ORIGINAL ARTICLE

Anatomical variations of tibial vessels: differential diagnosis of deep vein thrombosis by vascular ultrasound

Variações anatômicas dos vasos tibiais: diagnóstico diferencial de trombose venosa profunda antiga pela ecografia vascular

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Abstract

Background: Even though color Doppler ultrasound (CDUS) imaging is reliable in assessing deep vein thrombosis (DVT) in lower extremities, anatomical variations of tibial veins may limit the diagnosis and even lead to false positive results. **Objective:** To describe anatomic variations of the posterior tibial vein that may lead to false positive results in the CDUS diagnosis of chronic DVT. **Methods:** CDUS scans of patients with suspected deep vein thrombosis of the lower extremities obtained from January to December 2012 were reviewed to record the presence, number and course of deep veins and arteries. Suspected anatomic variations of the posterior tibial veins were reviewed by another vascular sonographer to confirm findings. Anatomic variations, such as absence or hypoplasia of the posterior tibial veins, were recorded when the posterior tibial artery was not detected in any segments, as well as when the artery was also not visualized in the same segments. **Results:** A total of 1458 CDUS scans of patients with suspected DVT in the lower extremities were reviewed. In six patients (0.41%), the posterior tibial veins were absent or hypoplastic. Scans were unilateral for five patients and bilateral for one, at a total of 7 lower extremities (3 right and 4 left). **Conclusion:** Although a rare condition, found in only 0.41% of the cases, awareness of posterior vein absence may help to avoid misdiagnoses and false-positive results of DVT in patients with this variation.

Keywords: posterior tibial vein; vein thrombosis; ultrasound.

Resumo

Contexto: Apesar de a ultrassonografia vascular com Doppler colorido (UVDC) ser confiável na avaliação de TVP em membros inferiores, situações como variações anatômicas das veias tibiais podem limitar o diagnóstico ou mesmo induzir a um resultado falso-positivo. **Objetivo:** Apresentar uma variação anatômica das veias tibiais posteriores potencialmente responsável por resultados falso-positivos no diagnóstico da TVP antiga pela UVDC. **Métodos:** Foram revisados exames de UVDC em pacientes com suspeita de trombose venosa profunda de membros inferiores realizados no período de janeiro a dezembro de 2012. Nestes, foram observados a presença, o número e o trajeto das veias profundas, e suas respectivas artérias. Os casos suspeitos de variação anatômica nas veias tibiais posteriores foram revisados por outro ultrassonografista vascular, para confirmação dos achados. A variação anatômica com agenesia ou hipoplasia das veias tibiais posteriores foi considerada somente quando a artéria tibial posterior também não foi identificada em toda a extensão ou nos respectivos segmentos nos quais não foram visibilizadas as veias. **Resultados:** Foram realizados 1458 estudos pela UVDC em pacientes com suspeita de TVP em membros inferiores. Em seis pacientes (0,41%), houve agenesia parcial ou completa das veias tibiais posteriores. Cinco pacientes tiveram avaliação unilateral e um bilateral, totalizando sete membros inferiores, três membros inferiores direitos e quatro esquerdos. **Conclusão:** Apesar de encontrada em apenas 0,41% dos casos, o conhecimento da agenesia das veias posteriores é útil, a fim de diminuir erros diagnósticos e resultados falso-positivos para TVP em pacientes com essas variações.

Palavras-chave: veia tibial posterior; trombose venosa; ultrassonografia.

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INTRODUCTION

Color Doppler ultrasound (CDUS), the method of choice to investigate the natural history of deep vein thrombosis (DVT) and establish its diagnosis, has a sensitivity of 97% and specificity of 94% when compared with phlebography[1-3].

A diagnosis of DVT is made when CDUS identifies deep vessels, determines their compressibility and detects flow or echogenic images in their lumen.

Recent DVT is diagnosed when CDUS detects an increase in the diameter of the vein in comparison with the artery, which may be semi- or noncompressible, and echogenic and predominantly hypoechoic images that fill the vein lumen partially or totally, as well as partial or no flow. Some of the CDUS diagnostic criteria of chronic DVT are: when using B mode, the vein is retracted, compressible, semicompressible or noncompressible, has a smaller caliber, a homogeneous thrombus that is predominantly echogenic, and thickened walls[4,5].

In the case of vein fibrosis without thrombosis recanalization, there is a marked decrease of the vein caliber, which makes it difficult to detect when using CDUS; however, the corresponding artery is found in its usual anatomic site.

Despite CDUS reliability to evaluate DVT, some factors may limit diagnosis or even lead to false positive results, such as muscle hematomas, ruptured Baker's cysts and anatomic variations.

Deep vein variations in lower limbs are often associated with duplicated femoral (31%) and popliteal (5%) veins, and single or multiple infrapatellar veins: anterior (33%) and posterior (17%) tibial and peroneal (6%) veins[6]. No cases of isolated agenesis of infrapatellar veins have been found in the literature.

This study described an anatomic variation of posterior tibial veins that might lead to false positive results in the CDUS diagnosis of chronic DVT.

METHODS

From January to December 2012, we reviewed CDUS scans of the deep vein system of consecutive patients referred to Angiolab – Laboratório Vascular Não Invasivo for the investigation of suspected lower limb DVT. This retrospective study was approved by the Committee on Ethics in Research with Human Beings of Pontifícia Universidade Católica do Paraná (PUCPR), under number 319429.

All patients were examined using a color Doppler Siemens Antares® or Siemens X300 Premium Edition® scanner at high image resolution and B mode. Five physicians, all qualified in angiology and vascular surgery, as well as certified by the Brazilian Society of Angiology and Vascular Surgery to perform CDUS scanning of blood vessels, performed the examination using the technique described below:

- The examination was performed while the patient was lying supine, the knee was flexed, and the lower limb to be evaluated was rotated externally;
- 5.0-10 MHz multifrequency convex transducers were used. The evaluation of deep veins in obese patients or patients with marked extremity edema was conducted using 5 and 7 MHz, and for patients with more superficial vessels, 7 and 10 MHz;
- The anatomic evaluation was made using grey scale B mode, cross-sectional imaging to detect vessels, and evaluation of compressibility of the whole deep vein system from the inguinal region to the ankle. The examination of the deep vein system included the common femoral, femoral, deep femoral, popliteal, posterior tibial and peroneal veins;
- The flow of all the venous system was assessed using color Doppler and longitudinal and cross-sectional imaging aided by distal muscle maneuvers;
- Pulsed color Doppler flow was evaluated using longitudinal sections and distal muscle compression of the common femoral, femoral and popliteal veins.

Presence, number and course of posterior and peroneal veins, as well as of their corresponding arteries, were routinely recorded. No interobserver analysis was conducted; however, cases in which anatomic variation was suspected were reviewed by a vascular sonographer to confirm findings.

Anatomic variations, including absence or hypoplasia of posterior tibial veins, were recorded only when the posterior tibial artery was also not detected along all the extension or in the segments where the respective veins were also not visualized (Figure 1).

RESULTS

From January to December 2012, 1458 CDUS studies (774 unilateral and 684 bilateral) were conducted in 432 men and 1026 women with suspected lower limb DVT, at a total of 2142 lower limbs studies (1018 right and 1124 left).

In the 1458 venous studies, absence or aplasia of posterior tibial veins was detected in six patients (0.41%): five unilateral scans and one, bilateral, at a total of seven lower extremities (three right and four left lower extremities). Absence or aplasia of posterior tibial veins was detected in 0.32% (7/2142) of the total number of extremities examined.

All patients in this group were women, and their ages ranged from 25 to 60 years (mean age: 42 years). Five of the seven extremities with this anatomic variation had total absence of posterior tibial vessels

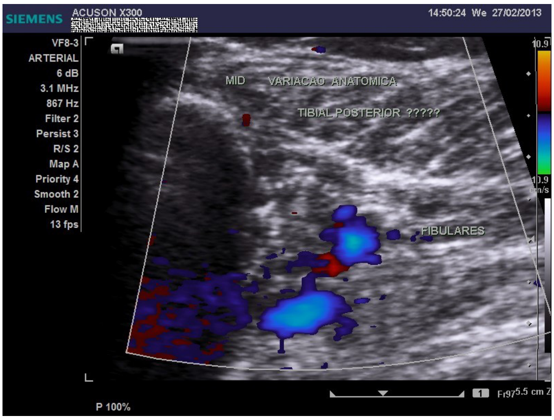

Figure 1. Cross-sectional US view of artery and peroneal veins. Image confirms absence of artery and posterior tibial veins.

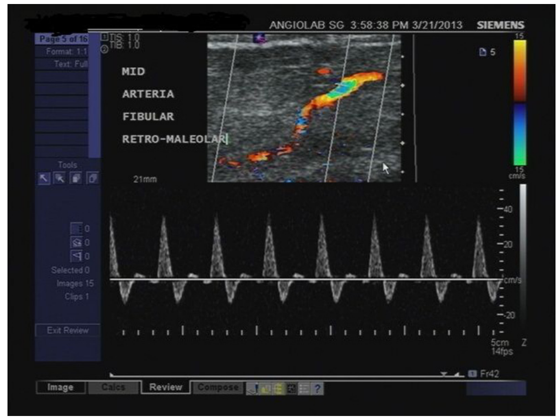

Figure 2. Longitudinal color-flow US scan and spectral curve of peroneal artery in posterior medial malleolus region.

(veins and arteries) in the usual anatomic site; in two extremities, the posterior tibial vessels were absent only in the distal segment of the leg (Table 1).

In all the seven limbs, two veins and one artery were detected in the posterior medial malleolus region, all running close to the anatomic course of the posterior peroneal veins and arteries (Figure 2).

Two patients had previous scans from other US services and a diagnosis of posterior tibial vein thrombosis.

Table 1. Patient characteristics and results.

Age (years)	Lower extremity	Absence of vessel
53	Right	Complete
60	Left	Complete
36	Right	Partial
52	Left	Partial
27	Bilateral	Complete
25	Left	Complete
Total (%)	100	100

DISCUSSION

During embryological development, the veins in the lower extremities form at the same time as their corresponding arteries. Lower extremity arteries arise from the sciatic artery (primary arterial lower limb bud) or the femoral artery. By the 14-mm embryonic stage, the femoral artery grows towards the thigh and joins the sciatic artery to form the largest arterial supply to the lower extremities. The most proximal segment of the sciatic artery usually disappears; however, the medium and distal segments persist and form the definitive popliteal and peroneal arteries.

The anterior tibial artery originates from the popliteal artery, and the anastomosis of the popliteal artery and the distal part of the femoral artery forms the posterior tibial artery.

Therefore, vascular anatomic variations in the lower extremities may be basically explained by some combinations of persistence of primitive artery segments, abnormal anastomoses, hypoplasia or even absent arteries[7-9].

Anatomically, posterior tibial veins are formed by the union of the plantar veins, posteriorly to the medial malleolus, from which they are separated by the tendons of the tibialis posterior and flexor digitorum longus muscles. They follow an ascending course together with their corresponding arteries and the tibial nerve, deeply set at the transverse intermuscular septum, protected by the soleus and gastrocnemius muscles, and run into the peroneal veins at the solear arch. They drain the posterior compartment of the leg[10].

At the popliteal fossa, the anterior tibial veins run along the edge of the interosseous membrane between the extensor hallucis longus and the anterior tibialis muscles, and join the tibioperoneal trunk to form the popliteal vein. The popliteal vein forms at different levels: 47.5% below the popliteal fossa; 8.35% at the popliteal fossa; and 44.15% above the popliteal fossa[10].

The anatomy of veins in the lower extremities and their possible variations can only be determined by vascular imaging studies, such as CDUS, phlebography, CT angiography and MR angiography.

The analysis of feasibility, cost, complications and reliability shows that CDUS is the test of choice to examine the veins in the lower extremities. CDUS has a sensitivity of 95% to 100% and specificity of 98% for the diagnosis of DVT in the femoropopliteal segment; and sensitivity of 80% to 94% and specificity of 75% for the infrapatellar segment[11,12]. The explanation for the lower accuracy of CDUS in the infrapatellar segment may be associated with its greater limitations when examining these veins because of their smaller caliber, the attenuation of edema, and the deeper position of vessels.

Because of the possible CDUS limitations to examine the infrapatellar segment, anatomic variations of the tibial vessels may lead to misinterpretations of venous ultrasound scans due to the multiplicity of veins or vein absence or hypoplasia. Of the six patients evaluated in this study, two had a previous diagnosis of past DVT in the posterior tibial veins, probably due to the difficulty in detecting those vessels.

No specific descriptions of posterior tibial vein agenesis have been found in the literature. In this study, the absence of posterior tibial veins was recorded only when there was also the absence of the corresponding arteries, to avoid the risk of misinterpreting past thrombosis as vein fibrosis. Kil and Jung examined 1242 arteriograms of lower extremities and found that the rate of hypoplasia or aplasia of the posterior tibial artery alone was 5%, and of both tibial arteries, 0.8%[13].

In all the cases in this study, two veins and one artery were detected in the posterior medial region of the peroneal artery. The clinical examination of vessels revealed that, even when the posterior tibial artery was absent, all patients had a palpable pulse at the site that corresponded to the posterior tibial artery posterior to the malleolus; therefore, such variation, which can only be detected using vascular imaging studies, is compatible with the case described by Jiji et al., in which a hypoplastic posterior tibial artery supplied the soleus muscle. This variation of the arterial supply was the result of an enlarged peroneal artery, which persisted as a lateral plantar artery[14].

One of the limitations of this study was the use of data collected by five different examiners, without any interobserver analysis; however, as described in the methods section, examiners were qualified and held specific certification in vascular ultrasonography, and the examination technique was standardized for all examiners. In addition, whenever anatomic variations were suspected, the case was reviewed and the diagnosis confirmed by another vascular sonographer to avoid incorrect results due to the misinterpretation of images.

The use of two different CDUS scanners may be construed as another limitation of this study; however, they were both produced by the same manufacturer and used the same technology to generate and control images, and the transducers were also similar. Therefore, we believe that image quality was similar, which ensured that image interpretation was accurate.

Although the posterior tibial vein was absent in only 0.32% of the lower extremities examined, the major objective of this study was to make vascular sonographers aware of this possible anatomic variation to avoid misdiagnoses and false positive DVT results when examining the posterior tibial veins.

Awareness of rare anatomic variations of posterior tibial veins may ensure that past thrombosis are not misdiagnosed when using CDUS.

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Critical revision of the article: ALDVE, FC
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