DOPPLER ULTRASOUND OF DEEP VENOUS THROMBOSIS

MILENA STANEVA, MD, PhD

Department of vascular surgery and angiology
Venous thromboembolic disease continues to cause significant morbidity and mortality, affecting millions of people worldwide.

It is considered to be the third most common acute cardiovascular disease after coronary artery disease and cerebrovascular accident.

*Deep venous thromboembolic disease* (DVT) is a disease in which a thrombus deep vein lumen is formed.

DVT and pulmonary embolism (PE) represent different manifestations of the same disease process - *venous thromboembolism* (VTE).
When should we consider deep venous thrombosis?
Newly appeared symptoms such as:
- Lower limb edema;
- Lower limb pain during rest or movement;
- Pain during passive dorsal flexion of the foot (Homan`s symptom);
- Pain during palpation over the projection line of the thrombosed vein
- Prominence of the superficial collateral veins
- Increased skin temperature;
- Redness or cyanosis of the affected extremity;
- Tachycardia;
- Subfebrility;

Symptomatical – 50%
Oligo/ asymptomatical – 50%
## Evaluation of DVT using modified Wells’ score

<table>
<thead>
<tr>
<th>History and clinical symptoms</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active malignancy</td>
<td>1</td>
</tr>
<tr>
<td>Paralysis or lower limb immobilization</td>
<td>1</td>
</tr>
<tr>
<td>Recent surgery within 1 month</td>
<td>1</td>
</tr>
<tr>
<td>Pain on lower limb deep vein</td>
<td>1</td>
</tr>
<tr>
<td>Fracture, immobilization</td>
<td>1</td>
</tr>
<tr>
<td>Unilateral calf oedema larger than 3 cm measured above the medial maleol</td>
<td>1</td>
</tr>
<tr>
<td>Unilateral pitting oedema</td>
<td>1</td>
</tr>
<tr>
<td>Superficial collateral veins</td>
<td>1</td>
</tr>
<tr>
<td>Alternative diagnosis with symptoms close to DVT</td>
<td>-2</td>
</tr>
</tbody>
</table>

> 3 points – high DVT risk; 1-2 points – intermediate DVT risk; 0 points – low DVT risk

Deep venous thromboembolic disease- phases:

**ACUTE PHASE** from 7-10 days,
- Formation and progression of the vein thrombosis
- Aptitude to embolisation of the unstable part of the thrombus
- Severe complications
  - Pulmonary embolism
  - Venous gangrene - rare cases

**SUBACUTE PHASE** - from 10 - 30 days
- Reducing or discontinuing of the trombotic process
- Thrombus organisation
- Different degree of compensation of the vein haemodynamics
- Complications
  - PE - rarely
  - DVT recurrence - frequently
CHRONIC PHASE - from 1 month to 1 year
✓ Thrombus recanalization process
✓ Destruction of the vein valves and development of valve insufficiency with different severity

LATE CHRONIC PHASE – POST THROMBOTIC SYNDROM – continues for life.
✓ Different severity of vein valve insufficiency.
✓ Recurrent DVT development – relatively high risk

According to the LOCALISATION, DVT of the lower extremities is divided in:

PROXIMAL VEIN THROMBOSESES:
• include iliac, femoral and popliteal veins
• Can be isolated or in different combinations

DISTAL VENOUS THROMBOSESES
• Include deep calf veins (v. tibialis anterior et posterior, v. peronea, v. soleus).
• Most frequent DVT, especially in patients after surgery
Compression venous ultrasonography (CUS)

- Leading non-invasive method for blood vessel diagnostic and 
**BASIC METHOD FOR DVT DIAGNOSTIC**- with opportunity for visualisation of the vessel wall, lumen and surrounding tissues

Despite the excellent diagnostic possibilities of the colour duplex, clinical opinion is the one which should point us to perform a forward ultrasound diagnostic screening

**CUS gives us information about:**
• Vein haemodynamic and the condition of the collateral blood stream of the proximal and distal segments
• Vein morphology and condition of the valves and the presence of valve reflux
• Type of pathological process – partial or full obturation of the blood vessel, degree of recanalization;
Recommendations of The PIOPED II Investigators:

- OPTIONAL PATHWAYS, ALL PATIENTS

A venous ultrasound before imaging with CT angiography or CT angiography/CT venography is optional and may guide treatment if positive

- CTA/CTV for DVT: sensitivity - 90%, specificity - 95%.
- CUS in DVT evaluation in the femoral and popliteal veins - sensitivity over 90% and a specificity of about 95%.
- CUS - less accurate for the diagnosis of DVT in the calf veins and pelvic veins
COLOR DUPLEX SCREENING
Indication for DVT screening with CUS:

- Combined indication – risk factors and clinical symptoms
  - Presence of risk factors
  - Combination of one of the risk factors with one clinical symptom – oedema and (or) low limb pain.

- Detached indication:
  - Established PE;
  - Massive oedema of the whole limb or the calf;
  - Pain and swelling of the lower limbs;
  - Calf pain which can not be explained with other disease.
INDICATIONS FOR DVT SCREENING USING COLOR DOPLEX:

- Indication for recurrent diagnostic examination using colour duplex
  ✓ In cases when the colour duplex can not affirm or exclude DVT;
  ✓ in cases with negative colour duplex in patients with high or moderate risk (Well’s score);

*In the period between the first and the second ultrasound prophylaxis with Heparin should be accomplished (outpatients with low molecular weight heparins).*

- Indications for therapeutical control with colour duplex sonography
  ✓ 7-10th day – degree of thrombus fixation
  ✓ Evaluation of the DVT recanalization degree
  ✓ Valve reflux diagnostic
Examination method:
• start from vena cava inferior
• consecutively examination of all the segments of the deep and superficial venous system of the lower extremities
• bilateral
• apply the functional test
  1. Vein compression using transducer
  2. Examination during normal breathing
  3. Examination of the blood flow during deep breathing
  4. Valsalva test
  5. Increasing the blood flow through a short-term manual pressure of the distal musculature
  6. During short-term manual pressure of the proximal musculature
CUS – normal vein

Figure 1. Colour duplex – transversal section of common femoral and saphenus vein

Figure 2. Colour triplex – longitudinal section of common femoral vein

Figure 3. Common femoral vein-compression with transducer
CUS – normal vein

Figure 4. CFV – normal breathing

Figure 5. CFV – deep breathing

Figure 6. CFV – Valsalva test
CUS – normal vein

Figure 7. Common femoral vein – proximal muscle pressure

Figure 8. Common femoral vein – increasing of the blood flow after distal muscle pressure
### Табл. 1 - CUS in normal patients, acute and chronic venous thrombosis of the limbs

<table>
<thead>
<tr>
<th>Examination</th>
<th>Normal vein</th>
<th>Acute phlebothrombosis</th>
<th>Chronic phlebothrombosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel wall</td>
<td>smooth</td>
<td>firm</td>
<td>Firm, rough</td>
</tr>
<tr>
<td>Thrombus</td>
<td></td>
<td>Not visible</td>
<td>Tight heretoehogeneus echostructure</td>
</tr>
<tr>
<td>Valves</td>
<td>movable</td>
<td>stable</td>
<td>stable</td>
</tr>
<tr>
<td>Venous collaterals</td>
<td>Not present</td>
<td>Not present</td>
<td>A lot of venous collaterals</td>
</tr>
<tr>
<td>Blood flow</td>
<td>Normal</td>
<td>Not established</td>
<td>Not established</td>
</tr>
<tr>
<td>Spontaneous breathing</td>
<td>Pulsations synchronized with breathing</td>
<td>No pulsations</td>
<td>No pulsations</td>
</tr>
<tr>
<td>Pressure with transducer</td>
<td>Easy compressive</td>
<td>Not compressive</td>
<td>Not compressive- if recanalization- low compressive</td>
</tr>
<tr>
<td>Valsalva test</td>
<td>Vein expands up to 50%.Blood flow stops</td>
<td>No change</td>
<td>No change. If recanalization and insufficiency is present – venous reflux</td>
</tr>
<tr>
<td>Proximal compression</td>
<td>Blood flow stops- after that</td>
<td>No change</td>
<td>If recanalization is present- venous reflux</td>
</tr>
<tr>
<td>distal compression</td>
<td>Intensive orthogradh blood flow</td>
<td>No change</td>
<td>Is recanalization is present – delayed orthogradh blood flow</td>
</tr>
</tbody>
</table>
CUS – DVT

Figure 9. Common femoral vein thrombosis
Figure 10. Popliteal vein- acute thrombosis

Figure 11. Popliteal vein – acute thrombosis – compression with transducer
Figure 12. Acute thrombosis of popliteal vein – lack of doppler signal

Figure 13. Mobile thrombus in saphenous vein penetrating in the femoral vein
Figure 14. Subacute thrombosis of the popliteal vein with partial recanalization

Figure 15. Chronic thrombosis of popliteal vein

Figure 16. The Doppler waveform in the femoral vein distal to an iliac vein occlusion often demonstrates continuous low-velocity flow with a loss of phasicity and slow acceleration through distal muscle pressure.
Figure 17. Passable inferior vena cava filter

Figure 18. Partial thrombosis of inferior vena cava
Figure 19. Acute inferior vena cava thrombosis

Figure 20. Subacute inferior vena cava filter
DIAGNOSTIC EVALUATION OF DVT

Clinical uncertainty of DVT

Colour Duplex

Negative or Uncertain CUS

D-dimers

DVT

Repeat Colour Duplex

Positive

Negative CUS

Insufficiently informative

CT / MRI phlebography

Phlebography

Exclusion of DVT
THANK YOU FOR YOUR ATTENTION!