Surgical disobliteration of postthrombotic deep veins—endophlebectomy—is feasible

Alessandra Puggioni, MD,a,c Robert L. Kistner, MD,a,b Bo Eklof, MD, PhD,a,b,c and Fedor Lurie, MD, PhD,a,b,c Honolulu, Hawaii

Objective: Partial obstruction of postthrombotic veins is caused by endovenous scar tissue, which creates synchiae and septae that narrow and sometimes block the lumen. We have performed surgical disobliteration, or endophlebectomy, of chronically obstructed venous segments during various kinds of deep venous reconstructions to increase the flow through previously obstructed segments. In this article we describe the endophlebectomy technique, and report the availability of this procedure as an adjunct to deep venous reconstructions for the treatment of postthrombotic chronic venous insufficiency.

Patients and Methods: Between July 1996 and February 2003, surgical disobliteration of 23 deep venous segments was performed in 13 patients in association with 14 deep venous reconstructions to treat advanced postthrombotic chronic venous insufficiency. Postthrombotic veins were surgically exposed, and a longitudinal venotomy was carried out at a variable length. The synchiae and masses attached to the intimal layer were carefully excised. Mean duplex scanning follow-up was 10.8 ± 8.2 months (median, 8 months; range, 1-28 months).

Results: In 10 patients (77%) the treated segments remained primarily patent at median follow-up of 8 months (range, 1-28 months). Early thrombosis near the endophlebectomy site occurred in 3 patients, at 2, 5, and 12 days, respectively, after surgery. In 2 patients with early thrombosis further interventions were carried out with success. In a third patient with early postoperative thrombosis the final outcome was recanalization and reflux. These results yielded an overall secondary patency rate of 93%. No perioperative pulmonary embolism was observed.

Conclusion: This series demonstrates that surgical disobliteration of postthrombotic deep veins is technically feasible, and led to patency of the segments for the duration of follow-up for up to 28 months (mean, 10.8 ± 8.2 months). We used this technique with the objective of disobstructing postthrombotic veins, to increase flow through a previously narrowed lumen. Postoperative thrombosis at the site of endophlebectomy occurred in 23% of patients. Although this early experience is encouraging, further studies and longer follow-up are necessary to assess the durability of the procedure. (J Vasc Surg 2004;39:1048-52.)

In postthrombotic deep venous disease, correction of both obstruction and reflux may be required to obtain relief of symptoms.1,2 Several kinds of deep venous reconstructions are currently available, including valve repair, vein transposition, bypass, and valve transplantation. Their success depends on adequate distal flow into and proximal flow out of the treated segments. Current techniques to increase venous inflow and outflow in chronically obstructed deep veins include angioplasty and stenting or arterovenous fistulas.

Partial obstruction of postthrombotic veins is caused by endovenous scar tissue, which creates synchiae and septae that narrow and sometimes block the lumen.3 Studies in animals4,5 and human beings6 show that these synchiae are covered with endothelium, creating a potentially non-thrombogenic surface in the chronic phase of venous disease.

Raju et al3 reported their experience with axillary vein transfer in trabeculated postthrombotic veins. Excision of intraluminal trabeculae was performed with the purpose of creating a single lumen for the anastomoses. These authors obtained a cumulative patency rate of 83% at 10 years in trabeculated veins.

We have performed surgical disobliteration, or endophlebectomy, of chronically obstructed venous segments during various kinds of deep venous reconstructions, to increase the flow into, through, and out of critically obstructed segments. The contribution of this procedure was to relieve obstruction and to increase the inflow and outflow surrounding deep venous reconstructions. In this article we describe the endophlebectomy technique, and report our results with this procedure used as an adjunct to deep venous reconstructions in postthrombotic disease.

PATIENTS AND METHODS

Between July 1996 and February 2003, surgical disobliteration of 23 deep venous segments was performed in 13 patients, in association with 14 deep venous reconstructions to treat advanced postthrombotic chronic venous insufficiency (Table 1). One patient underwent two procedures, on two separate occasions. Data from hospital charts were retrospectively reviewed. Mean patient age was 51.8 years (range, 35-75 years); 10 patients were male, and 3 patients were female. The anatomic distribution of endo-
The main reasons for disobstruction of deep vein segments were to increase external iliac vein flow for stenting (patients 2, 3, 7, 10-12), increase in flow from distal veins for proximal valve repair (patients 1, 4), vein valve transfer or transposition (patients 3, 5, 6, 8, 13), and relief of frank obstruction (patients 4, 9; Table I).

All patients underwent surgery as a result of failed conservative management, because of disabling symptoms that significantly impaired their quality of life. Indications for surgery included active ulcers in 7 patients, previous recurrent ulcers in 1 patient, swelling with severe pain in 4 patients, and disabling swelling in 1 patient. The CEAP classification was applied to all limbs (Table II).

### Table I. Indications for endophlebectomy as adjunctive procedure to deep venous reconstructions

<table>
<thead>
<tr>
<th>Patient</th>
<th>Endophlebectomy segment</th>
<th>Indication</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FV</td>
<td>Allow FV valve repair</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>EIV+CFV+PFV</td>
<td>Increase EIV inflow for stenting</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CFV</td>
<td>Increase EIV inflow for stenting and increase outflow for distal vein transposition</td>
<td>FV to GSV transposition</td>
</tr>
<tr>
<td>4</td>
<td>PV+TV</td>
<td>Increase calf outflow</td>
<td></td>
</tr>
<tr>
<td>5, 6</td>
<td>PV+TV</td>
<td>Increase inflow or outflow for basilic to PV transfer</td>
<td>PV and PFV connected; PFV was main venous outflow of lower extremity, and was repaired</td>
</tr>
<tr>
<td>7</td>
<td>EIV+CFV+PV</td>
<td>Increase EIV inflow for stenting</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>FV</td>
<td>Increase inflow for transposition</td>
<td>FV to GSV transposition</td>
</tr>
<tr>
<td>9</td>
<td>PV+TV</td>
<td>Increase calf outflow</td>
<td>GSV to PV transposition</td>
</tr>
<tr>
<td>10</td>
<td>CFV</td>
<td>Increase EIV inflow for stenting</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>CFV+PV</td>
<td>Increase in flow or outflow for basilic to PV transfer</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>CFV+PFV</td>
<td>Increase in flow and outflow for basilic to PFV transfer</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>EIV+CFV+PFV</td>
<td>Increase in flow and outflow for basilic to PFV transfer</td>
<td></td>
</tr>
</tbody>
</table>

Table II. Preoperative CEAP classification in 13 limbs with endophlebectomy

<table>
<thead>
<tr>
<th>Limb</th>
<th>C</th>
<th>E</th>
<th>A</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>S</td>
<td>SDP</td>
<td>2,5,11,13,14,18</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>S</td>
<td>SD</td>
<td>5,12,14</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>S</td>
<td>SD</td>
<td>5,12,13,15</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>S</td>
<td>SDP</td>
<td>2,13,14,18</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>S</td>
<td>SDP</td>
<td>2,11,12,13,14,18</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>S</td>
<td>DP</td>
<td>11,12,13,14,17</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>S</td>
<td>SDP</td>
<td>4,5,11,12,13,14,18</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>S</td>
<td>SD</td>
<td>4,12,13,14,15</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>S</td>
<td>SD</td>
<td>5,12</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>S</td>
<td>SDP</td>
<td>5,11,12,18</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>S</td>
<td>DP</td>
<td>11,13,14,18</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>S</td>
<td>SDP</td>
<td>4,13,18</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>S</td>
<td>SDP</td>
<td>2,11,12,13,14,18</td>
</tr>
</tbody>
</table>

Segment codes: 2, GSV above knee; 3, GSV below knee; 4, LSV; 5, nonsaphenous; 7, common iliac; 9, external iliac; 11, common femoral; 12, profunda femoris; 13, superficial femoral; 14, popliteal; 15, crural; 17, thigh perforator; 18, calf perforator. S, Superficial; D, deep; P, perforator; GSV, greater saphenous vein; LSV, lesser saphenous vein.

Phlebectomy sites is described in Table I. The main reasons for disobstruction of deep vein segments were to increase external iliac vein inflow for stenting (patients 2, 3, 7, 10-12), increase inflow from distal veins for proximal valve repair (patients 1, 4), vein valve transfer or transposition (patients 3, 5, 6, 8, 13), and relief of frank obstruction (patients 4, 9; Table I).

All patients underwent surgery as a result of failed conservative management, because of disabling symptoms that significantly impaired their quality of life. Indications for surgery included active ulcers in 7 patients, previous recurrent ulcers in 1 patient, swelling with severe pain in 4 patients, and disabling swelling in 1 patient. The CEAP classification was applied to all limbs (Table II).

**Preoperative workup.** Preoperative imaging workup included radiologic and ultrasound evaluation. Duplex scans were obtained first, to identify sites of deep venous obstruction and reflux. At ascending phlebography the deep and superficial systems were evaluated, from the ankle to the inferior vena cava, for patency and flow patterns. The presence of reflux in segments below the inguinal ligament was evaluated at descending phlebography. Although the superficial and deep venous systems were studied in all patients with duplex scanning as the initial screening study, they were studied again after phlebography for critical details before surgery. Phlebography and duplex ultrasound scanning were used as complementary studies to identify patent veins above and below stenotic segments.

Reflex at duplex scanning was defined as reversed flow duration of 0.5 seconds or more during the Valsalva maneuver and with manual compression and decompression in superficial or deep segments located below the inguinal ligament, including the perforating veins. The tibial veins were not routinely evaluated for reflux, because duplex
scanning of the posterior tibial veins produces inconsistencies and a low yield of reflux in symptomatic limbs. Obstructed deep venous segments previously identified on phlebograms were carefully restudied on duplex scans to differentiate partial obstruction from total obstruction in the search for potentially useful inflow and outflow segments. Appropriate local augmentation maneuvers during duplex scanning enabled differentiation between totally obstructed and severely stenotic deep segments, and helped in identification of patent deep collateral pathways. Seven patients had combined deep, superficial, and perforator reflux; 4 patients had superficial and deep reflux; and 2 patients had deep and perforator reflux.

**Surgical technique.** Postthrombotic veins and their major branches were surgically exposed, and a longitudinal venotomy was carried through the length of the obstructed segment for a variable distance, between 2 and 15 cm in this series. On opening the vein the synchiae attached to the intimal layer were placed on tension and carefully removed with scissors by snipping their attachments to the intimal surface of the vein.

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more occasions in some patients. There was no follow-up protocol, but further studies were obtained within 1, 6, and 12 months. Presence of symptoms mandated duplex scanning. Mean follow-up was 10.8 ± 8.2 months (range, 1-28 months).

**RESULTS**

Complications that occurred in the postoperative period included wound hematoma (n = 3), wound infection (n = 2), and leg cellulitis (n = 1). No perioperative pulmonary embolism was observed. Early thrombosis near the endophlebectomy site occurred in 3 patients, at 2, 5, and 12 days, respectively, after surgery. Thrombosis was immediately clinically evident in 2 of these patients. The details of the three cases with early postoperative thrombosis are as follows.

**Case reports**

**Case 1.** A popliteal endophlebectomy in association with basilic vein to popliteal vein transfer was performed. Thrombosis of the basilic vein graft occurred 2 days after surgery, and thrombectomy with graft revision and distal arteriovenous popliteal fistula were performed. At 6-month follow-up, duplex scans showed a patent graft.

**Case 2.** A femoral vein endophlebectomy in association with femoral vein to greater saphenous vein transposition was performed. The proximal segment of the femoral vein became thrombosed 5 days after surgery. Despite this, and perhaps because the obstruction was physiologically better than reflux in this segment, the patient improved clinically, and no intervention was undertaken at that time. Eight months later the patient had severe calf swelling and pain. Duplex scans showed that the previously thrombosed femoral vein, transposed to one of two duplicated greater saphenous veins, had recanalized, but had significant reflux. Surgery was performed, and consisted of interruption of the anastomosis between the femoral vein and one of the two greater saphenous veins.

**Case 3.** A common femoral vein and femoral vein endophlebectomy in association with external iliac vein angioplasty and stenting was performed. Deep venous thrombosis involving the common femoral vein occurred 12 days later. Surgical thrombectomy with insertion of an additional stent in the common femoral vein was performed. At the end of the procedure venous inflow appeared to be adequate, and an arteriovenous fistula was not considered necessary. At 8-month follow-up the stented venous segment was patent, with some residual narrowing.

In the remaining 10 patients (77%) the segments treated with endophlebectomy remained primarily patent at a mean follow-up of 12 months (median, 12 months; range, 1-28 months). One of these patients received revision angioplasty of an external iliac vein stent stenosis first, then a further endophlebectomy in association with a deep venous reconstruction. This second procedure was performed 13 months later at a site different from the initial endophlebectomy, and was patent on duplex scans at 16-month follow-up.

External iliac vein stent primary and secondary patency rates after endophlebectomy were 83% and 100%, respectively (mean follow-up, 15 months; range, 5-28 months). No new reflux developed in any patient after endophlebectomy.
Clinical outcome in patients with C3-4 disease was as follows. Three patients had significant improvement, 1 patient had no progression of symptoms, and an ulcer developed in 1 patient as a consequence of persistent external iliac vein stenosis and profunda femoral vein reflux. Of the patients with C5-6 disease, 5 had complete healing and 1 had partial healing of the ulcer, and 2 had recurrent ulcers. These last two failures were due to incompetent superficial femoral vein repair and preexisting popliteal vein reflux, respectively.

DISCUSSION

The presence of intraluminal synchiae and masses in postthrombotic veins has been considered a contraindication to deep venous reconstruction. Raju et al\(^3\) reported axillary vein transplant patency rates of 96% at 3 months and 83% at 10 years in trabeculated postthrombotic veins. They excised the intraluminal synchiae with the intent of creating a single lumen for the anastomoses. The endophlebectomy technique we describe extends the concept of resecting intraluminal septae and synechiae\(^3\) to improve inflow and outflow, to actually disobstruct segments that are narrowed by intraluminal scars and masses.

The term *endophlebectomy* must not be considered the equivalent of *endarterectomy* in a vein. Endarterectomy refers to the removal of the diseased intima and exposure of the media of the artery. Endophlebectomy, in this report, refers to removal of endoluminal synchiae and masses, with actual preservation of the intimal surface of the vein. When synchiae are removed at the base of their tenuous attachments, most of the lumen remains covered with endothelium. When large endoluminal masses of scar tissue are encountered, they are placed on traction inside the vein, and removed by meticulous separation of their attachment to the vein lumen, preserving as much of the intimal surface as possible. The plane of dissection lies along the intima of the postthrombotic vessel, because the synchiae belong to this vascular layer, so that exposure of the more thrombo- genic subintimal tissue is minimized.

We did not record the exact length of endophlebectomy in each patient, but the actual disobliteration length ranged from 2 to 15 cm. The procedure grew out of previous experience with resecting septae and bands at the sites of venous anastomoses. This series demonstrates that surgical disobliteration of postthrombotic deep veins can be done successfully in segments up to 15 cm long.

Early thrombosis in the area of endophlebectomy occurred in 3 patients. In 2 of these patients further interventions were carried out with success. In the third patient, early postoperative thrombosis must be counted as a failure, because the final outcome was recanalization and reflux. These results yielded an overall secondary patency rate of 93%. It is possible that an aggressive repeated intervention policy may salvage a reconstruction procedure, but each case must be individualized on its own merits.

We suggest endophlebectomy when there is extensive obstruction in the common femoral vein below the external iliac vein. The endophlebectomy permits reestablishment of patency to multiple branches of the common femoral vein, including profunda, femoral, and large unnamed vessels that are so often present. This is its advantage over common femoral vein stenting.

External iliac vein stent primary and secondary patency rates after endophlebectomy were 83% and 100%, respectively (mean follow-up, 15 months; range, 5-28 months). Primary and secondary patency rates for iliac venous stents in chronic venous insufficiency are, on average, 9-month follow-up have been reported by Raju et al\(^1\) as 71% and 97%, respectively. Inasmuch as endophlebectomy was not used as a stand-alone procedure, we can only suspect that iliac vein stent patency rates were improved in our small series by the adjunct of endophlebectomy, because the inflow from distal segments could be improved by opening additional branches and removing septae and intraluminal masses from existing branches. This report cannot prove this point. Of the patients with C3-4 disease, 3 improved significantly, 1 had no progression of symptoms, and in 1 an ulcer developed, perhaps as a consequence of persistent external iliac vein stenosis and profunda femoral vein reflux. Of the patients with C5-6 disease, 5 had complete healing and 1 had partial healing of the ulcer, and 2 patients had recurrent ulcers. These last two failures were associated with incompetent superficial femoral vein repair and preexisting popliteal vein reflux, respectively.

It is ideal that lower extremity deep venous thrombosis be treated early, to avoid valve damage and venous outflow obstruction leading to postthrombotic disease,\(^6\) but when these occur, several treatment options are available, including surgical reconstruction. The results of deep vein reconstruction can be affected by inadequate inflow and residual outflow obstruction, which might be responsible for early postoperative deep venous thrombosis and persistent symptoms of venous hypertension.

To obtain adequate inflow and outflow in reconstructed segments, several techniques can be used, such as venous angioplasty with stenting or arteriovenous fistulas. Endophlebectomy is a procedure that can be added to these techniques to increase the number of operable veins and the success rate.

The actual rate of early postoperative thrombosis after deep venous surgery to treat secondary disease is unclear, based on current literature. In a study by Perrin,\(^1\) ascending venograms were routinely obtained 24 to 48 hours after deep venous reconstruction. Very limited early postoperative thrombosis was observed in as many as 32% of patients after deep venous surgery in postthrombotic limbs, as opposed to 8.8% in primary venous disease. The study demonstrated a propensity for postoperative thrombotic events in postthrombotic limbs, although the natural history of these events needs further investigation. Potential thromboses of disobstructed venous segments are certainly of concern, because removal of the intimal layer may cause early postoperative thrombosis. We believe that to achieve a successful endophlebectomy one should preserve as much as possible of the endothelial lining while removing the intraluminal synchiae. In our experience, postoperative thrombosis at the site of endophlebectomy occurred in 23% of patients. Whether these thrombotic events were due to too
much or too little endophlebectomy is difficult to assess. It is possible that other factors, such as poor calf pump or inadequate stenting of obstructed segments, contributed significantly to these events. By performing additional inflow and outflow procedures (arteriovenous fistula in 1 patient and further endoluminal stenting in another patient), we were able to keep some obstructed segments patent.

This is an aggressive approach to restore patency to chronically obstructed deep veins using combined therapeutic modalities. The endophlebectomy procedure enables removal of obstruction in the late postthrombotic phase. The surgical release of synchieae, septae, and endoluminal masses significantly increases diameter, compliance, and flow in treated vein segments, as observed on duplex scans.

This study was retrospective, and we were not able to quantify the changes in flow through the obstructed segments. However, we observed that after endophlebectomy new sources of flow were attained by uncovering of the lateral ostia of venous tributaries.

The procedure has been used as an adjunct to deep venous reconstruction. It has the potential to be used as a stand-alone procedure for focal obstructions in the late chronic phase of postthrombotic disease.

This use of surgery in late postthrombotic venous obstruction disease challenges long-held taboos about the potential for reconstruction in these advanced cases. The cases in this series demonstrate the feasibility of operating successfully within the lumen in postthrombotic veins, and suggest the principle that the healed intimal surface in the late postthrombotic state need not be regarded as a hypercoagulable surface. This could provide encouragement for the future placement of functional valves in recanalized, postthrombotic segments.

Although this early experience is encouraging, further studies and longer follow-up are necessary to assess the durability of the procedure.

REFERENCES


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INVITED COMMENTARY

Michael C. Dalsing, MD, Indianapolis, Ind

This article describes a select group of patients with postthrombotic syndrome treated with open operative removal of synchieae and septa (endophlebectomy) that were blocking adequate flow in deep veins (length, 2-15 cm), with the goal of increasing flow and improving results of simultaneous deep venous reconstruction. Current belief would have postulated almost uniform failure (eg, recurrent thrombosis from exposed subintimal collagen in an already damaged vein), yet there was a 77% primary patency rate and 93% secondary patency rate.

This retrospective study took more than 6 years in a busy practice to accumulate 13 patients with such significant disease that endophlebectomy was deemed necessary to result in any hope of a successful stenting or reflux procedure. I surmise that the technique was first performed as an innovative solution to an operative finding, and matured from that experience. Because the study was retrospective, readers are not provided detailed information on the length of endophlebectomy or a duplex scan measure of the degree of increased diameter, compliance, or flow in the treated veins. In the Discussion the authors state that new sources of flow were observed via uncovered lateral ostia of venous tributaries after endophlebectomy, but confirmatory data were not presented.

Such information would provide insight into how aggressive one can be with the procedure (length of vein to treat) and what measurable effect one can expect. Patency and clinical outcome are clearly reported, demonstrating that endophlebectomy will generally provide a patent conduit and may benefit a simultaneous repair. The technique of “endophlebectomy,” as reported by the authors, is extremely important, and not equivalent to “endarterectomy,” but is preformed to preserve as much intima as possible. This is likely the key to the results noted.

This is another seminal paper regarding treatment of end-stage venous disease from a well-respected group of investigators in the field. They continue to “push the envelope” of treatment and to dispel long-held beliefs. They suggest and demonstrate that postthrombotic stenotic veins can be operated on to remove obstructing debris with a reasonable chance for success. Although currently preformed in conjunction with more standard interventions, the authors suggest that this procedure may work as a stand-alone method for improving flow. Clearly, more detailed study is needed to prove the utility of endophlebectomy in the treatment of venous disease, but the stage has been set by Puggioni and colleagues.