIAs do not increase in diameter. When enlargement does occur, the degree of dilation is minimal. Therefore, the bell-bottom technique appears to be an acceptable option in the management of large, nonaneurysmal iliac vessels during endoluminal AAA repair. With a longer follow-up period, the natural history of ectatic CIAs that are treated with this technique will be better understood.
REFERENCES


