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ENDOLUMINAL TREATMENT OF VARICOSE VEINS

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Introduction

Chronic venous insufficiency treatment options have changed dramatically over the last 10 years. Rapid endorsement of minimally invasive techniques has led to a proliferation of vein centers and growth in the number of venous procedures. Traditional treatment of venous insufficiency with high ligation and stripping is a time-tested and successful procedure that has been used worldwide. The transition to minimally invasive techniques, however, has progressively changed the treatment for this disease. Patients who previously would have had surgery in the hospital operating room under general anesthesia now commonly have a clinic-based procedure with local anesthetics only. The techniques that have enabled this transition utilized ablation of the vein with endoluminal techniques rather than physical removal of the diseased veins.

The various ablative techniques share a common mechanism — injury to the vessel wall with an energy source — that results in progressive fibrosis of the vessel and occlusion.[1] The commonly used techniques are radiofrequency ablation, laser ablation, and sclerotherapy. In the case of radiofrequency and laser therapy, the energy delivered is converted to heat as opposed to the direct chemical injury utilized in sclerotherapy.

Additional techniques that enable this ambulatory approach are ultrasound guidance and tumescent anesthesia. Ultrasound imaging is paramount to the success of these techniques: accurate diagnosis is established in most cases based exclusively on ultrasound findings, and procedural guidance to maximize success and avoid complications is directly related to its use. Following the procedure, ultrasound is again used to evaluate the success of the treatment and rule out any thrombotic complications. Tumescent anesthesia is critical in the performance of radiofrequency and laser ablation procedures. The benefits are multiple. Anesthesia of the perivenous tissue is the most obvious effect, but equally important are the compression of the vein by the infused fluid, which allows better treatment efficacy, and the displacement of other tissues to avoid injury to skin and nerves during treatment. The minimal level of patient discomfort associated with tumescent anesthesia enables the procedure to be performed in the clinic setting.[2] Additionally, multiple adjunctive phlebectomies can be performed in the clinic setting with this type of anesthetic, which previously would not have been possible.

Endoluminal vein treatments are performed for both the superficial venous system of greater and small saphenous veins and the perforator veins.

Superficial Veins

The focus of most ablation procedures has been the superficial venous system. It has been traditionally taught that saphenofemoral reflux is the responsible pathophysiology for most skin changes in venous insufficiency. This teaching has been challenged by ultrasound descriptions for varicose vein patients[3] but is clearly present in the majority of those with advanced venous disease, with or without other venous pathology.[4] Both the greater and small saphenous veins have been treated with ablation procedures.

A few randomized trials have compared percutaneous ablation techniques to conventional stripping.[5, 6] These trials have generally shown that patients in the ablation group experience less pain and a faster return to normal activities. There is a suggestion that the overall societal costs are less in the ablation group, particularly in working patients, because of an earlier return to work.[6] Also, recurrence from neovascularization is found to be less common in the ablation groups.[5] Interestingly, there is one randomized trial that suggested stripping was associated with a return to work equivalent to laser ablation, although more pain and bruising was reported.[7] The results of the trial are clouded by the fact that phlebectomies were performed in both groups, which may be the driving force for the levels of pain and return to activity. Tumescent anesthesia was utilized for the stripping group as well, which may also account for improved outcomes in that group. Overall, however, the less-invasive procedures are associated with improved outcomes in terms of pain and return to activity.

Techniques

Radiofrequency and laser procedures use very similar techniques. Currently available options include two types of radiofrequency catheters and several laser fibers with different wavelengths from multiple manufacturers. Careful interrogation of the greater saphenous vein from the saphenofemoral junction down to the knee or below knee area is performed, depending on the proposed vein segments to be treated. The size and depth of the vein, duplication, and general course are all noted. Generally, treatment is isolated to the above-knee segment to reduce the incidence of paresthesias.[8] Ultrasound guidance is used to access the vein percutaneously. If for some reason this is not feasible, a small incision can be made to dissect the vein or to capture it with a vein hook and then directly access the vein. The catheter is then passed up through the thigh. If the catheter does not pass easily, ultrasound or fluoroscopic guidance and guidewires can be utilized. Using ultrasound visualization, the final position of the catheter is placed roughly 2 cm below the saphenofemoral junction, preferably below the junction of the inferior superficial epigastric vein within the greater saphenous vein. This is done to prevent treatment of the saphenofemoral junction and possible deep venous thrombotic complications. Perivenous tumescent anesthesia is then injected to provide analgesia, to separate the catheter from the surrounding soft tissue, most importantly the skin and the saphenous nerve, and to provide vein compression against the catheter (Figures 1-2). The patient is then generally placed in the Trendelenburg position with or without additional external compression to further exsanguinate the vein. The catheter is pulled back per

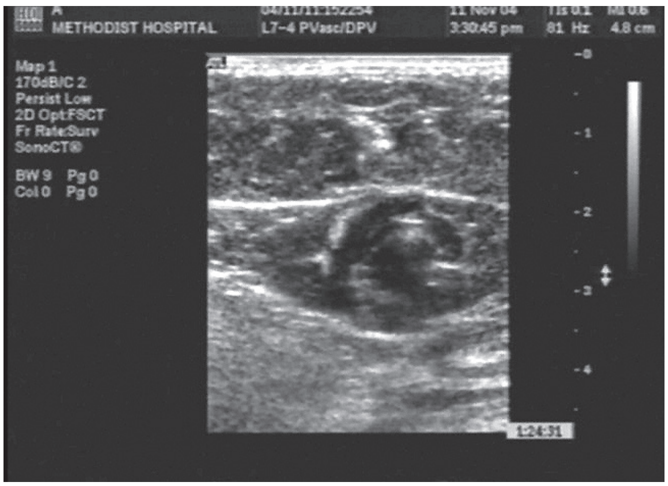

Figure 1. Saphenous vein before tumescence

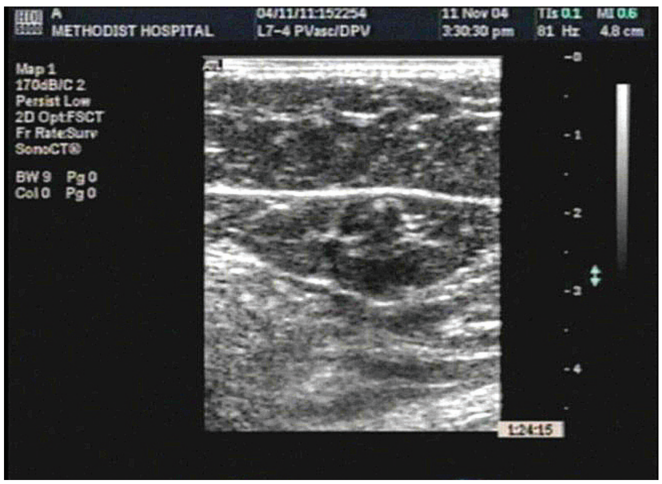

Figure 2. Saphenous vein after tumescence

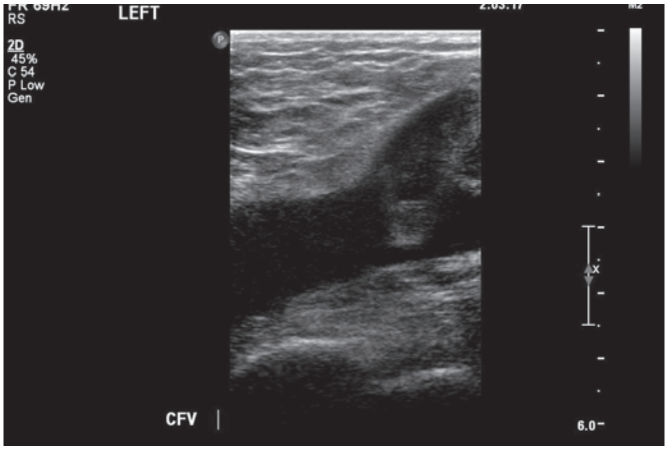

Figure 3. Thrombus extension from saphenous vein into common femoral vein

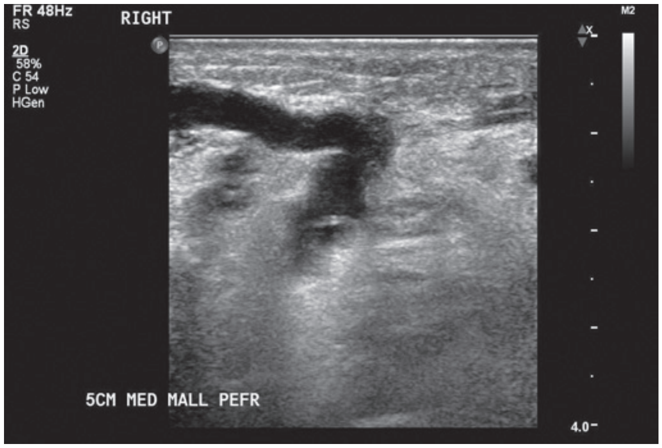

Figure 4. Perforator vein prior to ablation

the manufacturer's specifications, which vary from catheter to catheter. After treating the vein, ultrasound is used to confirm an ablated appearance of the vein and the patency of the common femoral vein. The saphenous vein should be small, thickened, and minimally compressible. Color flow and Doppler signals should be absent. The common femoral vein should be fully compressible. Following this, a compressive bandage with wraps or stockings is applied. The patient should then be restudied in a few days with venous duplex ultrasound to evaluate the treated vein and to rule out a thrombotic complication.

Sclerotherapy is performed using similar techniques, but there are some important differences. The saphenous vein is accessed with ultrasound guidance in the thigh using a short catheter. There are reports of both liquid and foam sclerotherapy, but the foam results have generally been better than liquid and this has been confirmed in randomized trials.[9, 10] Foam sclerosant is created by mixing a gas (generally room air) in one syringe with a sclerosant in a second syringe by means of a stop cock. Most reports use a ratio of 1:4, sclerosant to air, per the Tessari method.[11] Use of the foam form of sclerosant is not an FDA-approved modification of the drug and should be discussed with the patient. Sclerotherapy is not painful and does not require tumescence.

The foam is then injected with ultrasound observance of its course towards the saphenofemoral junction. Injection is stopped when the foam comes close to the junction. There have been many techniques described, but a recent report suggests that less foam gets into the deep venous system if the injection is performed with the leg elevated.[12] Stockings are then applied.

Results of Superficial Venous Treatments

Generally, the results of endoluminal treatments of superficial venous insufficiencies are good. It has been suggested that endoluminal treatments of saphenous incompetence are subject to less recurrence than stripping because of decreased neovascularization. Neovascularization is thought to be due to inflammatory changes related to surgery at the saphenofemoral junction, and clearly this is not experienced with endoluminal techniques.[5] The success rates for laser and radiofrequency treatment have been reported to be over 90%, with the rate for laser therapy being slightly higher than that of radiofrequency therapy.[13-16] Direct comparison between these two techniques has been limited due to the lack of appropriate randomized trials. Instead, differences or similarities have been indirectly inferred through meta-analyses of case reports and trials comparing the individual techniques to stripping. The most dreaded complication of saphenous ablation is deep venous thrombosis (DVT). This is seen as extension of thrombus from the saphenous vein into the common femoral vein (Figure 3). The reports of this complication are generally less than 1%, but one study reported a 16% occurrence of DVT in an isolated series.[17] Paresthesias have been reported in up to 15% of patients, but these are generally self-limited and improve over time.[8] Although fewer in number, small saphenous ablation has also been reported with both laser and radiofrequency techniques.[18-20] The occlusion rates are >90% in these series and the complications have been uncommon, with few reported DVTs and a surprisingly low paresthesia rate of 2-7%.

Foam sclerotherapy for saphenous incompetence has had somewhat less successful results, ranging from 39-96% occlusion rates,[10] and a recent review

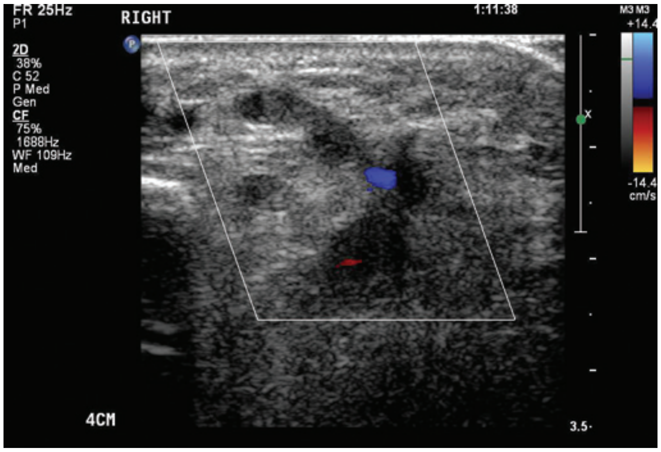

Figure 5. Perforator vein post ablation

reports saphenous occlusion rates between 80-90%.[21] There is some concern about the safety of foam sclerotherapy. Although thousands of patients have been treated worldwide, there are common reports of transient visual disturbances[21] and bubbles visualized in the heart on echocardiography,[12] and there have been infrequent reports of stroke and transient ischemic attack (TIA).[22-24] The use of foam sclerotherapy for small saphenous veins has also been reported, although usually mixed in with reports of greater saphenous vein treatments.[25] The results are good as well, with high occlusion rates and few reports of complications.

Perforator Vein Treatment

Significant controversy exists over the proper role of perforator vein treatment in the algorithm for chronic venous disease.[26] This has been the subject of multiple debates at national meetings and continues to stir controversy.[27] The popularity of perforator vein treatment has fluctuated considerably over time. The early description of perforator veins and then the Linton procedure led to early enthusiasm that was later tempered by high wound complication rates.[26] Endoscopic techniques led to increased operative procedures, but that, too, faded with reports of poor results in postthrombotic limbs. Lastly, percutaneous techniques have been described, causing resurgence in popularity of perforator vein treatment.[1]

This method of treatment has been termed PAPS, or percutaneous ablation perforator surgery. It is generally agreed that perforator vein incompetence can play a significant role in advanced venous disease,[1] but a lack of well-designed trials has lead to controversy over the particular benefit of perforator vein treatment, as almost all of the relevant trials and reports have included superficial vein treatment concomitantly.[26] A recent report of isolated perforator vein treatment for patients with advanced venous disease addresses some of these issues.[28] In this trial, perforator treatment resulted in improved venous clinical severity scores and ulcer healing. Furthermore, ulcer recurrence was significantly associated with incompetent perforator recurrence. These results certainly suggest a role for perforator treatment in patients with advanced venous disease.

Perforator Treatment Technique

Perforator treatment varies somewhat between the types of energy delivered. All treatments use ultrasound guidance to accurately visualize access to the perforator veins and to confirm the treatment effect. For radiofrequency and laser techniques, the perforator vein is accessed directly, at or preferably below the level of the fascia. For the radiofrequency perforator probe, an over-the-wire technique has been described, as well as a direct puncture and treatment. Preferably, a length of vein is treated, or two focal areas. If the treatment is being performed in the clinic setting, it is important to infuse local anesthetic around the area of the catheter to prevent pain. External pressure is then applied to ensure good contact between the probe and vessel wall. The manufacturer suggests a four-minute treatment, toggling the probe to contact each of the four walls for one minute each. During treatment, the impedance reading on the machine can be helpful to confirm intravascular treatment. Following treatment, the vein is tested for reflux with duplex imaging, although the presence of the anesthetic can limit visualization. Generally, the perforator should change in appearance and have a shrunken, more echogenic appearance with no color flow visualized (Figures 4-5).

The laser fiber can be passed directly through a 21-gauge needle and 2-3 focal treatments applied for 5 seconds each. Just as with radiofrequency, it is important to infuse local anesthetic around the catheter tip and hold external pressure. Sclerotherapy is again more unique than the other ablative techniques. Both foam and liquid sclerotherapy have been utilized. Direct perforator access is not mandatory, and commonly a nearby varix can be accessed and ultrasound imaging used to visualize passage of the sclerosant into the perforator, and the leg is then elevated. Anesthetic is not required.

Brief digital compression followed by the application of compressive bandaging is common to all of the above-mentioned techniques.

Perforator Treatment Results

The results of perforator treatment have been reported in a recent review.[1] Evaluation of the data is problematic — most of the results have been presented in abstract form at meetings, but few results have actually been published. In general, results have been good, with high occlusion rates and few complications.

Percutaneous ablation of perforator veins with a saphenous-style radiofrequency probe was first describe by Whiteley, and five-year results have recently been published.[29] Long-term successful ablation was achieved in 81% of veins, although attrition and loss to follow-up was substantial, with more than half of patients originally treated not included. In the review paper, 90% of perforator veins treated with radiofrequency were occluded in short-term follow-up.[1]

Laser ablation of perforators is shown to have an 85-100% early closure rate with few complications.[1] No deep venous thromboses, rare paresthesias, and a few blisters have been reported.

Sclerotherapy was reported for perforator vein treatment over four decades ago.[30] In the review paper, occlusion rates of 75-98% were reported with few complications.[1] Several references, however, pointed out the need for repeat intervention.

Perhaps the biggest advance of the PAPS technique over previously described procedures is that it is repeatable. The previous, more invasive techniques of direct or endoscopic perforator ligation are very difficult to repeat. Clearly, patients with advanced disease have chronic venous disease, making repeatability of the treatments all the more important.

Conclusion

Endoluminal treatment of venous insufficiency has rapidly gained widespread acceptance into mainstream practice. The advancement of minimally invasive techniques has enabled ambulatory clinic treatment in the majority of patients with varicose veins, allowing a return to full activity and work sooner than traditional open surgical methods. Increasing numbers of reports are being published with good results and low complication rates. These treatment techniques continue to evolve, and patients will clearly benefit from these advances in technology.

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