Multifaceted Management of the Postthrombotic Syndrome

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Semin Intervent Radiol 2012;29:16–22

Abstract

The postthrombotic syndrome (PTS) is a frequent cause of chronic pain, swelling, ulceration, and disability in patients with lower extremity deep vein thrombosis (DVT). As interventional radiologists are consulted on more patients with chronic DVT and PTS, their management strategies must be informed by a balanced understanding of the different facets of chronic DVT care and the available treatment options. This article provides an overview of the important elements of a multifaceted approach to the management of patients with PTS that includes pharmacological, physiological, and endovascular aspects of care.

Keywords

- postthrombotic syndrome
- iliac vein
- stent
- endovenous thermal ablation
- deep vein thrombosis

Objectives: Upon completion of this article, the reader should be able to identify the treatment options and patient selection considerations for patients with postthrombotic syndrome (PTS).

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The post-thrombotic syndrome (PTS) develops in 20 to 50% of patients after a first episode of lower extremity deep vein thrombosis (DVT).[1] PTS represents a constellation of lower extremity symptoms and clinical signs that commonly include chronic aching, swelling, fatigue, heaviness, edema, hyperpigmentation, and/or subcutaneous fibrosis in the affected limb.[2] More severe manifestations can include venous claudication and venous leg ulcers, both of which can significantly limit patients' activity and ability to work.[3] As a result, PTS has been shown to markedly reduce DVT patients' quality of life (QOL) to a degree comparable with that of other chronic diseases such as chronic obstructive pulmonary disease and arthritis.[4] In fact, in a 2008 large prospective cohort study, the presence and severity of PTS were the leading determinants of DVT patients' QOL 2 years after the initial episode.[1] The management of PTS has also been shown to result in major economic costs to patients and society.[5–7]

In recent years, endovascular techniques have been applied to selected patients with PTS, and in some clinical practices PTS referrals now exceed the number of patients referred for acute DVT therapy.[8,9] Although it is natural for interventional radiologists to focus on imaging-guided procedures, patient outcomes are most likely to be optimized when excellent endovascular care is delivered with the framework of a strong understanding of the varying clinical presentations of DVT and PTS and the potential contributions of nonprocedural interventions to PTS care. In this article, we describe one multifaceted clinical approach to PTS care, with the ultimate goal of strengthening the reader's ability to deliver PTS care within a comprehensive care framework.

Step 1: Assess the Patient in the Clinic

In most contemporary interventional radiology practices, patients referred for procedures are routinely triaged into

Issue Theme Venous Thromboembolism; Guest Editors, Suresh Vedantham, M.D., F.S.I.R., and Nael Saad, M.D.

DOI http://dx.doi.org/10.1055/s-0032-1302447.
ISSN 0739-9529.

those who can simply be scheduled versus those who first require a more detailed physician assessment in the interventional radiology clinic. Examples of patients who are now routinely seen in interventional radiology clinics include patients with uterine fibroid disease or hepatic malignancies. It is our impression that in many clinical practices, the patient with PTS is simply viewed as "another chronic venous occlusion" that may not routinely require a detailed pretreatment assessment in the clinic. However, the decision process for determining an appropriate treatment strategy for PTS must be carefully individualized to the specific patient due to broad variances in the clinical severity of disease, its impact on the patient's activities of daily living, the anatomical distribution of residual thrombus, patterns of venous obstruction and valvular reflux, the need for and previous tolerance of nonprocedural therapies, and the paucity of data supporting both endovascular and nonprocedural treatment modalities.

Therefore, as a first principle of delivering outstanding PTS care, interventional radiologists should commit the needed time to routinely evaluating patients with PTS in the clinic prior to determining a treatment strategy. A careful medical history should be obtained with particular attention to the details of previous DVT episodes and treatments previously used. The physician should become familiar with (1) the number and dates of previous DVT episodes; (2) whether they were associated with concomitant symptomatic pulmonary embolism; (3) whether they occurred in association with reversible risk factors (e.g., major surgery, major trauma, pregnancy) versus being unprovoked; (4) the current status of any additional DVT risk factors (e.g., hospitalization for acute medical illness, cancer, inherited thrombophilia, oral contraceptive use, etc.); (5) the type and duration of anticoagulant therapy that was administered and whether thrombolytic therapy was used; (6) whether an inferior vena cava filter was ever placed and if so, whether it was subsequently removed; (7) the type and duration of compression therapy that was administered; (8) what other PTS treatments were provided; and (9) the level of patient compliance with pharmacological therapy and compression. Attention should also be paid to the time course of symptoms because this can be important in determining treatment. For example, most patients describe long-standing symptoms that wax and wane from day to day, but the patient who describes an abrupt exacerbation 7 days ago may have a superimposed acute DVT that might be amenable to catheter-directed thrombolysis.[10]

A physical examination should also be performed and should include inspection of both lower extremities; the groins, buttock, and perineal regions; and the pelvis and lower abdomen. In the lower extremities, specific attention should be paid to evaluating the presence, degree, and distribution of edema and any skin changes such as hyperpigmentation, lipodermatosclerosis, dermatitis, and/or atrophie blanche. The presence, number, location, size, and status (i.e., open or healed, weeping or dry) of any ulcer should be carefully noted, and the patient should be queried about the length of time each lesion has been present. Inspection of all of these areas should also note any visible superficial veins. Depending on the distribution, superficial varicosities on the lower body wall may signify iliocaval obstruction or (less commonly) valvular incompetence of the ovarian veins that may necessitate additional medical history and/or imaging studies.

In patients with PTS, the physical examination should be routinely supplemented with duplex ultrasound of the lower extremity veins. Specifically, the proximal veins of the involved limb(s) from common femoral vein through popliteal vein should undergo compression supplemented with color Doppler to assess for new or residual thrombus. The great and small saphenous veins should be routinely assessed for reflux with the patient in the standing position.[9] Respiratory phasicity in the common femoral vein waveform should be carefully scrutinized and compared with that in the contralateral limb. Diminished phasicity may signify iliac vein obstruction.

The ultrasound information should be synthesized with the information gained from the history and physical examination to determine if the patient has PTS. In general, a diagnosis of PTS requires a history of previous ipsilateral DVT and characteristic symptoms and/or clinical signs of PTS.[11] Although ultrasound findings cannot be relied on to identify all patients with PTS, diagnostic confidence is certainly increased when ultrasound venous abnormalities are identified.[12,13] In all presenting patients, consideration should be given to other possible causes of lower extremity pain and/or swelling, such as peripheral arterial disease (evaluate with pulse examination and ankle-brachial index), congestive heart failure (symptoms more likely to be bilateral), and lymphedema (can be assessed with lymphoscintigraphy if needed).

Step 2: Ensure the Delivery of Evidence-Based Elements of DVT Therapy

The interventional radiologist should not assume that the nonprocedural elements of DVT care are being properly delivered to the patient who is referred for PTS care. As an initial step, the interventional radiologist should verify that the following elements of evidence-based DVT care are being appropriately implemented. If this is not the case, he or she should work with the patient's other physicians to reconsider the current approach and modify it as needed.

Anticoagulant Therapy

The long-term treatment of DVT is guided by the results of many multicenter randomized controlled trials (RCTs) of anticoagulant drugs, which are aptly summarized in available clinical practice guidelines organized by the American College of Chest Physicians (ACCP)[14] and the American Heart Association.[15] However, in actual practice (and especially in the United States), the delivery of evidence-based anticoagulant care to DVT patients is highly inconsistent due to a variety of factors including the diversity of physicians providing DVT care, differences between findings of clinical studies and physician perceptions about anticoagulant therapies, and socioeconomic barriers including varying patient education levels, patient issues with transport to medical visits and blood draws, and deficiencies in insurance coverage. These

challenges are increased by the inherent limitations of available anticoagulant drugs. Warfarin requires frequent blood testing for international normalized ratio (INR) determinations and is fairly sensitive to dietary changes, and low molecular weight heparins (LMWHs) are self-delivered by subcutaneous injections. Access to LMWHs is also limited for many patients, whose caregivers must avoid administrative obstacles to use these drugs.

As a result, the interventional radiologist's opportunity to improve the quality of PTS care in a referred patient often actually goes beyond his or her simple ability to perform endovascular procedures. However, as a key prerequisite, interventional radiologists must make it an important self-education priority to become familiar with the current standard of care for DVT treatment. At a minimum, this should include a basic understanding of the prognostic significance of the provoked, unprovoked, recurrent, and cancer-related DVT subgroups; the appropriate type and duration of therapy for patients in these groups; the correct dosing of locally used LMWHs; and the proper dosing, target INR, and INR monitoring of warfarin therapy. The specifics are beyond the scope of this article but are addressed in earlier articles in this issue.

Multiple studies have confirmed a strong association between the occurrence of recurrent ipsilateral DVT and the development of PTS in patients with proximal DVT.[1,16–18] In one large prospective registry, nontherapeutic anticoagulation was a predictor of PTS. Specifically, the development of PTS was 2.5 times more frequent in the DVT patients who spent $<$50% of the time within the therapeutic INR range.[19] As a result, it seems entirely reasonable to assume that proper anticoagulant therapy is an important element of primary PTS prevention. Therefore, it is important to ensure that DVT patients referred for PTS management actually complete their intended full course of anticoagulant therapy as determined by the characteristics of the initial DVT episode. If the duration, type, or dose of anticoagulation does not seem optimal, this should be discussed with the primary physician and the plan modified accordingly.

Although there is no direct evidence to support this, it seems likely that the progression of PTS to stages of increasing severity is also accelerated by recurrent episodes of DVT. For this reason, although the risk of treatment-related bleeding must certainly be weighed, we believe that for many PTS patients the long-term benefit of reinstituting anticoagulant therapy (and in particular LMWH, if possible) even if the patient has already completed the recommended course of treatment for the original DVT, may very well outweigh the risks. Because inflammation is likely a key mediator between the processes of recurrent DVT and PTS, it is very possible that both the antithrombotic effects and anti-inflammatory effects of LMWHs are active.[20,21] However, it should be noted that this is merely our opinion and there are no published studies that have specifically addressed PTS as an indication for reinstitution of anticoagulation.

Elastic Compression Stockings

Three single-center RCTs support the notion that the use of elastic compression stockings reduces the risk of developing PTS by ~50%.[17,18,22] However, once PTS has developed, the actual efficacy of compression therapy aimed at symptom control in the general population of PTS patients is less clear.[23] Because the risk of compression therapy is low and some patients appear to enjoy improved symptoms when wearing the garments, it is usually worthwhile to attempt a trial of compression stockings for patients with mild to moderate PTS. This recommendation is supported (grade 2C) in the ACCP clinical practice guidelines.[14]

Risk Factor Modification

Studies suggest that obesity is a risk factor for the development of PTS in DVT patients[1,24] and also that obese patients are more likely to exhibit progression to increasing levels of severity of chronic venous disease.[25,26] A 2010 population-based study found close similarities between atherosclerotic and venous disease populations, suggesting that they share similar risk factors.[27] In our experience, venous ulcers and other PTS manifestations that exhibit rapid clinical progression disproportionate to expectations tend to occur more commonly in DVT patients who are obese or who are smokers. Therefore, we routinely encourage patients with PTS to stop smoking, and when needed we help them access smoking cessation programs. We counsel them that weight loss (to the extent possible with their PTS activity limitations) may also assist in controlling their symptoms and disease progression.

About 6 months ago, an obese 37-year-old woman was referred to our clinic for the treatment of presumed PTS. She had experienced a first-episode right popliteal vein DVT 2 months earlier and was continuing to experience significant pain and swelling in that limb. She had been taking warfarin, but because her INR levels fluctuated excessively, the warfarin was stopped and she was converted to enoxaparin monotherapy at a once-daily dose of 80 mg/day. She had not been prescribed elastic compression stockings. Accordingly, rather than proceeding to endovascular intervention, we made three key modifications: (1) we observed that her enoxaparin dosing was inadequate (the correct dosing DVT treatment is either 1 mg/kg twice daily or 1.5 mg/kg once daily), and we switched her to 90 mg twice-daily subcutaneous injections (because she weighed 88 kg); (2) we prescribed her 30 to 40 mm Hg knee-high elastic compression stockings and instructed her to wear them daily; and (3) we advised her to lose weight if possible. Within 1 month, the patient reported that her symptoms had improved considerably. The patient was able to lose $>$30 pounds subsequently and was nearly asymptomatic 6 months later. This case clearly demonstrates why PTS should ideally not be diagnosed until at least 3 to 6 months after the original DVT episode and that with proper institution of evidence-based DVT care, many patients (especially those with limited clot extent) will not require aggressive intervention.

Step 3: Explore and Optimize Use of Noninvasive PTS Therapies

Although PTS is generally considered an irreversible condition, several pharmacological and physiological approaches

have undergone preliminary study as potential therapeutic options.

Pharmacological Therapies

Pharmacologic agents such as pentoxifylline (a competitive nonselective phosphodiesterase inhibitor) and rutosides (platelet aggregation inhibitors) have been used for the treatment of PTS in patients with venous leg ulceration. A Cochrane review evaluated 12 studies with a total of 864 patients with venous leg ulcers who were treated with pentoxifylline.[28] Eleven trials compared pentoxifylline with placebo or no therapy. The review concluded that (1) pentoxifylline is more effective than placebo in terms of complete ulcer healing or significant improvement (relative risk [RR]: 1.70; 95% confidence interval [CI] 1.30 to 2.24); (2) pentoxifylline plus compression is more effective than placebo plus compression (RR: 1.56; 95% CI, 1.14 to 2.13); and (3) pentoxifylline without compression appears to be more effective than placebo or no treatment (RR: 2.25; 95% CI, 1.49 to 3.39). A meta-analysis of five studies evaluated micronized purified flavonoid fraction (MPFF) in the management of patients with venous ulcers who were all treated with compression.[29] Two of the studies were placebo-controlled trials, whereas three studies did not incorporate a placebo. At 6 months, complete ulcer healing had occurred in 61% of the MPFF patients and in 48% of the control patients (RR reduction for persistent ulceration: 32%; 95% CI, 3 to 70%; $p = 0.03$).

Accordingly, the ACCP guidelines suggest the use of pentoxifylline in addition to local wound care and compression in patients with venous leg ulcers (grade 2B).[14] For persistent venous ulcers, the ACCP recommends the addition of rutosides in the form of oral MPFF, or sulodexide administered intramuscularly and then orally, to local wound care and compression (grade 2B).

Compressive Therapies Beyond Stockings

Compressive therapies such as intermittent pneumatic compression (IPC) are designed to counteract the elevated venous pressure in patients with PTS. Smith et al demonstrated that in patients with venous leg ulcers, IPC for 4 hours daily added to standard wound care and compression significantly increased healing ($p = 0.009$).[30] A separate small crossover study of 15 patients found IPC to 40 mm Hg to alleviate severe edema in some PTS patients.[31] Hence, for the subset of patients with severe leg edema and/or venous leg ulcers, the ACCP suggests a course of IPC at 40 mm Hg (grade 2B). The disadvantages of IPC therapy are its expense and inconvenience—in particular, the need to pump for several hours in a day.

The VenoPTS study evaluated a lightweight portable, battery-powered, boot-like compression device (the VenoWave). In this two-center placebo-controlled double-blind crossover RCT of 32 patients, patients with clinically severe PTS but no ulcer used the device daily for 8 weeks.[32] Patients were randomized either to initial treatment with the device versus placebo, followed by the reverse with a 4-week washout period. In this study, 31% of patients in the VenoWave arm were clinically improved compared with 13% in the placebo arm ($p = 0.11$).

Exercise Therapy

In a two-center prospective trial, 43 patients with mild to moderate PTS were randomized to undergo a 6-month program of trainer-supervised exercise therapy versus control treatment consisting of an education session with monthly telephone follow-up. PTS severity was reduced but did not reach statistical significance (exercise training mean change in Villalta score -3.6 ± 3.7 versus control group mean change -1.6 ± 4.3; $p = 0.14$) and venous disease–specific QOL was improved (mean positive change in VEINES-QOL score was 6.0 ± 5.1 for exercise group versus 1.4 ± 7.2 for control group; $p = 0.027$) in the exercise group.[33] However, only patients with mild to moderate PTS participated, and it is questionable if patients with severe PTS could tolerate this kind of exercise training regimen. Nevertheless, exercise therapy is inexpensive and could be widely applied if effective.

Wound Care

A broad range of products are available for the care of venous leg ulcers, including compression wraps, topical antibiotics, ointments, exfoliants, and growth factors. A detailed discussion of these options is beyond the scope of this article. However, two points should be stressed. First, venous leg ulcers are known to recur frequently despite adequate initial therapy, and they impose major QOL impairment on patients.[5] Given the known challenges of obtaining rapid and durable healing of venous leg ulcers, it is critical to obtain for such patients the benefit of a wound care clinic that specializes in the efficient delivery of expert ulcer care.[34] Second, the mainstay of venous ulcer care is compression therapy (and preferably multilayer compression garments), as summarized in a 2009 Cochrane analysis of 39 randomized studies.[35] Accordingly, the interventional radiologist who is evaluating a patient with a venous ulcer should, as an important treatment priority, confirm that the patient is following a reasonable ulcer care regimen that incorporates compression therapy as a critical element.

Step 4: Assess Suitability for Endovascular Stent Placement

As for acute DVT therapy, physicians should separately assess the clinical severity of PTS, anatomical/physiological findings, projected risks of complications, and patient inclinations prior to arriving at an individualized treatment strategy for PTS. The use of percutaneous placement of metallic stents to alleviate symptomatic PTS has been used with apparent success, as reported in uncontrolled case series.[8,9,36]

Clinical Severity

In considering stent-based intervention, the first question to ask is whether the clinical severity of disease appears to merit a more aggressive treatment approach. This is important because recurrent thrombosis and in-stent stenosis can occur after stent placement, and the effect of the stent itself on the predilection toward thrombosis is unknown. In addition, there is currently no stent approved for iliac vein use by the U.S. Food and Drug Administration, and there are

uncertainties concerning the long-term outcome of stented veins. As such, it is important to ensure that implantation of these permanent devices is undertaken in those patients in most need of benefit and that the risks and uncertainties are properly conveyed to the patient during the informed consent process.

The medical history should specifically query the impact of the patient's clinical manifestations of PTS on his or her daily activities and overall QOL. Is pain a major component of the problem? Does the patient's occupation include physical labor and is his or her ability to fulfill those requirements limited? Do the limitations only become apparent with extensive activity, or is the patient limited in performing even basic life functions like household tasks? Given the paucity of prospective data on venous stenting and the attendant risks and long-term uncertainties, patients with minimal or mild lifestyle limitations should first be managed with compassionate conditioning of expectations; optimization of and patient education on the importance of evidence-based DVT therapy, elastic compression stockings (if tolerated) and other noninvasive adjuncts as discussed earlier; and careful follow-up and monitoring for clinical change over time.

Physicians are strongly encouraged to routinely adopt validated venous disease classification and outcome instruments into their practices. The Clinical-Etiological-Anatomical-Pathophysiologic (CEAP) Classification System is an easy-to-apply method of descriptively classifying patients with PTS and other chronic venous disorders.[37] CEAP's simplicity, its broad use across the published venous disease literature and clinical practices worldwide, and its familiarity to payers are advantages in favor of its routine use. Physicians are also encouraged to adopt a measure of venous outcome such as the Villalta PTS Scale (endorsed by the International Society on Thrombosis and Haemostasis) or the Venous Clinical Severity Score (VCSS; endorsed by the American Venous Forum).[38–41] These two measures are useful in tracking clinical outcomes over time because they have been shown to be reliable, valid, and responsive to clinical change.

Although the ultimate decision is multifactorial, we expect that most patients with CEAP clinical class 4 to 6 (major skin changes and/or an ulcer) will meet the clinical severity threshold for endovascular stent placement because they have objective findings of severe progressive chronic venous insufficiency. However, many patients evaluated will fall into clinical class 3 (edema without skin changes or ulcer) but will have varying degrees of symptomatology that range from occasional late-day swelling to severe venous claudication that limits even minimal activity. For C3 patients, the amount of pain, the degree of activity and work limitation, and the degree of QOL impairment, along with the projected likelihood of success based on anatomical criteria (see later), should be weighed heavily in decisions as to whether to pursue endovascular stenting.

Anatomical/Physiological Findings

Patients with a history and/or physical findings indicative of PTS and symptoms deemed severe enough to warrant intervention should be evaluated by duplex ultrasound, with the goal of identifying iliac vein obstruction and/or superficial valvular incompetence in the great saphenous vein (GSV) and/or small saphenous vein (SSV). There should be a high index of suspicion for iliac vein obstruction based on the presence of one or more of the following findings: (1) pain or swelling of the entire limb (thigh and calf) as a feature of the initial DVT episode, daily PTS symptoms, or physical examination; (2) dominance of venous claudication; (3) a history of imaging-proven thrombosis of the common femoral vein (CFV) and/or iliac vein; (4) a CFV that was incompletely compressible on the ultrasound examination; and/or (5) a CFV Doppler waveform lacking phasicity compared with the contralateral CFV. Because the presence of absence of high-quality infrainguinal inflow veins can influence stent patency, ultrasound assessment of the femoral vein and profunda femoral vein can be helpful in determining whether to proceed with stent placement. For example, patients with chronic thrombus involving the CFV and extending into both major deep tributaries should be informed that the likelihood of success with endovascular intervention is less than optimal, and that the need for repeat procedures to maintain stent patency will be higher.[42] However, patients with excellent flow in the CFV may expect the best chance of success, especially if there is no obstruction or reflux in the femoropopliteal veins.

Step 5: Consider Elimination of Superficial Venous Reflux

At a macroscopic level, the development of PTS is related to ambulatory venous hypertension that results from two key physiological abnormalities that develop after a DVT episode: ongoing venous obstruction due to incomplete thrombus clearance and valvular reflux that results from direct valvular damage from the inflammatory response to thrombosis and from venous dilatation with separation of valve leaflets.[43–47] Valvular reflux occurs not only in the deep venous system, but also in the saphenous veins, particularly if they were initially clotted.

Physicians have used endovenous thermal ablation (EVTA) for incompetent truncal veins (GSV or SSV) since the late 1990s as an alternative to surgical saphenectomy.[48] The underlying mechanism of EVTA is to deliver sufficient thermal energy to the wall of an incompetent vein segment to produce irreversible occlusion, fibrosis, and ultimately resorption of the vein. The thermal energy is delivered by a radiofrequency (RF) catheter or a laser fiber (laser energy of a variety of different wavelengths) inserted into the venous system under ultrasound guidance. The procedure is generally performed on an ambulatory basis with local anesthetic, with or without conscious sedation. The patients are fully ambulatory following treatment, and the recovery time is short. The procedure's effectiveness in providing complete occlusion of the treated vein is very high in patients with primary valvular insufficiency. For example, Min et al reported a 3-year follow-up of 499 veins treated with laser ablation.[49] In this series, a 93% occlusion rate was reported.

Merchant et al reported 5-year results in 1222 venous segments treated with RF ablation, 117 of which had long-term data available for analysis.[50,51] The reflux-free and vein occlusion rates were 83.8% and 87.2%, respectively. In limbs with anatomical success reported at 5 years, 84 to 94% had symptom improvement that ranged from absence of pain, fatigue, or resolution of venous edema. Complications of EVTA can include DVT (<1%), paresthesias, superficial thrombophlebitis, and skin burns.

There are no robust studies of EVTA dedicated to patients with PTS. The use of EVTA to occlude refluxing superficial veins in the setting of established PTS may raise theoretical concerns that ablating a potential collateral channel could worsen venous hemodynamics. However, studies have demonstrated that deep femoral collaterals are more important than the saphenous system in providing collateral outflow from a limb with DVT.[52,53] Limited studies of surgical saphenectomy and endovenous laser ablation suggest that these procedures actually provide equivalent clinical outcomes in patients with or without concomitant deep femoropopliteal obstruction or reflux.[54,55] Hence eliminating the refluxing saphenous vein as a conduit for transmitted venous pressure into the limb may actually improve venous hemodynamics.[54]

In one study, single-stage percutaneous iliofemoral venous stenting was combined with GSV stripping or percutaneous GSV ablation performed by RF or laser in 99 limbs in 96 patients with PTS.[8] 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 visual analog scale [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 of 38 limbs (68%). All QOL categories significantly improved after treatment. No patients died, and the morbidity with EVTA was largely limited to ecchymosis and thrombophlebitis in the thigh area.

Conclusion

PTS is a common, morbid, and expensive condition. Although there is currently no consistently effective treatment for PTS, preliminary studies provide hope that endovascular interventions may produce significant symptom improvement in patients with PTS. However, to achieve these benefits, interventional radiologists need to consider endovascular treatment options within the framework of the diversity of PTS presentations and the different treatment options available.

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