Remote iliac artery endarterectomy: Seven-year results of a less invasive technique for iliac artery occlusive disease

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Objective: Remote endarterectomy of external and common iliac artery occlusions through a single, groin incision under fluoroscopic guidance is a relative unknown surgical procedure. This prospective single center cohort study describes this less invasive endovascular technique with the ring strip cutter and its early complications. The results at midterm follow-up are presented.

Patients and methods: From April 1994 to July 2001, 49 remote-endarterectomies of the external or common iliac artery were performed in a retrograde manner from a single, groin incision in 48 patients (30 men, 31 procedures). The median age was 66 years (39 to 82 years). Indications for operation were as follows: severe claudication in 28 (57%), rest pain in 13 (27%), and gangrene in 8 (16%) procedures. Follow-up included clinical evaluation, ankle-brachial index, and duplex scanning at 6 weeks, 3 months, and yearly thereafter.

Results: Intraoperative technical success was achieved in 43 (88%) procedures. A retroperitoneal incision was necessary in three patients for an additional arteriotomy in the iliac artery and in three others for a bypass procedure. The mean follow-up was 20 months (2 to 77 months). Three-year cumulative primary patency rate by means of life table analysis was 60.2% ± 12.0 (SE). During follow-up, percutaneous transluminal balloon angioplasty with and without stenting was performed in six and two patients, respectively, resulting in a 3-year primary-assisted patency rate of 85.7% ± 9.56. Three-year secondary patency was 94.2% ± 5.50.

Conclusions: Remote endarterectomy in external and common iliac arterial occlusive disease is a feasible endovascular procedure with a low complication rate. The midterm primary-assisted patency rate is good. (J Vasc Surg 2003;38:1297-304.)

Endovascular procedures such as percutaneous transluminal angioplasty (PTA) with or without stenting have been used to treat long arteriosclerotic occlusions of the external and common iliac artery, but they have proven to be ineffective in the long term.1,2 Moreover, recanalization of external iliac occlusions, sometimes even extending into the common femoral artery (CFA), can be difficult. When PTA is not possible in these iliac lesions, open surgery is the most common vascular procedure. Eversion endarterectomy of the iliac arteries has good long-term clinical results, as described by Le Veen et al,3 and has a lower restenosis rate than does endarterectomy of the superficial femoral artery. However, the technique of eversion endarterectomy requires extensive dissection in the pelvic area, leading to high morbidity.4-7 Therefore, the popularity of iliac endarterectomy declined and is now merely reserved for situations when prosthetic material cannot be used.

With the introduction of digital subtraction angiography (DSA) and fluoroscopy in the operating room for endovascular aneurysm repair in the mid-1990s, a new, less invasive technique for the treatment of arterial occlusive disease became available. Remote endarterectomy was introduced for the treatment of superficial femoral artery (SFA) occlusive disease.8 The ring strip cutter (MollRing Cutter; Vascular Architects Inc, San Jose, Calif) is additional to and substantially equivalent to the Vollmar ring stripper, except for its remote cutting mechanism. The two rings, with sharpened inner cutting edges, mimic a pair of scissors (Fig 1). With this device, it is possible to perform a minimally invasive retrograde endarterectomy of iliofemoral occlusions through a single, groin incision. The proximal intima core is transected at a specific endpoint remote from the site of entry. This, in advantage to the semiclosed endarterectomy, makes a second incision to expose the iliac artery at the proximal endpoint of the endarterectomized segment unnecessary. No prosthetic graft material is necessary, and the absence of graft anastomoses precludes the risk of both late anastomatic aneurysms and stenoses.

The procedure is also possible under regional or local anesthesia without either laparotomy or extensive retroperitoneal dissection. Therefore, patients with chronic obstructive pulmonary disease (COPD) or previous abdominal surgery could also benefit. There is also no risk of
postoperative abdominal hernia, as reported in 5% of patients treated with semiclosed endarterectomy.\textsuperscript{9,10} When the internal iliac artery is patent, it can be spared and is not bypassed. Endarterectomized arteries have a low incidence of acute thrombosis and, in the case of restenosis PTA with or without stenting is mostly possible.\textsuperscript{3,11,12}

In the present study, we report our single center mid-term results of remote iliac artery endarterectomy (RIAE) for long iliac artery occlusions.

**PATIENTS AND METHODS**

**Patients.** Patients were considered eligible for RIAE in cases of symptomatic iliac artery occlusive disease not extending into the aorta. Synchronous additional femoropopliteal occlusive disease, adjacent to the affected iliac artery, was not considered as a contraindication. From April 1994 to July 2001, a total of 48 patients were scheduled for 49 RIAE procedures in the St. Antonius Hospital, Nieuwegein, The Netherlands.

Patients were categorized into three groups—claudication, rest pain, or gangrene—and demographic data and risk factors for atherosclerosis were collected (Table I).\textsuperscript{13} In the claudication group, a conservative regime was initially established at first; cessation of smoking, walking exercise, and antiplatelet medication were started. When this conservative regime was unsuccessful for at least 6 months, patients were scheduled for an RIAE and, in some cases, an accompanying remote superficial femoral artery endarterectomy (RSFAE). Preoperative evaluation included ankle-brachial pressure measurements (ABI) and color-flow duplex scanning (HP Sonos 2000; Hewlett Packard Company, Imaging System Division, Andover, Mass), and the extent of the lesion was visualized by angiography.

The principal contraindications to endarterectomy were aneurysmal degeneration and fibrotic arterial segments of less than 5 mm in diameter. Also, common iliac occlusion extending into the aorta was a contraindication because of the risk of making a dissection in the aorta and debris tumbling into the contralateral iliac artery. A stenosed aorta and bilateral iliac disease were a relative contraindication, for which aortobifemoral bypass surgery was considered as one of the treatment options. However, in selected cases, especially in patients with a hostile abdomen or COPD, bilateral RIAE could be the first choice of treatment. A previous PTA could be the cause of heavy calcified intima hyperplasia in the iliac artery, which should be considered before operation.

Bilateral procedures in one stage have not yet been performed.

**Technique.** The patient should be prepped and draped, and consent should be obtained for the possibility of a larger, open surgical procedure in case of the need for conversion. A small pillow is placed under the ipsilateral buttock to hyperextend the hip joint, which facilitates delivery of the ring strippers.

The operative technique is similar to the semiclosed endarterectomy with an arteriotomy at the origin of the CFA. Through an 8-cm vertical groin incision, the CFA is exposed. Usually, the CFA, SFA, and deep femoral artery are encircled with silastic vessel loops instead of clamping,
which could make it difficult to obtain an appropriate cleavage plane. The patient then receives 5000 units of intravenous heparin as an anticoagulant. A longitudinal arteriotomy (3 cm) of the occluded or stenosed CFA permits a meticulous dissection of the intima core in the right cleavage plane. We prefer the plane between the lamina elastica interna and externa in the iliac artery.

The intima core is then dissected proximally from the arterial wall for a few centimeters of the CFA within the closed artery. Next, the intima core is distally transected and a regular ring stripper (Vollmar Dissector; Aesculap, South San Francisco, Calif) is selected to fit the diameter of the external iliac artery. Ring diameters range from 5 to 10 mm. The ring stripper is then advanced proximally into the artery beyond the affected segment or up to the patent common iliac artery under fluoroscopic guidance* with a gentle rotating movement, while the intima core and artery are stabilized. If the ring stripper cannot be advanced, a different size can be applied. Poupart’s ligament can be incised for extra control over the external iliac artery. The ring stripper is then exchanged for a suitable MollRing Cutter, which under fluoroscopic control cuts the proximal part of the intima core (Fig 2). It is of importance not to pass the aortoiliac bifurcation. A bony landmark or ruler can be useful for orientation. Sometimes a guide wire is inserted in the contralateral iliac artery to assess the exact location of the aortoiliac bifurcation. The entire intima core and the MollRing Cutter are removed simultaneously by applying slight traction and backward motion (Fig 3). If necessary, an additional part of the intima core can be dissected, cut, and removed. Also, loose parts can be removed by catching them between the two half-closed rings of the device (Fig 1). A brisk return of arterial flow typically signifies a satisfactory revascularization. Care should be taken to remove the entire core and leaving no remnants within the artery, as they could become a source for future emboli or restenosis. After flushing with a solution consisting of 5000-U heparin and 1-mg papavarine in 100-cc saline, additional debris may be removed with a Fogarty graft thrombectomy catheter (Baxter Health Corporation, Irvine, Calif).

The distal intima in the CFA needs to be anchored with 6-0 tacking sutures to ensure a smooth distal transition zone to normal intima. This will also prevent any dissection and subsequent occlusion of the artery after restoring the blood flow. On completion of the procedure, the arteriotomy can be extended to perform an open endarterectomy of the common femoral artery or profundaplasty, and it can be closed primarily or with a patch. Intraoperative angiography is performed in order to detect any loose intimal flaps. If an irregularity in the iliac artery at the proximal intima transection zone is seen, a stent might be used to correct it. The stent is preferably placed through the ipsilateral groin. In some cases, however, it might not be possible to pass the guide wire beyond the proximal transection zone and the contralateral groin has to be punctured to avoid the risk of

*Ceiling-suspended C-arm, OPC-9 and DSI, Philips Medical Systems, The Netherlands.
the guide wire creating a dissection of the iliac and aortic intima. Then the guide wire is advanced over the aortic bifurcation, down into the endarterectomized iliac conduit, and angioplasty with or without a stent can be performed safely and securely.

In the event of an occluded SFA, consecutive remote endarterectomy of the SFA can be performed with the same arteriotomy in the CFA for introduction of the MollRing Cutter, now working distally in an antegrade direction. The technique of remote endarterectomy of the SFA is basically equivalent to the technique previously mentioned. Working in an antegrade direction mandates endoluminal stenting of the distal intima edge to prevent any further dissection after restoring blood flow.

**FOLLOW-UP**

After the procedure, outpatient examinations were performed at 6 weeks, 3 months, and yearly thereafter. Routine surveillance consisted of color-flow duplex scanning, and clinical and hemodynamic sustained improvements were evaluated by recurrent symptoms and ABI at every follow-up visit.

All patients were placed or continued on acetylsalicylic acid and dipyridamole (200/25 mg twice a day). Alternatively, coumarins were continued when they were already prescribed for cardiac reasons. In the event of an acetylsalicylic acid allergy, clopidogrel (75 mg/day) was prescribed.

Adverse patient outcomes such as wound complication, ipsilateral major amputation, restenosis or reocclusion, and the need for revision were recorded. Restenosis was defined as more than 70% stenosis. Primary patency was defined as uninterrupted patency of the treated artery or its anastomoses without any secondary procedures being performed. If minor graft revisions, such as PTA of restenosis of the treated artery or adjacent arteries, were necessary to prevent occlusion, the artery was classified as primary assisted patent. In the event of occlusion when patency was restored by thrombectomy or thrombolysis, the artery was classified as secondary patent.

**STATISTICAL ANALYSIS**

Patency rates were calculated by life table analysis according to the Ad Hoc Committee on reporting standards. The limit of statistical significance was set at $P = .05$ (two-sided).

**RESULTS**

**Patients.** Thirty male and 18 female patients (median age, 66 years, range 39 to 82) were scheduled for 49 RIAEs in our institution (one patient underwent sequential bilateral procedures). All patients suffered from extensive occlusions or long-segmental disease of the common or external iliac artery and the common femoral artery. In 27 of these 49 procedures, the ipsilateral SFA was also occluded or

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*Fig 3. Thirteen centimeters long endarterectomy core after RIAE.*
Table II. Operative results of 49 commenced RIAEs

<table>
<thead>
<tr>
<th></th>
<th>CIA + EIA</th>
<th>EIA + SFA</th>
<th>CIA + EIA + SFA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>Initial success</td>
<td>20 (2)</td>
<td>10 (1)</td>
<td>10 (3)</td>
<td>3</td>
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<tr>
<td>Conversions</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
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<tr>
<td>Total</td>
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<td>13</td>
<td>12</td>
<td>3</td>
</tr>
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</table>

EIA, External iliac artery; CIA, common iliac artery; SFA, superficial femoral artery.

Between brackets: >70% stenosed.

stenosed over a long segment. Seven patients had a history of previous PTA in the ipsilateral iliac artery, and one patient had a previous ipsilateral femoropopliteal bypass.

Indications for operation were severe claudication in 28 (57%), rest pain in 13 (27%) of which 2 were acute, and gangrene in 8 (16%) procedures.

Procedure. Intraoperative technical success was achieved in 43 (88%) procedures (Table II). This meant a conversion to a more extended procedure in six procedures. In five procedures, an additional retroperitoneal incision was made to perform a proximal arteriogram in three cases and conventional iliofemoral bypass surgery in two cases. In the sixth procedure, aortobifemoral bypass surgery was performed. This was due to a perforation during endarterectomy in two procedures, both of which had a previous ipsilateral iliac PTA, and, in three procedures, to an arterial segment that could not be stripped because the intima core was too heavily calcified. In the remaining procedure, there was no suitably sized MolnRing Cutter available. The mean length of the endarterectomized segment was 12 cm (8 to 17 cm). A PTA with primary placement of a stent at the level of the transaction zone was performed in 24 procedures (48% of successful procedures), of which 5 were placed by means of the crossover method (see technique). In 15 procedures, a consecutive RSFAE was attempted in the same session, of which 3 were converted to a polytetrafluoroethylene femoropopliteal bypass procedure because of the inability to advance the ring stripper. The mean operation time (skin to skin) and the mean blood loss were, respectively, 151 minutes (50 to 250 minutes) and 640 cc (150 to 2000cc), with no statistical difference between the 43 successful cases and the 6 conversions. The mean ABI improved from 0.53 ± 0.12 preoperative to 0.88 ± 0.22 postoperative.

Postoperative complications. Postoperative complications consisted of pneumonia in one patient, wound infection in two patients, wound dehiscence in one patient, hemorrhage that required surgical exploration in one patient, and five acute occlusions within 2 days. Of these five occlusions, three were caused by a thrombus at the common femoral artery patch, and all were successfully removed by a Fogarty procedure and the patch was replaced. The other two occlusions were caused by a thrombus in the stent and were successfully treated by a Fogarty procedure and placement of a second stent. Aneurysmal degeneration of the endarterectomized segment and anastomotic aneu-

rgms of the common femoral artery were not seen, nor were stent and patch infections.

One patient with known coronary artery disease died of myocardial infarction within 30 days after the operation.

Patency at midterm follow-up. The mean follow-up time was 20 months (2 to 77 months). The 3-year patient survival rate was 91%. The 3-year cumulative primary patency rate for the 43 successful RIAEs by means of life table analysis was 60.2% ± 12.0 (SE). This rate was 100% for the other six procedures. The 3-year primary-assisted patency rate was 85.7% ± 9.56, because percutaneous transluminal balloon angioplasty with and without stent placement was performed in six and two patients, respectively. These eight reinterventions were all performed between 3 and 12 months postoperatively (median of 8 months). The reason for reintervention was restenosis of more than 70% in seven patients and a dissection of the proximal common iliac artery in one patient. In one of these patients, a stent was primarily placed in the initial procedure. The revascularization of the five acute early thromboses led to a 3-year secondary patency of 94.2% ± 5.50 (Fig 4). Occlusions occurred in two other patients within 1 year postoperatively. Both patients received an aortobifemoral prosthesis, which are both still patent. Limb salvage was established in all patients operated on for gangrene. At all last follow-up visits, no hemodynamic significant new restenoses were seen with duplex scan and the mean ABI was 0.84 ± 0.26 for the treated limb. Twenty-six of the 28 patients treated for claudication were symptom-free at the end of follow-up. We did not split our patient group into those with an open SFA (as a result of a concomitant RSFAE or not) or a group with an occluded SFA, because the numbers were too small for statistical analysis.

DISCUSSION

Remote endarterectomy is a combination of conventional surgery and endovascular therapy. In the recent past, we have acquired extensive experience with remote endarterectomy of the superficial femoral artery with satisfying results. Remote endarterectomy is best compared with semiclosed endarterectomy, and it offers the advantage of one incision instead of two, with no risk of postoperative abdominal hernia, as reported in 5% of patients treated with semiclosed endarterectomy. RIAE offers also several advantages over bypass surgery. When the internal iliac artery is patent, it can be spared and is not bypassed. No prosthetic graft material is necessary, and the absence of graft anastomoses precludes the risk of both late anastomotic aneurysms and stenoses. The procedure is also possible under regional or local anesthesia without either laparotomy or extensive retroperitoneal dissection. Therefore, patients with COPD or previous abdominal surgery could also benefit, and there is no consequent risk of sexual dysfunction.

However, from the very beginning of the remote endarterectomy procedure, the technical success depends on how well the first few centimeters of the intima core can be dissected. Once a cleavage plane is established, it is very well
possible to desobstruct the lumen up to the level of the common iliac artery.

In this study, intraoperative technical success was achieved in 43 (88%) procedures, which corresponds to other techniques. Van den Dungen et al.\textsuperscript{9} report an intraoperative technical success rate of 92% in his group of 101 scheduled semiclosed iliac endarterectomies. The initial success of PTA and recanalization of iliac occlusions is 80% to 85%, but the treated lesions are mostly shorter than in RIAE.\textsuperscript{16} In general, initial technical success of endovascular treatment of iliac occlusive lesions is 82%\textsuperscript{17}. In the event of an intraoperative complication, an additional arteriotomy through a retroperitoneal approach or conventional bypass surgery can be performed as a bail-out. In our group of six unsuccessful RIAEs, two patients received an iliofemoral bypass and one patient an aortobifemoral bypass, whereas three required only a proximal arteriotomy. This means that all of our patients had a successful revascularization.

Sometimes extreme calcification can be present, and a ring stripper is unable to pass or a perforation occurs. In our group, this was the event in, respectively, three and two procedures. A previous PTA of the iliac artery could be the cause of a difficult remote endarterectomy procedure. In five of the seven patients with a previous PTA of the iliac artery, the endarterectomy was possible, but in the other two patients, the artery was heavily calcified, which resulted in the previously mentioned perforations. Another potential disadvantage of RIAE could be aneurysmal degeneration of the endarterectomized segment and anastomotic aneurysms of the CFA, but this was not seen, even after 6 years of follow-up. Previous studies of the more traditional (semiclosed) endarterectomy with 10 years of follow-up also do not report this complication.\textsuperscript{9,18,21} Compared with bifurcation grafts with end-to-side femoral anastomoses, the risk for anastomotic aneurysms is extremely low and favors this nonbypass procedure. The dilation of Dacron grafts probably does not have clinical consequence, but graft infection, especially with groin anastomoses, always remains a risk factor. In our study, there were no stent or patch infections, whereas literature reports 0.3% to 3% aortoiliac bypass graft infection and even 6% to 13% femorofemoral crossover bypass infection.\textsuperscript{4-6}

Our midterm results of RIAE with a primary patency of 60.2% and a primary-assisted patency of 85.7% are comparable with results in literature on treatment of iliac occlusive disease. The TransAtlantic Inter-Society Consensus (TASC) reported the same average 3-year primary patency after endovascular treatment of iliac occlusions.\textsuperscript{17} Three-year prospective reports on semiclosed iliac endarterectomy are not available. The retrospective study of Van Dungen et al.\textsuperscript{9} describes a 3-year patency rate of 87%. For bypass surgery, the 3-year primary patency rates vary from 50% to 90%. Acute occlusions within 24 hours of surgery occurred in five patients despite a strict regime of preoperative heparin and postoperative coumarin or antiplatelet medication. All could be easily treated with a Fogarty procedure and replacement of the patch or a (second) stent. Not only after 3 years, but at all last follow-up visits (ranging from 2 to 77 months), limb salvage was 100%; no hemodynamic significant new restenoses were seen with duplex scan, and the mean ABI of .84 was the same as the directly postoperative ABI (.88).

In the event of restenosis, minimal invasive correction is usually possible. Previous studies have shown that PTA with selective stenting of recurrent disease after previous endarterectomy is feasible and safe.\textsuperscript{13,22,23} During the procedure, we placed a primary stent in a limited number of cases (n = 24). This is not to be compared with the placement of a stent in RSFAE, which is mandatory because of the downstream location of the postendarterectomy

\textbf{Fig 4.} Primary, assisted primary, and secondary patency curves by life table method, \textit{with number of patients at risk.}
intimal flap.24 The placement of a stent in RIAE is more an adaptation of this postendarterectomy intimal flap than is treatment of an incomplete endarterectomy or restenosis. We could not prove if this was really necessary. However, in six of the seven patients who required reintervention for restenosis, a stent was not primarily placed in the initial RIAE. All of these seven cases had an initial remote endarterectomy of the external iliac artery. And all reinterventions were performed because of restenosis located in the proximal external iliac artery. It could be that the external iliac artery is more prone to restenosis than is the common iliac artery. From other studies, we know that restenosis as a consequence of intima hyperplasia is less likely in the common iliac than in the external artery, which is a known significant factor of poor outcome.25 Or that the initial remote endarterectomy should have been extended into the common iliac artery. However, we believe that most of the restenosis could have been prevented when a stent was primarily placed at the transection zone in the proximal external iliac artery or distal common iliac artery.

We did not look at the results in relation to the arterial outflow of the femoral and popliteal arteries because the number of patients in this study was relatively small and no statistical consequences could be reached. Discrepant findings exist concerning the role of the SFA—open or occluded—as a prognostic factor in the outcome (patency) of iliac revascularization. One study found better clinical improvement of symptoms or better angiographic results in patients with an open SFA, whereas other studies found no correlation between the outcome of endarterectomy and the status of the SFA.9,26-30 However, when the surgeon is familiar with remote endarterectomy under fluoroscopic guidance, there is an excellent opportunity to improve the arterial outflow in the event of an occluded SFA, which could be of great value when the indication for operation is rest pain or gangrene of the lower extremity. In our study, 15 patients underwent a combined remote endarterectomy of the iliac artery and the SFA through the same incision.

Last but not least, medical therapy for atherosclerotic disease has improved considerably over the last 10 years. New thrombocyte aggregation inhibitors such as clopidogrel play a preventive role in thromboembolic events, and folic acid, ACE inhibitors and newly developed statins may further reduce the incidence of restenosis and occlusion after endarterectomy. New developments such as cell seeding are waiting to be introduced in the clinic, especially in combination with stem cell therapy.31 These developments will find their way into clinical practice, and the prospects of reducing restenosis in the future are more than promising.

In conclusion, although RIAE in our hands did not show better results than conventional treatment of iliac occlusive disease, it does offer all the advantages of less invasive surgery. For this reason, RIEA is worth considering as one of the treatment options for long-segmental iliac occlusive disease.

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