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Varicose Veins

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ABSTRACT

Varicose veins are enlarged, tortuous veins that are commonly found in the lower extremities, affecting people over a wide age range with increasing prevalence with age. This pathology is typically a benign process with complications that can decrease a person's quality of life and lead to potentially life-threatening complications. There are surgical, endovascular, and chemical treatments which improve quality of life and decrease secondary complications of varicose veins. This review article will discuss the technical aspects of these procedures, potential and rare complications, preprocedural and post-procedural considerations, and overall comparison of technique efficacy.

Background

Varicose veins (Figure 1) are enlarged, tortuous veins that are commonly found in the lower extremities, affecting people over a wide age range with increasing prevalence with age. These veins can cause symptoms of painful swelling of the lower legs, which may be associated with pruritus and discoloration of the skin. Although this disease process is typically a benign process, there are secondary complications, which can worsen with comorbidities such as peripheral vascular disease, diabetes, and congestive heart failure. Risk factors include genetic predisposition, age, female sex, pregnancy, prolonged standing, weakened vascular walls, prior shearing vessel damage, and increased intravenous pressure (Bergan et al., 2006; Jones & Carek, 2008; O'Flynn et al., 2014).

Pathophysiology and complications

The venous system is a low-pressure vascular network. A series of intraluminal valves in the veins assist with venous return of blood to the heart and prevent backflow of blood and engorgement of the superficial veins. Adequate venous return prevents stasis of blood in the superficial vessels and third spacing of fluid in the interstitial tissues (Bergan et al., 2006).

With aging and other risk factors, these intraluminal valves can become incompetent, resulting in turbulent backflow of venous blood. This backflow causes engorgement of the superficial feeder veins and the tortuous appearance of varicose veins. Metabolic waste products build up in these engorged vessels and inflammation precipitates pain, burning, itching, cramping, and edema (Bergan et al., 2006).

Common complications of varicose veins include debility and decreased quality of life and function from the pain and inflammation. With minor trauma, varicose veins can cause delayed healing and significant bleeding. These damaged tissues can develop into nonhealing ulcers leading to soft tissue infections and osteomyelitis (Bergan et al., 2006; O'Flynn et al., 2014; London & Nash, 2000).

Dermatitis presents as erythema; however, it can lead to complications such as superficial thrombophlebitis, and blood clots of the superficial veins. Although typically benign, if extensive enough, these clots can protrude into the deep veins and possibly lead to pulmonary embolism (Bergan et al., 2006; London & Nash, 2000; O'Flynn et al., 2014).

Diagnosis and Initial Management

Typically, diagnosis of varicose veins is by physical examination (Figure 2). The physical examination is correlated with history to determine if the patient's symptoms are most likely due to varicose veins or other potential disease. Severity is based on symptoms and physical manifestations of disease such as edema, size of varicosities, telangiectasias, lipodermatosclerosis, and ulceration. These physical findings can be further classified with a clinical, etiology, anatomy and pathophysiology (CEAP) score to document severity of disease (O'Flynn et al., 2014). If clinically indicated, the diagnosing clinician may order ultrasound (Figure 3) or veno/angiogram to

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further assess the vasculature of the lower extremities (Jones & Carek, 2008).

Depending on severity of symptoms, patients may be considered for intervention; however, most patients undergo conservative management for three to 6 weeks before attempting a minimally invasive procedure.

Conservative therapy

Conservative management includes avoidance of triggers, noninvasive interventions, and modification of risk factors. Triggers to avoid include prolonged standing, restrictive clothing, and straining. Conservative interventions include pressure stockings, elevation of the affected limb, and exercise. Activity may help decrease venous stasis and stimulate forward venous flow. Lifestyle modifications such as weight loss may decrease the symptoms of varicose veins. While these therapies may improve symptoms, there is limited evidence to support significant benefit from these therapies (Jones & Carek, 2008; O'Flynn et al., 2014). Medical herbs and supplements have been trialed with varying evidence for efficacy. Studies in Europe have shown some efficacy with using horse chestnut seed oil for edema (Jones & Carek, 2008).

Invasive treatments

Endovascular Laser Ablation and Radiofrequency Ablation

Developed in the 1990s, endovascular laser ablation (EVLA) with diode lasers has been used for treatment of varicose veins. Access into the targeted vessel is directed with Doppler ultrasound. A laser probe is advanced into the vessel lumen. The laser probe tip can quickly achieve temperatures up to 800°C, resulting in steam with heat damaging the vessel wall causing contraction of the vessel, venous thrombosis, and fibrosis. Before the laser is activated, the area of interest is compressed with local anesthetic, which narrows the venous caliber and acts as a heat sink for thermal damage, a technique known as tumescent anesthesia. The laser probe is then retracted continuously and damages the vessel equally along the length of the vessel. The laser is deactivated when almost out of the vessel tract to prevent skin damage at the insertion site (Ahadiat et al., 2018; London & Nash, 2000).

Radiofrequency ablation (RFA) began to be commonly used as a thermal ablation technique in the 1950s and has more recently been adapted for varicose vein treatment. RFA is similar in procedure to laser ablation. RFA uses a high frequency, alternating current causing localized temperatures of 110-120 Celsius within the RFA probe leading to venous spasm, collagen shrinkage, and physical contraction. Using ultrasound, a catheter is placed and the radiofrequency probe is retracted at regular intervals and venous segments are sequentially treated (Ahadiat et al., 2018; Kayssi et al., 2015).

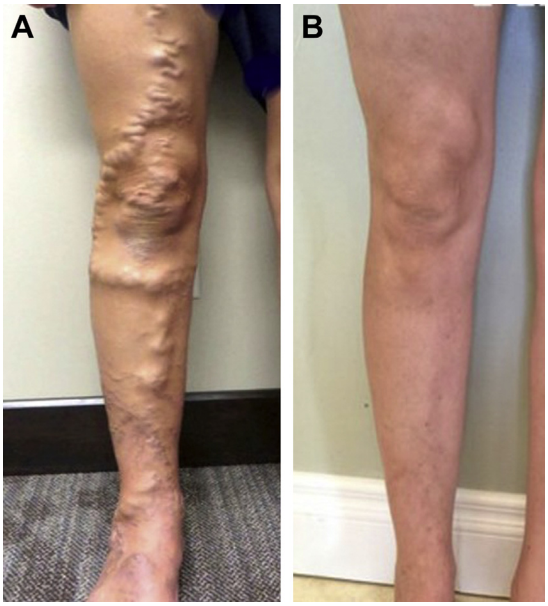

Figure 1. Varicose veins of lower extremity before (A) and after (B) treatment.

- Nurses' consideration:
- Varicose veins are enlarged, tortuous and abnormal subcutaneous veins
- The disease can cause a lot of symptoms that can prevent leading normal healthy life.
- Typically, diagnosis of varicose veins is by physical examination aided by ultrasound examination.
- Conservative management is the first line of treatment.
- Invasive treatments including ablative therapy, phlebectomy, and sclerotherapy are recommended after the failure of the conservative therapy.

Figure 2. Highlights about the varicose veins for nurses.

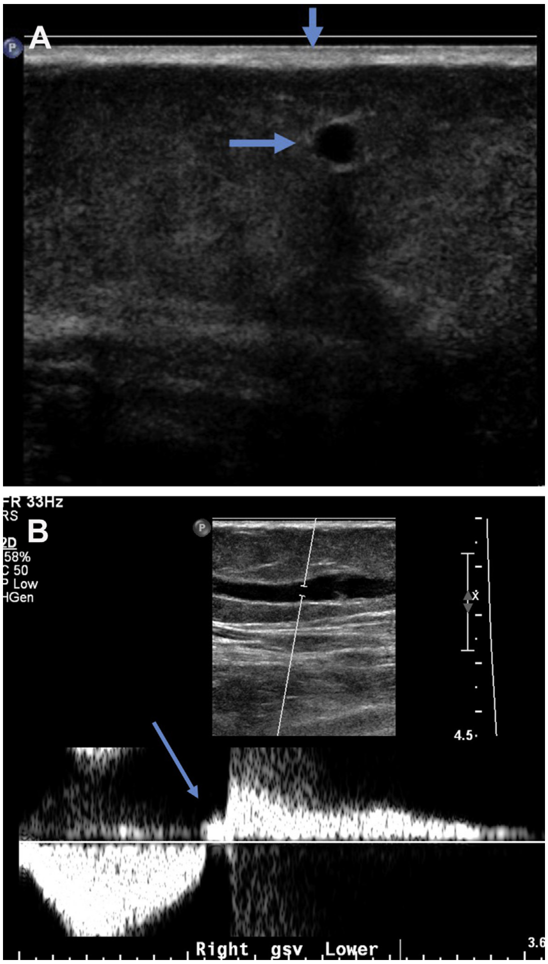

Figure 3. (A): Gray scale ultrasound of the lower extremity showing the dilated abnormal varicose vein (horizontal arrow) that is just below the skin surface (vertical arrow). (B): Spectral Doppler ultrasound of the abnormal vein demonstrating reflux on Valsalva maneuver (arrow) as change of the direction of flow.

Sclerotherapy

Sclerosing agents are injected agents that induce direct cellular damage to the venous lumen through inflammatory, toxic, or physical means. These agents may have a secondary embolic effect within the target vasculature. The cellular damage from these agents causes contraction of the targeted vessel and smaller adjacent feeder vessels where a thrombus typically forms. The thrombus will become replaced with connective tissue and be subsequently resorbed by the body (Kondo & Ray, 2010).

Sclerotherapy has been used as early as the 1600s for varicose veins; however, complications from early agents led to adoption of less complication prone surgical techniques in the 1800s. Not until the 1940s did sclerotherapy become a feasible therapeutic option. During this time sodium tetradecyl sulfate (STS) was developed; it is still used today. Since then, numerous other sclerosing agents have been developed. Introduction of duplex ultrasound in the 1980s allowed for targeted administration of these therapeutics agents and has made sclerotherapy a commonly performed and minimally invasive procedure (Kondo & Ray, 2010).

Many sclerosing agents can be modified with microfoam technique used in foam sclerotherapy (FS). A foaming agent can be formed using environmental air and mechanically agitating air with syringes and a stop cock. Air bubble distribution can be highly variable in size, and the presence of nitrogen slows the reabsorption of gas. Specially designed agents using carbon dioxide allow for a more consistent bubble size and quicker reabsorption of gas, decreasing the risk of air embolism (Eckmann, 2009; Kondo & Ray, 2010).

By mechanically introducing air to the agent, the foam displaces the blood and slows the blood flow in smaller caliber vessels, allowing for longer exposure to the targeted tissues at higher sclerosant concentrations. The decreased total dose also reduces the complications of overdose and systemic toxicity (Eckmann, 2009; Kondo & Ray, 2010).

Types of sclerosing agents

One of the earlier sclerosing agents, STS, is a detergent that binds to the lipid membranes of the intimal endothelium of the veins. The mechanism of this sclerosing agent is not well understood, but it is thought to induce an inflammatory reaction after disrupting the lipid membrane of exposed cells within the intima. The cytotoxic effect of this agent can lead to thrombosis and parenchymal damage with increased rates of injection and concentration similar to ethanol, an older sclerosing agent; however, the overall side effect profile is thought to be safer than ethanol (Kondo & Ray, 2010).

Polidocanol is a sclerosing agent that activates nitric oxide pathways and cellular calcium channel signaling, which leads to cell death. Cell injury is time and concentration dependent. Cell lysis involves the endothelium and intravascular contents such as erythrocytes and platelets, leading to microparticle formation that may precipitate blood coagulation (Eckmann, 2009).

Hypertonic agents such as hypertonic saline have been used to great effect. These agents act by osmotic differences over semipermeable cell membranes inducing cell dehydration and death. With larger concentration gradients between the sclerosing agent and intravascular lumen, there is more cell injury in a shorter exposure time. These agents affect the intravascular cells and surrounding tissue interstitium, leading to significant fluid shifts. Dilution of the hypertonic agent may result in decreased efficacy on the target tissue. The exact mechanism of cell death is not known as different concentrations of different solutes can cause variable types of cell death including apoptosis, fibrosis, and necrosis (Kondo & Ray, 2010).

N-butyl cyanoacrylate (NBCA) is a relatively new sclerosing agent and has been used for varicose vein treatment. This agent polymerizes when exposed to blood products in plasma and adheres to the vessel wall. There is stasis of blood with subsequent thrombus formation. This polymerization also results in an insult to the endothelium, leading to a vasculitis-induced necrosis. This material has also been shown to be bacteriostatic (Takeuchi et al., 2014).

Phlebectomy

Phlebectomy is an older technique that was developed in the 1950s and is similar to surgical venous stripping. In this technique, varicosities are identified by palpation and ultrasound while the patient is standing and marked before intervention. Localized anesthetics are used to numb the areas of intervention and to hydrodissect the soft tissues. Small incisions or small holes made by a skin punch are made at regular intervals along varicosities. A phlebectomy hook is used to snare the varicose vein and forceps are used to restrain and remove the varicose veins after ligation. This technique is used at each incision interval until the varicosities and feeder vessels are removed (Kabnick & Ombrellino, 2005).

Benefits and Complications of Intervention

These minimally invasive procedures share many benefits to patients. Given the small incisions and light anesthetic, these procedures can be conducted in the ambulatory setting. Usually, these procedures do not require significant postoperative management.

There are some unique benefits to specific techniques. Given the mechanism of NBCA, which acts through rapid polymerization and thrombus formation, there is no need for tumescent anesthesia or compression stockings in the postprocedural phase of care. In addition, this method has been shown to have decreased pigmentation after treatment.

General complications of these minimally procedures include ecchymosis, pain, skin discoloration, local nerve damage, infection, and deep vein thrombosis. The most significant postprocedural concern of these procedures is deep vein thrombosis, pulmonary embolism, and nontarget embolization (sclerosing agents).

Given the diversity in the mechanism of action of these therapies, there are unique complications. Sclerosing agents, when used in liquid form, have a variety of systemic toxicity effects, which is variable with different agents including ethanol poisoning and pulmonary hypertension with ethanol. These agent specific complications can be reduced with careful selection of slower flow vessels and agent modification, such as use with embolization coils or modification of the agent. Microfoam technique with sclerosing agents increases the efficacy of treatment and lowers the dose. However, these agents may potentially increase the risk of air embolism if foaming is induced mechanically in a syringe (Eckmann, 2009). Another drawback with sclerosing agents is the possible need for retreatment.

Complications that are unique to EVLA and RFA are technical in nature. With EVLA, treatment success is highly dependent on the energy of the laser and the caliber of the targeted vessel. Power of the laser affects the effectiveness of the treatment and the extent of thermal damage. Caliber of the vessel is important as a large caliber vessel may not have complete contact with the therapeutic portions of the laser probe. The speed at which the laser probe is retracted may affect the effectiveness of the treatment if retracted too quickly and if retracted at an inconsistent rate may affect the consistency of therapy and result in inconsistent contraction of the skin, perforation, or incomplete occlusion of the targeted vessel. With RFA, the segment of vessel treatment and overlap plays an important role in

Table 1
Summary of potential complications with EVLA, RFA, FS, and phlebectomy

Type of procedure	Drawbacks/adverse effects
Radiofrequency Ablation/Laser Ablation	Thermal damage, perforation, overtreatment of overlapping segments, undertreatment from technique/larger caliber vessels, thrombosis
Sclerotherapy	General sclerosant nontarget embolization, allergic reaction, deep vein thrombosis
	STS-extravasation, skin necrosis
	Polidocanol-Urticaria, chest tightness, visual disturbances, skin necrosis
	Hypertonic saline-failure of therapy, tissue necrosis, ulceration
	Mechanical-induced microfoam nontarget air emboli
Phlebectomy	Infection, bleeding, nerve damage, deep vein thrombosis and pulmonary embolism, ecchymosis, skin contraction, blisters, soft tissue necrosis, seroma, lymphocele, edema

treatment success. There should be little overlap between treated vessel segments; otherwise, there is a risk of overtreatment or untreated segments. RFA is also subject to thermal damage (Ahadiat et al., 2018; Kaufman & Lee, 2014; Kayssi et al., 2015).

A summary of complications for these techniques can be seen in Table 1.

Preoperative considerations

Patients who elect to have minimally invasive treatment of their varicose veins should consult their physicians. It is important for patients to disclose any medications taken for coagulopathies. If necessary, a hematology consult may be considered for preprocedural management.

For sclerotherapy, nonsteroidal antiinflammatory drugs (NSAIDs) should be avoided as the resulting inflammation is part of the treatment process.

Postoperative Management

Postoperative management is similar between these therapies. The major difference with pain management for sclerotherapy is that NSAIDs should not be used as they will inhibit the treatment process. With EVLA and RFA, NSAIDs can be used for pain control and should be taken with food.

Postprocedural pain control is typically controlled with oral acetaminophen. If the patient had moderate sedation during the procedure, the patient should avoid driving or manipulating heavy machinery until after 24 hours after the procedure.

Patients are encouraged to ambulate. Compression stockings should be worn for 2 weeks during activity but can be removed during sleep and showering. Patients treated with NBCA have not needed compression stockings in the postprocedural management (Koramaz et al., 2017). Patients can shower 24 hours after the procedure. Dressing should be kept clean and dry. Steri-Strips will fall off after a few days.

Direct skin exposure to the sun should be avoided. The skin may discolor and blister but will improve over time.

One week after the procedure, patients should have an ultrasound to determine if any clot has formed in the superficial and deep vessels as these procedures predispose patients to superficial clots, which can extend into the deep veins. If a deep vein thrombus is identified, patients may be placed on anticoagulation to prevent possible pulmonary embolism. Because of this risk, patients should be vigilant for calf pain and shortness of breath.

In addition, although there may be some weeping from the wounds, patients should monitor if there is increasing redness, pain, and purulent drainage that may result from an infection.

Discussion

Varicose veins can be managed conservatively and treated with these minimally invasive techniques. There are many benefits to these techniques, many of which are shared between techniques such as ambulatory surgery, quick recovery times, and significant improvement in quality of life. Each technique has rare adverse effects, some of which are unique to each technique.

There are many studies that have compared these techniques. One of the most comprehensive trials that were published in the New England Journal of Medicine, the Comparison of Laser, Surgery, and Foam Sclerotherapy (CLASS) trial, compares almost 800 patients randomized to these three techniques. This trial compares three groups. A surgery group using a combination of venous stripping and phlebectomy, laser therapy with possible 6-week follow-up sclerosing treatment or phlebectomy, and FS with STS. This study used a combination of multiple quality-of-life questionnaires and clinical assessment to compare these techniques (Brittenden et al., 2014).

The CLASS trial shows that there were no significant differences in quality of life. There was a slight but significant disease-specific quality-of-life difference that was worse in FS compared with EVLA and surgical treatments. It is unclear whether these slight differences were clinically significant and biased, given that patients were not blinded to what treatment they were receiving (Brittenden et al., 2014).

Clinically, there were more residual varicose veins with FS compared with the other treatments. It is unclear whether or not the additional concurrent treatments in the laser or surgery groups affected these results; however, comparisons between EVLA only and EVLA with concurrent therapy revealed no differences (Brittenden et al., 2014).

Other smaller analyses support the CLASS trial suggesting that EVLA and RFA are more successful compared with FS (Nesbitt et al., 2011).

In addition, there are multiple meta analyses that have compared EVLA, RFA, FS, and surgical stripping. In one meta-analysis involving 52 studies, the overall picture is more muddled. This analysis showed that minimally invasive procedures had similar outcomes compared with surgical stripping. Recurrence of disease appeared to be similar in all minimally invasive groups compared with stripping. The venous clinical severity score (lower suggestive of less severe disease) and European Quality of Life- 5 Dimensions (higher suggestive of better quality of life) were used as qualitative criteria to compared between invasive techniques. Venous clinical severity scores (VCSS) were lower for EVLA and FS and slightly elevated for RFA compared with stripping; however, overall quality-of-life measurements were better for all techniques compared with stripping. Cost effectiveness was evaluated and although FS seemingly appears to be more cost effective than the other techniques, however, this measurement is dependent on timeframe (Carroll et al., 2013). Immediate postprocedural pain was evaluated separately and was found to be increased in EVLA which is supported by other analytical studies (Carroll et al., 2013; Nesbitt et al., 2011). This was thought to be due to an accelerated peak temperature time in laser ablation, whereas RFA peak plateau time is slower and longer (Carroll et al., 2013).

NBCA has been shown to be similarly efficacious compared with EVLA in the immediate postprocedural stage. Quality of life is improved with this sclerosing agent as there is no need for tumescent anesthesia, and the skin is less prone to discoloration. This study was limited by lack of long-term efficacy (Koramaz et al., 2017).

There is limited evidence comparing conservative management with minimally invasive management because of the inherent differences between patient populations willing to accept conservative or desiring minimally invasive interventions (Carroll et al., 2013).

Conclusion

There are many alternatives to surgical techniques including EVLA, RFA, and FS. Comparison to surgical procedures, these techniques are shown to have the same, if not better, efficacy. Although these studies are limited because of lack of long-term efficacy data, these minimal invasive techniques are safe effective alternatives to surgical techniques with improved quality of life.

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