

## Section D: Pre-examination considerations

### What is the purpose of venous insufficiency ultrasound examination?

A full lower limb venous insufficiency ultrasound study is recommended as the primary choice of imaging modality for diagnosis and treatment planning in patients with suspected or clinically evident chronic venous disease (CVD).<sup>[43]</sup> This is supported by published studies showing better patient outcomes for those who undertake a pretreatment duplex ultrasound (US) compared to those who do not and indicating that CT-venography does not offer additional functional information beyond what duplex US can provide.<sup>[46]</sup>

Duplex US aims to answer the following questions:

1. Is there venous incompetence or obstruction in the deep venous system, such as deep vein thrombosis (DVT) and popliteal vein compression, and to what extent?
2. Is there any venous reflux in the superficial venous system, including both saphenous and nonsaphenous veins? What is the source of reflux, reflux pathway and re-entry point (where the incompetent superficial vein drains back into the deep venous system)?
3. Is there venous obstruction in the superficial venous system, such as superficial vein thrombosis (SVT), and to what extent?
4. What is the number, location and diameter of incompetent perforating veins?
5. Are there any anatomical variations, especially at the saphenous junction with the deep system?
6. What are the diameters of the truncal veins (e.g., GSV, SSV, ASV, etc.) and nontruncal veins (i.e., tributary veins) throughout the thigh and calf? If incompetent, are they suitable for thermal or nonthermal ablation treatment?
7. Are there developmental abnormalities primarily involving the saphenous veins?
8. Is pelvic venous pathology contributing to incompetence of the lower limb veins?

Existing evidence based clinical practice guidelines support the use of duplex US in the diagnosis of CVD for:

- evaluation of venous insufficiency;<sup>[78]</sup>
- review of treatment results within 3-6 months postsurgery;<sup>[79]</sup>
- pre- and post-treatment evaluation of an endovenous thermal ablation procedure;<sup>[79]</sup>
- investigation of varicose veins and venous malformations;<sup>[80]</sup>
- and evaluation prior to sclerotherapy in patients with recurrent varicose veins;<sup>[80]</sup>

### What are the indications, contraindications and limitations of duplex ultrasound to investigate chronic venous disease.

#### Indications

Sonographers usually receive requests from vascular care providers to perform duplex US investigation, to aid treatment planning, and make postoperative assessments.<sup>[20]</sup> Duplex US identifies the source of reflux as well as the locations and patterns of varicose veins. It is important to investigate for the presence of other venous pathologies that can produce symptoms similar to those of CVD (i.e., arteriovenous fistulas, DVT, venous aneurysms and congenital venous malformations and venous claudication). Ultrasound has a pivotal role in formulating treatment strategies and planning treatment as the superficial venous system is very variable.<sup>[20, 43, 81, 82]</sup> For treatment planning purposes, it can be used to identify and mark the target vein on the skin with consideration to anatomical variations, tortuosity and distance beneath the skin particularly when preparing for endovenous treatments.<sup>[21, 83-84]</sup>

Table D1 summarises the clinical indications for which sonographers receive referrals to perform venous insufficiency scans. It also provides an 'appropriateness rating' developed by authors in another publication<sup>[84]</sup>

for each clinical indication. The clinical indications and appropriateness ratings in this table inform sonographers about the most common reasons patients are referred to them.

### Contraindications and limitations

Duplex US for the assessment of CVD may be limited or rarely contraindicated, when the patient:

- is obese;
- has severe oedema and pain in the lower extremity;
- is unable to stand, or unable to stand for a length of time;#
- and/or they have open draining ulcers or other obstructions to the ultrasound imaging window. <sup>[85]</sup>

# It is recommended that sonographers should perform the venous insufficiency studies with the patient in an upright position (see Recommendation G2, Section G), but due to the reasons and risks outlined in Table D2, this may not always be possible. Under the circumstance, adaptations to the procedure or equipment used will need to be made (refer to Section F).

If an acute SVT or DVT is identified, the sonographer may need to consider terminating the reflux testing and must notify the referring physician immediately. <sup>[86]</sup>

Table D1: Clinical indications for venous insufficiency ultrasound studies. (adapted from <sup>[80]</sup>)

Clinical indication	Appropriateness rating
Active venous ulcer	<b>Appropriate</b> (a strong indication for duplex ultrasound as benefits generally outweigh risks)
Healed venous ulcer	
Symptomatic varicose veins (e.g., pain, ache, burning, throbbing or heaviness)	
Visible varicose veins with oedema	
Skin changes associated with chronic venous insufficiency with/without visible varicose veins (e.g. hyperpigmentation, lipodermatosclerosis)	
Mapping prior to venous ablation procedure	
Prior endovenous (great or small) saphenous ablation procedure with new or worsening varicose veins in the ipsilateral limb	
Entirely asymptomatic varicose veins	<b>Maybe appropriate</b> (a moderate indication for duplex ultrasound due to variable evidence or agreement regarding the benefits/risks ratio, potential benefit)
Lower extremity pain or heaviness without signs of venous disease	<b>Usually not appropriate</b> (a weak indication for duplex ultrasound due to the lack of a clear benefit/risk advantage).  * Duplex ultrasound might be considered if the spider veins are in the distribution of saphenous veins and treatment was being considered. <sup>[68]</sup>  # An initial follow up for deep vein thrombosis 10 days after the ablation procedure may be requested. <sup>[45]</sup>
Spider veins (telangiectasias)*	
Prior endovenous (great or small) saphenous ablation procedure with no residual symptoms#	

Table D2: Potential difficulties associated with the standing position used in venous insufficiency studies (adapted from <sup>[87]</sup>)

Patient may not be able to stand because:	<ul style="list-style-type: none"> <li>• of uncomfortable/tired/weak legs</li> <li>• they feel unstable on one leg</li> <li>• they feel like fainting or falling</li> <li>• they have leg numbness</li> <li>• they have back, knee or foot pain</li> </ul>
Duplex ultrasound becomes difficult to perform due to patient:	<ul style="list-style-type: none"> <li>• fidgeting or unable to stay still</li> <li>• sighing</li> <li>• movement during reflux augmentation manoeuvres</li> <li>• becoming weak, dizzy</li> <li>• fainting or falling</li> </ul>
Duplex ultrasound becomes difficult for sonographer due to ergonomic factors requiring them:	<ul style="list-style-type: none"> <li>• to sit on the floor for distal calf assessment</li> <li>• to have difficulty in visualising monitor or reaching keyboard during calf assessment</li> <li>• to get tired or sore neck, arms and back</li> </ul>

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## What patient preparation is required?

No specific patient preparation is required however the following advice may be useful:

At the time of booking, the patient should be informed:

- to allow full distension of the lower limb veins, not to wear compression stockings on the day of the examination, and that they should arrive as warm as possible; <sup>[35]</sup>
- to dress in clothes that can easily be removed or adjusted to enable access to the groin, and the full lower limb for scanning; <sup>[82]</sup>
- that an afternoon appointment is preferred for best results;
- that they should advise the practice if they have a preference for a male or female sonographer.

Immediately prior to the examination, and in the privacy of the examination room, the sonographer should:

- provide a clear explanation about the examination, obtain consent and a medical and surgical history (see sections below);
- ask the patient to advise if they are not feeling well or cannot tolerate the examination;
- ask that any compression stockings to be removed, or ask for consent for the sonographer to remove them;
- if appropriate, remove any items that may interfere with acoustic windows such as dressings. Be sure the patient is comfortable with this action, and that if an active ulcer is present take steps to follow infection control protocols. <sup>[82]</sup>

## What explanation should be provided to the patient prior to the examination?

Prior to the examination, it is necessary to have a conversation with the patient so they understand what is going to be done and are informed to provide consent to proceed with the examination, <sup>[88]</sup> which can lead to improved compliance. <sup>[81-82]</sup> This conversation includes:

- verifying the patient's identity; <sup>[85]</sup>
- sonographer(s) introducing themselves;
- with consideration of the age and mental status of the patient, <sup>[85]</sup> providing a clear explanation of:
  - why the examination is being performed (e.g., why it is important to assess the entire leg rather than just the varicose veins in the calf), how it will be performed and how much time it will take. <sup>[85]</sup>
  - how ultrasound gel will be applied to the bare skin from the groin to the foot
  - the positions and manoeuvres required (i.e. semierect position, transducer compression, squeezing of the limb, Valsalva manoeuvre and tip toe movement).
- responding to any questions and concerns the patient may have. <sup>[85]</sup>
- educate the patient about risk factors and symptoms of CVD. <sup>[85]</sup> In the context of a VI examination, this is a low-risk procedure. Potential risks include the potential of light-headedness, dizziness or fainting, resulting in a fall during the examination, mild discomfort if the leg is sensitive to pressure, bruising, skin irritation or infection to open wounds.
- refer specific questions that fall outside the sonographer's expertise to the referring vascular care provider. This may include questions about diagnosis, treatment or prognosis (e.g., is my leg bad enough to require surgery)? <sup>[85]</sup>
- Prior to making physical contact with the patient, and after the above recommended conversation the sonographer should obtain consent from the patient to proceed.

Refer to:

Guide to Consent for Medical Ultrasound Examinations

[Clinical Guidelines: Consent for Medical Ultrasound Scans \(sonographers.org\)](https://www.sonographers.org/publicassets/023b27c7-047b-ef11-9133-0050568796d8/Guide-to-Consent-for-Medical-Ultrasound-Scans-sonographers.org)

The Guide to Consent and Chaperones for Intimate Medical Ultrasound Examinations

<https://www.sonographers.org/publicassets/023b27c7-047b-ef11-9133-0050568796d8/Guide-to-Consent-for-Intimate-Examinations-Sept-24.pdf>

## What medical and surgical patient history should the sonographer collect?

Prior to commencing the duplex US, the sonographer should obtain the patient's medical and surgical history and their current clinical presentation from either the patient or their medical records.

Table D3 summarises history items relevant to the sonographic examination, such as those that inform expected sonographic appearances or technical adjustments that may need to be made during the procedure.

## How should sonographers perform physical assessment prior to the examination?

The sonographer should complete a physical assessment of the patient before commencing the duplex US examination. This should also include an assessment of the patient's ability to tolerate the procedure and of any conditions that may limit the procedure. <sup>[35]</sup>

Visual inspection and palpation of the lower limb is helpful in determining the scope of the scan, <sup>[35, 47, 82]</sup> identifying sources of reflux, and assists in making the duplex US easier and quicker. It also decreases the probability of missing a relevant finding such as varicose tributaries or an atypical source of reflux. <sup>[35, 39, 46-47, 48, 81]</sup> The sonographer should make visual assessment with the patient standing, thoroughly examining the trunk, both legs, groin, and pubic area, and documenting any visual findings listed in Table D4. Sonographers should be aware that some patients may regard palpation of the groin area as an intimate examination and if applicable guidelines for consent for intimate examinations should be followed.

Refer to:

Guide to Consent for Medical Ultrasound Examinations	<a href="https://www.sonographers.org/publicassets/023b27c7-047b-ef11-9133-0050568796d8/Guide-to-Consent-for-Medical-Ultrasound-Scans-sonographers.org">Clinical Guidelines: Consent for Medical Ultrasound Scans (sonographers.org)</a>
The Guide to Consent and Chaperones for Intimate Medical Ultrasound Examinations	<a href="https://www.sonographers.org/publicassets/023b27c7-047b-ef11-9133-0050568796d8/Guide-to-Consent-for-Intimate-Examinations-Sept-24.pdf">https://www.sonographers.org/publicassets/023b27c7-047b-ef11-9133-0050568796d8/Guide-to-Consent-for-Intimate-Examinations-Sept-24.pdf</a>

Table D3: Medical and surgical patient history items the sonographer should consider prior to the prior to the venous insufficiency ultrasound scan

History item	Rationale
What are the problem areas related to the veins from the patient's point of view?	These questions will inform the sonographer of the concerns of the patient, which may be different to what is evident to the sonographer. For instance, telangiectasia may or may not be a concern to the patient.
Is the patient able to stand for an extended period of time? Does the patient have any mobility issues?	These questions will inform the sonographer of any difficulties in positioning the patient for the examination, which should be performed in the standing position whenever possible as this ensures accurate and standardised measurements of venous reflux. [81, 86-90] The scanning time may also need to be extended if the patient has mobility issues or cannot stand for extended periods.
Does the patient suffer from fainting?	This question will alert the sonographer to the risk of the patient fainting and prompt the implementation of strategies to minimise this risk, such as lowering room temperature, having water on hand, providing breaks from standing, and carefully watching the patient for signs of syncope. It is not uncommon for patients to feel faint or light headed during a venous insufficiency ultrasound examination, especially among those in a younger age group. The causes are unknown; however, it may be associated with high room temperature, fatigue, anxiety, motion sickness, and a sudden drop in blood pressure due to reduced venous tone. [35, 91-92]
Does the patient have any tender areas?	This question alerts the sonographer to areas that they should take care in applying pressure to (i.e., transducer pressure, or augmentation manoeuvres). Possible sources of pain and tenderness are lipoedema, superficial thrombophlebitis, neuroma and fibromyalgia.
Is there a history of deep vein and/or superficial vein thrombosis?	This question can alert the sonographer to existing deep or superficial vein thrombosis, a pathology which should be recorded. Additionally, previous clots in the veins may cause damage to the valves, leading to valvular insufficiency and/or venous obstruction if they reside within the lumen of the veins. [79]
Is there a family history of venous thrombosis?	This question alerts the sonographer to the possibility of existing venous thromboembolism as family history is a risk factor. Genetic risk factors relating to a family history of venous thrombosis include Factor V Leiden mutation, Prothrombin G20210A mutation, deficiency in Protein C, Protein S and antithrombin, hyperhomocysteinemia, and sticky platelet syndrome.
Is there a history of trauma to the lower extremity?	This question alerts the sonographer to potential DVT, secondary CVI and venous leg ulcer. Patients with a leg injury may develop DVT and with later complication such as post-thrombotic syndrome. Secondary CVI can arise due to valvular dysfunction and vein wall damage during a thrombotic event. [50] Local trauma to untreated varicose veins has the potential to lead to excessive bleeding and initiate the formation of venous leg ulcer. [31, 43]
Is there a history of venous ulcers and/or varicosities?	The presence or history of venous leg ulcers or varicosities will alert the sonographer to a focused examination to identify refluxing veins responsible for the ulcer, such as pathologic perforating veins. A venous stasis ulcer is an indicator of chronic venous hypertension and local tissue hypoxia. A high percentage of patients with a venous leg ulcer have primary venous insufficiency, with a lesser percentage having secondary venous insufficiency resulting from post-thrombotic syndrome (20-30%). The recurrence rates for venous leg ulcer can be substantial, reaching as high as 50-70% within six months. [7, 67] If the varicose veins are recurrent, then the sonographer should be aware that they may be filled via unusual sites such as a lateral thigh incompetent perforating or vulvar veins. [20, 81]
Is there a history of heart problems such as congestive heart failure?	This question alerts the sonographer to CVI which is linked to venous hypertension. The backward pressure generated by the heart in congestive heart failure may lead to valve dysfunction. [41, 45, 92]
What medications is the patient currently taking?	This information is useful to know as some medications, such as oral contraceptives, hormone replacement therapy, corticosteroids, are associated with DVT and clotting disorders. Sonographers can then concentrate on identifying any residual thrombi and/or postthrombotic change that could result in venous obstruction. Patients who are on long term anticoagulant therapy (e.g., aspirin, rivaroxaban, apixaban, and dabigatran) may have an increased risk if they temporarily discontinue their medication. [21, 43, 45, 93-94]
Is there a history of vein surgeries or interventions (i.e., vein ablation procedures, venous stripping, vein harvest, iliac vein stenting for iliac vein compression, sclerotherapy)?	Sonographers performing venous insufficiency ultrasound examinations must have a fundamental understanding of the various treatment options, as different procedures can yield distinct outcomes. For instance, the appearance of a treated GSV varies depending on the treatment. <ol style="list-style-type: none"> <li>1. Stripping Surgery: After stripping surgery, the GSV typically becomes no longer visible on ultrasound.</li> <li>2. Thermal Ablation: Once the GSV has undergone thermal ablation, it may gradually dissolve over time, resulting in changes detectable through ultrasound.</li> <li>3. Nonthermal ablation/cyanoacrylate glue: The GSV treated with adhesive typically exhibits acoustic shadowing on ultrasound, which can serve as a distinctive feature for differentiation from superficial venous thrombus.</li> <li>4. Sclerotherapy: sclerosed vein with trapped blood may have similar appearance as superficial thrombophlebitis.</li> </ol> Understanding these treatment related changes in the sonographic appearance of the treated veins is important for sonographers to accurately interpret ultrasound images and make informed clinical assessment.
Are there results available for comparison or any other relevant diagnostic procedures?	Having this information <ol style="list-style-type: none"> <li>1. Adds to a patient's health and medical history in order to make the most informed diagnosis that guides the treatment decision making.</li> <li>2. Allows for cross referencing of different diagnostic information leading to a more precise diagnosis, especially as US is operator dependent. It can also help identify any inconsistency or discrepancy in the results.</li> <li>3. Asking patients about their past diagnostic procedures can also avoid unnecessary redundancy in testing.</li> </ol> Previous diagnostic findings can be used for monitoring patient's progress throughout the course of the treatment.

Table D4: Visual assessments that the sonographer should consider prior to the prior to the venous insufficiency ultrasound scan

Visual assessment items (of trunk, both legs, groin, and pubic area, preferably made with the patient standing)	Rationale
Surgical scars	Surgical scars indicate to the sonographer that there have been prior procedures, such as ligation, stripping, or stab avulsion, offering clues about the visibility of the veins and affecting the sonographic appearances.
Telangiectasia <sup>[45, 47]</sup>	These items indicate mild to moderate stage of CVD. It is important to note the location, size and distribution of all visible spider veins and varicosities, as they serve as clues for sources of reflux. In addition, telangiectasia frequently has feeder veins which may require sclerotherapy treatment if the patient has aesthetic concerns.
Reticular veins <sup>[45]</sup>	
Varicose veins <sup>[46]</sup>	
Prominent veins of the trunk <sup>[45]</sup>	Prominent superficial veins at the lower abdomen alerts the sonographer to possible venous obstruction in the ilio caval veins. <sup>[45]</sup>
Oedema <sup>[47, 85]</sup>	The presence of oedema in the leg may be caused by venous insufficiency or venous obstruction in addition to other causes such as heart failure, renal failure and liver failure. The presence of chronic oedema (>3 months) should alert the sonographer to the possibility of CVI or post thrombotic syndrome. The presence of acute oedema should alert the sonographer to the possibility of deep vein thrombosis. Venous oedema should be differentiated from lymphoedema. Venous oedema primarily manifests in the ankle or lower calf, with relief after rest or leg elevation, and worsening throughout the day. In contrast, lymphoedema often begins on the dorsal side of the foot and can sometimes be identified by the presence of a positive Stemmer sign. <sup>[95]</sup>
Skin changes (i.e., pigmentation, eczema) <sup>[47, 85]</sup>	Skin changes should alert the sonographer to the possibility of chronic venous hypertension as a result of venous insufficiency. Skin changes result from erythrocytes escaping into surrounding spaces (erythrocyte diapedesis). Dermal erythrocytes break down, releasing haemoglobin, ferritin, and hemosiderin. Over time, hemosiderin accumulates in the tissue, along with increased epidermal melanin production, causing discolouration, pigmentation and skin changes. <sup>[96-97]</sup>
Atrophie blanche (porcelain white scars) <sup>[47]</sup>	The presence of atrophie blanche, which occurs when the small vessels in the superficial dermis become occluded, should alert the sonographer to CVI due to its association with this condition.
Active or healed ulceration <sup>[47, 85]</sup>	If active or healed venous leg ulcer is present, the sonographer should be alerted to the presence of CVI caused by venous insufficiency. Venous ulcers are usually large but shallow, with a granulating base and irregular border. Nonhealing ulcers in the medial ankle area are most likely due to underlying venous hypertension. Sonographers should search for pathological perforating veins (e.g., incompetent posterior tibial perforating vein) which play a crucial role in the altered haemodynamic of this area.
Does the patient have flat feet?	If the patient has flat feet, the toe elevation manoeuvre may not be as effective in eliciting venous reflux due to deteriorated calf and foot muscle pump function. A deteriorated foot muscle pump mechanism, secondary to static foot disorder or decreased ankle mobility, can lead to inadequate emptying of blood from the lateral plantar veins and reduced flow into the posterior tibial veins. While patients with static foot disorder have increased risk of developing CVD, no studies have been conducted to assess the difference in augmented venous flow between manual calf squeezing and toe elevation manoeuvres. <sup>[8, 51, 98]</sup>
At medial calf and medial ankle: Varicose veins, oedema, and skin changes	Alerts the sonographer to great saphenous venous reflux. <sup>[45]</sup>
Posterior calf and lateral ankle: Varicose veins, oedema, and skin changes	Alerts the sonographer to small saphenous venous reflux. <sup>[45]</sup>
Varicose veins in the groin and pubic area	Alerts the sonographer to the possibility of: <ul style="list-style-type: none"> <li>• Pelvic venous disorder with a reflux source in the abdominopelvic region. (Signs and symptoms arising from pelvic origin may include dysmenorrhoea, dysuria, dyspareunia, symptoms of pelvic heaviness, and exacerbation during the menstrual cycle in multiparous women;</li> <li>• Compression of the common Iliac vein;</li> <li>• Internal iliac vein incompetence;</li> <li>• Compression of the left renal vein; <sup>[45]</sup></li> <li>• Gonadal vein incompetence.</li> </ul>
Lateral varicose veins in the thigh	Alerts the sonographer to: <ul style="list-style-type: none"> <li>• Insufficiency in the posterolateral perforator veins;</li> <li>• Insufficient ASV (these could also show an anterolateral course);</li> <li>• Embryonic lateral marginal vein remnant, and if associated with limb hypertrophy, oedema, and/or port wine stain, Klippel-Trenaunay Syndrome can be suspected. <sup>[45]</sup></li> </ul>

**Key:** ASV; Anterior Saphenous Vein, CVD; chronic venous disease, CVI; chronic venous insufficiency.