Combined saphenous ablation and iliac stent placement for complex severe chronic venous disease

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Background: **Severe chronic venous disease frequently has a complex pathophysiology. This study describes results after combined interventions to correct outflow obstruction and superficial reflux, even in the presence of deep venous reflux.**
Methods: **Between 1997 and 2005, 99 limbs in 96 patients had percutaneous iliofemoral venous stenting combined with great saphenous vein (GSV) stripping (39 limbs), or percutaneous GSV ablation performed by radiofrequency (27 limbs) or laser (33 limbs). Clinical severity score in CEAP was C4 in 51 limbs, C5 in eight limbs, and C6 in 40 limbs; median age was 56 years (range, 27 to 87 years); left–right limb ratio, 2.3:1; female–male ratio, 1.8:1; primary–secondary etiology, 58:41. Perioperative investigations included visual analogue pain scale (VAS), degree of swelling (grade 0 to 3); quality-of-life questionnaire; venous filling index in milliliters per second (VFI_{90}), venous filling time in seconds (VFT), percentage in ambulatory venous pressure drop (AVP), duplex Doppler scanning, and radiologic studies.**
Results: **Clinical follow-up was performed in 97 (98%) of 99 for up to 5.5 years. Axial deep reflux was found in 27% (27/99). At least three venous segments were refluxing in 40% of limbs. Preoperative hemodynamic parameters reflected the presence of reflux and improved significantly ($P < .01$) after the procedure (VFI_{90}, 3.8 to 2.3 mL/s; VFT, 11 to 16 seconds; AVP, 55% to 65%). No patients died, and the morbidity with endovenous GSV ablation was largely limited to ecchymosis and thrombophlebitis in the thigh area. Cumulative primary, assisted primary, and secondary stent patency rates at 4 years were 83%, 97%, and 97%, respectively. After treatment, limb swelling and pain substantially improved. The rate of limbs with severe pain (≥5 on VAS) fell from 44% to 3% after intervention. Gross swelling (grade 3) decreased from 30% to 6% of limbs. Cumulative analysis showed sustained complete relief of pain (VAS = 0) and swelling (grade 0) after 4 years in 73% and 47% of limbs, respectively. Ulcers healed in 26 (68%) of 38 ulcerated limbs. Cumulative ulcer-healing rate was 64% at 48 months. All quality-of-life categories significantly improved after treatment.**
Conclusion: **The single-stage combination of percutaneous venous stenting and superficial ablation in patients with severe chronic venous disease is safe, gives excellent symptom relief and improvement of quality of life, and a well-maintained ulcer-healing rate. It seems logical to initially perform multiple minimally invasive interventions rather than open surgery. Any associated deep reflux can initially be ignored pending clinical response to the combined intervention. (J Vasc Surg 2006;44:828-33.)**

The evolution in surgery as a whole is towards less invasive procedures. This is true for general surgery and various subspecialties. Open removal of the gall bladder has been replaced by laparoscopic cholecystectomy, and abdominal aortic aneurysm is often controlled by aortic stent grafts. The approach towards treatment for chronic venous disorders has also changed with the introduction of minimally invasive techniques. Saphenous vein stripping has largely been replaced by endovenous obliteration techniques.[1,2] The safe and efficient percutaneous stenting of femoral-ilial-caval outflow obstruction has largely replaced open bypass surgery.

It has also focused interest on the importance of outflow obstruction in the projection of symptoms and allowed relatively simple treatment with wider applicability.[3,4] When complex venous disease is present with severe clinical symptoms, often multiple venous segments are involved by obstruction or reflux. This study assessed one-stage treatment with saphenous ablation and iliofemoral stenting for severe chronic venous disorders.

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METHODS

The study patients were selected from a database of 970 consecutive patients undergoing venous stenting between October 1997 and March 2005. The CEAP classification according to the reporting standards of International Society of Cardiovascular Surgeons (ISCVS)/Society of Vascular Surgeons (SVS) had been used to assess presenting clinical severity.[5,6] The selected limbs belonged to the clinical severity class 4 to 6 in the CEAP classification, had a combination of great saphenous vein (GSV) reflux (with or without deep reflux) and iliofemoral obstruction, and had no previous interventions for the venous disease. These criteria were used to identify 99 limbs in 96 patients, which were included in the analysis.

The obstructive lesion was considered thrombotic when the patient had a known history of deep venous thrombosis (DVT) or when postthrombotic changes in the lower extremity were found on venogram or duplex ultra-

sound imaging. A variety of investigations were performed before treatment.

Duplex Doppler study. Standardized compression-release was used for this study.[7] Duration of reflux >0.5 seconds was considered significant. The pattern of reflux was reported in two ways: (1) in a deep axial fashion, mimicking Kistner's classification, giving 1 to 4 points, as the reflux involved common femoral, femoral, popliteal, and distal posterior tibial veins, consecutively; (2) in a multisegment score with 1 point each awarded to the femoral, profunda, popliteal, posterior tibial, above and below knee great saphenous, and small saphenous veins (maximum score = 7), whether or not axial reflux was present.[8-10] Deep reflux reaching below the popliteal vein (ie, Kistner classes 3 and 4) was considered axial and severe. Duplex ultrasound imaging was also used to assess patency of pelvic stents postinsertion.

Ambulatory venous pressure measurement. The pressure was recorded in the dorsal vein with the patient standing erect and motionless and holding on to a frame, during ten toe-stands, and throughout the period of pressure recovery to baseline level. The ambulatory venous pressure was measured as percent drop of baseline pressure at rest to the level at the end of the exercise (AVP, %). The time required for the pressure to return to base level was the venous filling time (VFT, seconds).

Air plethysmography. Details of air plethysmography using APG-1000 (ACI Medical Inc, Sun Valley, Calif) have been described by Christopolous et al.[11] Venous filling index (VFI, mL/s), measured at 90% of total increase of calf volume when shifting from the supine to the erect position (VFI_{90}), has been shown to be a useful parameter to reflect global venous hemodynamics.[8]

Ascending and transfemoral venography. Injection of contrast medium into the common femoral or femoral vein was made to delineate the distribution and nature of femoral-ilial-caval morphologic changes, including occlusion, stenosis, and presence of collateral circulation, and to assess patency of inserted iliofemoral stents. Ascending venogram with injection of contrast medium into a dorsal foot vein was occasionally used to evaluate stent patency.

Intervention. Percutaneous stenting of the iliofemoral venous outflow was performed in all patients in combination with control of the superficial reflux. Procedures were performed in a dedicated angiography suite under general anesthesia because patients often experience intensive back pain uncontrolled by sedation and local anesthesia during balloon angioplasty of a tight iliac vein obstruction, the recanalization procedure may be lengthy, and multiple phlebectomies and sharp debridement of ulcers are often performed in the same sitting. Remaining deep reflux, if present, was left untreated.

During 1997 to 2000, stripping of the GSV was mainly performed, radiofrequency obliteration of the GSV was used in 2001 and 2002, and from 2003, the GSV was ablated by laser (810 nm). Standard techniques were used and are described elsewhere.[1,2]

Significant superficial saphenous vein reflux, if present, was treated with stripping, and stab miniphlebectomies of nontruncal varicosities were performed as indicated. The procedure started with treatment of the superficial reflux and a temporary compression bandage was applied up to the lower thigh.

After femoral vein cannulation, transfemoral venogram, and intravascular ultrasound (IVUS) imaging, but before balloon venoplasty and stenting, 3000 units of heparin was given intravenously. The patients also received 2500 units of dalteparin subcutaneously before and after surgery, and an additional dose of 5000 units was administered the postoperative morning before discharge. Patients with nonthrombotic disease continued taking 81 mg of aspirin daily. Patients with thrombotic disease taking warfarin preintervention continued anticoagulation postintervention or anticoagulation with warfarin was started postintervention in patients when thrombophilia was diagnosed before stent insertion.

The technical details of percutaneous stenting of the iliofemoral venous outflow tract have been outlined previously.[12-14] The indication for stenting was the finding of a >50% morphologic stenosis on transfemoral venography or IVUS imaging. Crosscut area of the stenosis was measured by IVUS and compared with the area of the normal vein below the stenosis.

Follow-up. The treated limbs were monitored clinically. The study end point of legs with stasis ulceration was healing (ie, complete epithelialization). Most patients had exhausted conservative treatment, including ulcer dressings, compression stockings, and Unna boot application before intervention, without healing of the ulcer. Compression and local ulcer therapy was continued after intervention until healing. Prolonged use of compression regimen in general was not encouraged, because many considered it a quality-of-life issue. Noncompliant patients were not fitted with new stockings.

After intervention, the local ulcer care and compression therapy was continued. Cumulative ulcer healing rate was calculated including legs with ulcers that never healed and legs with ulcers that healed but later recurred. Ulcers that never healed were initially considered healed for up to 3 months (given time to heal) before being considered nonhealed in the cumulative analysis. Any breakdown of an ulcer after healing was considered a recurrence.

The degree of pain was evaluated perioperatively by using a visual analog scale from 0 to 10, wherein 10 is the most severe pain.[15] Swelling was assessed as grade 0 (absent), grade 1 (pitting, not obvious), grade 2 (visible ankle edema), and grade 3 (massive, encompassing the entire leg) as per reporting standards. Patients were asked to fill out a quality-of-life questionnaire assessing subjective pain, sleep disturbance, morale, and social activities, as well as routine and strenuous physical activities (CIVIQ), prospectively before intervention and again at each subsequent postoperative visit.[16] This quality-of-life questionnaire has been validated for assessment of chronic venous insufficiency. Numerical grades (1 to 5) were provided for each question,

Venous hemodynamic parameters before compared with after treatment

	AVP, % drop	*VFT (seconds)*	*VFI_{90}, (mL/s)*
Pretreatment	55 (11-100) (n = 83)	11 (1-108) (n = 81)	3.8 (0.4-13.2) (n = 93)
Post-treatment	65 (22-89)*** (n = 32)	16 (2-120)** (n = 33)	2.3 (0.6-13.2)*** (n = 62)

AVP, Ambulatory venous pressure; *VFT,* venous filling time; *VFI_{90},* venous filling index measured at 90% of total increase of calf volume.
Data are median (range).
**< .01
**< .001

allowing the patient to assign a numeric value to the answers. The last available response was used in postoperative outcome analysis.

Venous function studies were repeated on follow-up. In addition, a single-plane transfemoral venogram, an ascending venogram, or an iliofemoral duplex ultrasound scan was obtained early (2 to 3 months) after stenting, repeated 9 months later, and then performed annually thereafter as a routine surveillance of stent patency. If the patient returned with recurrence of symptoms, transfemoral venogram was always used to assess patency of the venous outflow tract. In-stent restenosis, if present, was assessed as percentage diameter reduction of patent lumen of the stent on venogram.

Clinical data were entered prospectively into a time-stamped electronic medical records program for subsequent analysis. The nonparametric Wilcoxon rank test for paired and unpaired data and χ^2 were used for statistical analysis as appropriate. The commercially available statistical program Graph Pad Prism 3 (GraphPad Software, San Diego, Calif) for Windows (Microsoft Corp., Redmond, Wash) was used for analysis. Primary, assisted primary (patency after preemptive intervention), and secondary patency (patency after intervention for occlusion) rates as defined by the reporting standards of the SVS/ISCVS[5] were calculated using survival analysis with the Kaplan-Meier method. Cumulative survival curves were also used to analyze and compare recurrence of pain, swelling, and ulcer after the treatment. $P < .05$ was considered significant.

RESULTS

The median age of the patients was 56 years (range, 27 to 87 years). Female gender and left lower limb involvement was twice as common than male gender and right lower limb (female–male ratio was 2.3:1 and left–right lower limb ratio was 1.8:1). The C score in CEAP was C4 (hyperpigmentation, dermatitis, lipodermatosclerosis) in 51 limbs, C5 (healed venous ulcer) in eight limbs, and C6 (active ulcer) in 40 limbs. The etiology was primary in 58 and secondary in 41 lower limbs.

The pathophysiology of all limbs included the combination of outflow obstruction and reflux. All limbs had superficial incompetence, including GSV reflux from groin to below the knee. In addition, deep venous reflux was observed in 34 limbs, but axial deep reflux to below the knee (Kistner class 3 and 4) was found in only 27 limbs (27%). The median multisegment score was 2 (range, 1 to 7); that is, 40% of limbs had ≥3 segments with reflux. Preoperative venous hemodynamic parameters are summarized in the Table.

All patients underwent endovenous stenting. IVUS detected a mean ± SD area stenosis of 73% ± 18%. The prestent crosscut area of the most severe stenosis was 0.47 ± 0.30 cm^2 and increased after stenting to 1.74 ± 0.39 cm^2. Five limbs required recanalization of occlusion before stenting. In the same sitting, the superficial reflux was treated in all patients. Stripping of the GSV was performed in 39 limbs combined with superficial saphenous vein (SSV) stripping/stab avulsions in five, SSV stripping in one, and stab avulsions in 18. Radiofrequency ablation of the GSV was performed in 27 limbs combined with SSV stripping/stab avulsion in one, and stab avulsions in six. Endovenous laser obliteration was performed in 33 limbs combined with SSV stripping/stabs in two, and stab avulsions in 18. The interventions were performed with <23 hours hospital stay.

The interventions were performed with no mortality (<30 days), and no access related complications occurred in this series. Possibly because of severe thrombophilia, one patient developed immediate intraoperative clotting of the inserted stent, despite anticoagulation, and had open thrombectomy, which failed. The stent remained closed. Complications related to the procedure occurred in 18 patients ≤30 days postoperatively. The rate and severity was lower when endovenous GSV ablation was used compared with the stripping procedure.

Conservatively treated thigh thrombophlebitis, bruising, or pulling pain, or a combination, were observed in seven limbs and mild first-degree skin burn in one limb with radiofrequency closure (8/60, 13%). GSV stripping resulted in complications in nine (23%) of 39 patients: infected groin wound surgically drained in two, conservatively treated "strip channel" hematoma in four, and one patient each with groin seroma, wound necrosis, and delayed wound healing. DVT developed postoperatively in two patients. In one patient, early DVT of the contralateral iliofemoral vein occurred 27 days postintervention, which was successfully lysed. Ipsilateral DVT developed in another patient 13 months after surgery; clot removal failed.

Venography or iliofemoral venous ultrasonography was performed one or several times in 74 limbs (75%) to verify patency 3 to 66 months (mean, 22 months) after stent placement. Cumulative primary, assisted primary, and secondary patency rates at 4 years were 83%, 97%, and 97%,

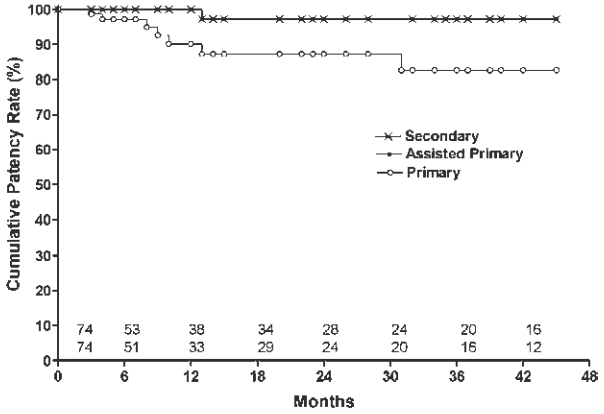

Fig 1. Cumulative primary, assisted primary, and secondary patency rates of iliofemoral stents. The lower numbers represent limbs at risk for each time interval (all SEM <10%).

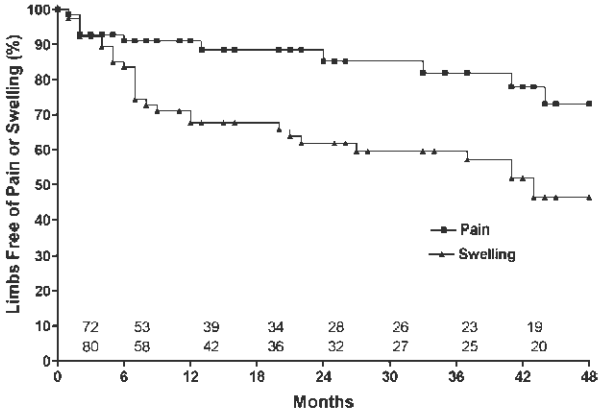

Fig 2. Sustained relief of pain and swelling relief after the combined intervention. The cumulative curves represent limbs with complete relief of pain and swelling, respectively. Only limbs that had preoperative pain or swelling are shown. The lower numbers represent limbs at risk for each time interval (all SEM <10%).

respectively (Fig 1). Eight secondary interventions were performed during the observation period: additional stenting of stenosis above and below the previous stent in one and three limbs, respectively; balloon angioplasty of instent restenosis in three limbs, and combination of these procedures in one limb. Duplex Doppler ultrasound imaging was performed in 41 of 60 limbs with endovenous GSV obliteration (laser obliteration in 21 limbs and radiofrequency closure in 20 limbs). The GSV was found patent and refluxive in 9% and 25% in limbs treated with laser and radiofrequency, respectively.

Mean postinterventional clinical follow-up was 22 months (range, 2 to 68) and was available in 97 (98%) of 99 limbs. Before treatment, 22% of limbs were completely pain-free and 15% had no swelling. After treatment there was a substantial improvement of limbs with swelling and pain. The rate of limbs with severe pain (≥5 on visual analogue scale) fell from 44% to 3% after intervention. Gross swelling (grade 3) decreased from 30% to 6% of limbs. Cumulative outcome of pain and swelling long-term are shown in Fig 2. These graphs are based on complete relief (grade 0 swelling and 0 level of pain) as they provide clear clinical endpoints. After 4 years, 73% remained completely free of pain and 47% from swelling.

The outcome of the venous ulcer was monitored n 38 of 40 ulcerated limbs. The ulcer did not heal in 12 limbs. In the remaining 26 limbs, the ulcer healed and recurred in only one limb during the follow-up period. Thus, ulcer recurrence was rare if healing of the ulcer was achieved after this intervention. The cumulative ulcer-healing rate at 4 years was 64% (Fig 3).

The quality-of-life questionnaire was introduced later in the study explaining the shorter mean follow-up and the smaller number of patients. Preintervention and postintervention quality-of-life results were obtained in 44 patients at mean 6 months (range, 1 to 38 months) after the intervention. All quality-of-life categories after treatment significantly improved, including lower limb pain ($P = .0016$),

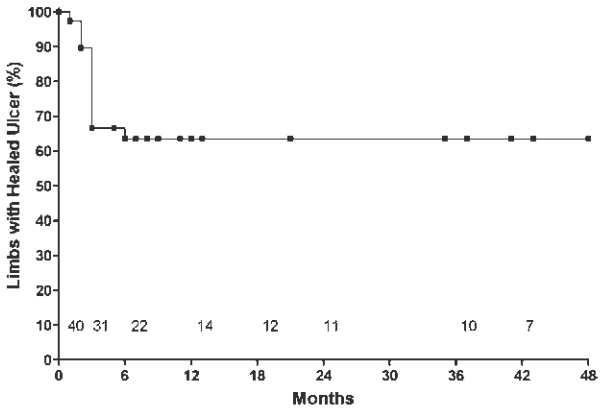

Fig 3. Cumulative rate of healed ulcer after the combined intervention. Ulcers were given a 3-month grace period after intervention to heal and were then considered a recurrence. The lower numbers represent limbs at risk for each time interval (all SEM <10%).

work-related leg problems ($P = .0006$), sleep ($P = .0036$), social activities ($P < .0001$), and morale ($P = .0009$). Generally, the quality-of-life sum of scores decreased by 20% to 30%.

The venous hemodynamic parameters are given in the Table. Air plethysmography was performed one or several times in 63 limbs at a mean 18 months (range, 3 to 60 months) after surgery. Ambulatory venous pressure drop, venous filling time, and venous filling index are mainly indicators that reflux improved significantly overall. After surgery, 16 of 27 limbs with axial deep reflux had repeat ultrasound imaging. The deep reflux remained in all limbs and was not affected by the correction of the superficial reflux.

Certain characteristics of the subgroups of patients with healed ulcers (26) were compared with those with unhealed

ulcer (12). The rate of axial reflux was greater and more venous segments (>3) were involved in the unhealed compared with the healed group (75% and 31%, 67% and 31%, respectively). The VFI_{90} remained elevated after intervention in the unhealed group (6.7 mL/s) and dropped significantly in the healed group (median 4.5 to 2.9 mL/s, $P = .0004$). The healing rate was 77% in the patients that had GSV pin stripping performed compared with 62% in the group with GSV endovenous treatment, but this was not statistically significant ($P = .318$).

The clinical outcome of the 27 patients with untreated axial deep reflux was assessed. Despite this remaining deep reflux, there was substantial clinical improvement after the combined intervention: 8 (50%) of 16 ulcerated limbs healed, 6 (27%) of 22 swollen legs were completely free of swelling, and 13 (68%) 19 patients with pain were completely pain-free.

DISCUSSION

The treatment of severe chronic venous disease by saphenous ablation and venous outflow stenting in one stage gives excellent symptom relief, well-maintained ulcer-healing rate, and improves significantly the patient's quality of life. These results are even achieved in patients with deep axial venous reflux, which was left untreated in the patients in this study. The results appear to be durable, at least in the mid-term, and certainly make it possible to postpone more invasive surgery.

Deep reflux was observed more frequently in limbs with failure of ulcer healing in this study, and open deep valve repair may be required later. When percutaneous repair of the deep valves or replacement of deep valve stations has been developed, it may be added to the treatment arsenal at an earlier stage. The combination of percutaneous stenting and GSV ablation makes this one-stage intervention truly minimally invasive.

It may be argued that one should perform individual interventions in stages. Our experience is that this prolongs the duration of treatment and time to symptom relief. In a multisystem, multilevel disease, the treatment should be directed towards the pivotal diseased venous segment, if such a segment does exist. Perhaps it is entirely presumptuous of us to expect complete symptom relief by treating a single system/level. In any case, presently it is impossible to identify this pivotal segment. In fact, we are presently unable to quantify segmental reflux or obstruction or describe how they interact. The choice of type of individual intervention would therefore be purely conjecture. The basis for intervention would probably be simplicity of intervention.

Partial treatment may also only achieve partial symptom relief, which may be temporary. The introduction of the CEAP classification has been a major step towards appropriate definition of venous disease and report standards. Chronic venous disease is very complex and so is its symptomatology. Substantial leg pain and gross swelling can be present without skin changes,[17] which is not necessarily reflected in the severity classification. Swelling may exist without pain and vice versa. The *C* in CEAP lacks power to evaluate the detailed impact of swelling and pain on clinical severity and needs to be complemented, perhaps, by measurement of degree of swelling, a visual analogue pain scale, and quality-of-life assessment. The use of these measurements in the present study showed substantial and statistically significant improvement in all these aspects.

It is a mistake to assume that when a venous ulcer heals the patient becomes asymptomatic. Leg pain may not be attributed to the presence of ulcer alone.[18] Different pathophysiologic aspects of venous disease may result in varying symptoms. Obstruction appears to project itself mainly as pain, and ulcer formation is rare without reflux.[17] A combination of both may contribute to the development of swelling. In our experience, gross swelling requires a component of obstruction. The superficial and axial deep reflux will not improve or deteriorate when only iliofemoral stenting is performed in limbs with combined pathology.[17] Multiple interventions would, therefore, have a greater chance to achieve better and sustained symptom relief, as in this study.

This study spans many years and the technique of controlling the superficial reflux has evolved. GSV stripping performed in presence of intraoperative anticoagulation resulted in unreasonably high rate of complications (23%). The introduction of endovenous ablation procedures substantially decreased the rate and severity of complications, most of which are minor. For no obvious reason, the saphenous veins remained occluded at a higher rate after laser treatment.

The patients with failed ulcer healing had a higher rate of axial deep reflux and failed to decrease the amount of global reflux, since VFI_{90} remained unchanged. Axial deep reflux is frequently observed with severe chronic venous disease,[19,20] and may be the sole cause of treatment failure in this group of patients. The failure to maintain the GSV closed by endovenous ablation may also contribute to the lack of decrease of global reflux. Even if the GSV remains open and refluxing, however, the global reflux and symptoms may be improved because of the removal of branch varicosities and perforators. The reasons for treatment failure may be many. Owing to the size of the material in this study, firm conclusions cannot be made in this regard.

CONCLUSION

The evolving basis for management of patients with chronic venous disease is to accurately verify and classify the presence of venous dysfunction. The initial treatment in symptomatic patients must take into account the degree and distribution of valve reflux and outflow obstruction. It seems logical to initially perform minimally invasive percutaneous stenting and saphenous ablation rather than open surgery in patients with venous outflow obstruction and superficial reflux. These interventions do not exclude simultaneous nonoperative treatment such as compression therapy, which if accepted by the patient, may be seen as complimentary.

AUTHOR CONTRIBUTIONS

Conception and design: PN, SR
Analysis and interpretation: PN, SR, KH
Data collection: PN, SR, KH
Writing the article: PN
Critical revision of the article: PN, SR, KH
Final approval of the article: PN, SR, KH
Statistical analysis: PN, KH
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Overall responsibility: PN

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