Practical Approach to Varicose Veins in the Lower Extremities: What every radiologist should know

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Learning objectives

• To review the main causes and clinical manifestations of varicose disease in the lower extremities

• To review and characterize the imaging features of this disease.

• To suggest a practical approach to the diagnosis and therapeutic decision of varicose veins in the lower extremities.
Background

Varicose veins are defined as abnormal dilatation or enlargement of a blood vessel, usually accompanied by tortuous development.

The main issues with these veins are not only the cosmetic problem but the fact that they usually represent a manifestation of an underlying chronic venous insufficiency with ensuing venous hypertension.

It’s a common disease that affects mainly women and has a higher prevalence in Westernized and industrialized countries.

The radiologist must have a clear understanding of the venous disorders lexicon so that, in the presence of a varicose patient, his report can have the most precise and patient-tailored information allowing proper multidisciplinary communication with the surgical staff.

Objectives:

Why does the varicose patient come to us, radiologists?

The main reasons are to know if the varicose veins are an isolated finding or if they represent one of the manifestations of chronic venous insufficiency with subsequent venous hypertension and for the radiologists to orientate the therapeutic decision of these patients.

Chronic venous insufficiency, in Doppler study, is demonstrated by the presence of venous reflux, which is defined by retrograde flow in the reverse direction to physiological flow lasting for more than 0.5 s in the superficial veins and perforators and lasting more than 1 s in the deep veins of the lower limb.

Venous reflux is demonstrated by imaging the vein in question while applying compression to the limb using a calf squeeze for proximal veins, foot squeeze for calf veins or with the Valsalva maneuver.

Requirements:

• The know-how:

The Radiologist must be experienced in terms of the principles of ultrasonography, must have a thorough understanding of the anatomy of veins (Fig.1) and have the proper use of terminology to correctly diagnose underlying venous insufficiencies and related varicose veins.
• Technical requirements and settings:

The most appropriate device for this exam is a color duplex ultrasound machine with B-mode and pulse-wave spectral. Two transducers should be present, a high-frequency linear array transducer of 7.5-13 MHz, appropriate for lower limbs to obtain good quality images of superficial veins and a curvilinear array transducer of 3.5-5 MHz, useful for very large or edematous limbs.

On B-mode, the focal zone of the transducer should be on the lumen of the vein that is being studied with the gain and dynamic gain control optimized so that the lumen of the vein can be dark in the absence of thrombosis or very slow blood flow.

When performing the Doppler study, an angle of insonation (40-60°) between the vein and the transducer should be obtained and low flow velocities settings should be used, normally a Doppler range of 5-10 cm/s.

Programs of image registration and an archive system for the images obtained are also needed.

To achieve these goals we propose these step-by-step guidelines, which are used in our department.

The diagnostic and evaluation steps:

1st Step - Complete Anamnesis and Physical observation

• Acknowledge the patient symptoms and, with enough light in the room, examine the lower limbs to establish the varices location and distribution. (Fig.2)

• Inquire about previous operations to the lower extremities to optimize the exam and to predict the source of the reflux.

2nd Step - Beginning the exam

• The room temperature should be warm to avoid vasoconstriction,

• Explain the exam and how it is going to be performed to the patient,
• Position the patient in orthostatism with the weight of the body supported by the opposite leg and with both heels on the ground. This will promote vasodilatation and facilitate the exam.

3rd Step - The Exam

• With the patient facing towards you start by examining, in B-mode and transverse view, the groin area to look for the "Mickey Mouse" sign which is composed by the great saphenous vein (GSV) and the common femoral vein, both localized medial to the common femoral artery. 

• Turn to a longitudinal view and identify the terminal valve (approximately 2mm distal to the saphenofemoral junction) and the pre-terminal valve that represents the distal limit of the SFJ, usually located 2cm below the terminal valve.

• At this point one should look for possible causes of reflux or valvular insufficiency including SFJ incompetence, tributaries veins from the lower abdomen or pelvis (Fig. 4), thigh or calf perforators or the vein of Giacomini.

• Next we move to the GSV trunk which has its own interfascial compartment and when looked in a transverse view forms the greatly known "saphenous eye" or "Egyptian eye". The fascial components which constitute the saphenous compartment are, superficially, the saphenous fascia and deeply the deep muscular fascia. (Fig.3)

• Besides evaluating the anatomical and lumen aspects of the GSV trunk, if reflux is found, the GSV trunk diameter should be measured 3cm below the junction, in the mid-thigh and at the knee. These measures will influence the therapeutic decision and can be used as references for post-procedures exams.

• Be aware that if the GSV leaves its interfascial compartment it should be designated collateral in its extracompartimental portion.

• Next, with the varices location and distribution in mind, locate the collateral veins in the thigh and leg that should be superficial to the saphenous fascia and should penetrate it in order to connect to the GSV. (Fig.5-7) There are a number of possible anatomical variants but some are more commonly found, like the two circumflex veins of the thigh, anterior and posterior, that are tributaries of the GSV, the intersaphenous veins that connect the GSV and the small saphenous vein (SSV) or the anterior or posterior arch veins (Leonardo vein) in the leg. Collaterals should be
referenced accordingly to two anatomical sites, the popliteal skin crease for the thigh and the floor level for the leg.

The last thing that should be checked, concerning these veins, is the presence of reflux in the GSV trunk below the collateral because this information has the potential to influence the therapeutic decision.

- The presence of perforators, veins that establish the communication between the superficial and deep venous system, should also be accounted for in the thigh and calf region if clinical assessment shows varices in these regions. (Fig.8)
  
The presence of bi-directional flux and a caliber superior to 3mm are usually indicators of venous incompetence and the perforators should be referenced using the same anatomical sites mentioned before. ³

- With the back of the patient facing towards you, examine the popliteal fossa with an axial view to study the anatomy and flux characteristics. Next, in a longitudinal view and with the help of the calf squeezing maneuver, try to understand the anatomical and hemodynamic relationship of the popliteal vein (PV), sapheno-popliteal junction (SPJ) (if present) and gastrocnemius veins and look for the presence of reflux.

- If there is SPJ incompetence with SSV reflux associated the diameter of the SSV should be measured 3 cm distal to the SPJ (or at the popliteal crease) and at mid-calf, excluding any varix in the vein. (Fig.9)
  
The level of the SPJ in relation to the popliteal skin crease should also be registered since it can only be accessible through a popliteal crease incision if it is within a range of 5 cm. In the other cases, the incision has to be made in a different topography.

- The SSV is located in the intergemelar groove, emerges from behind the external tibial malleolus and ends usually in the popliteal vein. ⁵ When present the venous reflux can have a primary origin on the GSV and extend inferiorly to the SSV (through the Giacomini vein) or it can be primary from the SSV with superior progression through the posterior thigh and be the cause of secondary reflux of the GSV.

- The deep venous system should also be analyzed, preferably above the SFJ and above the SPJ to study, respectively, the presence of reflux in the CFV and in the PV so that venous incompetence can be distinguished from reflux of the deep venous system.

- Finally search for the posterior arch vein (vein of Leonardo) which is a major tributary of the GSV in the leg³, look for calf perforating veins that join this vein in the medial calf region, and test for reflux in the vein that may result in medial calf varices.
4th Step - The Report

- The radiologist should make his report always with the clinician that asked for the exam in his mind so that he can utilize detailed information and accurate nomenclature regarding venous reflux and its relation with varicose veins. If necessary the radiologist can add and use a diagram to show the morphology and hemodynamic abnormalities relating to varices and location of diseased veins.

Treatment Options:

- The therapeutic approach to the varicose patient has been changing over time with the objective to become less invasive for the patient. The current techniques that are available and with promising results are the endovenous laser ablation, radiofrequency ablation, foam sclerotherapy and surgical stripping.
Fig. 1: Diagram showing the venous anatomy of the lower limb.

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Fig. 2: A and B: Example of a varicose patient that are usually referred to our department
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Fig. 3: B-Mode image: GSV trunk in an axial view limited, superficially, by the saphenous fascia and deeply by the deep muscular fascia, forming the "Egyptian eye".

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Fig. 4: B mode and color Doppler-US: Reflux in the saphenofemoral junction and in a tributary vein from the pélvis.

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Fig. 5: Spectral and color Doppler-US image shows the velocity and duration of the reflux in a collateral from the GSV.

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Fig. 6: B-Mode and color Doppler-US images showing incompetent collaterals that were responsible for the varicose veins that the patient presented in the physical exam.

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**Fig. 7:** Color Doppler-US image of an incompetent collateral that drained into the GSV in the thigh area.

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Fig. 8: Spectral and color Doppler-US image shows the velocity and duration of the reflux in an incompetent perforator in the calf area.

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Fig. 9: B-Mode and Color Doppler-US images that show reflux in sapheno-popliteal junction and in the small saphenous vein

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Findings and procedure details

• This Educational Exhibit presents an approach to the lower extremities ultrasound Doppler, often performed to study the presence of varicose veins and its complications in patients who came to our Radiology Department.
Conclusion

• Overall understanding and in-depth knowledge of varicosities are the main requirements to the successful diagnosis and follow-up of patients with varicose veins and are fundamental to the treatment planning of these patients.
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