Two-Point Compression Ultrasound

for detection of a deep vein thrombosis

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General facts

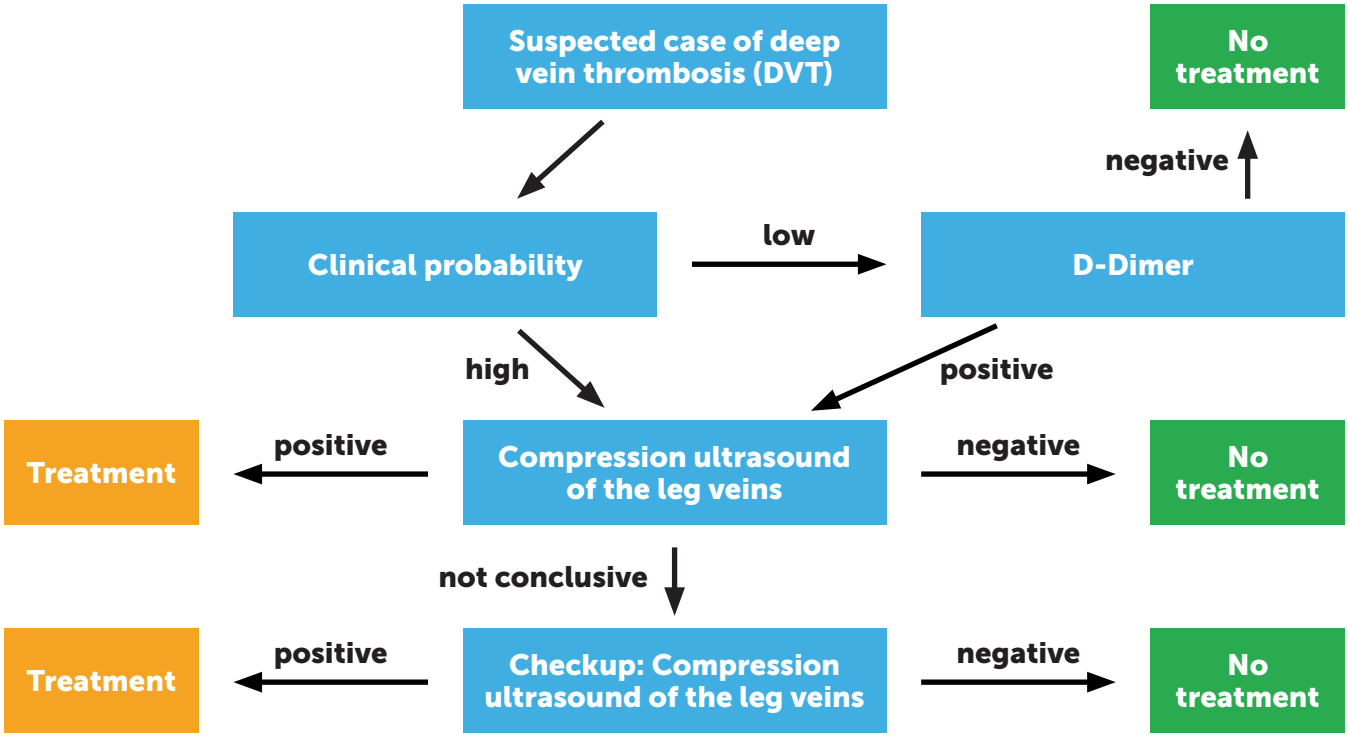
The leg vein sonography is the most important imaging technique for the exclusion or evidence of a deep vein thrombosis. An experienced examiner can make a safe diagnosis in approximately 97% of cases.

Clinical procedure

Before beginning the examination by ultrasound the "clinical probability" of a deep vein thrombosis should be estimated. Therefore the Wells score has established itself:

Clinical findings	Score	
Active cancer	1,0	**Score ≥ 2** DVT **likely.**
Paralysis, paresis or recent plaster immobilization of the lower extremity	1,0	
Bedridden recently (>3 Tage) or major surgery (<12 Wochen)	1,0	
Localised tenderness along the deep venous system	1,0	
Entire leg swollen	1,0	**Score < 2** DVT **unlikely.**
Calf swelling >3cm compared to other leg	1,0	
Pitting edema, confined to symptomatic leg	1,0	
Collateral (nonvaricose) superficial veins present	1,0	
Previously documented DVT	1,0	
Alternative diagnosis to DVT at least as likely	-2,0	

The interpretation of this score allows the determination of the pre-test probability, which is used to increase the significance (=positive and negative predictive value) of the subsequent tests (in this case the ultrasound examination).
The D-dimer test, which is described in the figure below, will be dealt with later on.



Anatomy

The sonographic examination is focused on the common femoral vein (V. femoralis communis), the great saphenous vein (V. saphena magna) and the popliteal vein (V. poplitea).
The main anatomic guide structures are the accompanying arteries, the inguinal ligament and the popliteal fossa.

At the height of the inguinal ligament the femoral vein lies medially to the femoral artery.
The femoral vein is traced distally until the great saphenous vein, coming from medial, joins the femoral vein.

The popliteal vein results from the confluence of the anterior tibial vein (V. tibialis anterior), the posterior tibial vein (V. tibialis posterior) and the fibular vein (V. fibularis).
In the ultrasound images the popliteal vein is recognisable due to the fact, that it lies more superficial than the popliteal artery (= closer to the probe).

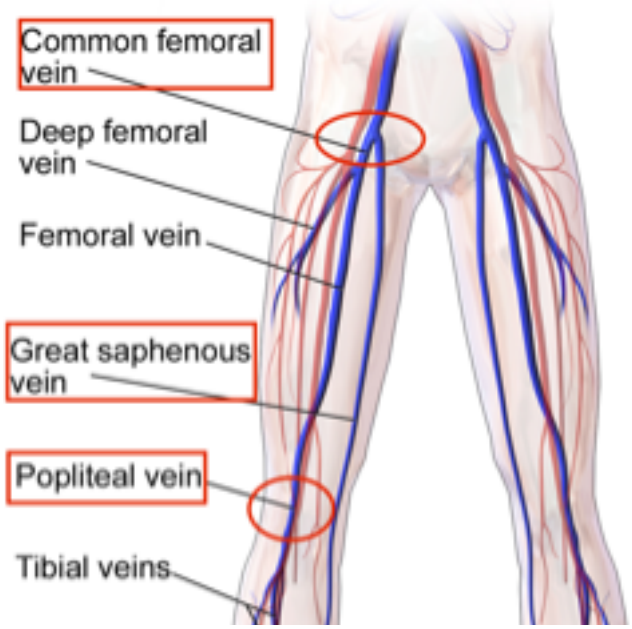


Fig. 1: Relevant anatomic structures of the lower extremity.

The ultrasound examination

Patient positioning
The patient lies in a reverse Trendelenburg position. For this positioning the patient is in a supine position with the patient table inclined, so that the head is the highest point. The legs are pointing downwards, whereby the veins fill better under the influence of gravity.

Leg covering clothing should be removed. A blanket, which is covering the groin region, protects the intimate zone and so the patient's privacy. For an easy access to the femoral vessels the patient's thigh is slightly rotated outwards, the leg lies down flat.

The popliteal vessels can be easily examined when the patient's knee is flexed at a right angle. Alternatively the patient can be asked to lie prone (for the examination of the popliteal fossa).

Probe selection
For the clarification of a DVT a high-frequency linear array probe is usually used. This one has a high resolution. Through its straight probe surface it enables an even pressure distribution on the vessels.
In special circumstances (e.g. sever obesity, oedema of the lower limb) the use of a probe with a higher penetration depth (e.g. convex array probe) is recommendable.

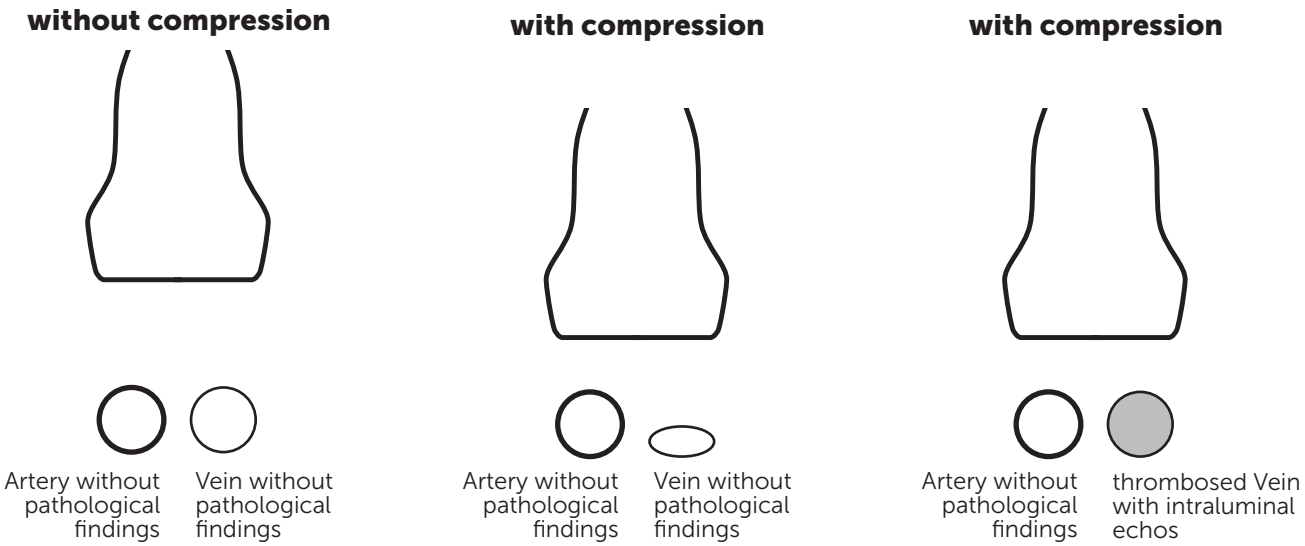
Probe placing
Ideally the probe is placed right below the orientation of the inguinal ligament. The probe marker shows to the examiner.
The femoral artery and vein should be seen in cross section, whereby the lateral vessel is the artery and the medial one the vein.
Then the vessels are scanned by moving the probe caudally until the great saphe-

nous vein, coming from medial, appears in the picture ("Mickey Mouse sign").
To find the popliteal vessels, the probe must be placed in the popliteal fossa.

The right probe placing is of high importance. The probe must be placed orthogonally to the patient's body surface. Otherwise the results of the vein compressing can be falsified.

In case of difficulties at the differentiation the vessels the color Doppler can help. Arteries have a pulsatile flow pattern, whereas veins show a continuous flow.

Compression technique/method
At an angle of 90° to the skin surface even pressure is applied, to achieve the collapse of the vein. For the exclusion of a possibly existing thrombus the lumen of the vein must disappear. Arteries cannot be compressed, because they maintain their form due to the higher inner pressure.



Compression point femoral vein and great saphenous vein
Accompanied by the femoral artery the femoral vein is located distally of the inguinal ligament. If these vessels are traced distally, the great saphenous vein will be found. After a few centimeters the medially situated great saphenous vein joins the femoral vein.

Compression point popliteal vein
This vein is located in the popliteal fossa. The popliteal vein is more superficial (and so closer to the probe) than the artery.

Sonographic signs for a normal finding

- compressibility of the vein
- equal enlargement of the vein during the Vasalva maneuver on both sides
- short reflux (<1 s) after the Vasalva maneuver
- significant venous flow increase during manual compression of the calf

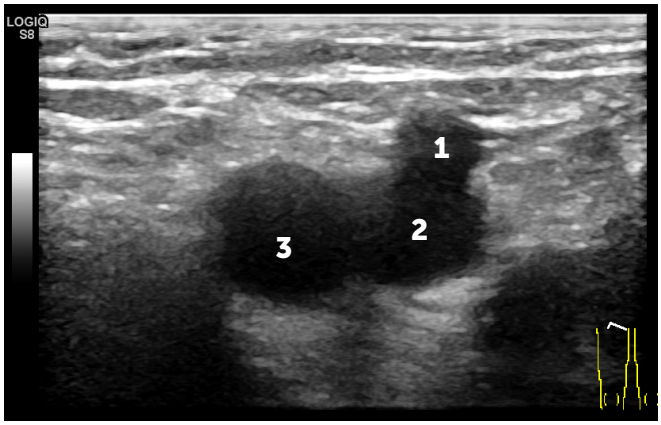


Fig. 2: Femoral vein and great saphenous vein.
1: Great saphenous vein, 2: Common femoral vein,
3: Common femoral artery

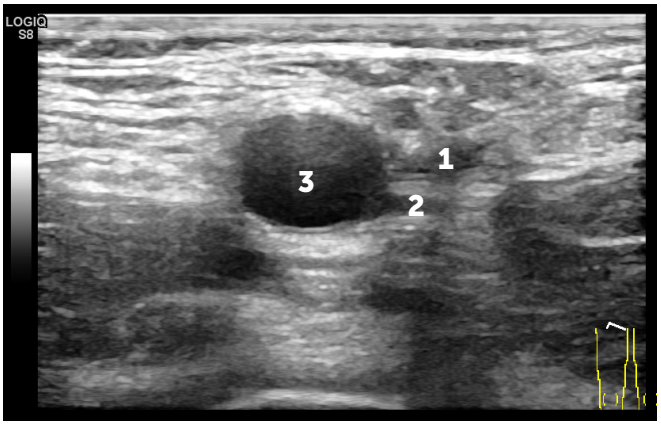


Fig. 3: Femoral vein and great saphenous vein compressed.
1: Compressed great saphenous vein, 2: Compressed common femoral vein, 3: Common femoral artery

Sonographic signs for a DVT

- non-compressible vein
- intraluminal visible thrombus
- absent fluency signal during the use of the color Doppler module
- larger vessel diameter in side comparison

The safest sign is a missing compressibility of the examined vein.
Because of poor image quality a supposed visible thrombus can often be misinterpreted.

Fig. 4: Common femoral vein is not compressible.
1: Common femoral vein. Intraluminal presence of echogenic structure.

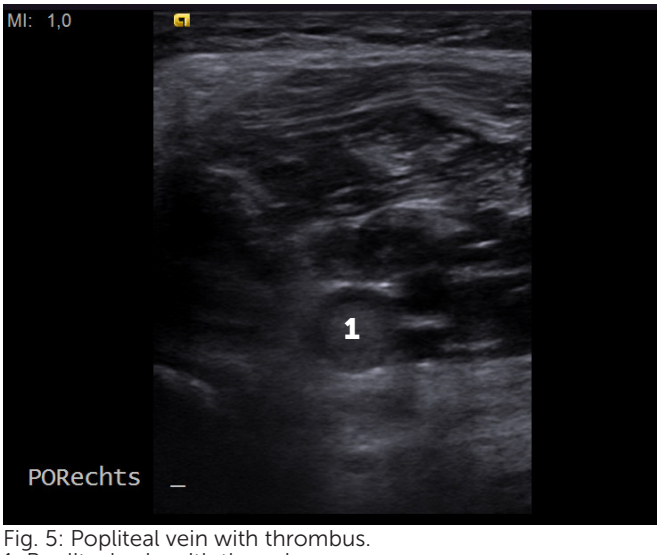


Fig. 5: Popliteal vein with thrombus.
1: Popliteal vein with thrombus.

Pitfalls

- "Lopsided" probe placing on the skin. By this no direct pressure is created on the underlying vessels during the application of the compression technique. A false positive result is the consequence.
- An empty vascular lumen is not to be equated with the absence of thrombi. Acute thrombi can be anechoic. The best proof of an occlusion is the non-compressibility of the vein.
- Technical difficulties at the examination of severely obese patients or patients with superficial oedema require the usage of a probe with a high penetration depth.
- Confusion of a Baker's cyst or lymph node with a thrombus.
- As the described method doesn't include the examination of the superficial femoral vein (V. femoralis superficialis), thrombi being located here cannot be detected.
- Unexperienced examiners evidentially have problems regarding the representation of the popliteal vessels.

D-dimer test

The D-dimer test should only be applied after an assessment of the clinical probability of a DVT. If there is a high clinical probability for the presence of a DVT, D-dimer testing should not be performed, because a positive result wouldn't have any consequence on the diagnostic and therapeutic procedure. In contrast to that a false negative result could wrongly prevent a required continuative diagnostic.

Consequently a low clinical probability for the presence of DVT is the only reasonable application of this test. In that case a negative result means that a leg vein thrombosis doesn't exist and the patient doesn't need any continuative diagnostic.

Sources

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Table of figures

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