

Standard Operating Procedure (SOP)

Lower Limb Venous Examination for Deep Vein Thrombosis and Venous Insufficiency

SETTING	Gloucestershire Hospitals NHS Foundation Trust
FOR STAFF	Vascular Laboratory
PATIENTS	Patients referred for the examination of lower limb veins

PURPOSE

To evaluate the lower limb deep and superficial venous systems to determine the presence, severity and location of venous disease, such as deep or superficial venous obstruction, presence of thrombus or post-thrombotic changes, evidence of valvular incompetence and identification of the source of reflux.

For the purpose of this document, the terms proximal and distal are defined in relation to the heart as per standard anatomic practice (i.e. structures closer to the heart are described as proximal).

COMMON INDICATIONS

Common indications include but are not limited to:

- Symptomatic lower limb venous disease, including leg swelling, aching, skin changes (discolouration, lipodermatosclerosis, venous eczema, venous ulcers)
- Suspected deep vein thrombosis (DVT)
- Visible varicose veins
- Venous claudication
- Bleeding from varicose veins
- Superficial vein thrombosis (SVT)
- Post-intervention to assess completion or possible complications of ablation procedures

CONTRA-INDICATIONS AND LIMITATIONS

Contraindications and limitations may include the following:

- Recent surgical intervention
- Ulceration, open wounds, bandaging or casts
- Patients unable to cooperate or those with involuntary movements
- Patients with impaired mobility physically unsuitable for scan
- Examinations performed using portable equipment or undertaken on wards may be limited due to equipment design and room dimensions

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PATIENT PREPARATION

Prior to beginning the exam, the examiner should:

- Introduce themselves, explain why the examination is being performed and indicate how much time the examination will take. Be aware of special circumstances such as the need for an interpreter or chaperone.
- Correctly identify the patient according to the relevant trust policies and procedures.
- Explain the procedure, taking into consideration the age and mental status of the patient ensuring that the necessity for each portion of the evaluation is understood.
- Respond to questions and concerns about any aspect of the evaluation.
- Refer specific diagnostic, treatment or prognosis questions to the patient's referring clinician.
- Verbal consent is suitable for this examination. Additional consent is required if the scan is being performed for teaching or research purposes.

PATIENT ASSESSMENT AND PHYSICAL EXAMINATION

Patient assessment must be performed prior to imaging. This includes assessment of the patient's ability to tolerate the examination or any contraindications to the procedure. A medical history relevant to pathology (i.e. previous history of DVT, varicose vein treatment etc.) should be taken prior to the scan. This should include presenting symptoms, their timescales and frequency, and presence of risk factors. Verify that the requested procedure correlates with the patient's clinical presentation. Perform a limited or focused physical exam, including observation and localisation of any signs or symptoms of lower limb venous disease. All consultations must be made and documented in accordance with the relevant Trust policies, for example promoting dignity and respect, maintaining patient confidentiality.

PATIENT POSITIONING

The patient should be positioned on the examination couch in a manner commensurate with the procedure being undertaken. Ask patient to remove clothing and jewellery appropriate to the procedure, assisting if necessary. Throughout the procedure the patient's privacy, dignity and security should be observed. Examiner should be as close to the examined extremity as possible to allow for ergonomically sound scanning.

For the assessment of the femoropopliteal segment the patient should be scanned in the standing position leaning against or sitting on the edge of the braked examination couch on its highest setting facing the examiner with the leg to be examined slightly rotated externally with most of the body weight on the opposite leg. The position should be as similar to standing as possible in order to reproduce physiological conditions. The patient may stand on a platform with a support bar so that they are at a height such that the examiner can comfortably interrogate the limb from the groin to the ankle. Alternately, for scanning below the knee, the patient may be seated on a height adjustable chair or the examination couch, with the examiner seated below with the limb to be examined resting on the examiner's knee. A combination of sitting and standing can be used depending on the patient's physical condition. Patients with

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significantly impaired mobility and at risk of falls can be examined supine in the reversed Trendelenburg position (feet at least 30 degrees lower than the heart). The report should indicate if the patient examined in supine position and that the results are likely to be unreliable. For abdominal vein assessment the patient should be positioned supine on the examination couch with the arms down by their sides.

EQUIPMENT

The examination is performed using an appropriate transducer for the vessel being examined. The ultrasound machine should be regularly safety checked and maintained according to local Quality Assurance protocols.

To ensure best recommended practice to reduce the risk of musculo-skeletal disorders, the examination couch should be height adjustable and the examiner's chair, if required, should be height adjustable and designed to promote best ergonomic positioning.

The examination room should be temperature-controlled with adjustable lighting suitable for examination.

Cleaning materials should be available in line with local and manufacturer's guidelines.

EXAMINATION PROTOCOL

The examination may be unilateral or bilateral depending on clinical symptoms.

The vascular optimised preset is selected at the start of the examination. The patient demographics/operator ID should be entered for image capture either manually or selected from the daily worklist.

As a minimum, the following veins should be examined:

Deep veins

- Common femoral vein (CFV)
- Femoral vein (FV)
- Proximal profunda femoris vein (PFV)
- Popliteal vein (PopV)
- Any other significant deep vein in the femoro-popliteal segment, i.e. sciatic vein
- Posterior tibial (PTV), peroneal (PeroV), gastrocnemius and soleal vein should be examined in patients referred for DVT assessment or at the discretion of the examiner when deemed necessary (i.e. superficial thrombus propagation, arterio-venous malformation, soft tissue lesions, for training purposes etc.).

Superficial veins

- Long saphenous vein (LSV) and sapheno-femoral junction (SFJ)
- Short saphenous vein (SSV) and sapheno-popliteal junction (SPJ) if present
- Femoro-popliteal intersaphenous vein (Giacomini) if present
- Thigh extension vein (TE) if present

If present and is part of reflux pathway or affected by thrombus

- Anterior accessory saphenous vein (AASV)
- Posterior accessory saphenous vein (PASV)

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- Any significant tributaries such as lateral marginal vein of the thigh, posterior arch vein etc.

In the presence of reflux only

- Superficial epigastric vein (SEV)
- External pudendal vein (EPV)
- Extra pelvic tributaries of pelvic origin

Perforating veins (if present and significant)

- Thigh perforators
- Popliteal perforator
- Posterior tibial and peroneal perforators
- Gastrocnemius perforators
- Ankle perforators
- Any other unclassified significant perforating veins

Abdominal veins

If requested by the referring clinician, in the absence of respiratory modulations in the CFV, in the presence of CFV deep vein thrombosis, if abnormal superficial veins are identified in the inguinal region or lower abdominal wall which may indicate iliac vein obstruction:

- Inferior vena cava (IVC)
- Common iliac vein (CIV)
- External iliac vein (EIV)
- Internal iliac vein (IIV) if demonstrated

For pelvic congestion evaluation

- Abdominal veins
- Ovarian vein (OV)
- Left renal vein (LRV)
- Any significant pelvic varicosities

TECHNIQUE FOR EVALUATION OF THE LOWER LIMB VENOUS SYSTEM

Throughout the scan the machine controls (e.g. scale, gain, angle, depth, gate etc.) should be adjusted to optimise the image/colour filling/spectral trace.

Care should be taken to ensure the Doppler angle is $\leq 60^\circ$, the Doppler gate size is adjusted to the size of the vein and the Doppler cursor is angled in the direction of flow.

Follow a standard exam protocol for each segment examined.

B-mode should be utilised to assess vein patency by observation of the compressibility of the vein which should be done in the transverse plane. The vein walls should meet on compression to show no material is present within the lumen. Spectral and colour Doppler should be utilised to assess flow characteristics within the vein which will include assessment of phasicity,

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spontaneity and direction of flow. Flow characteristics should be assessed in the longitudinal plane with combination of colour and spectral Doppler. Manual distal (usually calf) augmentation should be used to enhance the flow and to assess for reflux (Valsalva manoeuvre can be used for CFV assessment). If calf augmentation is difficult, augmentation of the thigh or foot can be performed.

For DVT examination, assessment of venous reflux is not required.

Deep Veins

- In the transverse plane, begin imaging at the inguinal ligament, identify the CFV and SFJ. Assess the compressibility and flow in the CFV. Flow should be spontaneous with respiratory and cardiac modulations.
- In the transverse plane continue down the medial aspect of the thigh and posteriorly towards the popliteal fossa following the course of the FV and PopV. Assess for patency and flow characteristics. Compressions should be performed approximately 2-3 cm apart. Note any anatomical variations such as duplications, multiple networks, hypo- or aplasia. PopV should be assessed in its entirety down to the vessel division into the crural veins. Ensure there is sufficient overlap in the assessment of the distal FV segment and the proximal PopV segment in the adductor canal. Pulsatile flow should be noted if present.
- Assessment of deep calf vein (gastrocnemius, soleal, posterior tibial, peroneal) will be required if the referral is for DVT assessment or at the discretion of the examiner.

Superficial Veins

- SFJ, LSV, SPJ, SSV and any significant tributaries and perforators should be assessed for patency and competency using a combination of colour and spectral Doppler. Follow the same techniques as the assessment of deep veins.
- When reflux is present, the anatomy of the vein, tributary or perforator should be noted. The calibre and fascial relationship of any vein deemed suitable for intraluminal ablation, such as radiofrequency ablation or endovenous laser treatment, should be measured and reported. It might be beneficial to indicate the calibre of other veins or perforators which might aid treatment such as foamsclerotherapy. Particular attention should be paid to areas of ulceration and any incompetent tributaries feeding into the ulcer site.

INTERPRETATION

Normal imaging observations

The vessel is observed for the presence or absence of visible echogenic luminal material. If no visible echogenic material is visualised in the vein and the vessel collapses completely using the transducer pressure, the vein is thrombus-free at that location. Colour should fill the vein completely in response to distal augmentation.

Abnormal imaging observations

Thrombus is considered to be present when echogenic material is visualised within the vein and compression of the vein is observed to be limited by the contained thrombus. The colour normally moves around the echogenic material with distal limb compression if the thrombus is not fully occlusive. The vein is considered occluded when no flow is identified within the vessel.

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Once thrombus is identified, further characterisation of thrombus might be beneficial for patient management (sonographic thrombus characteristics are subjective and should be used as guidance only as often age of thrombus remains undetermined):

Recent thrombus:

- is most often lightly echogenic or hypoechoic
- may be poorly attached to the vein wall and represent a `floating` structure
- often dilates the vein wall (if the vein is totally acutely obstructed)

Non-recent thrombus (defined as thrombus likely to be older than 6 weeks of age) or post-thrombotic changes most often will:

- appear more echogenic
- be attached to the vein wall
- be associated with a reduced vein diameter (fibrosis progression)
- contract the vein wall over time (if totally obstructed)
- often be accompanied by collateral veins nearby
- likely to have some recanalization

A significant SVT is defined as a thrombus longer than 5cm or situated closer than 3cm to the junction with a deep vein.

Normal Doppler signals

Spontaneous and phasic signals are observed at all levels except at the calf, where signals may or may not be spontaneous or phasic. Distal compression of the limb augments the Doppler signals.

Abnormal Doppler signals

When venous Doppler signals are absent, obstruction of the vein at that level is suspected.

When a signal is present but is continuous, proximal obstruction or extrinsic compression is suspected.

When distal compression does not augment the venous signal, obstruction between the examined vein segment and the point of compression is suspected.

Weak or dampened augmentation might suggest total or partial obstruction of the veins.

ADDITIONAL CONSIDERATIONS

In the presence of SFJ incompetency, interrogate the pre-terminal and terminal LSV valves to establish reflux pathway and involvement of the SFJ tributaries to aid treatment options.

Identify any absent veins, for example due to congenital abnormality or previous harvesting for bypass surgery.

In the presence of the LSV, SSV or tributaries reflux, note vein tortuosity, varices and the relationship to the fascia using the groin, knee or ankle skin crease as anatomical landmark.

Measurement of vein diameter is performed in the transverse plane using calipers positioned on the anterior and posterior walls of the vessel measuring from leading edge to leading edge.

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Some patients may require an examination for recurrent varicose veins in which case close attention should be paid to the source of reflux as it may be unpredictable or small. In the case of previous ligation of the SFJ or SPJ, a tortuous recurrent junction may be present or neovascularisation which appears as a web of small and tortuous veins.

A perforating vein greater than 3.5mm in diameter is usually considered pathological.

CRITERIA FOR QUANTIFICATION OF REFLUX

Most RCTs and guidelines accept the duplex ultrasound value of reflux >0.5 second as the primary criterion for treatment of superficial venous incompetence.

Reflux is recorded as significant if reflux time is greater than 0.5s, except for the CFV, FV and PopV where significant reflux is considered as greater than 1.0s.

REPORTING

The report should include patient demographics, date of examination, examination type and status of vascular scientist. Any other considerations regarding trust policies including but not limited to consent and chaperone should be documented.

A diagrammatic report with written conclusions should be provided alongside appropriate ultrasound images to give a visual representation of the position and presence of any reflux, thrombus or occlusions.

IMAGE STORAGE

Images form a part of the patient record and may be used as evidence in relation to the management of patient care. Images should be as clear as possible for the purposes of demonstrating the appropriate pathology, including measurements where necessary, and provide sufficient information to support the written report.

Images should be clearly and adequately labelled, including patient identification information, date and time of examination and hospital/department information.

Recorded images should be labelled according to the side examined, vessel segment and the anatomical position of any reflux or thrombus.

As a minimum, the following images should be archived on PACS using B-Mode, colour and spectral Doppler as required.

Deep veins

DVT examination

Spectral Doppler image (in triplex mode):

- CFV demonstrating the flow pattern/respiratory phasicity

B-mode image of compression in split screen:

- CFV
- Proximal, mid and distal FV
- Proximal and distal PopV
- Any other significant pathology

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Representative images of PTV, PeroV, gastrocnemius and soleal veins (if assessed) in B-mode and/or colour Doppler.

Venous insufficiency assessment

Spectral Doppler image (in triplex mode):

- CFV demonstrating the flow pattern/respiratory phasicity
- CFV demonstrating competency/reflux
- Proximal, mid and distal FV demonstrating competency/reflux
- Mid PopV demonstrating competency/reflux
- Any thrombus or post-thrombotic changes
- Any other significant pathology

SFJ, SPJ and saphenous veins

- Spectral Doppler image (in triplex mode) to confirm patency and competency/reflux. For LSV at least two images of the above knee segment and one below knee segment should be recorded. No images of varicose veins are required as those will be described in the diagrammatic report unless contain thrombus.
- Any other significant pathology

POST PROCEDURE

The result of the scan is explained to the patient. The patient is informed that the result will be communicated to the referrer, who will contact them in the next week or two regarding follow up/review date.

If a recent DVT or significant SVT is suspected, the referring clinician should be informed to review the patient immediately. Alternatively, if the referring clinician is not available, the patient should be referred to A&E with a report and /or covering letter in a sealed envelope.

If the patient presents with recent untreated non-significant SVT, the patient should be advised to contact their General Practitioner as soon as possible.

The referring clinician should be informed of any non-urgent but actionable findings.

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