# American College of Radiology
## ACR Appropriateness Criteria®
## Lower Extremity Chronic Venous Disease

**Variant 1:** **Varicose veins. Initial diagnosis.**

| Procedure | Appropriateness Category |
|---|---|
| US duplex Doppler lower extremity | Usually Appropriate |
| Catheter venography iliac veins | Usually Not Appropriate |
| Catheter venography lower extremity | Usually Not Appropriate |
| CTV lower extremity with IV contrast | Usually Not Appropriate |
| CTV pelvis with IV contrast | Usually Not Appropriate |
| MRV lower extremity without and with IV contrast | Usually Not Appropriate |
| MRV pelvis without and with IV contrast | Usually Not Appropriate |
| US intravascular iliac veins | Usually Not Appropriate |

**Variant 2:** **Varicose veins. Treatment.**

| Procedure | Appropriateness Category |
|---|---|
| Compression therapy | Usually Appropriate |
| Saphenous vein ablation | Usually Appropriate |
| Compression sclerotherapy | Usually Appropriate |
| Microphlebectomy | Usually Appropriate |
| Ligation and stripping | May Be Appropriate |

**Variant 3:** **Venous leg ulcer. Initial diagnosis.**

| Procedure | Appropriateness Category |
|---|---|
| US duplex Doppler lower extremity | Usually Appropriate |
| US duplex Doppler IVC and iliac veins | Usually Appropriate |
| CTV abdomen and pelvis with IV contrast | May Be Appropriate |
| MRV abdomen and pelvis without and with IV contrast | May Be Appropriate |
| Catheter venography iliac veins | May Be Appropriate |
| CTV lower extremity with IV contrast | May Be Appropriate (Disagreement) |
| MRV lower extremity without and with IV contrast | May Be Appropriate (Disagreement) |
| US intravascular iliac veins | May Be Appropriate (Disagreement) |
| Catheter venography lower extremity | May Be Appropriate |

**Variant 4:** **Venous leg ulcer. Treatment.**

| Procedure | Appropriateness Category |
|---|---|
| Wound care | Usually Appropriate |
| Compression therapy | Usually Appropriate |
| Saphenous vein ablation | Usually Appropriate |
| Compression sclerotherapy | Usually Appropriate |
| Iliac vein stenting | May Be Appropriate |
| Ligation and stripping | May Be Appropriate |
| Microphlebectomy | May Be Appropriate |

**Variant 5:** **Suspected pelvic-origin lower extremity varicose veins in females. Initial diagnosis.**

| Procedure | Appropriateness Category |
|---|---|
| US duplex Doppler lower extremity | Usually Appropriate |
| US duplex Doppler pelvis | Usually Appropriate |
| CTV abdomen and pelvis with IV contrast | Usually Appropriate |
| MRV abdomen and pelvis without and with IV contrast | Usually Appropriate |
| US duplex Doppler IVC and iliac veins | Usually Appropriate |
| Catheter venography pelvis | May Be Appropriate |
| US intravascular iliac veins | May Be Appropriate (Disagreement) |
| US intravascular renal veins | Usually Not Appropriate |

**Variant 6:** **Pelvic-origin lower extremity varicose veins in females. Treatment.**

| Procedure | Appropriateness Category |
|---|---|
| Conservative management | Usually Appropriate |
| Compression sclerotherapy | May Be Appropriate |
| Microphlebectomy | May Be Appropriate |
| Saphenous vein ablation | May Be Appropriate (Disagreement) |
| Iliac vein embolization | May Be Appropriate |
| Iliac vein stenting | Usually Not Appropriate |
| Left renal vein stenting | Usually Not Appropriate |
| Left renal vein surgery | Usually Not Appropriate |
| Ovarian vein embolization | Usually Not Appropriate |
| Iliac vein surgery | Usually Not Appropriate |

**Variant 7:** **Suspected iliocaval or lower extremity disease with severe post-thrombotic changes. Initial diagnosis.**

| Procedure | Appropriateness Category |
|---|---|
| US duplex Doppler lower extremity | Usually Appropriate |
| CTV abdomen and pelvis with IV contrast | Usually Appropriate |
| MRV abdomen and pelvis without and with IV contrast | Usually Appropriate |
| US duplex Doppler IVC and iliac veins | Usually Appropriate |
| Catheter venography iliac veins | May Be Appropriate |
| Catheter venography lower extremity | May Be Appropriate |
| CTV lower extremity with IV contrast | May Be Appropriate (Disagreement) |
| MRV lower extremity without and with IV contrast | May Be Appropriate (Disagreement) |
| US intravascular iliac veins | May Be Appropriate (Disagreement) |

**Variant 8:** **Iliocaval or lower extremity disease with severe post-thrombotic changes. Treatment.**

| Procedure | Appropriateness Category |
|---|---|
| Anticoagulation | Usually Appropriate |
| Compression therapy | Usually Appropriate |
| Endovascular stenting | Usually Appropriate |
| Catheter-directed thrombolysis with or without thrombectomy lower extremity | May Be Appropriate |
| Venous angioplasty | May Be Appropriate |
| Saphenous vein ablation | May Be Appropriate (Disagreement) |
| Venous bypass procedure | May Be Appropriate |
| Compression sclerotherapy | Usually Not Appropriate |

# LOWER EXTREMITY CHRONIC VENOUS DISEASE

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## Summary of Literature Review

### Introduction/Background

Lower extremity venous insufficiency is a common chronic medical condition resulting from primary valvular incompetence or, less commonly, prior deep venous thrombosis (DVT) or extrinsic venous obstruction. Venous insufficiency may cause varicosities that vary in presentation from cosmetic concern to chronic lower extremity discomfort, swelling, induration, dermatitis, and ulceration [1].

Varicose veins are dilated and usually tortuous subcutaneous veins measuring at least 3 mm in diameter in an upright position, larger than reticular veins (subdermal veins, 1-3 mm in diameter) and telangiectasia (intradermal veins, <1 mm in diameter) [1].

Venous disease of the legs can be categorized according to the severity, cause, site, and specific abnormality using the Clinical Etiologic Anatomic Pathophysiologic (CEAP) classification system [1,2]. The elements of the CEAP classification include, 1) Clinical severity (grade 0-6, asymptomatic, symptomatic), 2) Etiology (congenital, primary, secondary), 3) Anatomical distribution (superficial, deep, perforator veins), and 4) Pathophysiological dysfunction (reflux, obstruction).

Lower extremity chronic venous disease has a high prevalence with a related socioeconomic burden. In the United States, over 11 million men and 22 million women 40 to 80 years of age have varicose veins, with over 2 million adults having advanced chronic venous disease [3]. Approximate total prevalence of C2 to C3 disease is 25% and 5% for stages C4 to C6 [1,3]. Additionally, most chronic leg ulcers are venous in origin, with prevalence of nearly 1% [4,5]. The high cost to the health care system is related to the recurrent nature of venous ulcerative disease, with total treatment costs estimated >$2.5 billion per year in the United States, with at least 20,556 individuals with newly diagnosed venous ulcers yearly [4].

Treatment of superficial venous insufficiency is intended to alleviate symptoms and reduce the risk of complications. Conventional management targeted at reducing reflux has been surgical removal of the great saphenous vein (GSV) from the level of the saphenofemoral junction to the level of the knee or ankle (along with saphenous vein branch ligation in the groin). Alternatives to saphenous vein stripping and ligation include vein ablation using laser energy, radiofrequency-generated thermal energy, or chemical sclerosing agents [6-8].

### Discussion of Procedures by Variant

### Variant 1: Varicose veins. Initial diagnosis.

### Catheter Venography Iliac Veins

Catheter venography of the iliac veins can aid in evaluating proximal occlusions or significant stenosis when proximal varicosities are present. Adjunctive usage of intravascular ultrasound (IVUS) can improve the specificity

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of such lesions. However, there is no relevant literature regarding the use of catheter-directed venography of the iliac veins when evaluating for varicose veins.

**Catheter Venography Lower Extremity**
Catheter venography is ideal in performing descending venography of the lower extremity to evaluate for deep vein reflux [9]. However, there is no relevant literature regarding the use of catheter-directed lower extremity venography in the evaluation of bilateral GSV insufficiency with visible varicose veins.

**CTV Lower Extremity**
CT venography (CTV) of the lower extremity has not been cited as a first-line examination. However, given the high rate of recurrence 2 years postintervention (15%-35%), it has been suggested that further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13].

Understanding the anatomy could aid in the appropriate selection of treatment, plan interventions, reduce recurrence, and decrease complication rates. In a study, a retrospective evaluation of a prospectively acquired database, out of 810 studied limbs, there were numerous anatomic variations, including 1 anatomic variant that had not been described in the literature [11]. Limitations of this study include retrospective nature and possible selection bias given that it was a single center and consecutively acquired data.

US has been championed as a best initial test. However, there are rare cases in which US imaging is limited, such as obesity. In these cases, where characterization of lower extremity veins is suboptimal, CTV can be used adjunctively [9].

**CTV Pelvis**
There is no relevant literature regarding the use of CTV of the pelvis in the evaluation of bilateral GSV insufficiency with visible varicose veins. However, a comprehensive understanding of the anatomy could aid in the appropriate selection of treatment, planning interventions, and decreasing complication rates.

**US Intravascular Iliac Veins**
There is no relevant literature regarding the use of iliac vein IVUS in the evaluation of bilateral GSV insufficiency with visible varicose veins.

**MRV Lower Extremity**
MR venography (MRV) of the lower extremity has not been cited as a first-line examination. However, given the high rate of recurrence 2 years postintervention (15%-35%), it has been suggested that further anatomic characterization before therapy may be useful and could result in selecting more effective treatment [10-13].

In rare cases in which US imaging is limited, characterization of lower extremity veins is suboptimal, or the goal is to avoid iodinated contrast, MRV can be used adjunctively [9].

**MRV Pelvis**
There is no relevant literature regarding the use of MRV of the pelvis in the evaluation of asymptomatic bilateral GSV insufficiency with visible varicose veins. However, a comprehensive understanding of the anatomy could aid in the appropriate selection of treatment, planning interventions, and decreasing complication rates.

**US Duplex Doppler Lower Extremity**
It is widely agreed upon that duplex US should be the first assessment of the lower extremity venous system [1,9,14]. Duplex US evaluation should include condition of the deep venous system, GSV, small saphenous vein (SSV), and accessory saphenous veins. Presence and location of clinically relevant perforating veins and extent of possible alternative refluxing superficial venous pathways should also be included in any duplex US evaluation. Evaluation of venous structures should be accomplished via both transverse and longitudinal planes. Respiratory variation and cardiac pulsations are normally present and indicate a patent pathway to the heart [1].

The association between reflux and clinical manifestations of chronic venous disease is well established. Reflux, defined as retrograde venous flow >500 ms is almost always the result of primary degenerative changes within the venous wall and valves or as sequela of acute DVT causing destruction of venous valves [15]. Duplex Doppler US recordings should thus document presence, absence, and location of reflux. At a base level, abnormal reflux times should be measured and reported [16].

The optimal technique involves the patient standing on 1 leg while the other leg is scanned, but this maneuver is frequently not tolerated. A proposed and studied alternative involves maneuvering patients to 60° of Trendelenburg; however, this maneuver has only been studied in the symptomatic population [17].

**Variant 2: Varicose veins. Treatment.**

**Compression Therapy**

Compression therapy has been widely described as the best initial treatment for varicose veins [18-20]. Compression therapy involves the use of a wide varying degree of devices to provide extrinsic compression on the lower extremity. As a group, they reduce venous stasis in various ways. Edema is contained by reduction of capillary filtration, fluid shift into noncompressed regions, and improved lymphatic drainage. Veins are directly affected by increasing venous blood flow velocity, reducing blood pooling, and improving venous pumping function. Lastly, microcirculation is influenced by transient increases in sheer stress, which in turn causes the release of anti-inflammatory, vasodilating, and antithrombotic mediators [19,21].

When using compression therapy, a minimum pressure of 20 to 30 mm Hg is recommended. Pressures of 30 to 40 mm Hg are advised for more severe disease [20]. Of note, improved ejection fraction in refluxing vessels and higher extrinsic pressures were achieved when higher pressures were exerted at the calf over the distal ankle (negative graduated compression bandage). Improved pressures and ejection fractions were also observed when placing the compression bandage over the calf versus the distal leg [18].

Until recently, it had been widely accepted that treatment failure typically results from noncompliance [16,17]. However, 2 high-quality systematic reviews have concluded that the current published data are inadequate. The weakness in the data relates to the reliance on surrogate outcomes and subjective clinical improvement. Though present, few data demonstrate correlation with quality of life (QoL) improvement with routine use of compression alone [15]. Adherence should nonetheless be encouraged with proper fitting, education, and detailed instructions [19,20].

Despite the minimal evidence regarding C2 to C4 disease, there is evidence that compression therapy has value in C5 (preventing ulcer recurrence) and C6 disease (healing ulcers) [15]. Mosti and Partsch [18] demonstrated that 30 to 40 mm Hg inelastic compression is better than elastic bandaging for wound healing. They also showed that for ankle-brachial indices between 0.9 and 0.6, reduced compression to 20 to 30 mm Hg is successful and safe for venous leg ulcers (VLU) healing. Velcro inelastic compression was noted to be as good as 3- or 4-layer inelastic bandages. Caution is advised, however, when the ankle-brachial index is <0.6 because it indicates an arterial anomaly needing revascularization [21].

**Saphenous Vein Ablation**

Endovenous ablation has largely supplanted surgical ligation and stripping as the main invasive method to treat varicose veins with similar efficacy, improved early QoL, and reduced hospital recovery [7,22,23].

The 2 types of endovenous ablation are radiofrequency ablation (RFA) and endovenous laser ablation (EVLA). RFA is a minimally invasive procedure in which a catheter is inserted into a target vein lumen. Intense, local heat-based energy through the catheter then obliterates the vein lumen and destroys the wall. EVLA uses laser energy that is absorbed by the target tissue and converted to heat. Both treatments use tumescent anesthesia, a method by which diluted local anesthetic with or without epinephrine and/or sodium bicarbonate are injected around the target vessel. This adjuvant protects the surrounding tissue and collapses the vein wall extrinsically to further ensure the target tissue is ablated in its entirety [7]. By 3 months post-treatment, endothelium is absent and organized thrombus is formed. Occlusion rates for these types of endovenous ablation vary from 91% to 100% within 1-year post-treatment [7,22].

Multiple recent meta-analyses confirm that EVLA and RFA are at least as efficacious, if not slightly more so, than surgery [12,24-26]. When compared to surgery, EVLA had fewer rates of bleeding, hematoma, and wound infection [24]. EVLA and RFA were also noted to have reduced rates of paresthesia compared to surgery [27]. A meta-analysis pooling 52 studies of both RFA and EVLA demonstrated postprocedural thrombotic events infrequently; DVT occurred in 0.3% of cases, and pulmonary embolism occurred in 0.1% of cases [28]. Rates of recurrence between surgery and EVLA had conflicting data, with Paravastu et al [25] noting improved recurrence rates with EVLA at 6 weeks and 1 year and Pan et al [24] noting no significant difference.

So far, little difference is seen when comparing the various endovenous treatments in terms of QoL, benefit, and durability [15]. Current data on RFA versus EVLA is rather limited, although there have been some recent developments. Gale et al [29] randomized 48 patients into EVLA and 46 patients into RFA, with 11 RFA patients demonstrating recurrence compared with 2 cases of recurrence in the EVLA arm. A meta-analysis showed not only no statistically significant difference in long-term outcomes between conventional surgery and endovenous therapy but also no statistically significant difference in long-term outcomes between RFA and EVLA or conventional surgery [30]. An additional meta-analysis including 792 EVLA-treated and 785 RFA-treated patients demonstrated the same safety and efficacy between the 2 treatment cohorts. Outcomes included 3-day and 10-day pain scores, 1 month and 1 year QoL, occlusion, thrombophlebitis, hematoma, and recanalization. Though limited, data from this meta-analysis suggest RFA seems to have a lower overall risk of complication when compared to EVLA [31].

We can conclude that the aggregate of evidence supports that ablation of saphenous veins provides significant benefits compared with compression [15].

**Compression Sclerotherapy**

Compression sclerotherapy has been used effectively in the treatment of varicose veins, reticular veins, and telangiectasias [7,14]. In sclerotherapy, a liquid or foamed sclerosing drug is injected into the lumen of the varicose vein. This sclerosant is a chemical that damages the vein wall and ultimately occludes it secondary to fibrotic transformation of the vessel. Foamed sclerosant is used to increase the surface area by which the luminal wall can be treated. Doppler US of the GSV ablated with foam at 1-year post-treatment demonstrated occlusion rates vary from 72% to 89%, which is lower compared to EVLA at 1 year [7,32]. Sclerosant can also be administered over a rotating wire, which causes local trauma to the vessel. This form of mechanochemical ablation has closure rates that vary from 88% to 94% in the literature [7].

Advantages of these chemical ablative techniques include a lack of potential thermal injury that could injure the skin, nerves, muscles, and nontarget blood vessels, which is rarely seen with endovenous ablation. Additionally, because of a lack of thermal energy, tumescent anesthesia is not needed. Potential complications include phlebitis, new telangiectasias, and residual pigmentations. Exceedingly rare complications include DVT [7]. Other nontumescent techniques that are used are cyanoacrylate glue. Risk factors would be allergies to adhesives.

Multiple studies have shown that, compared with conventional open surgery and EVLA, chemical sclerotherapy has worse outcomes at 1-, 5-, and 8-year follow-ups, with higher rates of recurrent GSV reflux and saphenofemoral junction failure [33-36]. There are conflicting data on QoL, however, with equivalent improvement reported per the Aberdeen Varicose Vein Severity Score [36] and inferior improvement reported per the Chronic Venous Insufficiency Quality of Life Questionnaire [35].

**Ligation and Stripping**

Higher rates of GSV reflux recurrence are identified with EVLA compared with high ligation and stripping. Both EVLA and high ligation and stripping, however, were noted to have similar metrics on disease specific QoL [37-39]. Another study comparing high ligation and stripping versus EVLA in patients with GSV incompetence showed no significant difference between the 2 groups in recurrent GSV reflux, recurrent varicose veins, frequency of reoperations, Venous Clinical Severity Score, and QoL scores in a 5-year follow-up [40]. The RELACS study demonstrated, specifically, that high ligation and stripping was superior to EVLA in recurrence rates 5 years post-treatment [38].

There are conflicting data regarding procedural complications. Pan et al [24] affirms that there is no significant difference in postprocedural phlebitis and bruising and concludes that there are fewer complications regarding bleeding, hematoma, wound infection, and paresthesia with EVLA. Rass et al [39], on the other hand, affirms that higher rates of phlebitis, tightness, and dyspigmentation were noted with EVLA.

**Microphlebectomy**

Microphlebectomy involves the surgical excision of pathologic vessels. This method is used in combination with sclerotherapy ablation for best results. The most common complication involves skin blistering from dressing abrasions and adhesive tape. Wound infections may occur. Less commonly, small sensory nerves can be injured leading to areas of anesthesia and less commonly hyperesthesia. A rare injury could result from common peroneal nerve injury. The common peroneal nerve is commonly located just medial to the biceps femoris tendon and near the fibular head. Injury to this nerve can cause sensory loss or foot drop. When planning microphlebectomy, care or avoidance of this region is recommended [2].

**Variant 3: Venous leg ulcer. Initial diagnosis.**

**Catheter Venography Iliac Veins**

Catheter-directed venography of the iliac veins has been described as the next step in diagnosis after CTV/MRV has characterized an occlusion or stenosis [9]. Venography has been criticized for low sensitivity for identifying critical lesions in the iliac vein [41]. Venographic findings can be grouped into normal, stenosis, and occlusion [8].

**Catheter Venography Lower Extremity**

Digital subtraction ascending venography has been described as the next step in diagnosis after CTV or MRV has characterized an occlusion or stenosis [9]. Catheter-directed venography of the lower extremity is used mainly as part of a procedure in which treatment is planned for post-thrombotic and nonthrombotic obstruction of the iliac veins and much less often for post-thrombotic femoral veins.

**CTV Lower Extremity**

CTV of the lower extremity has not been cited as a first-line examination. However, it is helpful after duplex US in evaluation for occlusion, stenosis, collaterals, post-thrombotic changes, and axial transformation of the profunda vein [8]. Further highlighting the importance of CTV before intervention is the high rate of recurrence 2 years postintervention (15%-35%). Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Understanding the anatomy could aid in the appropriate selection of treatment and reduce recurrence and complication rates.

**CTV Abdomen and Pelvis**

CTV of the abdomen and pelvis has been suggested in the literature in cases with signs of iliac or inferior vena cava (IVC) involvement [9]. Further anatomic characterization before therapy can ensure appropriate and effective treatment, thus reducing the frequency for reintervention [10-13]. Understanding the anatomy could aid in the selection of an appropriate treatment modality and reduce recurrence and complication rates.

**US Intravascular Iliac Veins**

IVUS has been cited as the most sensitive and specific imaging modality for detecting deep vein obstructive disease. Compared to multiplanar venography, IVUS has been found to be more sensitive for detecting significant stenosis. One study found that, in 26.3% of patients, significant lesions were detected with IVUS not initially seen with 3-view venography [42]. Up to 10% of significant stenotic lesions, however, could not be seen via IVUS and required trial balloon angioplasty to unmask stenosis [8].

IVUS has also shown utility at predicting when stenting for iliofemoral vein stenosis will result in symptomatic improvement. One study involving CEAP C4 to C6 study population has shown significant improvement symptomatology in stenting >50% iliofemoral vein stenosis (50% area reduction chosen by authors) [41].

**MRV Lower Extremity**

MRV of the lower extremity has not been cited as a first-line examination. As with CTV, MRV identifies stenosis, occlusion, venous atresia, collaterals, and edema. In addition, MRV can show webs, trabeculations, and vein wall thickening [9]. Furthermore, understanding unique patient anatomy [10] could aid in the selection of the appropriate treatment modality and reduce recurrence and complication rates.

In cases in which characterization of lower extremity veins is suboptimal, MRV can be used adjunctively [9].

**MRV Abdomen and Pelvis**

MRV of the abdomen and pelvis has not been cited as a first-line examination. As with CTV, MRV identifies stenosis, occlusion, venous atresia, collaterals, and edema. In addition, MRV can show webs, trabeculations, and vein wall thickening [9]. Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Characterization of these potential variants is important for treatment planning purposes.

**US Duplex Doppler Lower Extremity**

It is widely agreed upon that duplex US should be the first assessment of the lower extremity venous system [1,9,14]. Duplex US is currently the most common imaging technique because it is noninvasive. Evaluation should include direction of blood flow, assessment for venous reflux, and venous obstruction [20].

Additionally, duplex US evaluation should include the condition of the deep venous system, GSV, SSV and its thigh extension (Giacomini Vein), and accessory saphenous veins. Presence and location of perforating veins near a VLU should also be included in any duplex US evaluation [1].

If after treatment an ulcer recurs, repeat duplex US should assess for recanalization of treated GSV or reflux into the Giacomini vein, transmitting to the short saphenous vein [8].

Arterial vascular characterization may also prove useful because it has been noted that 16% of patients with VLU have concomitant arterial occlusive disease, which is frequently not recognized [19,43].

**US Duplex Doppler IVC and Iliac Veins**

As in arterial vasculature, critical stenosis is defined by a sharp reduction in forward flow; in venous vasculature, critical stenosis is related to venous hypertension. In fact, the beneficial effects of venous stenting are related to peripheral venous decompression [44]. This is an important distinction to make because Doppler US can be used to evaluate for this metric via peak systolic velocities. Labropoulos et al [45] and Metzger et al [46] agree that a peak systolic velocity ratio >2.5 across the stenosis (poststenotic velocity to prestenotic velocity) as an accurate criterion to use for the presence of a pressure gradient of 3 mm Hg. Doppler US can thus be used to determine candidacy for intervention and also monitor success of treatment on follow-up.

**Variant 4: Venous leg ulcer. Treatment.**

**Compression Therapy**

Compression therapy has been widely described as a helpful initial treatment for VLU [18-20]. Compression therapy involves the use of a wide varying degree of devices to provide extrinsic compression on the lower extremity. As a group, they reduce venous stasis in various ways. Edema is contained by reduction of capillary filtration, fluid shift into noncompressed regions, and improved lymphatic drainage. Veins are directly affected by increasing venous blood flow velocity, reducing blood pooling, and improving venous pumping function. Lastly, microcirculation is influenced by transient increases in sheer stress, which in turn causes the release of anti-inflammatory, vasodilating, and antithrombotic mediators [19,47].

When using compression therapy, a minimum pressure of 20 to 30 mm Hg is recommended. Pressures of 30 to 40 mm Hg are advised for more severe disease [20]. Of note, improved ejection fraction in refluxing vessels and higher extrinsic pressures were achieved when higher pressures were exerted at the calf over the distal ankle (negative graduated compression bandage). The alternative, graduated compression bandage, in which more force is generated at the distal ankle over the calf, demonstrated inferior ejection fraction in refluxing vessels and lower extrinsic pressures compared with their negative graduated compression bandage counterparts. Improved pressures and ejection fractions were also observed when placing the compression bandage over the calf versus the distal leg [18].

Until recently, it had been widely accepted that treatment failure typically results from noncompliance [16,17]. However, 2 high-quality systematic reviews have concluded that the current published data are inadequate. The weakness in the data relates to the reliance on surrogate outcomes and subjective clinical improvement. Though present, few data demonstrate correlation with QoL improvement with routine use of compression alone [15]. Adherence should nonetheless be encouraged with proper fitting, education, and detailed instructions [19,20].

Despite the minimal evidence regarding C2 to C4 disease, there is evidence that compression therapy has value in C5 (preventing ulcer recurrence) and C6 disease (healing ulcers) [15]. Mosti and Partsch [18] demonstrated that 30 to 40 mm Hg inelastic compression is better than elastic bandaging for wound healing. They also showed that for ankle-brachial indices between 0.9 to 0.6, reduced compression to 20 to 30 mm Hg is successful and safe for VLU healing. Velcro inelastic compression was noted to be as good as 3- or 4-layer inelastic bandages. Caution is advised, however, when the ankle-brachial index is <0.6 because it indicates an arterial anomaly needing revascularization [21].

**Saphenous Vein Ablation**

Multiple recent meta-analyses confirm that EVLA and RFA are at least as efficacious, if not slightly more so, than surgery [12,24-26]. When compared to surgery, EVLA had fewer rates of bleeding, hematoma, and wound infection [24]. EVLA and RFA were also noted to have reduced rates of paresthesia compared to surgery [27]. A meta-analysis pooling 52 studies of both RFA and EVLA demonstrated postprocedural thrombotic events infrequently; DVT occurred in 0.3% of cases, and pulmonary embolism occurred in 0.1% of cases [28]. Rates of recurrence between surgery and EVLA had conflicting data, with Paravastu et al [25] noting improved recurrence rates with EVLA at 6 weeks and 1 year and Pan et al [24] noting no significant difference.

Gohel et al [48] compared timing of EVLA, either immediately (within 2 weeks) or deferred (after 6 months or resolution of ulcer) and determined that early EVLA resulted in faster healing of venous ulcers and more ulcer-free time.

Current data on RFA versus EVLA is rather limited, although there have been some recent developments. Gale et al [29] randomized 48 patients into EVLA and 46 patients into RFA, with 11 RFA patients demonstrating recurrence compared with 2 cases of recurrence in the EVLA arm. A meta-analysis showed not only no statistically significant difference in long-term outcomes between conventional surgery and endovenous therapy but also no statistically significant difference in long-term outcomes between RFA and EVLA or conventional surgery [30]. An additional meta-analysis including 792 EVLA-treated and 785 RFA-treated patients demonstrated the same safety and efficacy between the 2 treatment cohorts. Outcomes included 3-day and 10-day pain scores, 1-month and 1-year QoL, occlusion, thrombophlebitis, hematoma, and recanalization. Although limited, data from this meta-analysis suggest RFA seems to have a lower overall risk of complication compared to EVLA [31].

**Compression Sclerotherapy**

Compression sclerotherapy has been used effectively in the treatment of varicose veins, reticular veins, and telangiectasias [7,14]. In foam sclerotherapy, a liquid or foamed sclerosing drug is injected into the lumen of the varicose vein. This sclerosant is a chemical that damages the vessel wall and occludes the affecting vasculature secondary to fibrotic transformation of the vessel. Foamed sclerosant is used to increase the surface area by which the luminal wall can be treated. At 1-year post-treatment, occlusion rates vary from 72% to 89%, which is lower when compared to EVLA at 1 year [7,32]. Sclerosant can also be administered over a rotating wire, which causes local trauma to the vessel. This form of mechanochemical ablation has closure rates that vary from 88% to 94% in the literature [7].

Advantages of these chemical ablative techniques include a lack of potential thermal injury that could injure the skin, nerves, muscles, and nontarget blood vessels, which is rarely seen with endovenous ablation. Additionally, because of a lack of thermal energy, tumescent anesthesia is not needed. Potential complications include phlebitis, new telangiectasias, and residual pigmentations. Exceedingly rare complications include DVT [7]. Other nontumescent techniques that are used are cyanoacrylate glue. Risk factors would be allergies to adhesives.

Multiple studies have shown that, compared with conventional open surgery and EVLA, chemical sclerotherapy has worse outcomes at 1-, 5-, and 8-year follow-ups, with higher rates of recurrent GSV reflux and saphenofemoral junction failure [33-36]. There are conflicting data on QoL, however, with equivalent improvement reported per the Aberdeen Varicose Vein Severity Score [36] and inferior improvement reported per the Chronic Venous Insufficiency Quality of Life Questionnaire [35].

**Iliac Vein Stenting**

If venography has characterized a central occlusive vascular insult as a culprit for disease that involves the iliocaval segments, angioplasty with possible stenting should be performed. Cases with large ulcers that have decreased in size from prior superficial vein ablation usually require iliac vein stenting to complete ulcer healing [8].

Post-thrombotic iliac vein obstruction can lead to many QoL affecting symptoms including pain, swelling, and VLU. Multiple studies have shown iliac vein stenting to be advantageous with iliac vein stenosis >50%. Rossi et al [49] attests that compared with medial therapy alone, QoL and symptomatology are dramatically improved in both the short and long term with iliac vein stenting and medial therapy. A meta-analysis of available studies demonstrated that iliac vein stenting improved pain, swelling, and venous ulcer healing with secondary patency rates acceptable given relatively low overall risk [15].

**Microphlebectom**y

There is no relevant literature regarding the use of microphlebectomy in the treatment of venous ulcers.

**Ligation and Stripping**

Higher rates of GSV reflux recurrence are identified with EVLA compared with high ligation and stripping. Both EVLA and high ligation and stripping, however, were noted to have similar metrics on disease specific QoL [37-39]. Another study comparing high ligation and stripping versus EVLA in patients with GSV incompetence showed no significant difference between the 2 groups in recurrent GSV reflux, recurrent varicose veins, frequency of reoperations, Venous Clinical Severity Score, and QoL scores in a 5-year follow-up [40]. The RELACS study demonstrated, specifically, that high ligation and stripping was superior to EVLA in recurrence rates 5 years post-treatment [38].

There are conflicting data regarding procedural complications. Pan et al [24] affirms that there is no significant difference in postprocedural phlebitis and bruising and concludes that there are fewer complications regarding bleeding, hematoma, wound infection, and paresthesia with EVLA. Rass et al [39], on the other hand, affirms that higher rates of phlebitis, tightness, and dyspigmentation were noted with EVLA.

**Wound Care**

Although literature has shown benefit in ulcer debridement in improving venous ulcer, the optimal protocol for wound care is yet to be elucidated. Beyond debridement, wound exudate control and surface bacteria management are additional important goals in wound care. Antibiotic dressings, however, have shown no benefit. Adjuncts such as topical dressings to control wound exudate and maintain moisture as well as skin protectants are also important [6,21].

The Society of Vascular Surgery and American Venous Forum, in their clinical practice guidelines for management of VLU, list recommendations regarding wound bed preparation, wound infection and bacterial control, primary wound dressings, and adjunctive wound therapies. Surgical debridement is helpful in converting a biologically chronic wound to that of an acute wound to promote healing. Nontraditional methods such as ultrasonic and enzymatic debridement are considered acceptable alternatives to surgical debridement. Antimicrobial therapy can be useful in the setting of localized cellulitis, VLU with $>1 \times 10^6$ CFU, and for difficult to eradicate bacteria at lower CFUs such as beta-hemolytic streptococci, pseudomonas, and resistant staphylococcal species. Primary wound dressing can also provide a topical dressing to maintain a moist, warm wound while advising against the use of topical antimicrobial dressings and anti-inflammatories. Adjunctive techniques such as split-thickness skin grafting and cellular therapy should only be considered for VLU that fail to demonstrate improvement after a minimum of 4 to 6 weeks with standard therapy [21].

**Variant 5: Suspected pelvic-origin lower extremity varicose veins in females. Initial diagnosis.**

**Catheter Venography Pelvis**

Catheter-directed venography of the iliac veins has been described as the next step in diagnosis after US of the iliac veins, ovarian veins, renal veins, and IVC, CTV/MRV has characterized an occlusion or stenosis [9]. Venographic findings can be grouped into normal, stenosis, and occlusion [8]. Pelvic varices can sometimes be demonstrated with direct catheterization plus or minus balloon occlusion.

**CTV Abdomen and Pelvis**

There is no relevant literature regarding the use of CTV abdomen and pelvis in the evaluation of pelvic-derived lower extremity varicose veins in women. This examination can be useful in evaluating the anatomy of dilated ovarian veins and nutcracker phenomenon, which can explain connections to pelvic-origin lower extremity varicose veins.

CTV of the abdomen and pelvis has been suggested in the literature in cases with signs of iliac or IVC involvement [9]. Further anatomic characterization before therapy can ensure appropriate and effective treatment thus reducing the frequency for reintervention [10-13]. Understanding the anatomy could aid in the selection of an appropriate treatment modality and reduce recurrence and complication rates.

**US Intravascular Iliac Veins**

IVUS has been cited as the most sensitive and specific imaging modality for detecting deep vein obstructive disease. Compared to multiplanar venography, IVUS has been found to be more sensitive for detecting significant stenosis. One study found that in 26.3% of patients, significant lesions were detected with IVUS not initially seen with 3-view venography [42]. Up to 10% of significant stenotic lesions, however, could not be seen via IVUS and required trial balloon angioplasty to unmask stenosis [8].

**US Intravascular Renal Veins**

There is no relevant literature regarding the use of IVUS for renal veins in the evaluation of pelvic-derived lower extremity varicose veins in women, although it can accurately characterize the severity of a stenosis of a renal vein but compression over the adjacent aorta and superior mesenteric artery.

**MRV Abdomen and Pelvis**

MRV of the abdomen and pelvis can identify stenosis, occlusion, venous atresia, collaterals, and edema. In addition, MRV can show webs, trabeculations, and vein wall thickening [9]. MRV can also demonstrate the diameters of pelvic veins and ovarian veins to identify those that are varicose (>5 mm periuterine and periovarian veins and >6-8 mm in diameter ovarian veins) [50]. Further highlighting the importance of MRV before intervention is a high rate of recurrence 2 years postintervention (15%-35%). Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Characterization of these potential variants is important for treatment planning purposes.

**US Duplex Doppler Lower Extremity**

It is widely agreed upon that duplex US should be the first assessment of the lower extremity venous system [1,9,14]. Duplex US is currently the most common imaging technique because it is noninvasive. Evaluation should include direction of blood flow, assessment for venous reflux, and venous obstruction [20].

Duplex US evaluation should additionally include condition of the deep venous system, GSV, SSV, and accessory saphenous veins. Presence and location of clinically relevant perforating veins and extent of possible alternative refluxing superficial venous pathways should also be included in any duplex US evaluation [1].

In a study of 56 women with pelvic varicose veins, 44 patients demonstrated varying degrees of venous insufficiency. This information suggests a connection between pelvic varicose veins and venous insufficiency. Duplex US of the lower extremities may then be a very reasonable evaluation in patients with known pelvic varicose veins [51].

In addition, Khilnani et al [52] notes that duplex US in patients with varicose veins in the posterior thigh, vulva, and inguinal regions (nonsaphenous pelvic origin varicose veins) can help identify venous escape points from reflux in the internal iliac venous system.

**US Duplex Doppler Pelvis**

It is widely agreed upon that duplex US should be the first assessment of the lower extremity venous system [1,9,14]. Duplex US is currently the most common imaging technique because it is noninvasive. Evaluation should include direction of blood flow, assessment for venous reflux, and venous obstruction [20].

Doppler US is particularly important because the grayscale appearance of dilated veins can mimic that of cystic adnexal masses. The positive predictive value of a left ovarian vein diameter of 5 mm was 71% and of 6 mm was 83%. US does have its limitations on body habitus and bowel gas and is operator dependent. Three distinguishing sonographic criteria should be present to suggest the diagnosis of pelvic venous insufficiency: a dilated, tortuous pelvic vein >4 mm, slow or reversed blood flow (≤3 cm/s), and a dilated arcuate vein in the myometrium that communicates with pelvic varicosities [53,54]. Hansrani et al [55] demonstrated increased sensitivities with assessments that included supine and semistanding positions as well as Valsalva maneuver.

If there are vulvar varicose veins, operators are rarely able to trace these vessels to a pelvic origin. These examinations require a very experienced sonographer to acquire relevant information. Most often, it is necessary to characterize with advanced imaging [1].

**US Duplex Doppler IVC and Iliac Veins**

There is no relevant literature regarding the use of US for evaluation of the IVC and iliac veins in the treatment of pelvic-origin lower extremity varicose veins. As in arterial vasculature, critical stenosis is defined by a sharp reduction in forward flow; in venous vasculature, critical stenosis is related to venous hypertension. In fact, the beneficial effects of venous stenting are related to peripheral venous decompression [44]. This is an important distinction to make because Doppler US can be used to evaluate for this metric via peak systolic velocities. Labropoulos et al [45] and Metzger et al [46] agree that a peak systolic velocity ratio >2.5 across the stenosis (poststenotic velocity to prestenotic velocity) as an accurate criterion to use for the presence of a pressure gradient of 3 mm Hg. Doppler US can thus be used to determine candidacy for intervention and monitor success of treatment on follow-up.

**Variant 6: Pelvic-origin lower extremity varicose veins in females. Treatment.**

**Saphenous Vein Ablation**

Patients commonly present with lower extremity symptoms related to pelvic venous insufficiency. Typically after embolization and sclerotherapy of gonadal veins and pelvic varices, respectively, they may then have endovenous venous ablation of their saphenous veins for definitive treatment [56].

**Compression Sclerotherapy**

Foam sclerotherapy is an option to treat chronic pelvic pain and pelvic-origin lower extremity varicose veins in women caused by a pelvic venous disorder, often in conjunction with embolization. Most of the current literature involves therapy of pelvic venous disease.

The commonly used substances reported in the literature for sclerotherapy are sodium tetradecyl sulfate and polidocanol. In high-flow pelvic varicoceles, there is a small risk of systemic dispersion of the sclerosant. In order to optimize the quantity and efficacy of the sclerosant, stop-flow foam sclerotherapy techniques have been described. This technique involves the use of balloon occlusion of high-outflow collaterals to achieve the complete filling of pelvic varices and exclusion of collaterals, thereby embolizing the entire length of incompetent vessels, including tributaries [57].

In a retrospective study of 26 patients involving the use of 3% sodium tetradecyl sulfate foam, significant improvement in symptoms was observed at 1, 3, 6, and 12 months. Of note, all patients had colic-like pain that spontaneously resolved after 5 minutes [58].

In a meta-analysis of 21 prospective case series involving a total of 1,308 women, early substantial pain relief was observed in 75% of women undergoing embolization (including combinations of coil, glue, and sclerotherapy), generally increasing and sustained over time. Repeat interventions were generally low, and, although there were few data on post-treatment impact on menstruation, ovarian reserve, and fertility, no concerns were noted. Overall, transient pain was common following foam embolization, and there was <2% risk of coil migration. Overall, data from studies that used a sclerosant suggest significant symptomatic improvement of approximately 75% [59].

Foam sclerotherapy has also shown good results as an alternative to embolization in patients with leg, vulvar, and pudendal varicosities of pelvic origin without pelvic venous disease [60].

**Iliac Vein Stenting**
There is no relevant literature regarding the use of iliac stenting in the treatment of pelvic-origin lower extremity varicose veins in women, although it is postulated that stenting may relieve the congestion in the pelvis. However, there is no high-quality data.

**Iliac Vein Embolization**
Internal iliac vein embolization (in addition to ovarian vein embolization) has been shown to be safe and effective in treating pelvic venous insufficiency and reducing pelvic pain in most women undergoing treatment for pelvic congestion syndrome [61]. However, there is no high-quality data demonstrating the value of pelvic embolization or iliac or renal vein stenting to improve pelvic origin varicose veins and their related symptoms.

**Iliac Vein Surgery**
There is no relevant literature regarding the use of iliac vein surgery in the treatment of pelvic-origin lower extremity varicose veins in women.

**Left Renal Vein Stenting**
The treatment of pelvic venous disease due to nutcracker syndrome has been primarily surgical in the past, employing left renal vein bypass, transposition, and external stent placement. However, because of the morbidity associated with surgical techniques, percutaneous endoluminal left renal vein stenting is now performed [62]. No studies have demonstrated benefit of renal vein stenting on pelvic origin lower extremity varicose veins. A limited number of studies have demonstrated remission of pelvic venous symptoms with stenting of the left renal vein as an alternative to open surgery [63], although none have demonstrated improvement in lower extremity varicose veins or symptoms.

**Left Renal Vein Surgery**
Though no literature has focused on nutcracker syndrome causing pelvic-derived varicose veins, the treatment of pelvic venous disease due to nutcracker syndrome has been primarily surgical in the past, employing left renal vein bypass, transposition, and external stent placement. However, because of the morbidity associated with surgical techniques, percutaneous endoluminal left renal vein stenting is increasingly performed [62].

Rundqvist et al [64] described the first open surgical removal of the left ovarian vein in patients with pelvic congestion syndrome. Symptomatic improvement was described in two-thirds of this studied cohort. Laparoscopic left ovarian vein surgical ligation in patients with pelvic congestion syndrome was described in 2003 by Gargiulo et al [65]; 23 out of 23 patients reported complete resolution of symptoms in the 1-year follow-up. No studies have demonstrated benefit of renal vein surgery on pelvic origin lower extremity varicose veins. Surgery should be considered in patients with lifestyle-limiting chronic pelvic pain that have recurred despite embolotherapy [63,66].

**Microphlebectomy**
There is no relevant literature regarding the use of microphlebectomy in the treatment of isolated pelvic-derived lower extremity varicose veins. However, it is well established as an effective tool at eliminating varicose veins in general and may be helpful in the correct clinical setting.

**Ovarian Vein Embolization**
Ovarian vein embolization is the most frequently cited treatment for pelvic venous disease, often in conjunction with sclerotherapy. In a meta-analysis of 21 prospective case series involving a total of 1,308 women, early substantial pain relief was observed in 75% of women undergoing embolization (including combinations of coil, glue, and sclerotherapy), generally increasing, and sustained over time. Repeat interventions were generally low, and, although there were few data on post-treatment impact on menstruation, ovarian reserve, and fertility, no concerns were noted. Overall, transient pain was common following foam embolization, and there was <2% risk of coil migration. Overall, data from studies that used a sclerosant suggest significant symptomatic improvement of approximately 75% [59].

Immediate success rates for the endovascular treatment of pelvic venous disease have been favorable with the low complication rate. In a study, most patients reported pain relief in symptoms for up to 5 years post-treatment [67]. In a study involving 11 embolization procedures for 10 women (1 patient had an additional embolization procedure), 3 women (30%) had mild recurrence of pain at midterm follow-up. Of 8 patients who complained of dyspareunia, 6 were cured [68].

Evidence of efficacy in a second embolization procedure is contradictory. One study notes that embolization of pelvic varices may be an effective treatment in a well-selected group; however, if there is no improvement after the initial embolization, a second procedure is unlikely to be effective [69]. In a second study, 4 patients required second embolization, 3 of whom reported improved symptoms [70]. In another study involving retreatment after pregnancy-related recurrence, repeat embolization was shown to eliminate recurrent reflux [71].

Complications of embolization procedures have been noted in up to 9% of patients. These include thrombophlebitis, embolization of nontarget vessels, recurrence varices, and stroke-related paradoxical emboli. Postembolization abdominal discomfort was reported in up to 14.8% of patients and is usually self-limited or treated with analgesic or anti-inflammatory medications [57].

Although success rates are favorable, excluding other causes such as nutcracker syndrome are important. Additionally, no randomized or high-quality controlled trials have been recorded, which limits the provided evidence. Though no gynecological complications were noted in the above literature, they have not been explicitly studied.

No current prospective studies or randomized control trials demonstrating benefit of embolization for patients with pelvic-origin lower extremity varicose veins have been published. Current literature is limited to single-center case series which have failed to demonstrate significant improvement after pelvic venous embolization or stenting [52].

Overall, in distinction to ovarian vein embolization for patients with chronic pelvic pain, there is little evidence to support the use of embolization or stenting to aid in lower extremity pelvic origin varicose veins [52].

**Conservative Management**
There is no relevant literature regarding the use of compression therapy in the treatment of pelvic-origin lower extremity varicose veins in women. Conservative therapies to manage symptoms of pelvic origin lower extremity varicose veins include compression therapy, nonsteroidal anti-inflammatory drugs, hormonal agents, ergot alkaloid derivatives, and venoactive agents [72].

**Variant 7: Suspected iliocaval or lower extremity disease with severe post-thrombotic changes. Initial diagnosis.**

**Catheter Venography Iliac Veins**
Catheter-directed venography of the iliac veins has been described as a diagnostic technique but is often now only performed as part of procedure with the intent to treat an iliocaval lesion. It is invasive, and in patients with post-thrombotic iliac and caval lesions, it is typically done after US/CTV/MRV has characterized an occlusion or stenosis [9].

Catheter venography with IVUS is usually performed in those with an indication for venous intervention, such as iliac vein stenting typically after CTV or MRV has characterized an occlusion or stenosis [6,9].

**Catheter Venography Lower Extremity**
Venography is performed mostly during procedures with the intent on treating an iliac or IVC obstructive lesion. Collaterals and post thrombotic changes from stenoses and/or occlusions are typically noted.

**CTV Lower Extremity**
CTV of the lower extremity has not been cited as a first-line examination. However, it is very rarely used after duplex US in evaluation for occlusion, stenosis, collaterals, post-thrombotic changes, and axial transformation of the profunda vein [8]. Further highlighting the importance of CTV before intervention is the high rate of recurrence 2 years postintervention (15%-35%). Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Understanding anatomy could aid in the selection of appropriate treatment modality and reduce recurrence and complication rates. In a study, retrospective evaluation of a prospectively acquired database, out of 810 studied limbs, there were numerous anatomic variations, including 1 anatomic variant that had not been described in the literature [11]. Characterization of these potential variants is important for treatment planning purposes.

**CTV Abdomen and Pelvis**
There are 2 scenarios described in the literature characterizing pelvic venous obstruction. Primary chronic venous disease describes a phenomenon in which there is obstruction in the pelvic or abdominal veins (eg, May-Thurner) without a prior DVT. Imaging can then be used to identify the cause of obstruction. Secondary chronic venous disease describes a phenomenon in which primary thrombotic events cause a post-thrombotic syndrome. In addition to an occlusive IVC or iliac vein lesion, these cases also show signs of delayed or incomplete recanalization of the pelvic and lower extremity deep veins with extensive intraluminal changes. In both of the above types, primary focus should be on anatomy to accurately identify stenosis and occlusion related to outflow obstruction [9].

CTV of the abdomen and pelvis has been suggested in the literature in cases in which there are signs of iliac vein or IVC involvement, and in cases with fast recurrence of varicose veins after adequate treatment, CTV clearly identifies stenosis, occlusion, venous atresia, collaterals, and edema [9]. Further highlighting the importance of CTV before intervention is the high rate of recurrence 2 years postintervention (15%-35%). Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Understanding anatomy could aid in the selection of appropriate treatment modality and reduce recurrence and complication rates. In this study, retrospective evaluation of a prospectively acquired database, out of 810 studied limbs, there were numerous anatomic variations, including 1 anatomic variant that had not been described in the literature [11]. Characterization of these potential variants is important for treatment planning purposes.

**US Intravascular Iliac Veins**
IVUS has been cited as the most sensitive and specific modality for deep vein obstructive disease. Up to 10% of significant stenotic lesions, however, could not be seen via IVUS and required trial balloon angioplasty to unmask stenosis [8]. Catheter venography with IVUS should be performed in those with an indication for venous intervention such as iliac vein stenting [6].

**MRV Lower Extremity**
MRV of the lower extremity has not been cited as a first-line examination. As with CTV, MRV identifies stenosis, occlusion, venous atresia, collaterals, and edema. In addition, MRV can show webs, trabeculations, and vein wall thickening [9]. Furthermore, understanding unique patient anatomy could aid in the selection of appropriate treatment modality and reduction of recurrence and complication rates. In a study, a retrospective evaluation of a prospectively acquired database, out of 810 studied limbs, there were numerous anatomic variations, including 1 anatomic variant that had not been described in the literature [11]. Further highlighting the importance of MRV before intervention is the high rate of recurrence 2 years postintervention (15%-35%). Appropriate anatomic characterization before therapy can thus ensure appropriate and effective treatment [11-13].

**MRV Abdomen and Pelvis**
MRV of the abdomen and pelvis has not been cited as a first-line examination. As with CTV, MRV identifies stenosis, occlusion, venous atresia, collaterals, and edema. In addition, MRV can show webs, trabeculations, and vein wall thickening [9]. Further highlighting the importance of MRV before intervention is a high rate of recurrence 2 years postintervention (15%-35%). Further anatomic characterization before therapy can ensure appropriate and effective treatment [10-13]. Characterization of these potential variants is important for treatment planning purposes.

There are 2 scenarios described in the literature characterizing pelvic venous obstruction. Primary chronic venous disease describes a phenomenon in which there is obstruction in the pelvic or abdominal veins (eg, May-Thurner) without a prior DVT. Imaging can then be used to identify the cause of obstruction. Secondary chronic venous disease describes a phenomenon in which primary thrombotic events cause a post-thrombotic syndrome. In addition to an occlusive IVC or iliac vein lesion, these cases also show signs of delayed or incomplete recanalization of the pelvic and lower extremity deep veins with extensive intraluminal changes. In both the above types, primary focus should be on anatomy to accurately identify stenosis and occlusion related to outflow obstruction [9].

Gadolinium-enhanced MRV with contrast seems to be the examination of choice because of the high intravascular enhancement and acquisition of isotropic voxels with a high spatial resolution allowing for evaluation of subtle changes. Three-dimensional volumetric imaging is preferred over MR direct thrombus or time-of-flight subtraction angiography because surrounding soft tissue should be visible to identify causes of stenosis or occlusion [9].

Pascarella and Shortell [6] believe that imaging of IVC and iliac veins when there is a history of persistent venous ulcers or duplex US evidence of iliocaval obstruction. These findings include diffuse venous reflux, nonphasic common femoral vein velocity spectral waveforms, and reduced flow augmentation with distal thigh compression.

**US Duplex Doppler Lower Extremity**

It is widely agreed upon that duplex US should be the first assessment of the lower extremity venous system [1,9,14]. Duplex US is currently the most common technique because of its noninvasiveness [20].

Duplex US evaluation should additionally include condition of the deep venous system, GSV, SSV, and accessory saphenous veins. Presence and location of clinically relevant perforating veins and extent of possible alternative refluxing superficial venous pathways should also be included in any duplex US evaluation [1].

Though duplex US is widely considered the reference standard in evaluation of DVT, Hua et al [10] demonstrates that invasive preoperative venography is necessary before intervention to clarify the nature of disease and guide therapy. It is difficult to evaluate iliac vein involvement using this modality [73].

**US Duplex Doppler IVC and Iliac Veins**

Because duplex US is noted as the first assessment of the lower extremity veins, it can also be used as means to determine patency of the IVC and iliac veins. A good quality examination with normal findings may obviate the need for further imaging. However, in some cases, visualization of the IVC and common iliac veins can be limited in some patients because of obesity or artifacts. Spectral waveforms can aid as an indirect means of assessing patency of the iliac veins or IVC. Evaluation of waveforms in the common femoral veins will show loss of respiratory phase variation and exhibit monophasic physiology with severe iliac vein occlusive disease with a high specificity but low sensitivity [74,75].

**Variant 8: Iliocaval or lower extremity disease with severe post-thrombotic changes. Treatment.**

**Anticoagulation**

The role of anticoagulation is most frequently noted in acute DVT [76]. In chronic DVT, anticoagulation also should have a pivotal role. Many patients with prior chronic DVT are at high risk for thrombosis, and these patients should be given therapeutic anticoagulation [77]. Because of the highly thrombotic environment, most of these patients should be given full dose anticoagulation throughout and immediately after recanalization procedures.

**Catheter-Directed Thrombolysis With or Without Thrombectomy Lower Extremity**

Post-thrombotic syndrome is a potentially morbid complication that >50% chronic proximal DVT patients develop with limited treatment options. Until recently, there was little to no data describing the potential usage of catheter-directed thrombolysis in these patients. In the ACCESS PTS study, a multicenter, single-arm study following patients with chronic femoral DVT and post-thrombotic syndrome after percutaneous transluminal venoplasty and US-accelerated thrombolysis, a statistically significant decrease in Villalta Score ≥4 was noted at 30 and 365 days with corresponding improvement in QoL [78,79].

**Compression Therapy**

Despite the minimal evidence regarding C2 to C4 disease, there is evidence that compression therapy has value in C5 (preventing ulcer recurrence) and C6 disease (healing ulcers) [15]. Mosti and Partsch [18] demonstrated that 30 to 40 mm Hg inelastic compression is better than elastic bandaging for wound healing. They also showed that for ankle-brachial indices between 0.9 to 0.6, reduced compression to 20 to 30 mm Hg is successful and safe for VLU healing. Velcro inelastic compression was noted to be as good as 3- or 4-layer inelastic bandages. Caution is advised, however, when the ankle-brachial index is <0.6 because it indicates an arterial anomaly needing revascularization [21].

**Endovascular Stenting**

In a randomized trial by Rossi et al [49], iliac vein stenting was shown to improve symptomatology and QoL compared with medical treatment alone. Thus, based on the morbidity of moderate to severe post-thrombotic syndrome and the available clinical studies and experience with iliac vein stenting for post-thrombotic syndrome treatment, endovascular stenting is a useful treatment [15].

**Saphenous Vein Ablation**

There is no relevant literature regarding the use of saphenous ablation in the treatment of iliocaval or lower extremity post-thrombotic changes.

**Compression Sclerotherapy**

There is no relevant literature regarding the use of foam and compression sclerotherapy or cyanoacrylates in the treatment of iliocaval or lower extremity chronic DVT.

**Venous Angioplasty**

When recanalization of femoral and popliteal veins is performed because of chronic post-thrombotic changes, angioplasty is typically the first-line therapy. Stenting of femoral vein below the lesser trochanter and popliteal veins is not routinely performed because of an increased risk of in-stent thrombosis and occlusion [80,81].

**Venous Bypass Procedure**

Surgical iliac vein reconstruction and variations of venous bypass have been reported. Endovascular options, as discussed above, have proven to be a viable alternative. Venous bypasses in the setting of iliocaval and lower extremity venous disease can be performed in situations in which minimally invasive or conservative options are unsuccessful. The clinical success and patency of these bypasses are poor (infrainguinal) and associated with significant postoperative morbidity (suprainguinal surgery). Poor patency is likely due to low velocity through the graft, external compression, inherent thrombus formation, and/or inadequate distal venous inflow [82].

**Summary of Recommendations**

- **Variant 1**: US duplex Doppler of the lower extremity is usually appropriate for the initial diagnosis of varicose veins.
- **Variant 2**: Compression therapy, saphenous vein ablation, compression sclerotherapy, or microphlebectomy is usually appropriate for the treatment of varicose veins. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously in which each procedure provides unique clinical information to effectively manage the patient’s care).
- **Variant 3**: US duplex Doppler of the IVC and iliac veins or US duplex Doppler of the lower extremity is usually appropriate for the initial diagnosis of a VLU. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care). The panel did not agree with recommending IVUS of the iliac veins, MRV of the lower extremity without and with IV contrast, or CTV of the lower extremity with IV contrast for the initial diagnosis of a VLU. There is insufficient medical literature to conclude whether or not these patients would benefit from these procedures. Imaging with these procedures in this patient population is controversial but may be appropriate.
- **Variant 4**: Compression sclerotherapy, compression therapy, saphenous vein ablation, or would care is usually appropriate for the treatment of a VLU. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care).
- **Variant 5**: US duplex Doppler of the IVC and iliac veins, US duplex Doppler of the lower extremity, US duplex Doppler of the pelvis, MRV of the abdomen and pelvis without and with IV contrast, or CTV of the abdomen and pelvis with IV contrast is usually appropriate for the initial diagnosis of pelvic-origin lower extremity varicose veins suspected in females. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care). The panel did not agree on recommending IVUS of the iliac veins for the initial diagnosis of pelvic-origin lower extremity varicose veins suspected in females. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure in this patient population is controversial but may be appropriate.

- **Variant 6**: Conservative management is usually appropriate for the treatment of pelvic-origin lower extremity varicose veins in females. The panel did not agree on recommending saphenous vein ablation in this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this therapy. Treatment in this patient population is controversial but may be appropriate.
- **Variant 7**: US duplex Doppler of the IVC and iliac veins, US duplex Doppler of the lower extremity, MRV of the abdomen and pelvis without and with IV contrast, or CTV of the abdomen and pelvis with IV contrast is usually appropriate for the initial diagnosis of iliocaval or lower extremity disease with severe post-thrombotic changes suspected in patients. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending IVUS of the iliac veins, MRV of the lower extremity without and with contrast, or CTV of the lower extremity with IV contrast for the initial diagnosis of iliocaval or lower extremity disease with severe post-thrombotic changes suspected in patients. There is insufficient medical literature to conclude whether or not these patients would benefit from these procedures. Imaging with these procedures in this patient population is controversial but may be appropriate.
- **Variant 8**: Anticoagulation, compression therapy, or endovascular stenting is usually appropriate for the treatment of iliocaval or lower extremity disease with severe post-thrombotic changes in patients. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending saphenous vein ablation for the treatment of iliocaval or lower extremity disease with severe post-thrombotic changes in patients. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Treatment with ablation in this patient population is controversial but may be appropriate.

**Supporting Documents**

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

**Appropriateness Category Names and Definitions**

| Appropriateness Category Name | Appropriateness Rating | Appropriateness Category Definition |
|---|---|---|
| Usually Appropriate | 7, 8, or 9 | The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients. |
| May Be Appropriate | 4, 5, or 6 | The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal. |
| May Be Appropriate (Disagreement) | 5 | The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned. |
| Usually Not Appropriate | 1, 2, or 3 | The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable. |

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