Doppler examination of lower limb venous insufficiency: consensus among specialists

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Abstract A consensus among Diagnostic Imaging specialists and vascular surgeons on a protocol for carrying out Doppler studies for lower limb venous insufficiency is presented. This includes an agreement on the pathophysiology of the disease, the nomenclature and vessel diameters that make up the different venous systems, as well as the Doppler parameters to be used in study reports. A meeting was held with 6 vascular surgeons and 10 imaging specialists in which these different topics were discussed. Two Doppler studies of the lower limbs were performed during this meeting as an example, and a draft document was prepared on the points agreed. The result of this multidisciplinary meeting is the starting point for using a common terminology in order to improve the diagnosis and treatment of this disease.

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Introduction

Doppler ultrasound is the method of choice for evaluating venous insufficiency, its pathophysiology and diagnosis. A thorough understanding of the venous anatomy, as well as of potential functional impairments detected by Doppler examination is essential for the evaluation of this pathology and the making of an ultrasound mapping that allows vascular surgeons to choose the most appropriate treatment for each patient. For this reason, it is essential that all the professionals involved in the diagnosis and management of this condition use a common terminology. With this aim, a consensus among phlebologists and radiologists of the city of Bahía Blanca was reached through a multidisciplinary meeting. The issues discussed included:

- Pathophysiology of venous insufficiency (VI) of the lower limbs (LL).
- Anatomy of the superficial and deep venous systems (nomenclature, diameters, etc.).
- Doppler parameters (reflux on color and spectral Doppler, reflux time, etc.)
- Examination technique and report.

Results are reported below.

Results

Pathophysiology

Chronic venous disease is manifested by signs and symptoms when venous return decreases due to failure of peripheral pumps, obstruction of the venous axis draining the limb or reflux. These pathological conditions, often in combination, result in venous hypertension. When collateral circuits and lymphatic drainage are insufficient to compensate for decreased venous return, hydrostatic hypertension inevitably occurs. Venous valvular incompetence: venous valve dysfunction resulting in retrograde venous flow with a duration longer than 0.5 sec. Venous reflux: retrograde venous flow of abnormal duration, in any venous segment. It is divided into: primary, if caused by idiopathic venous valve dysfunction; secondary, when caused by thrombosis, trauma or mechanical, chemical or thermal etiologies (accounting for 80-95% of cases); or congenital, when caused by abnormal or absent development of venous valves. Perforator incompetence: perforating veins with outward flow of abnormal duration. Criteria for reflux: retrograde flow during muscle relaxation longer than 0.5 sec., or shorter if the velocity is greater than the anterograde velocity during muscle contraction. Insufficient communicating vein: when retrograde flow oc-
curs during muscle relaxation or when retrograde flow during muscle contraction is greater than the antegrade flow during muscle relaxation.

After discussing pathophysiology, the procedure to be followed in the study of venous disease was established. As a starting point, the patient's clinical manifestations should be observed, which include the development of varicose veins and trophic skin changes.

Anatomy

Nomenclature of the deep venous system
- Common femoral vein
- Femoral vein
- Popliteal vein
- Anterior tibial veins
- Peroneal veins
- Posterior tibial veins
- Sapheno-femoral junction (SFJ)
  - The nomenclature used for naming saphenous veins was considered irrelevant as to which of the synonyms should be used. However, the preferred terms in our consensus were small saphenous vein [vena saphena parva] and great saphenous vein [vena saphena magna].
- Great saphenous vein (GSV): as normal diameters, the saphenous ostium measures 6 to 8 mm, the arch measures 5 to 6 mm, and the saphenous trunk measures 3 to 4.5 mm in the thigh and 3 mm in the infrapatellar region.
- Small saphenous vein (SSV): its normal diameter is 1-4 mm.
- Small saphenous vein of the thigh.
- As regards the terminology for perforating veins, it was thought that for a most accurate location they should be identified on the basis of their distance from the sole of the foot in centimeters and their location relative to clock times. Thus, its was established that the patella is the 12 o’clock position and the popliteal fossa is 6 o’clock.

- In the right lower limb, the 9 o’clock position is external and the 3 o’clock position is internal.
- In the left lower limb, the 9 o’clock position is internal and the 3 o’clock position is external (fig. 1).
- The diameter of perforating veins must be documented when ≥ 3 mm.

Doppler examination protocol
- Examination is performed in the standing position.
- Examination starts at the inguinal arch, with a transverse...
view of the sapheno-femoral junction (Mickey Mouse’s sign) (fig. 2). Reflux is assessed at the level of the common femoral vein, femoral vein and GSV (figs. 3 and 4) by Valsava maneuvers using color and spectral Doppler (fig. 5).
- At the SFJ, the presence of tributaries draining into the arch should be evaluated, documenting their diameter and whether or not they are tortuous or insufficient.
- When the GSV is insufficient, we should document if reflux occurs through the terminal valve (ostial reflux) or at preterminal valve (figs. 6 and 7).
- In addition, the diameter of the great saphenous vein should be measured at the ostium (fig. 8).
- Only in obese patients or in patients with venous gulfs, the distance between the anterior border of the vein and the skin is marked close to the ostium.
- By moving the transducer down, reflux is assessed in the femoral vein and the great saphenous vein, in the upper, middle and lower thirds of the thigh.
- When saphenous veins are insufficient, the point at which the insufficient course starts and ends should be defined, reporting if this results in one or more dilated epifascial veins (varicose veins), their location and the point at which reentry to the deep venous system occurs, documenting also the perforator veins (the veins that pass through the muscle fascia, draining flow from superficial veins into the deep venous system) (fig. 9).
- The presence of reflux should be assessed, both by color and spectral Doppler examination, by Valsava maneuvers and ascending compression/release maneuvers, consisting in manually compressing the calf and waiting for valve closure or competence, or reflux (“upstream” maneuver by Prof. Schadeck). Insufficient perforating veins should be recorded only when their diameter is greater than 3 mm (figures 10 and 11).

- Examination of the SSV axis is performed with the patient facing away from the operator; transverse views are obtained in the posterior aspect of the calf (from caudal to cephalad), visualizing the small saphenous vein and calculating reflux at different levels. The presence or absence of tortuosity should be documented as well as the point at which the SSV terminates into the popliteal vein (if applicable), measuring the distance from the sole. In turn, the presence or absence of the small saphenous vein of the thigh should be ascertained and, if present, it should be identified as sufficient or insufficient.

- At the level of the popliteal fossa, the popliteal vein should be tested for reflux.
- If insufficiency of the small saphenous vein is found, we should record whether the ostium is involved or if reflux begins more caudally, if there are dilated epifascial veins and which are the points of re-entry of flow.
- Posterior and anterior tibial veins, and peroneal veins should be scanned.
- The presence of varicose veins unrelated to the saphenous veins should be evaluated and reported; their source should be established (for example, pelvic vein), as ligation of the saphenous veins may not be required.

Parameters to be evaluated in patients that underwent saphenectomy through thermal obliteration treatment

1) Identify any segments of saphenous vein and document where they begin and end.
2) It is important to take into account that in the immediate postoperative stage, hyperechoic images may be seen in the lumen of the vein, usually secondary to thermal obliteration by laser. Such images should not be misinterpreted as thrombosis and should be reported as thermally obliterated saphenous vein.
3) Laser is applied one centimeter from the SFJ; therefore, if the radiologist identifies a stump greater than 5 cm, it should be considered recurrence.
4) Postoperative reflux is normal when detected within 1-2 cm of the SFJ; if detected farther away, it is considered pathological.

To sum up, the aim of the examination is to determine the point of leakage, the presence of insufficient epifascial veins and the point of re-entry, recording the presence of insufficient perforating veins and their location.
Parameters to be evaluated in patients that underwent saphenous vein removal by conventional surgery

Varicose recurrences should be examined, focusing on the location of their origin. Furthermore, tributaries draining into the arch should be documented, stating their origin and whether or not they are sufficient. The presence of insufficient re-entry perforating veins and their proper location should also be recorded.

Treatment

Procedures in chronic venous disease

- High ligation and division: ligation and division of the great saphenous vein at its confluence with the common femoral vein, including ligation and division of all tributaries.
- Stripping: removal of a vein segment by means of a device.
- Saphenectomy: removal of the saphenous vein.
- Venous ablation: removal, destruction or exclusion of venous flow by chemical or thermal means.
- Perforating vein ligation: interruption of a perforating vein by mechanical means.

Figure 9 (a) Perforating yuxta-tibial vein, (b) perforating yuxta-tibial vein with flow present performing no stimulating maneuvers and (c) insufficient perforating yuxta-tibial vein with aliasing (multidirectional color flow), after the upstream compression maneuver (compression of the calf muscle).
Figure 10 Perforating vein greater than 3 mm with reflux on color Doppler.

Figure 11 Insufficient perforating vein greater than 3 mm in diameter, showing aliasing by upstream compression maneuver on color Doppler.

Figure 12 Sketch of the deep (a) and superficial (b) venous system for the report.
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- Mini-phlebectomy: removal of a vein segment through a small skin incision, generally using a No. 11 scalpel, beaver or large gauge needles.
- Sclerotherapy: obliteration of a vein by chemical introduction (liquid or foam).
- Foam: sclerosing agent with tensoactive properties, resulting from fluid mixing with air in the turbulent flow generated by the passage of fluid along a segment of reduced diameter (Tessari technique)
- ENOF (Endovenous Occlusion Foam): a technique that consists in releasing sclerosing foam into the saphenous vein under ultrasound-guided puncture.

Treatment consists in removal of the diseased saphenous vein and its tributaries, with concomitant ligation of insufficient perforating veins (as the latter play an essential role in recurrence of varicose veins). Tributaries draining into the arch and perforating veins are only treated when they are insufficient. The incidence of postoperative thrombosis related to intraluminal therapies of internal and/or external saphenous veins is lower than 1%.

- Figure 13 Text report: dilated GSV (10 mm) from the SFJ with epifascial varicose vein in the thigh and leg and re-entry into insufficient perforating vein at the 3 o’clock position and 20 cm away from the sole of the foot.

Treatment of deep venous insufficiency

Deep venous insufficiency poses a therapeutic challenge for vascular surgeons. Most of them think that tightly fitted graded compression stockings and care of areas affected by wounds constitute adequate treatment for most patients. However, sometimes symptoms are not controlled and ulcers often recur or fail to heal despite application of conservative measures. In these cases, for severe venous insufficiency some vascular surgeons recommend surgery (for example, valvuloplasty, venous segment transposition and venous segment transplantation). Surgery outcomes do not provide consistent and long-term improvement of symptoms or venous hemodynamic abnormalities related to this disease.

Sample report

We propose a report documenting only the point of leakage and the presence of insufficient epifascial veins and insufficient re-entry perforating veins. For example: “The exami-
nation performed shows insufficient great saphenous vein dilated at the ostium (10 mm), with reflux from the saphe-nofemoral junction generating epifascial veins in the thigh and leg, with re-entry into insufficient perforating vein at the 3 o’clock position and 20 cm away from the sole of the foot, etc. Sufficient deep venous system and small saphenous vein.” We suggest complementing the report with a sketch (figs. 12 and 13).

**Conclusion**

There was consensus about the various issues discussed, and an agreement was reached on the nomenclature, pathophysiology, Doppler parameters and a complete sample report. The latter is the starting point for the diagnosis and treatment of a disease that requires the joint work of phlebologists and specialists in diagnostic imaging.

**Conflicts of interest**

The authors declare no conflicts of interest.

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**References**


