Complications of the Treatment of Venous Insufficiency

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Clinical Pearls

1. Superficial phlebitis related to ablation of a superficial vein can be treated with anti-inflammatory medications and topical moist heat compression.
2. EHIT can occur with thermal and nonthermal ablation of the saphenous vein and is best avoided by starting treatment 2–3 cm away from the junction with the deep venous system.
3. Nerve injury increases with anatomical location, where the cutaneous nerves are close to the veins such as the below-knee great saphenous vein and the small saphenous vein in the mid-calf.

Introduction

Complications that occur during the treatment of chronic venous insufficiency have become less frequent since endovenous procedures have replaced surgery in most patients [1]. Therefore, many patients are treated in outpatient or office centers and discharged to home soon after a procedure [2]. However, some complications need to be prevented, diagnosed when they occur, and treated. Many are related to superficial or deep venous thrombosis, and some are related to injury to adjacent structures in the leg, such as the skin and nerve. In addition, hematoma and staining from hemosiderin pigmentation are significant concerns to patients who undergo these procedures for cosmetic, as well as other treatment goals. In addition, as with all procedures, there can be failures, which are usually termed "recurrences," but may actually be inadequate initial therapy or recanalization of veins that were initially properly treated.

Venous Thrombosis

Venous thrombosis of either superficial, perforator, or deep system is one of the greatest concerns in patients undergoing interventional treatments for venous insufficiency (Fig. 16.1). It is usually benign but can occasionally cause significant morbidity and rarely mortality.

Superficial Venous Thrombosis (SVT)

Superficial venous thrombosis comes in two forms—those close to the treated vein, whether it is a thermal or nonthermal ablation procedure, a

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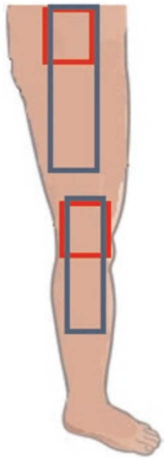

Fig. 16.1 Location of potential DVT and EHIT. EHIT occurs at the junction of superficial truncal and deep veins, while DVT can occur anywhere within the deep venous system. The *red boxes* indicate the sites of potential EHIT, where a truncal vein (great and small saphenous) joins the deep veins. The *blue boxes* are the sites of potential DVT. There is overlap between the two zones

ligation, or an excision of a superficial vein, and those unrelated to an interventional or surgical procedure. The most common is related to the procedure and occurs when there is both stagnant flow in a treated vein, due to proximal or distal ligation and injury, or when there is trapped blood within a treated vein, where the proximal and/or distal vein is ligated or thrombosed, so that the blood in between becomes stagnant and eventually thromboses.

Signs and Symptoms of SVT

SVT may be either asymptomatic or symptomatic, depending on the vein involved, the extent of inflammation within the vein, and the tissue surrounding the vein. SVT in veins that become dilated and inflamed may cause significant discomfort, and those adjacent to sensory nerves may have significant burning as well as pain, while those with minimal inflammation and swelling may be asymptomatic.

Prevention of SVT

There is little data or information on the prevention of SVT in patients undergoing venous procedures, probably because the consequences of SVT are usually not life threatening; they are usually self-limited and of little clinical consequence. The one technical principle to prevent SVT is to remove as much superficial vein as possible when performing excision and not leave large amounts of entrapped blood when performing ablation or sclerotherapy. When SVT occurs after sclerotherapy, where no vein is excised, placement of the solution in the vein is associated with spasm and inflammation of the vein being treated. Consequently, sclerotherapy of larger veins is performed with the leg elevated to collapse the vein, and after injection of the sclerosant, the leg should be compressed until the inflammatory reaction in the vein has become self-limited and the diameter of the thrombus in the vein is the smallest possible. Reducing the volume of blood in a vein with SVT reduces discomfort and later hemosiderin pigmentation related to the vein that is sclerosed [2].

Diagnosis of SVT

Clinical exam is the primary method of diagnosing SVT. Areas of SVT have localized tenderness, erythema along the vein, and firmness due to the thrombus within the vein. Localized SVT is often confused with infection. Duplex ultrasound is the primary technique to diagnose SVT and is used in cases where the cause of pain is not obvious. When there is concern about the extent of the SVT, duplex ultrasound can also easily identify the proximal and distal extent of the thrombus, determine the size of the thrombosed vein, and determine if it may be amenable to aspiration to release trapped blood.

Treatment of SVT

Treatment is dependent on the degree of patient discomfort and the anticipated cosmetic consequences of untreated SVT. When a large superficial vein is thrombosed, there is considerable likelihood of long-term pigmentation, and therefore treatment may be indicated for cosmetic purposes. In addition, the degree of inflammation and pain will influence treatment. The options for treatment include symptomatic relief with anti-inflammatory medications and topical moist heat compression. When symptoms are severe or the risk of pigmentation is high, the release of entrapped blood with needle or micro-incision, followed by aspiration, usually results in rapid relief of pain and a lower likelihood of long-term pigmentation.

EHIT

Endothermal heat-induced thrombosis (EHIT) is defined as thrombus extension from a thermally treated superficial truncal vein into the deep system (Fig. 16.2). It may also occur with nonthermal techniques such as mechanochemical ablation (MOCA), foam, or glue ablation [3]. EHIT occurs at the junction between superficial and deep veins. Since the thrombus originates in the superficial vein and the thrombus extends into the deep vein without deep vein wall attachment, it is not a true DVT and it has a different natural history, unless it remains in the deep vein for a prolonged period and eventually attaches to the wall of the deep vein. In most circumstances, it is self-limited, with retraction of the thrombus back into the superficial vein within days to weeks and with no long-term consequences to the deep venous system. Consequently, the major risk of EHIT is that thrombus will break off during the time when it is unattached and/or floating in the deep venous system.

The location of the tip of a thermal catheter, when the vein is ablated, is critical in determining the likelihood of EHIT (Fig. 16.3). At least 2–3 cm from the junction is the recommended distance to prevent EHIT—the closer to the deep vein, the higher the likelihood that the thrombus will extend into the deep vein. It can occur with any thermal or nonthermal procedure that closes a large superficial axial vein at its junction with

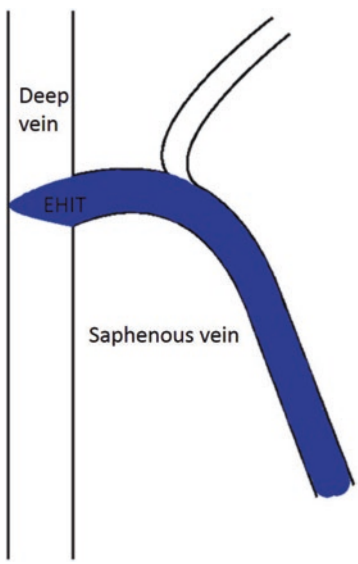

Fig. 16.2 Diagram of endovenous heat-induced thrombus (EHIT) extending into a deep vein. *Blue* represents thrombus extending from the saphenous vein into the deep venous system through the junction

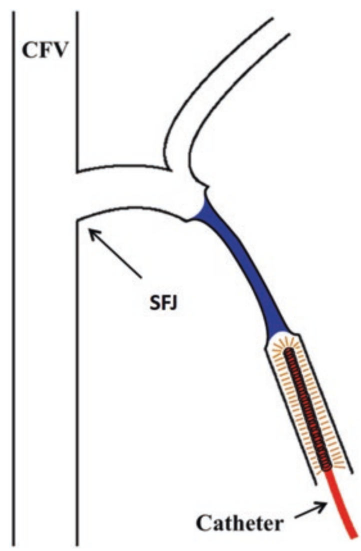

Fig. 16.3 Catheter positioned 2–3 cm from the saphenofemoral junction (SFJ) to reduce the risk of EHIT (CFV = common femoral vein)

the deep venous system. The identification of the extension into the deep system is dependent on the timing of imaging to identify EHIT.

Even though the risk of EHIT is low (<5%), it is the most common concern of the treating physician in patients who have a complication after a superficial endovenous procedure. EHIT is more common in patients with a very large truncal vein, in hypercoagulable patients, and in those patients with a prior history of DVT.

There has been no standardized and validated system of classification of EHIT, but there have been several classification systems proposed, which, although they have some differences, are similar in most ways [4–6].

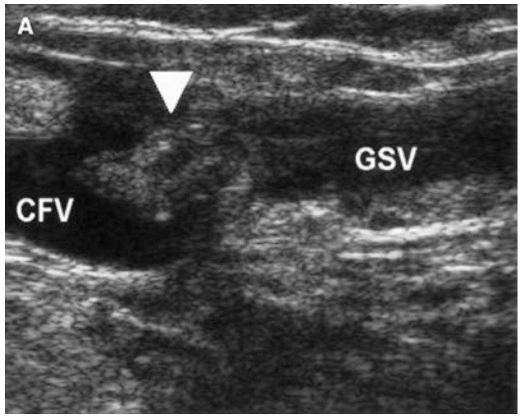

Fig. 16.4 Ultrasound appearance of EHIT, when thrombus has extended into the deep vein from the saphenous vein (GSV = great saphenous vein and CFV = common femoral vein)

Diagnosis of EHIT

Differentiating the causes of post-procedure pain and swelling is difficult, and differentiating EHIT from DVT clinically is difficult, unless duplex ultrasound is used to image the site of concern. Because there are significant differences in the natural history and treatment of EHIT and DVT, it is important to determine the etiology of postoperative complications in all patients with pain and swelling.

Duplex Ultrasound

Not all patients require a DU post-procedure to evaluate them for EHIT or DVT, but patients with significant post-op pain or swelling and those who have high risk factors for DVT and EHIT should undergo DU to assess the site of ablation, for hematoma or superficial branch or truncal vein thrombus. Both B mode and color flow, using transducers in the 2–10 MHz range, should be used for each study (Fig. 16.4). The transducer wavelength used will depend on the patient's body habitus and the depth of the superficial and deep venous system at the site of the diagnostic study. The diagnostic ultrasound should be performed in both the supine or standing position. Measurements should be taken using an electronic cursor in transverse, axial, and orthogonal positions to determine the distance and relationship between any thrombus identified and the vein wall, as well as the presence, absence, and extent of protrusion into the deep system.

Classification of EHIT

The key to the classification system is determining whether thrombus has protruded into the deep venous system, as well as the extent of protrusion [5, 6]. A simple classification system is as follows:

1. A = Closure limited to the superficial veins
2. B = Thrombus present in the deep venous system
   a. B1 = Thrombus bulging into the deep venous system but not significantly obstructing deep venous flow and not attached to the wall of the deep vein
   b. B2 = Thrombus extending into the deep venous system and occupying <½ of the deep venous diameter, as measured by cross-sectional duplex ultrasound
   c. B3 = Thrombus occupying >50% of the deep venous system at the level of protrusion, but not attached to the contralateral

deep venous wall (the thrombus can be free-floating or not free-floating)

d. B4 = Thrombus occupying the entire deep vein by cross-sectional duplex imaging and appearing similar to a short segment DVT (even though the patient does not have true DVT since all thrombus may retract)

Natural History of EHIT

The natural history of EHIT remains poorly defined, particularly when one evaluates the subgroups within an EHIT classification system. The timing of DU is critical since most thrombus that extends into the deep venous system is benign, retracts within a week, and causes no symptoms. Studies that image a patient within a few days of the procedure will identify many more patients with benign EHIT, while those that image a week to a month later will find very few cases of EHIT. The goal of all studies is to identify patients who have a risk of progressing from EHIT to DVT and treat them before they develop DVT or even pulmonary embolus.

Deep Vein Thrombosis (DVT)

DVT can occur after any interventional venous procedure, whether that procedure is performed on the superficial, perforator, or deep venous system. DVT is unrelated to the site of catheter placement and can occur in any deep vein, contiguous with the treated vein or a distance from it. In deep venous procedures such as lysis, balloon angioplasty, or stenting of the deep venous system, DVT may be related to the prior deep venous problem such as thrombosis or chronic webs and intraluminal wall changes or due to catheter, balloon, or stent manipulation within the deep venous system. It can be diagnosed by intravascular ultrasound at the time of the procedure, venography at the time of the procedure, or post-procedure duplex ultrasound, CT venography, or MR venography. Treatment is the same as DVT from any other cause.

Skin Infection

Skin infections may occur after incisions and puncture of the skin during superficial and deep venous procedures. They are most likely to occur in a patient who has a pre-existing skin infection or skin colonization, as well as situations where a hematoma occurs as part of the procedure. For those reasons, ablation of perforator veins (Fig. 16.5), when a venous ulcer is present, is among the highest risk procedures for infection, and infection may be prevented by using prophylactic antibiotics against skin and wound organisms. In addition, when multiple incisions are made in the skin to remove tributary or superficial axial veins, there is an increased risk of skin infection. It can sometimes be difficult to differentiate between infection and hematoma after venous procedures, particularly when there are pre-existing skin changes such as lipodermatosclerosis, so the prudent surgeons treat with antibiotics until the cause of the skin changes declares itself [6, 7].

Skin Necrosis

Initially, when thermal ablation procedures were first developed and reported, skin necrosis occurred directly over the site of the catheter, due to the transmission of thermal energy to

Fig. 16.5 Technique of perforator ablation which, when a venous ulcer is present in the region of the catheter, increases the risk of wound infection at the catheter puncture site

the skin. However, with new laser wavelengths, new designs of radiofrequency catheters, and tumescent techniques that separate the skin from the vein, as well as the increasing use of nonthermal devices for superficial vein closure, the frequency of skin burns has become extremely uncommon and virtually never occurs, as long as proper technique is used. The liberal use of tumescence solution around the vein to be treated with thermal energy has several purposes; it moves the vein away from the skin, moves the vein away from sensory nerves which parallel the vein, and collapses the vein to reduce the volume of intraluminal thrombus. Consequently, the current technique of thermal ablation of superficial axial veins, with the liberal use of tumescent solution, is virtually never associated with a skin burn.

Skin Pigmentation

When a truncal or superficial vein is ablated, whether with thermal or nonthermal techniques, the size of the vein at the time of closure determines the extent of pigmentation of the overlying skin. Large veins that are ablated with little reduction in their size during the ablation process often result in overlying skin pigmentation. In addition, the distance from the skin to the vein is critical, as well as whether the vein is located below the fascia. Large veins that are close to the skin require either extensive tumescence to reduce their size or nonthermal techniques to remove them. Microphlebectomy can often be used to remove very superficial truncal veins that would otherwise lead to severe pigmentation if they were ablated or closed with either a thermal or nonthermal technique. Other cosmetic concerns include the size of incisions, which may lead to scars at the site of either puncture for an interventional procedure or the sites of incisions for removal of tributary veins. Micro-incisions using an 18 gauge needle combined with a small crochet hook reduce the size of incisions so that they are nearly invisible.

Neurologic Injuries

Nerve injury may occur when a superficial sensory nerve runs adjacent to a superficial axial vein and that vein is treated with thermal energy, whether it be with a laser or radiofrequency energy. Recently, nonthermal devices have been developed that do not require heat for vein closure, and these devices have been associated with a much lower incidence of sensory nerve injury. If a thermal device must be used, the vein being treated should be separated from the surrounding tissue and sensory nerve with tumescent solution. In addition, areas of the axial vein that are adjacent to the nerve are best left alone and not treated. This includes the saphenous vein below the knee and the small saphenous vein from the mid-calf to the ankle. A commonly used approach is to first treat the proximal saphenous vein with thermal ablation and reserve treatment of the distal saphenous vein and the small saphenous vein for a nonthermal technique at a later time and only if it is needed to control symptoms or for venous ulcer healing. Ablation of the proximal small and great saphenous vein is often associated with complete resolution of symptoms and no further treatment is needed [6].

Motor nerve injury is extremely uncommon and only occurs if a catheter is placed below the fascia of the leg. This may rarely occur with small saphenous ablation, when the catheter is advanced to the popliteal vein, and during perforator ablation, if the perforating vein is treated with thermal energy below the fascia of the leg (Fig. 16.6).

Residual Symptoms

Pain occurs initially after superficial venous procedures due to skin incisions, hematomas, infection, and superficial and deep vein thrombophlebitis. A small amount of pain can be expected in every patient, due to a skin puncture (Fig. 16.7) and subcutaneous manipulation, but most mini-

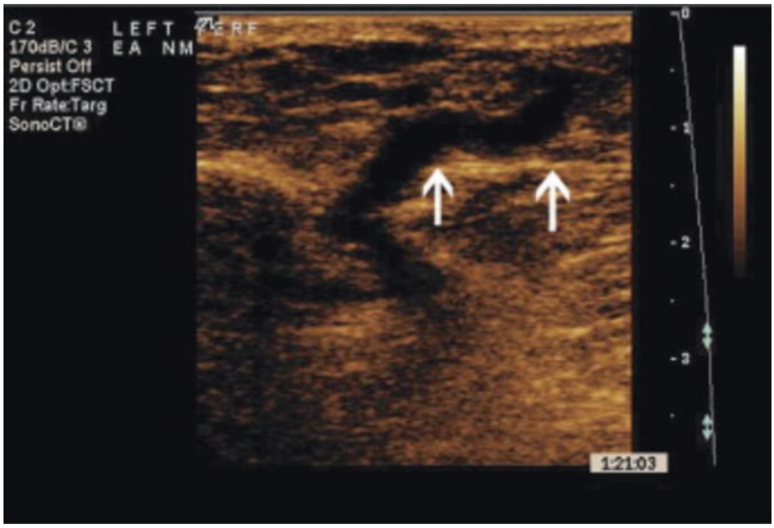

Fig. 16.6 Path of a perforator vein as it travels through the fascia. In the ankle, the perforator vein is very close to the tibial artery and motor and sensory nerves

Fig. 16.7 Technique of laser or radiofrequency ablation of a truncal saphenous vein, with the puncture site being the potential site of either skin infection or superficial thrombophlebitis

mally invasive venous procedures in the modern era, where stripping is not used, are relatively pain-free. There have been comparisons of laser and radiofrequency ablation regarding postoperative pain, but it is apparent from most studies that either technique can be performed almost pain-free, as long as the catheter does not perforate the vein wall. When pain does occur, it is incumbent on the surgeon to perform a physical exam, conduct a duplex ultrasound study, and then treat, based on the findings.

Swelling

Swelling is the consequence of tissue trauma, whether it is from infection, hematoma, or superficial or deep venous thrombosis. Swelling is another indication for conducting a thorough physical exam, duplex ultrasound of the leg veins, and occasionally CT venogram and/or MR venogram, to determine the etiology of the swelling. Long-term swelling is very uncommon after superficial venous procedures and usually indicates that another problem is the cause.

Recurrence

For many patients, the most important outcome of a venous procedure is long-term success and the lack of a recurrence. Many times, what is termed a recurrence is actually incomplete removal of the offending veins or incomplete ablation of an axial or perforator vein, rather than a true recurrence. Recent reviews of recurrence have demonstrated that the frequency of recurrence is similar between the current era and previous eras when vein stripping was the method of choice. Currently, recurrence occurs in ~5% of patients and is due to recanalization of superficial truncal veins, which can often be retreated with sclerotherapy. Neovascularization is uncommon with current minimally invasive devices, while it is more common with stripping [8].

Procedures on the deep venous system are much less commonly associated with recurrence (Fig. 16.8), although stents that occlude the contralateral iliac vein are increasingly being reported to cause contralateral leg swelling (Fig. 16.9) [9].

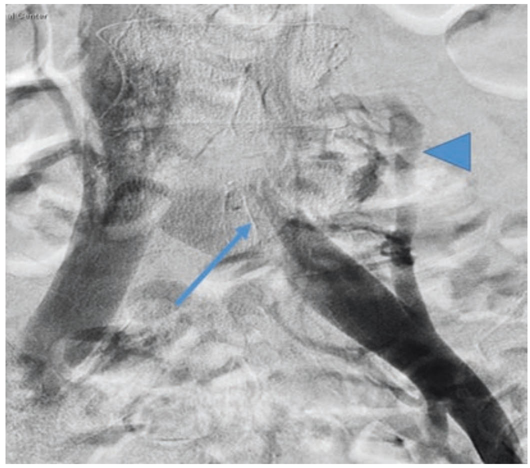

Fig. 16.8 Compression of the deep venous system (*arrow*) may lead to swelling and even DVT, when severe. Venous congestion leads to the development of large collateral veins (*arrowhead*)

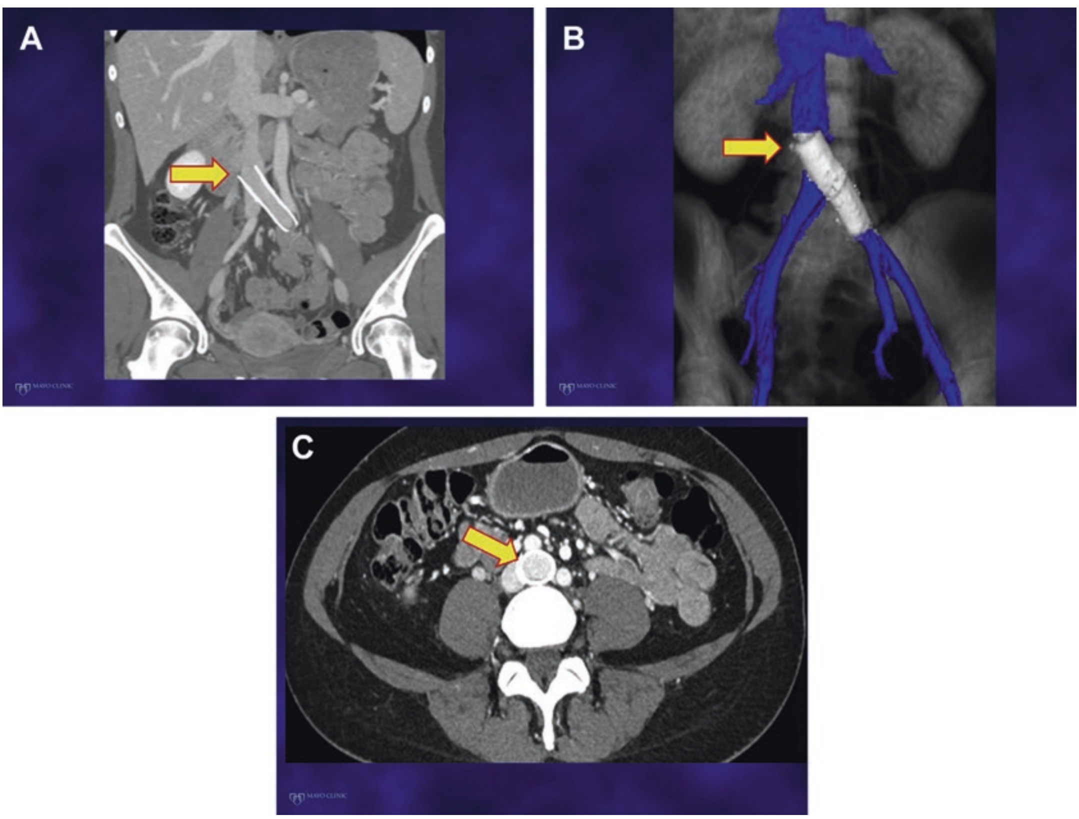

Fig. 16.9 These images show a potential complication related to iliac stent placement. The stent in the left common iliac vein (*arrow*) crosses the right iliac vein and occludes the contralateral venous outflow, potentially leading to contralateral leg swelling or DVT (**a** = frontal view, **b** = 3D reconstruction, **c** = cross-sectional view)

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