Radiofrequency Ablation as a Treatment for Chronic Venous Insufficiency

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For some individuals, varicose veins are simply a cosmetic concern, most often noticeable as spider veins in the lower extremities. For others, varicose veins can cause an aching discomfort in the legs and appear distended, tortuous and unsightly. Varicose veins can be indicative of a more serious condition called chronic venous insufficiency (CVI).[2]

CHRONIC VENOUS INSUFFICIENCY

Symptoms of CVI include varicose veins, venous ulcerations, itching, pain, discoloration and chronic swelling of the lower legs and ankles.[2] CVI occurs when the pairs of valves in the legs designed to prevent venous stasis and retrograde blood flow do not close effectively, or the venous wall becomes distended impeding blood flow from the legs back to the heart. In addition to varicose veins, other risk factors related to development of CVI include pelvic tumors, vascular malformations, aging (especially those older than age 50), reduced mobility, deep vein thrombosis, smoking, being female, obesity and extended periods of sitting and standing. Surgical technologists, especially those who work in specialty areas with long cases such as spinal and reconstructive procedures, are at risk of developing CVI related to prolonged intervals of standing. Wearing compression stockings with comfortable shoes, performing isotonic and isometric exercises and frequently changing the positions can help improve venous return.

LEARNING OBJECTIVES

- Review the anatomy associated with chronic venous insufficiency
- Evaluate the multiple treatment options for CVI
- Identify those at a greater risk for developing CVI
- Describe the steps of radiofrequency ablation for treatment of this condition
- Compare RFA to the other methods used to treat chronic venous insufficiency

VEIN ANATOMY AND PHYSIOLOGY

Primary components of the vascular system include the heart, arteries, capillaries and veins. The heart is the pump that forces blood to move away from the heart to the organs and tissues through the arteries. Small arteries, called arterioles, connect arteries to the capillaries. Capillaries are thin-walled microscopic vessels that allow transfer of nutrients, oxygen, carbon dioxide and products of cellular metabolism to and from the blood. Small veins called venules connect capillaries to veins. Veins return blood from the organs and tissues to the heart. The wall of a vein consists of three layers: The outer layer is called the tunica externa or the tunica adventitia and is comprised of collagen and elastin to provide strength. The middle layer is called the tunica media or the muscularis and is comprised of smooth muscle and elastin. The thin, smooth muscle layer of the tunica media provides resistance, but is not strong enough to support venous return. Skeletal muscle outside of the veins aids venous return. For example, contraction of the gastrocnemius and soleus muscles located in the calf force blood from the lower leg upward through the veins toward the thigh. Pairs of unidirectional valves within the veins are designed to be forced open when the skeletal muscles are contracted to allow blood pass through and close after each contraction to prevent reflux. The inner layer is called the tunica interna or the tunica intima and is comprised of endothelial cells that are in direct contact with the blood. Blood flows through the central canal of the vein which is called the lumen.1

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There are three types of veins that are found in the leg:

Superficial veins are located near the surface and often can be seen as a bluish discoloration through the skin. Approximately 10% of the blood from the lower leg is carried through the superficial veins. The great saphenous vein is considered a superficial vein, and is the most important vein in the lower limbs. The term saphenous is derived from the word safina, which means "hidden," as in the vein is hidden in a facial compartment.

Deep veins are located within the muscles of the leg. Approximately 90% of the blood from the lower leg is carried through the deep veins.

Perforator veins run perpendicular to the superficial veins and connect the superficial veins to the deep veins by perforating the deep fascia of muscles. Sometimes perforator veins are referred to as communicating veins.[5]

TREATMENT OPTIONS FOR CVI

Options for treatment of CVI include compression therapy, vein stripping and ligation, sclerotherapy, endovenous laser treatment and radiofrequency ablation (RFA). Documentation of treatment of varicose veins can be found as early as the fourth century BCE, when Hippocrates writes of treatment of varicosed veins with a metal instrument.[9]

COMPRESSION THERAPY

Compression therapy is often the first method considered for treatment of CVI and is the most cost effective and least invasive treatment. Compression therapy is classified as static and dynamic. Static (constant) compression therapy involves fitting the patient with compression hosiery or applying compression wraps such as an elastic bandages. Dynamic (intermittent) compression therapy involves application of half-leg or full-leg inflatable sleeve along with the use of a pneumatic sequential compression pump.

VEIN STRIPPING AND LIGATION

The probable advent of vein stripping of the great saphenous vein was reported in 1844 by Madelung and is considered the oldest technique for treatment of CVI.[2] Vein stripping involves making small incisions proximally (usually near the groin) and distally (usually near the ankle) over the saphenous vein, ligating the proximal and distal ends of the vein, inserting a plastic or wire cable called a "vein stripper" through the proximal lumen to the distal lumen of the vein. Following insertion of the cable, a cap called an "olive" is attached proximally and a handle is attached distally allowing the vein to be pulled through the distal incision on the stripper. Vein ligation (also called avulsion phlebectomy) involves double ligation and removal of tributary veins.

SCLEROTHERAPY

Sclerotherapy involves injecting a drug directly into the vein which causes the vein to collapse and disappear. In 1682, D

Zollikofer of Switzerland injected acid into a vein to induce formation of thrombis and in 1854, Desgranges reported curing 16 cases of varicose veins by injecting iodine and tannin into the vein. The use of acid, iodine and tannin had several reported side effects, and mechanical vein stripping returned as the more popular treatment option as surgical advancements and development of anesthetic techniques advanced.[9] Sclerotherapy is the treatment of choice for spider veins, telangiectasias (a bluish vein less than 1 mm in diameter) and reticular veins (1-3 mm in diameter) and often is used as an adjunct to larger vein treatments.[6]

Sclerosants in today's use fall into three categories:

Osmotic agents that work to disrupt and destroy the cell wall by dehydration. The effect of the osmotic agent is localized because the sclerosing agent is rapidly diluted as it is absorbed into the bloodstream. Examples of osmotic agents include hypertonic (23.4%) saline or a combination of hypertonic saline and dextrose.

Detergents that work by disrupting the cell membrane. Endothelial damage occurs, but can spread beyond the area of desired treatment because they take longer to be absorbed and diluted.

Foam sclerotherapy uses a detergent sclerosant and air which is mixed to create a foam, and the foam has the effect of increasing the time in which the sclerosant is in contact with the cell wall.[8]

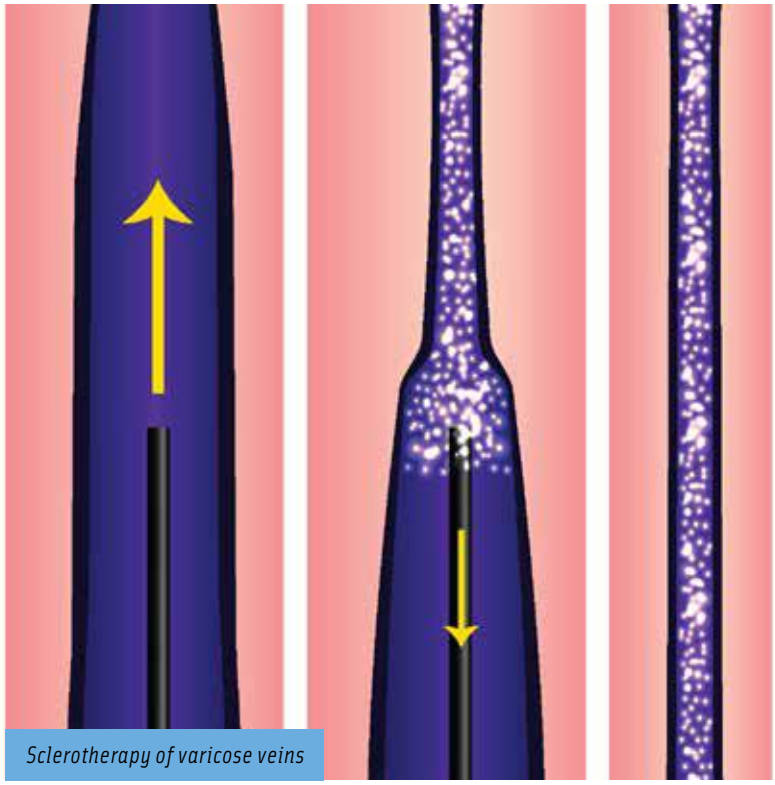
ENDOVENOUS LASER THERAPY

In 2002, the FDA-approved endovenous laser therapy as an appropriate treatment for great saphenous vein reflux. Endovenous laser therapy involves insertion of a laser fiber into the affected vein through a small incision. Energy in the form of a highly concentrated beam of light is emitted through the fiber along the length of the vein, causing a reaction with the tissue that causes the vein to collapse and adhere to itself. Collateral vessels develop to allow redirection of the blood flow.[2]

RADIOFREQUENCY ABLATION (RFA)

The term radiofrequency refers to use of an oscillating electromagnetic frequency wave similar to frequencies used in communication technologies. When medium frequency (approximately 350-500 kHz) alternating current is concentrated and directed into tissue, heat is generated and the tissue is ablated. The term ablation refers to the destruction or

removal of tissue. Radiofrequency ablation (RFA) has many medical applications in a variety of surgical specialties, such as in otolaryngology for treatment of airway obstructions (such as occur during sleep apnea), in dermatology to remove age spots and resurface the skin, ablation of brain tissue to treat neurological disorders, treatment of cardiac dysrhythmias and, most recently, in genetic ablation, which may be a potential treatment for certain types of cancers. The focus of this article relates to the use of RFA in the treatment of CVI. Radiofrequency ablation of varicose veins involves endovenous insertion of a probe containing an array of electrodes into the targeted area of the great saphenous vein. When the probe is activated, the energy emitted creates ionic agitation and friction, which in turn causes heating of the tissue. When the heat reaches the desired temperature (greater than 113° Fahrenheit/45° Celsius) in the targeted tissue, proteins in the tissue are permanently damaged, causing fusion of the cell membranes. Small thermocouples, or thermometers, contained within the tip of the probe monitor the temperature emitted by the probe. The margin of tissue ablated is controlled by the size of the probe used. The ablation probe is connected to a generator that displays the temperature in the surrounding tissue and is created when the probe is deployed by the surgeon via a foot pedal. The surgeon will also monitor the targeted tissues under ultrasound guidance.



Sclerotherapy of varicose veins

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The introduction of a tumescent solution aids in reducing postoperative pain, swelling and bruising following both endovenous laser therapy and RFA. The word tumescent literally means swollen and firm. A combination of lidocaine, sodium bicarbonate and epinephrine is injected into the subcutaneous tissue in large volumes to provide a long-acting and widespread area of local anesthesia. The epinephrine acts as a vasoconstrictor, which minimizes bleeding and bruising of the affected area. General anesthesia or monitored anesthesia care accompany the tumescent technique.

CASE STUDY

A procedure in which removal of varicose veins was performed by using radiofrequency ablation is described. Following admission procedures to the preoperative holding area, the patient was asked to stand so that the varicose veins would engorge with blood so they would be visualized, mapped and marked by the surgeon with a surgical pen. Marking the targeted areas in advance provides the surgeon a guide of the affected veins once the patient is in the supine position. The patient was brought to the operating room on a gurney and was assisted onto the operating table by the anesthesia provider and the circulator. A foam donut was placed under the patient's head and a nasal cannula with oxygen flowing was placed in the nose. The patient was secured on the operating table in the supine position with the safety strap, arms secured on arm boards, and warm blankets were provided. When all the surgical team members were present in the operating room, a time out was called

per universal protocol. Following completion of the time out, the anesthesia provider administered 250 mcg of remifentanyl and 2 mg of midazolam to sedate the patient. This procedure was performed under monitored anesthesia care (MAC).

The circulator exposed the patient's left leg by moving the blankets and patient gown to above the waist. The affected leg was placed in a picket fence leg holder during the prep, which was accomplished with chlorhexidine circumferentially from the toes to the hip. After the resident and surgeon were gowned and gloved, the patient was draped using U drapes. The ultrasound transducer was covered with a sterile cover, ultrasound gel was placed on the patient's leg and the surgeon began to identify the vascular structures. A micropuncture needle was inserted into the distal portion of great saphenous vein under ultrasound visualization. Entry into the vein was confirmed by observing backfill of blood into the syringe and a mixture of heparinized saline (5000 units of heparin in 500 ml of 0.9% saline) was used to flush the vein. A 0.018-inch guide wire was inserted into the needle, and the needle was withdrawn. A #11 blade was used to extend the incision to accommodate a 7 French sheath inserted over the wire. A syringe with heparinized saline was used to flush the vein and ensure proper location of the sheath within the vein. The patient was placed in the Trendelenburg position to decrease venous congestion and aid in visualization.

The surgeon selected a 6 x 100 cm RFA probe based on the patient's size and the probe was inserted into the sheath. Following verification of proper placement of the probe with the ultrasound, 450 ml of the Tumescent solution – which is a mixture of 500 ml of 0.9% saline with 50 ml of 1% lidocaine with epinephrine 1:100,000 and 8 ml of 8.4% sodium bicarbonate – was injected under ultrasound guidance along the length of the saphenous vein containing the RFA probe, to the level above the end of the RFA wire. The heating element was deployed, the optimum temperature achieved in the tissue and after each 20-second cycle of temperature "runoff" the probe was moved distally along the vein and deployed repeatedly. After all cycles, the entire length of the saphenous vein was ablated, the RFA wire was removed, the sheath was removed and pressure was placed over the incision for five minutes until the wound was no longer bleeding. The patient's leg was cleaned and skin closure strips were placed over the incision. This particular patient also was suffering from an ulceration due to venous insufficiency. The small (1x1 cm) lateral malleolar ulceration was sharply debrided with a #11 blade through the dermis but not extending through the subcutaneous or surrounding muscular tissue, until capillary bleeding was observed. The debrided area was cleaned and a medicated dressing containing a combination of calamine and zinc oxide was applied to aid in reepithelization of the wound. The surgical drapes were removed and a compression dressing consisting of fluffed gauze and elastic wraps was placed over the leg circumferentially from the foot to the thigh.

The patient was assisted back onto the gurney, covered with warm blankets, transported to the postanesthesia care unit and discharged approximately 30 minutes after the end of the procedure.

Most patients typically return to their normal daily activities later the same day. Over-the-counter pain medication is generally all that is needed to provide adequate postoperative pain relief. The dressing was removed at a follow-up visit with the surgeon the next day.

Complications are minimal following this procedure, but can include pain, abscesses, swelling, bleeding and hematoma. Once the greater saphenous have been ablated, it is not available should a future coronary artery bypass grafting (CABG) be needed.

ABOUT THE AUTHOR

Julie Beard, CST, has worked as a surgical technologist for 12 years, all at Denver Health Hospital in Denver, Colorado, with eight of those years as the chief surgical tech for general surgery. She would like to thank Dr Charles Fox and Steffanie Laslo, PA, for their assistance in the writing of this article.

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1. Which is one of the most notable symptoms related to Chronic Venous Insufficiency?
a. Itching
b. Pelvic tumors
c. Varicose veins
d. Chronic swelling

2. The wall of a vein consists of how many layers?
a. 4
b. 3
c. 2
d. 1

3. These types of veins often can be seen as a bluish discoloration through the skin:
a. Deep veins
b. Perforator veins
c. Superficial veins
d. Communicating veins

4. The first method prescribed to treat the CVI condition is usually:
a. Vein stripping
b. Radiofrequency ablation
c. Sclerotherapy
d. Compression therapy

5. In the case study mentioned in this article, the patient was moved from the supine position to what position?
a. Supine
b. Trendelenburg
c. Lateral
d. Reverse Trendelenburg

6. Approximately 90% of the blood from the lower leg is carried through the _____.
a. Deep veins
b. Superficial veins
c. Perforator veins
d. Saphenous vein

7. Patients recovering from this procedure usually return to their daily activities within:
a. 2-3 days
b. 1-2 days
c. The same day
d. 5 days

8. During the procedure, a micropuncture needle is inserted into the distal portion of _____.
a. Superficial vein
b. The great saphenous vein
c. Deep vein
d. Both a and b

9. Vein stripping involves making small incisions near the ____ and the ____.
a. Groin, knee
b. Groin, ankle
c. Knee, toes
d. Thigh, ankle

10. RFA of varicose veins involves endovenous insertion of a probe containing an array of electrodes into the targeted area of the ____.
a. Deep vein
b. Perforator vein
c. Communicating vein
d. The great saphenous vein

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