ECHOCOLOR DOPPLER LESSONS

The echocolor Doppler in the diagnosis of the superficial vein thrombosis of the lower limbs

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The echocolor Doppler in the diagnosis of the superficial vein thrombosis

INTRODUCTION

The superficial venous thrombosis (SVT) of the lower limbs is an inflammatory-thrombotic pathology in which a thrombus develops in the saphenous veins or its tributaries.

It is needed to distinguish the SVT on varicose or on nonvaricose veins and the proximal (above-knee) or distal localization of SVT (below-knee) for prognostic and therapeutic implications.

The clinical findings can be used to establish the diagnosis but they are not reliable in determining in most cases: a) the proximal extent of SVT (the thrombus usually extends beyond the area of clinical involvement); b) whether the SVT is associated with DVT.

So further tests are required: the echocolor Doppler is the diagnostic tool of choice in the detection of SVT and can be used routinely for serial evaluation to document any disease progression or resolution.

In this lesson will be presented the echocolor Doppler role in the diagnosis of the SVT (in acute phase and follow up), and in the diagnosis of the SVT associated with occult DVT.
The echocolor Doppler in the diagnosis of the superficial vein thrombosis

1. SVT: clinical signs and risk factors
2. echocolor Doppler diagnosis of SVT in:
   a. acute phase
   b. follow up
3. SVT and DVT
SUPERFICIAL VENOUS THROMBOSIS

The echocolor Doppler in the diagnosis of the superficial vein thrombosis

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Superficial Venous Thrombosis (SVT)

- SVT is an inflammatory-thrombotic disorder in which a thrombus develops in a superficial vein (usually the long saphenous vein of the leg or its tributaries).
- It may be spontaneous, or associated with one or more risk factors.
SUPERFICIAL VENOUS THROMBOSIS

superficial venous thrombosis (SVT)
- the most common cause of SVT is varicose vein
- varicose vein is enlarged with slow blood flow
- in the varicose vein the slowly moving blood is prone to clot
SUPERFICIAL VENOUS THROMBOSIS

Superficial venous thrombosis: main risk factors (Virchow’s triad)
1. damage to the blood vessel wall (trauma, infection, inflammation)
2. stasis of blood flow
3. hypercoagulability of blood

Other specific risk factors include:

i. thrombophilia
ii. obesity
iii. intravenous drug abuse
iv. intravenous infusion
v. oral contraceptives
vi. pregnancy
Superficial venous thrombosis (SVT)

It is needed to distinguish:

I. SVT on varices

II. SVT on nonvaricose veins (unrelated to varicose vein: traumatic, iatrogenic, paraneoplastic, intravenous infusion of irritant substance)

III. proximal localization of SVT (above-knee SVT)

IV. distal localization of SVT (below-knee SVT)
Superficial venous thrombosis

The physical diagnosis of SVT is based on presence of:
I. erythema and tenderness in the distribution of the superficial veins
II. palpable cord
Superficial venous thrombosis
differential diagnosis:

i. lymphangitis
ii. deep vein thrombosis
iii. tendonitis
iv. cellulitis
v. muscle rupture
Clinical diagnosis of SVT

- the thrombus usually extends beyond the area of clinical involvement

- the clinical findings can be used to establish the diagnosis but they are not reliable in determining the proximal extent of SVT; further test is required


SVT diagnosis

SVT is a clinical diagnosis. However clinical findings are not reliable in:

i. determining the proximal extent of SVT

ii. ruling out deep venous thrombosis

**Further test is required**

**Duplex US is the diagnostic study of choice for confirmation**
SUPERFICIAL VENOUS THROMBOSIS

The echocolor Doppler in the diagnosis of the superficial vein thrombosis

1. SVT: clinical signs and risk factors

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the echocolor Doppler in diagnosis of SVT

- is a quick and non-invasive diagnostic method of diagnosing TVS in the lower limbs
- provides both morphologic and haemodynamic findings
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS

the echocolor Doppler in the diagnosis of SVT

It is needed a 5 MHz linear array:
1. transverse imaging (B mode and color) and
2. longitudinal imaging (B mode and color)
The echocolor Doppler in the diagnosis of the superficial vein thrombosis

1. SVT: clinical signs and risk factors

2. echocolor Doppler diagnosis of SVT in:
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3. SVT and DVT
The echocolor Doppler in the diagnosis of SVT
In acute phase:

I. duplex ultrasound provides objective evidence of the presence of thrombotic obstruction

II. duplex ultrasound provides objective evidence of the definition of its proximal extent

III. an alteration of normal venous Doppler flow signals is a useful complementary data for the evaluation of hemodynamics
The echocolor Doppler in the diagnosis of SVT
- thrombosed veins may appear thickened
- the most consistent diagnostic finding is a lack of compressibility using the transducer
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

- Thrombosed veins appear thickened and the most consistent ultrasound diagnostic finding is a lack of compressibility of the vein.
- An acutely thrombosed vein will often be dilated with hypoechoic material in the lumen.

US diagnosis of SVT (B mode)

I. Presence of echogenic material within the lumen of the vein and
II. Inability to compress the vein completely (longitudinal and transverse imaging)
The echocolor Doppler in the diagnosis of SVT
In acute phase:

I. Duplex ultrasound provides objective evidence of the presence of thrombotic obstruction

II. Duplex ultrasound provides objective evidence of the definition of its proximal extent

III. An alteration of normal venous Doppler flow signals is a useful complementary data for the evaluation of hemodynamics
The echocolor Doppler in the diagnosis of SVT.

It is necessary to verify the SVT cranial extension

The extent of the SVT must be recorded by its most proximal point of involvement. It is necessary to verify:

i. the saphenofemoral and saphenopopliteal crosses

ii. the greater saphenous vein above the knee

iii. the greater saphenous or lesser saphenous veins below the knee

iv. if the SVT is limited to varicosities
the echocolor Doppler in the diagnosis of SVT

- an involvement of the saphenofemoral/popliteal junction is considered as present if the distance from the clot to the junction is ≤ 3 cm.


the echocolor Doppler in the diagnosis of SVT

- the thrombus 3 cm away from the saphenous crosse is considered at risk.

Guidelines GIUV. International angiology 2012
it is necessary to verify the SVT cranial extension

- the US evaluation concerns the location and extent of the SVT as well as the proximity to the deep venous system at the saphenofemoral or saphenopopliteal junction

thrombus “at risk” (pulmonary embolism risk!)

- color and B mode: longitudinal scans. SVT of the greater saphenous vein with thrombus in common femoral vein
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

it is necessary to verify the SVT cranial extension

- the US evaluation concerns the location and extent of the SVT as well as the proximity to the deep venous system at the saphenofemoral or saphenopopliteal junction

thrombi “at risk” (pulmonary embolism risk!)
in these cases: a) acutely thrombosed long saphenous veins (dilated with low level echoes in the lumen); b) thrombosed saphenofemoral junctions
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

It is necessary to verify the SVT cranial extension

- The US evaluation concerns the location and extent of the SVT as well as the proximity to the deep venous system at the saphenofemoral or saphenopopliteal junction.

**Thrombi “at risk”**

- In these cases (a, b) the cranial extension of the thrombi are in the long saphenous vein, near the saphenofemoral junction (≤ 3 cm.: thrombus “at risk”)

it is necessary to verify the SVT cranial extension

- the US evaluation concerns the location and extent of the SVT as well as the proximity to the deep venous system at the saphenofemoral or saphenopopliteal junction

SVT of the greater saphenous vein

- longitudinal and transverse scans: thrombosis of the greater saphenous vein above the knee > 3 cm away from the saphenous crosse and of the collateral
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

it is necessary to verify the SVT cranial extension

- the US evaluation concerns the location and extent of the SVT as well as the proximity to the deep venous system at the saphenofemoral or saphenopopliteal junction

thrombi not “at risk”

- in these two cases (a, b) the cranial extensions of the thrombi are in tributaries of the long saphenous veins, under the knee (thrombi not “at risk”)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

it is necessary to verify the SVT cranial extension
- the US evaluation concerns the location and extent of the SVT

thrombus not “at risk”

a) the deep venous system is regular (common femoral, popliteal and distal veins); b) varicose vein with reflux in greater saphenous vein, and SVT of a tributary vein (c) under the knee (thrombus not “at risk”)
The color Doppler in the diagnosis of SVT in acute phase:

I. Duplex ultrasound provides objective evidence of the presence of thrombotic obstruction.

II. Duplex ultrasound provides objective evidence of the definition of its proximal extent.

III. An alteration of normal venous Doppler flow signals is a useful complementary data for the evaluation of hemodynamics.
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

Venous Doppler flow signals:
A. if the vein is normal:
   i. if compressed with the transducer, the vein narrows and the flow is blocked
   ii. when the pressure is removed the vein refills
   iii. if we apply the pulsed Doppler, we observe a typical venous flow
   iv. if the segment of the leg below the vein is squeezed, there is an effect on the vein that is filled to accommodate the increase in blood flow
   v. in case of varicose veins a venous reflux is present

Venous Doppler flow signals:
B. if the vein is thrombosed:
   i. US cannot show the venous flow
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

SVT: acute phase
i. thrombosed veins may appear thickened
ii. the alteration of normal venous Doppler flow signals is a useful complementary data
The alteration of normal venous Doppler flow signals is a useful complementary data.

**SVT limited to varicosities**

a. SVT limited to varicosities dilated with low level echoes (hypoechoic) in the lumen

b. In this case the reflux at the saphenofemoral junction and in greater saphenous vein (c) confirms the presence of varicose veins.
The alteration of normal venous Doppler flow signals is a useful complementary data.

**SVT near the saphenofemoral junction**

a. the head of the thrombus (mobile) is near the saphenofemoral junction

b. the reflux at the saphenofemoral junction confirms the presence of varicose veins
The echocolor Doppler in the diagnosis of the superficial vein thrombosis

1. SVT: clinical signs and risk factors

2. echocolor Doppler diagnosis of SVT in:
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   b. follow up

3. SVT and DVT
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

venous duplex ultrasonography
i. is a valuable method for serial evaluation to document any disease progression or resolution (noninvasive method)
ii. is a method for noninvasive follow-up of the results of therapy
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method).

progressive SVT of the distal greater saphenous vein:

1. acute phase (2-1)
   SVT of the distal greater saphenous vein (longitudinal and transverse scan)

2. control (29-1)
   partial resolution of the thrombus (longitudinal and transverse scan)

3. control (21-5)
   progressive SVT extending near the saphenofemoral junction

distal greater saphenous vein
proximal greater saphenous vein
saphenofemoral junction
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography
US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

progressive SVT:
the saphenofemoral junction as source for deep venous extension

1. acute phase
(patient with bowel cancer)
SVT of the greater saphenous vein above the knee

2. control five days later
progressive SVT extending into the deep venous system (saphenofemoral junction as site of involvement)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

SVT of the greater saphenous vein
a. acute phase: (mobile thrombus)
b. control 12 days later: partial regression (no longer present the mobile thrombus)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

SVT of the greater saphenous vein
a. acute phase: (mobile thrombus)
b. control 10 days later: partial regression (no longer present the mobile thrombus)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

SVT of the greater saphenous vein
a. acute phase: occlusive thrombus in varicose vein
b. control 15 days later: early partial recanalization of the thrombus with reflux
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

SVT of SSV
a. acute phase: (mobile thrombus in SSV, and collateral)
b. control 15 days later: resolution of the thrombus in SSV, with pathological reflux (due to valvular incontinence), with partial regression of the thrombus of the collateral vein
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

SVT of the greater saphenous vein
a. acute phase: occlusive thrombus
b. partial resolution two months later: hyperechoic, non occlusive, material in the greater saphenous vein (longitudinal and transverse imaging)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method)

SVT: partial regression

outcome of previous SVT

a. acute phase: SVT (thrombus with mobile head) of the greater saphenous vein above the knee
b. control two months later: hyperechoic, non occlusive, material in the vein (B mode/color longitudinal imaging)
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography

US can be used routinely for serial evaluation to document any disease progression or resolution (noninvasive method).

1. SVT of the greater saphenous vein: acute phase
   a. occlusive thrombus above the knee
   b. occlusive thrombus under the knee

2. 11 months later (typical outcome of SVT)
   a. partial resolution: hyperechoic, non occlusive, material in the greater saphenous vein (above the knee)
   b. Doppler: pathological reflux is visualized, due to valvular incontinence (above the knee).
   c. the greater saphenous vein under the knee is open
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: FOLLOW UP

Duplex ultrasonography
is a method for noninvasive follow-up of the results of therapy

outcome of previous SVT of the greater saphenous vein
a. Bmode/color: residual venous thrombosis which partially fills the venous lumen of the greater saphenous vein
b. Doppler: pathological reflux due to valvular incontinence (varicose vein)
Duplex ultrasonography is a method for noninvasive follow-up of the results of therapy.

Outcome of previous SVT of the greater saphenous vein:

a. B mode/color: residual venous thrombosis (the distance to the junction is 1 cm.) which partially fills the venous lumen of the greater saphenous vein

b. Doppler: pathological reflux due to valvular incontinence (varicose vein)
Duplex ultrasonography is a method for noninvasive follow-up of the results of therapy.

**Outcome of previous SVT of the GSV and perforating vein**

- **a. B mode:** residual venous thrombosis of the greater saphenous vein extending into a perforating vein.
- **b. Doppler:** pathological reflux in the perforating vein.
The echocolor Doppler in the diagnosis of the superficial vein thrombosis

1. SVT: clinical signs and risk factors

2. echocolor Doppler diagnosis of SVT in:
   a. acute phase
   b. follow up

3. SVT and DVT
Superficial vein thrombosis.

Possible relationship with DVT:

i. association with occult DVT

ii. tendency to progression with possible involvement of the deep veins. Source for deep venous extension:
   a. the saphenofemoral junction
   b. saphenopopliteal junction
   c. perforating veins

iii. SVT as cause of pulmonary embolism
Superficial vein thrombosis: possible relationship with DVT

i. association with occult DVT

ii. tendency to progression with possible involvement of the deep veins.

Source for deep venous extension:
   a. the saphenofemoral junction
   b. saphenopopliteal junction
   c. perforating veins

iii. SVT as cause of pulmonary embolism
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

SVT and DVT

- SVT has been usually described as a benign self-limiting disease but it is frequently associated with DVT which may be clinically silent


prevalence of DVT in patients with STV

- in this study 19% of patients were noted to have concurrent deep and superficial disease


prevalence of DVT in patients with STV (duplex US study)

- a 20% to 40% prevalence of concurrent DVT in patients with superficial venous thrombosis

SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

POST Study Investigators.

SVT and compression US imaging

A total of 844 patients with clinical symptoms of SVT were recruited

- of which 99 isolated SVTs (21.4%) had saphenofemoral/popliteal junction involvement, 198 (23.5%) had a concomitant DVT, with 41.8% of them proximal DVTs
- in 83 patients (41.9%), DVT and SVT were not contiguous
- five of 639 patients (1%) had an isolated contralateral DVT (ie, not bilateral)

Conclusions

In patients with symptomatic SVT, a CUS exploration screening the whole venous system of the affected limb is useful because it provides information that has important consequences for the management of these patients

SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

**SVT and DVT**

- SVT may be associated with DVT which may be clinically silent.

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**Acute SVT associated with a gastrocnemius DVT clinically silent, in patient with residual popliteal thrombosis**

- Acute SVT, under the knee (a) associated with (b) acute gastrocnemius DVT (transverse scan: echogenic material). In popliteal vein (c) we see the residual vein thrombosis (CUS = 0.43 cm. and pathological reflux, due to valvular incontinence).
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

SVT and DVT

- SVT may be associated with DVT which may be clinically silent

1. acute SVT and DVT
   - acute SVT of the SSV (a) (longitudinal and transverse scan) associated with (b) acute gastrocnemius DVT clinically silent (transverse scan: echogenic material).

2. control 40 days later
   residual vein thrombosis of the SSV (a) (longitudinal and transverse scan) and (b) of the gastrocnemius DVT
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

SVT and DVT

in many cases it is not possible to determine whether the progression is from the superficial to the deep venous system or vice versa

acute SVT associated with DVT

- acute SVT (GSV and saphenofemoral junction) associated with DVT (common femoral v.): in this case it is not possible to determine whether the progression is from the superficial (saphenofem. junction) to the deep venous system or vice versa
Superficial vein thrombosis: possible relationship with DVT

i. association with occult DVT

ii. tendency to progression with possible involvement of the deep veins. Source for deep venous extension:
   a. the saphenofemoral junction
   b. saphenopopliteal junction
   c. perforating veins

iii. SVT as cause of pulmonary embolism
progressive superficial venous thrombosis: possible source for deep venous extension

i. the saphenofemoral junction
ii. saphenopopliteal junction
iii. perforating veins
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND DVT

Duplex ultrasonography

i. the saphenofemoral junction as source for deep venous extension

saphenofemoral junction as site of involvement
SVT of the greater saph. vein extending into the deep venous system ("free-floating" thrombus with a "tongue" extending into the common femoral vein)
**SUPERFICIAL VENOUS THROMBOSIS**
**US DIAGNOSIS: SVT AND DVT**

**Duplex ultrasonography**

ii. the saphenopopliteal junction as source for DVT

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**Saphenopopliteal junction as site of involvement**

SVT of the short saphenous vein (a) extending into the popliteal vein (b) with the end of the “free-floating” thrombus in superficial femoral vein (c). The saphenopopliteal junction is source for deep venous extension.
Duplex ultrasonography

iii. perforating veins as source for deep venous extension

perforating vein as site of involvement
progressive thrombosis of perforating veins extending into the deep venous system (posterior tibial veins)
Superficial vein thrombosis:
possible relationship with DVT

i. association with occult DVT

ii. tendency to progression with possible involvement of the deep veins. Source for deep venous extension:
   a. the saphenofemoral junction
   b. saphenopopliteal junction
   c. perforating veins

iii. SVT as cause of pulmonary embolism
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND PE

frequency of pulmonary embolism in patients with SVT

- consecutive 21 ambulant patients with SVT of the greater saphenous vein, involving the above-knee segment, underwent a complete venous US examination of the lower limbs, perfusion lung scanning, and chest radiography
- findings compatible with a high probability of pulmonary embolism were detected in seven patients (33.3%), although clinical symptoms of PE were present only in one patient

SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND PE

frequency of pulmonary embolism in patients with SVT

occult DVT and PE complicating SVT

- 8313 limbs studied by duplex scanning in 6148 patients

conclusions:

- STP can extend into the DVS
- in this series STP of the proximal greater saphenous vein extended into the common femoral vein in 8.6% of the cases, of which 10% embolized to the lungs

SuprFICial venous thrombosis: US diagnosis: SVT and PE

Pulmonary embolism in patients with superficial venous thrombosis

Patient with pulmonary embolism

- Longitudinal scans: thrombus at the saphenofemoral junction, attached proximally to the greater saphenous vein. The head of the thrombus is cut off by recent pulmonary embolism.
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: ACUTE PHASE

pulmonary embolism
in patients with superficial venous thrombosis

patient with pulmonary embolism
- longitudinal scans: echogenic material at the saphenofemoral junction.
- the head of the thrombus cut off by recent pulmonary embolism
pulmonary embolism in patients with superficial venous thrombosis

patient with pulmonary embolism

a) longitudinal scans: echogenic material at the saphenofemoral junction. The head of the thrombus cut off by recent pulmonary embolism; b) CUS: echogenic material within the lumen of the vein and inability to compress the vein; c) thrombosis of collaterals of the greater saphenous vein
SUPERFICIAL VENOUS THROMBOSIS
US DIAGNOSIS: SVT AND PE

pulmonary embolism
in patients with superficial venous thrombosis

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**patient with pulmonary embolism**

- longitudinal scan: cranial extension of the thrombus at the saphenofemoral junction. The head of the thrombus is cut off by recent pulmonary embolism
pulmonary embolism in patients with superficial venous thrombosis

patient with pulmonary embolism

- longitudinal and transverse scans: progressive thrombosis of perforating veins extending into the deep venous system (posterior tibial veins)
short videos and playlists on echocolor Doppler physics are available on
https://www.facebook.com/francoaccorsiecodoppler/ and my youtube channel:
http://www.youtube.com/channel/UCij561sX0bQoEjXIWKuPnKg