The Effect of Deep Venous Stenting on Healing of Lower Limb Venous Ulcers

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WHAT THIS PAPER ADDS
This study reports ulcer healing outcomes following deep vein stenting. It will guide decision makers in treatment choices for venous ulcer management.

Objective: To report the outcomes of endovascular interventions on deep veins in patients with venous ulcers (C6).

Methods: This was a retrospective review of a case series. All patients with active venous ulceration who underwent endovascular interventions to the deep venous system from February 2011 to June 2013 were included. Patients with C6 disease who failed a trial of adequate compression therapy or superficial vein interventions were considered for evaluation of the deep veins. Patients with deep vein reflux or without significant venous reflux or with a previous history of deep vein thrombosis underwent computed tomographic venogram or ascending venogram. In the absence of intravenous ultrasound trial ballooning to look for a “waist” to identify subtle lesions was used. Lesions were stented with long Nitinol stents.

Results: Thirty-eight patients underwent deep vein stenting of 44 limbs with venous ulcers. The lesions were considered to be post-thrombotic in 31 limbs and non-thrombotic iliac vein lesions in 13 limbs. A mean of 1.8 stents were used per patient. There were no significant complications associated with the interventions. At a median follow-up of 15 months, the primary and assisted primary patency rates were 94% and 97%, respectively. Sustained ulcer healing was achieved in 60% of limbs. A further 20% of ulcers had reduced in size. Recurrent ulcers developed in 13% of limbs, and half of these healed with interventions for newly developed incompetence in superficial veins.

Conclusion: Endovascular interventions to the deep veins appear to be an effective adjunct in achieving the healing of recalcitrant ulcers.

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INTRODUCTION

Venous ulcers are a common and recalcitrant problem. The estimated prevalence of active venous ulcers is 0.8—1.0 per 1000 population.1 The mainstay of management has been compression therapy with or without interventions to correct superficial venous reflux.2,3 However, all strategies are known to be associated with a recurrence rate of 25—56% in the longer term.4

In the past, persistent ulcers have been addressed by repair or transposition of deep vein valves with good success.5 The contribution of obstructive disease within the deep venous system in the development of venous stasis ulcers has been largely ignored. Work from a few centers has highlighted its relevance in the development of the features of venous insufficiency.6,7

The aim of the current study was to report experience with the stenting of deep veins in patients with persistent venous ulcers.

MATERIAL AND METHODS

This was a retrospective review of prospectively collected data.

Study group

Patients with active venous ulcers attending the outpatient clinics of the Narayana Institute of Vascular Sciences during the period February 2011—June 2013 were evaluated for venous insufficiency.

Assessment

In addition to taking a thorough history and physical examination, all patients underwent duplex ultrasound (US) evaluation of the superficial and deep venous systems of the affected limb. Incompetence was defined as the presence of reverse flow in the femoral vein lasting >1 s after
distal augmentation, and at the saphenofemoral/saphenopopliteal junctions and saphenous trunks lasting >0.5 s.8

Patients with superficial reflux were offered endovenous ablation with compression therapy, and others were treated with compression therapy alone. Patients who failed an adequate trial of compression therapy or who had a persistent ulcer despite successful abolition of superficial reflux underwent assessment of the deep venous system by contrast-enhanced computed tomographic (CT) venogram.

CT venogram images were reviewed for telltale signs of deep venous pathology. CT characteristics of deep venous obstruction were the absence or narrowing of the vein, and discrepancy in bilateral vein diameters. A reduced diameter was considered suggestive of fibrosis and an increased diameter was suggestive of pre-stenotic dilatation, the presence of significant pelvic or axial collaterals, or visible compression of the iliac vein by overlying arterial structures. Enlargement and prominence of the deep femoral vein, especially in comparison with the opposite side, was assessed at the same time. Patients with the features of deep vein obstruction on CT venogram underwent ascending venography and intervention, if appropriate.

**Interventional techniques**

All procedures were performed under local anesthesia supplemented with intravenous analgesia and sedation when required. This was most often at the time of trial ballooning or therapeutic angioplasty or stenting.

Ascending venogram was performed by US-guided percutaneous puncture of a normal segment of vein caudad to the presumed site of disease, most commonly the common femoral vein through a 6-Fr sheath. Images were acquired with a contralateral 20° oblique view for the iliacs and 20° ipsilateral oblique view for the femoral vein. If normal, images were acquired in a projection of 90° to the original plane.

When the common femoral vein (CFV) was assessed as being disease-free it was the preferred site for access. For patients with diseased femoral veins but well developed deep femoral veins, access was obtained through the normal section of femoral vein or popliteal or small saphenous vein (SSV). Where the deep femoral vein was not well developed, access was always obtained through the popliteal or SSV with the patient prone.

Compression or narrowing is not considered to be the only sign of venous obstruction; other features were also considered.9 Features suggestive of iliac vein obstruction were occlusion, stenosis, abnormal collaterals, layering of contrast, holdup and non-clearance of contrast, filling defects, and axial or cross-pelvic collaterals. Fig. 1 shows the venographic appearance of an NIVL lesion before and after stenting.

Lesions were classified as being likely post-thrombotic or non-thrombotic iliac vein lesions (NIVL) according to their venographic features. Discrete areas of abnormality at sites described for proximal and distal NIVL were classified as NIVL. Non discrete lesions and lesions in patients with a history of deep vein thrombosis (DVT) were classified as post-thrombotic.

Unfractionated heparin (80 IU/kg) was administered and the lesion crossed using a combination of an angled catheter with a 0.35′ hydrophilic wire. Once across the lesion, the hydrophilic wire was exchanged for a stiff J tip 0.35′ guidewire (Emerald; Cordis, Bridgewater, NJ, USA).

In the absence of clearly visualized occlusions or stenosis, “trial angioplasty” was performed. The 6-Fr sheath was exchanged for a 9-Fr one compatible with 12−14-mm balloons (Atlas, Bard Peripheral Vascular, Tempe, AZ, USA; and Maxi LD, Cordis). A 14-mm (common iliac vein [CIV]) or a 12-mm balloon (external iliac vein [EIV]) was inflated until it achieved a smooth cylindrical shape or a pressure of 1 atmosphere under fluoroscopic guidance. The presence of a “waist” during this process was considered to be diagnostic of a stenosis.

All stenotic and occlusive lesions were treated by stenting. For significantly stenotic or occlusive lesions predilation with smaller diameter balloons was performed first. Self-expanding Nitinol stents were used preferentially. For inferior vena cava (IVC) lesions, large-diameter (16−24 mm) Niti stents (Taewoong Medical, Seoul, Korea) were used. E-Luminexx stents (Bard Peripheral Vascular) were used for common iliac lesions of 12−14 mm diameter, external iliac lesions of 10−12 mm, common femoral lesions of 8−10 mm diameter, and femoral vein lesions of 6−8 mm diameter. Where multiple stents were used extensive overlap was avoided ensuring that no areas were left uncovered.

Long stents were used with the aim of covering the visible lesion and also a minimum of 2−3 cm proximal and distal to the lesion. For common iliac lesions the cranial end of the stent was extended well into the IVC.

In the case of bilateral disease, the stents were deployed by a kissing technique with the creation of a double barrel of stents in the IVC. If required, the external iliac stent was extended across the inguinal ligament to reach a healthy inflow segment. All stents were post-dilated to their nominal diameters and checked via venograms to confirm an.

![Figure 1. Non-thrombotic iliac vein lesion before and after stenting. Note degree of stent extension within the inferior vena cava.](image-url)
adequate flow. Improved diameter with good washout of contrast from the stented area, the disappearance of collaterals, the absence of filling defects, dye stasis, and layering were treated as successful end points.

Sheaths were removed in the angiosuite and local compression applied.

Postoperative management and follow-up

In the absence of contraindications all patients were started on therapeutic anticoagulation with low molecular weight heparin (LMWH) within 6 h of sheath removal.

Patients were discharged the next morning on warfarin with LMWH cover until an international normalized ratio (INR) of >2 was achieved (target INR 2–3). Below-knee stockings providing 23–32 mmHg of compression (Sigvaris, Winterthur, Switzerland) were applied over a paraffin gauze dressing. Patients were advised to wear them 24 h a day. Fig. 2 illustrates the ulcer outcomes during follow up.

Patients were advised to attend follow-up at 6 weeks, 3 months, and annually thereafter for clinical assessment. Ulcers were assessed clinically with regard to whether they had healed (i.e., completely epithelialized, reduced in size, remained the same, recurred, or increased in size).

Where possible, duplex US examination was carried out to confirm stent patency at 6 weeks and 3 months, and thereafter at 3-monthly intervals until 2 years after surgery. Unless there was an underlying pro-thrombotic condition requiring continued warfarin use, it was stopped at 3 months. All other patients were advised to continue on low-dose aspirin indefinitely at 75 mg once daily.

Patients living overseas or far from the hospital were followed up by telephone and email with the assistance of clinical photographs. Attempts were made to contact all patients immediately prior to publication of this article.

All patients were advised to contact the hospital urgently in the event of developing any leg swelling or pain.

Statistical analysis

Data were entered into an Excel spreadsheet (Microsoft, Redmond, WA, USA) and exported to SPSS version 15.0 (IBM, Armonk, NY, USA) for analysis. The outcomes were assessed in three groups: ulcer-free, ulcer-persistent, and ulcer-recurrent. The proportions of risk factors associated with outcome were assessed using Fisher’s test. A p-value < .05 was considered significant. A Kaplan–Meier analysis for ulcer outcomes for all patients and also for those who achieved ulcer healing was carried out.

RESULTS

During the study period, 38 patients underwent stenting of the deep venous system because of the presence of venous ulcers in 44 lower limbs. The clinical data are presented in Table 1.

Procedure details

All procedures were completed under local anesthesia with percutaneous access. Percutaneous access was obtained through CFV and femoral vein in 26 and seven patients, respectively. Access was obtained through the small saphenous or popliteal veins in five patients. In three patients with unilateral iliac vein occlusions, the contralateral CFV was accessed to acquire a roadmap of the iliac confluence and IVC. In three patients with IVC occlusions, additional access was obtained from right UV.

Table 1. Clinical and ultrasound data.

<table>
<thead>
<tr>
<th>Patients (n)</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (F:M)</td>
<td>1:2:1</td>
</tr>
<tr>
<td>Age in years (median)</td>
<td>25–67 (45)</td>
</tr>
<tr>
<td>History of DVT (n)</td>
<td>7</td>
</tr>
<tr>
<td>Duration of ulceration, mo (median)</td>
<td>1–120 (36)</td>
</tr>
<tr>
<td>Limbs involved (n)</td>
<td>44</td>
</tr>
<tr>
<td>Right only (n)</td>
<td>13</td>
</tr>
<tr>
<td>Left only (n)</td>
<td>19</td>
</tr>
<tr>
<td>Bilateral ulceration (n)</td>
<td>6</td>
</tr>
<tr>
<td>Previous venous procedures in limbs (n)</td>
<td>13</td>
</tr>
<tr>
<td>High ligation with stripping (n)</td>
<td>9</td>
</tr>
<tr>
<td>Femoro-caval bypass graft (n)</td>
<td>1</td>
</tr>
<tr>
<td>EVLT (n)</td>
<td>1</td>
</tr>
<tr>
<td>IVC filter (n)</td>
<td>1</td>
</tr>
<tr>
<td>IVC stent (n)</td>
<td>1</td>
</tr>
</tbody>
</table>

Venous duplex ultrasound findings

<table>
<thead>
<tr>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep venous reflux (femoral vein)</td>
<td>8</td>
</tr>
<tr>
<td>Significant SFJ reflux</td>
<td>3</td>
</tr>
<tr>
<td>Significant SPJ reflux</td>
<td>0</td>
</tr>
<tr>
<td>Perforator incompetence</td>
<td>28</td>
</tr>
</tbody>
</table>

Note. F = female; M = male; DVT = deep vein thrombosis; EVLT = endovenous laser treatment; IVC = inferior vena cava; SFJ = saphenofemoral junction; SPJ = saphenopopliteal junction.

Figure 2. Clinical evolution of lesions treated with deep venous stenting.
The probable lesion was classed as NIVL in 13 limbs and post-thrombotic in 31. Four patients had complete occlusions and 34 had stenotic lesions.

The distribution of stented regions, and of stenosis and occlusions is shown in Table 2. The stented regions correspond with the distribution of pathology and the CIV/EIV segment was the most commonly covered. A mean of 1.8 stents was used per patient.

The stents were extended across the inguinal ligament in five limbs.

The stents ranged from 40 mm to 120 mm in length. The most commonly used stents were the \(14/8 \times 100\) mm and \(14/8 \times 120\) mm stents, reflecting the preponderance of CIV involvement and the smaller size of blood vessels in the Indian subcontinent. Median stent length was 100 mm (40–120 mm) and the median length of vein stented was 140 mm (60–260 mm).

Procedure-related complications included extravasation of contrast due to presumed venous perforation in three patients with venous occlusions. None of these events was associated with hemodynamic instability, the need for blood transfusions, or other clinical consequences.

Two access site hematomas were managed conservatively. All patients were discharged the day after the procedure.

### Outcomes

#### Stent patency
Thirty-five limbs were assessed at 6-week, 3-month, and annual follow-up appointments. Patients living far from the hospital were advised to have a venous duplex US carried out locally and to report the results. A median follow-up of 15 months (1.5–28.0) was available for 35 limbs.

For calculation of the Kaplan–Meir analysis of stent patency, if any stent was found to be patent, it was assumed to have been patent at all time points prior to this. Venous Doppler at 6 weeks demonstrated one confirmed stent occlusion, which occurred within the first 2 weeks. Stents in the other 43 limbs remained patent. At 13 months, one patient required reintervention for a new ulcer with evidence of more caudad disease, which was successfully treated by placing a further stent. The cumulative primary and primary assisted patency at a median follow-up of 15 months were 94% and 97%, respectively.

#### Ulcer outcomes

At a median follow-up of 15 months, sustained ulcer healing was achieved in 51% of limbs. The majority (58%) of these ulcers had healed at 6 weeks. An ulcer healing rate of 60% was achieved with the use of adjunctive procedures. Ulcer-

### Table 2. Distribution of vein lesions (n) by region.

<table>
<thead>
<tr>
<th>Region stented</th>
<th>Stenosis</th>
<th>Occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVC only</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>CIV only</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>EIV only</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>CFV only</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FV only</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>IVC + CIV</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>IVC + CIV + EIV</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>IVC + CIV + EIV + CFV</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>CIV + EIV</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>CIV + EIV + CFV</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>EIV + CFV</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note. IVC = inferior vena cava; CIV = common iliac vein; EIV = external iliac vein; CFV = common femoral vein; FV = femoral vein.

### Table 3. Ulcer-related outcomes.

<table>
<thead>
<tr>
<th>Follow up (%)</th>
<th>6 weeks (n = 37)</th>
<th>15 months (n = 35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healed</td>
<td>22 (59.4)</td>
<td>18 (51.4)</td>
</tr>
<tr>
<td>Reduced</td>
<td>11 (29.7)</td>
<td>7 (20.0)</td>
</tr>
<tr>
<td>Unchanged</td>
<td>4 (10.8)</td>
<td>4 (11.4)</td>
</tr>
<tr>
<td>Recurred and healed</td>
<td>0</td>
<td>3 (8.5)</td>
</tr>
<tr>
<td>Recurred and persistent</td>
<td>0</td>
<td>3 (8.5)</td>
</tr>
</tbody>
</table>

### Table 4. Statistical analysis of impact of variables on achieving ulcer-free status at 15 months.

<table>
<thead>
<tr>
<th>Ulcer-free at 15 mo</th>
<th>Ulcer recurrence at 15 mo</th>
<th>Ulcer persistence at 15 mo</th>
<th>Impact on achieving complete healing at 15 mo (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of DVT</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Previous superficial vein surgery</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Deep vein reflux</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>SFJ or GSV reflux</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>SPJ or SSV reflux</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>≥3 incompetent perforators</td>
<td>7</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Oclusion</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Post-thrombotic</td>
<td>13</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>NIVL</td>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Only IVC stented</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Iliocaval stenting</td>
<td>19</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>CFV stent</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Note. DVT = deep vein thrombosis; SFJ = saphenofemoral junction; GSV = great saphenous vein; SPJ = saphenopopliteal junction; SSV = small saphenous vein; NIVL = non-thrombotic iliac vein lesions; IVC = inferior vena cava; CFV = common femoral vein.
related outcomes, in terms of limbs affected, are listed in Table 3, and the statistical analysis in Table 4. Fig. 3 shows the proportions of ulcers achieving healing and Fig. 4 shows the outcomes among ulcers once initial healing is achieved.

The presence of pre-procedure saphenopopliteal junction or SSV reflux was the only factor found to have a significant impact on the achievement of ulcer healing \( (p = .015) \), but given the small numbers it is difficult to be certain about its clinical significance.

Ulcer persistence. At 6 weeks, 11% of ulcers were unchanged and 30% were reduced, but persistent. Median follow-up data at 15 months were available for 35 limbs. Of these, 11% remained unchanged and 20% were reduced, but persistent. Of this group, 73% had changes consistent with post-thrombotic sequelae, and 27% had features suggestive of NIVL.

Two patients were found to have new-onset segmental superficial reflux—they underwent endovenous laser ablation of a refluxing segment of the great saphenous vein. In both limbs, the ulcer healed within 6 weeks of intervention.

Another patient underwent foam sclerotherapy of a short saphenous vein, but the ulcer has persisted.

Another patient has a possible vasculitic component to a very large ulcer. The ulcer has reduced by approximately 30% over 12 weeks.

Of note, among the three patients with NIVL and persistent ulcers, significant ulcer healing defined as a reduction in size of approximately 70–95% was achieved in all. All three patients had very large confluent ulcers covering most of the lower leg. One of this group had had an ulcer for 15 years with multiple local procedures carried out, including skin grafts and failed flaps. This patient had originally approached the unit for an elective below-knee amputation.

Ulcer recurrence. Of the healed ulcers, recurrences occurred in six limbs within the first 6 months. Three of these ulcers have persisted. All ulcer recurrences have been in patients with post-thrombotic damage.

Of the persistent recurrent ulcers, two were tiny ulcers in a patient with bilateral disease. In the other limb, recurrence was associated with new onset postmenopausal bleeding and suspected endometrial cancer. In both patients, the stents appeared patent with freedom from restenosis on duplex US and CT venogram.

Three ulcers recurred and healed after interventions. One ulcer healed after foam sclerotherapy of a dilated short saphenous vein. Another ulcer appeared in association with infection of an occluded cavo-femoral graft, which was implanted 3 years before, and resolved after removal of the graft. In one patient, ascending venogram demonstrated additional disease in the common femoral vein. The diseased area was stented with an 8-mm stent, and healing was achieved within 2 weeks.

DISCUSSION

Surgical interventions to treat venous ulcers have consisted largely of procedures directed at the reflux pathology within the superficial venous system.\(^4\) Deep vein pathology has been recognized as a risk factor for venous ulcers, especially those that fail to heal after superficial vein surgery. Much effort had been directed towards deep vein valve reconstruction, with good results.\(^5,10\)

Since their development in the 1990s, endovascular interventions for deep venous pathology have gained popularity. The current trend of thrombolysis of iliofemoral DVT is recognition of the likely role of deep vein obstruction in the development of post-thrombotic syndrome.\(^11,12\)
These two strategies, of deep vein stenting and thrombolysis to treat iliacaval occlusions, recognize the vital importance of the iliacaval outflow segment in the development of chronic venous insufficiency.

This series included patients from the Indian subcontinent, the Middle East, and Africa. This has posed challenges in terms of maintaining follow-up.

Compared with other series, this one showed a complete reversal of the sex ratio (female: male [F:M] 1.0:2.1). Others have reported F:M ratios of 4:1 or more, and female gender has been identified to be a risk factor.5,10,13 This perhaps reflects the unique socioeconomic nature of healthcare in India, where women’s access to healthcare is notoriously poorer than for men.14

The distribution of unilateral pathology in this series also differs from other larger series. The left to right ratio was 1.4:1.0, which is different from that reported in the literature, where it ranges from 2.4:1.0 to 8.7:1.0.6,15 Perhaps one reason for this difference could be the relatively smaller proportion of NIVL lesions in this series compared with that of Neglén et al.13

There is no access to intravascular US at the Narayana Institute of Vascular Sciences. This tool has been described as being the most accurate method of diagnosing and treating deep vein obstructive lesions.5,16 A combination of duplex US and CT venography has been relied upon to select patients for an ascending venogram. In addition to the usual techniques of obtaining views in more than one plane, a trial ballooning was utilized to uncover hidden lesions.

Unlike most other reports in the literature, in this study Nitolin stents were used almost exclusively. The largest experience (>1000 limbs) in venous stenting to date has been reported.7,17,18 These studies used stainless steel Wallstents (Boston Scientific-Schneider, Minneapolis, MN, USA) for 98% of cases. Originally, Nitolin stents were used at the Narayana Institute of Vascular Sciences because of the lack of availability of Wallstents. The radial strength and flexibility of the E-Luminexx stent was soon appreciated. Its availability in larger diameters and longer lengths make it ideally suited to venous interventions. Bench testing has previously shown that Nitolin stents have greater radial resistive force than Wallstents.15 In addition, these stents do not elongate and narrow at stenotic segments and thus have a more predictable length.

One patient developed early stent thromboses. This patient had undergone a difficult and prolonged procedure to re cannalize post-thrombotic occlusion of the CIV and EIV. The literature also shows that the majority of stent occlusions occur early,13,20,21 and especially in post-thrombotic limbs.14 Some authors have successfully lysed acutely occluded stents and corrected the underlying problem, with a satisfactory long-term outcome.13 Unfortunately, the patients in this study were unwilling for the same.

In this study, the primary assisted patency rate of 97% is similar to other large series reported.5,13,22

So far, one endovascular reintervention has been performed, at 13 months, to achieve ulcer healing. This was perhaps because the primary stents did not reach healthy inflow or due to the development of fibrosis caudad to the stent. Other series have reported a median reintervention time of 8 or 15 months, with a reintervention rate of 13%.6,12,20

In this series patients had a distribution ratio of NIVL lesion:post-thrombotic lesion of 1.0:2.4. This is different from the series of Neglén et al.,13 where a nearly equal distribution between the two groups was found.

In this study, an ulcer healing rate of 51% was achieved at 15 months, which increased to 60% with the assistance of additional procedures distant from the index stenting, which is similar to other large series.14 Alhalbouni et al.23 also report a 58% ulcer healing rate with a median follow-up of 3.6 months.

Among the 31% of ulcers that persisted three were associated with NIVL lesions and had been expected to heal. These three patients had very large and chronic ulcers, with one patient previously having had multiple surgical procedures on the ulcer.

The ulcer healing rates in the post-thrombotic and NIVL groups were similar (64% and 66%, respectively). This is similar to the series reported by Neglén and Raju.13 The healing rates in this study are inferior to those of Ye et al.,22 where a healing rate of 82% was achieved in a series of 205 patients (62 with ulcers) with NIVL.22

In this study, ulcer recurrence occurred in six limbs (17%). Compared with the data of Neglén and Raju,13 this is unusual as their experience suggests that once ulcers heal they stay healed. All recurrences in this study occurred in the post-thrombotic group. Three of these recurrences healed following an additional intervention, as detailed above. A cause for ulcer recurrence in the remaining three patients was not identified.

CONCLUSION

Endovascular treatment of deep veins may be an effective adjunctive treatment in the management of recalcitrant venous ulcers. Using a combination of US, CT venography, and ascending venography with trial ballooning, it is possible to identify patients with deep vein disease. It is important to have a high index of suspicion of deep vein pathology, especially among patients with venous ulcers without evidence of significant superficial reflux.

Ulcer recurrence should prompt a search for undiagnosed or new onset deep or superficial venous system pathology. Some patients will need further interventions on either or both the deep and superficial systems.

ACKNOWLEDGMENTS

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CONFLICT OF INTEREST

None.
REFERENCES