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Duplex-Doppler Ultrasonography in the Detection of Lower Extremities Deep Venous Thrombosis and in the Detection of Alternative Findings

Boris Brkljačić¹, Tonči Mišević², Renata Huzjan¹, Hrvoje Brajčić³
and Gordana Ivanac¹

¹ Department of Diagnostic and Interventional Radiology, University Hospital »Dubrava«, Zagreb, Croatia

² Department of Radiology, University Hospital »Osijek«, Osijek, Croatia

³ Policlinic Brajčić, Dubrovnik, Croatia

ABSTRACT

The diagnoses observed in patients referred for the Doppler ultrasonographic examination of peripheral and iliac veins for suspected deep venous thrombosis (DVT) are presented in this study. During 48 months 2,610 patients were examined by duplex Doppler ultrasonography (US). Among these, 1,879 were women (72%) and 731 men (28%), with the age-range 16–91 (mean 56, 2) years. Ultrasonic scanners Acuson 128 XP 10, ATL HDI 5000, GE Logiq 7, and GE Logiq 9 were used, with transducers in the frequency range from 2.5–14 MHz. Findings were categorized into four main categories: (1) deep venous thrombosis (DVT); (2) pathology predominantly related to superficial veins without DVT; (3) pathology of adjacent structures; (4) normal findings. 562 patients had DVT (21.5%). 1,108 patients (42.5%) had predominant pathology of superficial veins: postthrombotic syndrome, superficial thrombophlebitis and varicose veins. 390 patients (14.9%) had pathology of surrounding structures, unrelated to veins, the most common pathology being popliteal cysts and muscular hematomas. These lesions must be properly diagnosed by US to avoid erroneous anticoagulant treatment.

Key words: *ultrasonography, Doppler, deep venous thrombosis, alternative findings*

Introduction

Over the last 10–15 years imaging algorithms have completely changed regar-

ding venous pathology of lower extremities and pelvis, and ultrasonography (US)

with color and power Doppler has become the primary imaging modality that has almost completely replaced contrast venography^{1–3}. The most important clinical problem is diagnosis of deep venous thrombosis (DVT). DVT of lower extremity and pelvic veins is a common condition with high propensity for the development of pulmonary embolism. Patients who have high risk of developing DVT are patients after the major trauma, bone fractures, surgery, especially orthopedic surgery (e.g. hip replacement), pregnant and puerperal women, bed-ridden patients, and patients with coagulopathies^{4–9}. Accurate and fast diagnosis of DVT is important in order to commence proper anticoagulant therapy. The advantages of Doppler ultrasonography over venography are well documented in several studies; Doppler US is highly accurate in detection of iliac and lower extremities DVT, and unlike venography US can demonstrate pathologies of surrounding structures (muscles, joints, etc.)^{2,3,10–13}. US is also routinely used for evaluation of superficial veins, demonstration and grading of saphenofemoral and saphenopopliteal insufficiency, and other changes in postthrombotic syndrome, and it is useful for presurgical mapping of superficial veins used for bypasses^{10–14}. In patients with clinically suspected DVT who actually do not have DVT the recognition of alternative pathologies is very important to avoid erroneous and potentially harmful medical therapy.

In this paper the US diagnoses are presented observed in a large series of patients referred for initial Doppler-US examinations of pelvic and peripheral veins for suspected DVT.

Materials and Methods

Between May 1999 and April 2003 2,610 patients were referred to the first author for Doppler-US of pelvic and low-

er extremity veins, with clinical suspicion of DVT. Among these 1,879 were women (72%), and 731 were men (28%), with the age range 16–91 (mean 56.2 years). The patients with known diagnosed DVT, who were referred to US follow-up of the anticoagulant treatment, were excluded from this study.

By far the most common clinical finding that arouses suspicion of DVT and the reason to refer patients to US examination was the unilateral swelling of the leg. The other reasons were posttraumatic or postoperative conditions, postthrombotic syndrome with suspected re-thrombosis, Klippel-Trenaunay syndrome, hemangioma, and erysipelas. 1,020 patients (39.1%) of patients were referred urgently from the acute medical or surgical services, or hospital wards as urgent patients. These patients were examined on the same day. The rest of the patients were referred from hospital wards, other hospitals, or came as outpatients with previous signing-in, with shorter or longer waiting period. Many patients after femoral catheterization who developed unilateral swelling were referred for Doppler US to rule out DVT and pseudoaneurysm or arteriovenous fistula.

Doppler US was performed using state-of-art color Doppler scanners Acuson 128 XP 10 (Acuson Corp., Mountain View, CA, USA), ATL-HDI 5000 (Advanced Technology Laboratories-Phillips, Bothell, WA, USA) and Logiq 7 and Logiq 9 General Electric (G.E. Medical Systems, Milwaukee, WI, USA), with the variety of transducers in the frequency range from 2.5–14 MHz. Images were stored as the hard copies or on the workstation (Advantx GE).

Ultrasound examination consisted of compression of the deep veins segments with the transducer to evaluate venous compressibility, and to rule out DVT, followed by color Doppler evaluation of intraluminal flow, and distal compression-

-augmentation tests. Iliac veins were examined first, followed by common femoral veins (CFV), superficial femoral veins (SFV), deep femoral veins, popliteal veins, and all three groups of crural deep veins were examined. Doppler spectra were obtained and tests of distal compression and flow augmentation were performed on the level of CFV, SFV and popliteal veins. After that superficial veins were examined for the presence of varices and superficial thrombophlebitis, and saphenofemoral and saphenopopliteal junctions were evaluated for insufficiency. After that surrounding structures were examined: arteries, lymph nodes, muscles, joints, and soft tissues were evaluated for the presence of edema, hematoma, pseudoaneurysm, or other pathology.

Contrast venography was not performed in any patient; US exam was sufficient for further clinical decision taking: in cases of DVT the medical anticoagulant treatment was introduced on the basis of US findings, and follow-up of the therapy was performed using US, as well. In cases when patients were already receiving anticoagulant therapy and DVT was excluded ultrasonographically, the medical treatment would be terminated.

Ultrasonographic findings were categorized into four broad groups: (1) deep

venous thrombosis (DVT), (2) pathology predominantly related to superficial veins without DVT, (3) pathology of surrounding, adjacent structures, (4) normal US findings. Patients who had DVT with additional pathology findings (e.g. DVT with popliteal cyst, muscle hematoma, or superficial venous pathology) were categorized into the first group. Patients who had pathology of surrounding structures, combined with pathology of superficial veins were categorized into the third group.

Results

The ultrasonographic findings categorized into four groups are presented in the Table 1. Among 2,610 examined patients the DVT was found in only 562 (21.5%). The acute complete DVT or DVT of major part of the leg was found in 421 patients, and acute isolated DVT in 89 patients (crural DVT in 52, including gastrocnemius and soleal veins DVT, SFV DVT in 13, CFV DVT 5, popliteal vein DVT in 12, iliac vein DVT in seven patients). These patients had distended veins with hypoechoic intraluminal content. Chronic DVT was found in 52 patients, with retracted veins and/or echogenic intraluminal content. In patients with DVT 34 popliteal cysts were noted. 38 patients in addition to DVT had muscular hematomas, as a consequence of trauma, that caused DVT as well.

Types of findings in this group are presented in the Table 2. The largest category consisted of 1,108 patients (42.5%) who did not have DVT, but had superficial venous pathology detected on US. They did not have pathology of surrounding structures. 476 patients in this group had postthrombotic syndrome, with edema, leg swelling, changes of skin coloration, varices and ectatic perforate veins, and no signs of DVT. 103 patients had the dominant finding of superficial thrombophlebitis. The rest of 526 patients had

TABLE 1
TYPES OF ULTRASONOGRAPHIC FINDINGS
IN ALL EXAMINED PATIENTS

Diagnosis	N	%
DVT	562	21.5
Superficial venous pathology without DVT	1,108	42.5
Pathology of adjacent structures	390	14.9
Normal findings	550	21.1
Total (patients)	2,610	100.0

DVT – deep venous thrombosis

TABLE 2
FINDINGS IN PATIENTS WITH DEEP VENOUS THROMBOSIS (DVT)

Diagnosis	N (%)
Acute complete DVT	421 (74.9)
Acute isolated DVT	89 (15.8)
Chronic DVT	52 (9.3)
Total	562 (100.0)

truncal varicose veins and no significant edema or ulceration. Three patients had venous aneurysms: one male patient had large popliteal vein aneurysm, and two female patients had isolated large aneurysm of gastrocnemic vein (part of the deep venous system). Types of findings in this group are presented in the Table 3.

In the large number of 550 patients (21.1%) US examination of lower extremities veins was normal, with no pathology found in veins, arteries and surrounding structures.

The predominant pathology of adjacent structures, unrelated to veins, was observed in as many as 390 patients (14.9% of all examined patients). Almost 100 of these patients had pathology of superficial veins in addition, but were categorized into this group, because dominant clinical pathology was in the adjacent structures.

In 168 patients popliteal cysts were observed; in 39 cases rupture, inflammation and/or hemorrhage was found. In 79 patients hematomas were observed in the

TABLE 3
FINDINGS IN PATIENTS WITH PATHOLOGY OF SUPERFICIAL VEINS, WHO DID NOT HAVE DVT

Diagnosis	N (%)
Postthrombotic syndrome	476 (43.0)
Varicose veins	526 (47.5)
Superficial thrombophlebitis	103 (9.3)
Venous aneurysms	3 (0.3)
Total	1.108 (100.0)

musculature of the leg; 55 patients had hematoma of the gastrocnemic muscle, 12 of the quadriceps femoral muscle, 7 of the soleal muscle and five had hematomas adjacent to ruptured Achilles tendons. Iliopsoas bursitis was found in 26 patients, with the enlarged bursa between trochanter minor, common femoral artery and common femoral vein. Pronounced inguinal lymphadenopathy with swelling of the leg was observed in 24 patients, with normally patent deep veins. Twenty-three patients had pseudoaneurysms of common or deep femoral artery following cardiac catheterization (22) and peripheral angiography (one patient). Four of these patients had arteriovenous fistula, in addition. Sixteen patients had diffuse phlegmonous inflammation of crural soft tissues with clinical signs of erysipelas. Eight patients had Klippel-Trenaunay syndrome, with no evidence of AV fistula. Five patients had cavernous hemangioma, all in the femoral region. Twenty-six patients had popliteal artery aneurysms, majority of which had a partial thrombosis.

Very rare pathologies were found in four patients. One female patient with known acute myeloid leukemia developed multiple abscesses in muscles of both legs: proper US diagnosis prevented unnecessary anticoagulant therapy. One patient had a large sarcoma of the gastrocnemic and soleal muscle, misdiagnosed clinically as DVT. One patient had iatrogenic pseudoaneurysm (PSAN) of the proximal segment of peroneal artery, as a result of the traumatic injury of peroneal artery with screw during the surgery of patellar ventralization. Multiple nodules were found in soft tissues of one patient with Von Recklingshausen's disease.

Isolated edema, most probably due to cardiac decompensation, with no other detectable pathology was seen in 13 patients.

In the relatively small, but significant group of 35 patients without DVT, the an-

TABLE 4
FINDINGS IN PATIENTS WITH PATHOLOGY
OF ADJACENT STRUCTURES,
UNRELATED TO VEINS

Diagnosis	N (%)
Popliteal (Baker's) cysts	168 (43.1)
Muscular hematomas	79 (20.3)
Illiopsoas bursitis	26 (6.7)
Inguinal lymphadenopathy	24 (6.2)
ustright Pseudoaneurysm of common femoral artery	23 (5.9)
Erysipelas	16 (4.1)
Klippel-Trenaunay's syndrome	8 (2.1)
Popliteal artery aneurysm	26 (6.7)
Cavernous hemangioma	5 (1.3)
Isolated edema	13 (3.3)
Very rare pathologies	4 (1.0)
Total	390 (100.0)

ticoagulant therapy was erroneously introduced prior to the CDD-US examination, based only on clinical symptoms of leg swelling. The patients in which the DVT was misdiagnosed, and mistreated with anticoagulant therapy had several underlying diseases: hematomas in gastrocnemius muscle, and in quadriceps femoral muscle, inflamed and/or ruptured popliteal cysts, diffuse phlegmonous inflammation of crural soft tissues, a large sarcoma of gastrocnemius and soleus muscle. In one patient with iatrogenic PSAN of peroneal artery, the anticoagulant medications were being administered for three months, and large hematoma and swelling compromised arterial perfusion of the limb. This patient was published as a case report¹⁵. Findings in this group of patients are summarized in the Table 4.

Discussion

Ultrasonography is established as a primary imaging modality for diagnosis of venous pathology, and especially for

the diagnosis of deep venous thrombosis (DVT). Groups of patients with the high risk of developing DVT are those to whom US imaging should be primarily directed^{5–9,16}. In addition to previously discussed risk factors one should emphasize that the risk of DVT is higher with aging; in old people, after long surgery, the risk of DVT is 40–70%, and pulmonary emboli occurs in 1–5% of patients^{5–9,17}. It is known that the accuracy of US in diagnosis of the DVT above the knee is 99%, and below the knee > 81%^{1,2,10,12}. Therefore, it is not necessary any more to compare US findings with venography and US is usually the only imaging modality used in clinical practice.

Since US is the only clinical modality used for patients suspected to have DVT we believe that it is important to analyze the data on venous US examination results in a large series of patients referred to venous US. In addition, it is well-known that clinical diagnosis of DVT is not very accurate. Classical clinical symptoms, like positive Homan's sign, local swelling and tenderness, are not reliable, and DVT is often overcalled, based on these findings^{1–4}. The same clinical symptoms can be caused by the variety of other conditions: abscesses, muscle hematomas, ruptured popliteal cysts, etc. Also, DVT is often clinically silent, with absent local symptoms^{1–4,10}. If anticoagulant therapy is introduced only upon the clinical criteria, one may expect significant number of cases of erroneous, unnecessary, and potentially harmful therapy.

The results of our study show that only 21.5% of patients referred to US examination for suspected DVT actually had DVT, which is a relatively small number. It indicates that clinical selection of patients is often insufficient. In a subgroup of 1,020 urgently referred patients DVT was found in 411, which is 40.3%. Even in this subgroup of patients there are less than half of patients who actually do ha-

ve the DVT. Also, 21.1% of examined patients had completely normal US findings. This confirms common feeling among sonologists performing these exams, that a large proportion of studies is not indicated and that patients are being referred to examinations unnecessarily, with improper clinical screening.

High proportion of patients (42.5%) had the pathology of superficial veins, mainly postthrombotic syndrome and varicosities. Although superficial venous pathology may cause swelling, it is not very common to find DVT in these patients.

The most interesting group of patients is that with the pathology of surrounding structures that was found in 15% of patients. Apparently, high number of examined patients (1 in 7) has alternative pathologies detectable by US that can clinically mimic DVT^{13,14}. Most commonly one encounters popliteal cysts, and it is well known that ruptured popliteal cyst clinically mimics DVT. There were many muscular hematomas that should be suspected on the basis of pre-existent trauma and DVT should be ruled out. Also, iliopsoas bursitis was seen in 26 patients, and inexperienced sonologists can easily misdiagnose it as isolated DVT^{1,2}. Such changes cannot be seen with contrast venography, while ultrasonography enables their visualization with very high accuracy.

One should also be familiar with the appearance of inguinal lymphadenopathy, pseudoaneurysms and popliteal artery aneurysms, Klippel-Trenaunay syndrome, cavernous hemangioma, and erysipelas.

We also had very rare pathologies misdiagnosed as DVT: a case of iatrogenic peroneal artery pseudoaneurysm, multiple abscesses in a patient with acute leukemia, crural sarcoma, and Von Recklinghausen's disease. In the first two patients US was crucial in order to stop the anticoagulant therapy introduced to treat the misdiagnosed DVT. Bleeding could seriously complicate such cases like peroneal artery PSAN, or muscular hematoma, in cases of erroneous anticoagulant therapy¹⁵. This shows the importance of proper US diagnosis in order to make the diagnosis of DVT in patients, who really have it, and to make alternative diagnosis in patients who do not have DVT and to avoid potentially harmful and unnecessary therapy. Therefore, the anticoagulant therapy for DVT should not be introduced prior to US examination of lower extremities veins, even if all typical clinical symptoms of DVT are present.

As a conclusion, ultrasound is very useful tool for diagnosis of DVT, pathology of superficial veins, and for visualization of changes in adjacent structures that are relatively common. In many patients US examinations are performed unnecessarily. However, sonologists performing these examinations should be aware of signs for DVT and of existence and manifestations of numerous pathologies of surrounding structures that may clinically mimic DVT. These lesions must be properly diagnosed by US to avoid erroneous anticoagulant therapy.

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B. Brkljačić

*Department of Diagnostic and Interventional Radiology, University Hospital
»Dubrava«, Avenija G. Šuška 6, 10000 Zagreb, Croatia*

DUPLEKS DOPLER ULTRAZVUK U DIJAGNOSTICI TROMBOZE DUBINSKIH VENA NOGU TE U PREPOZNAVANJU PATOLOGIJE OKOLNIH STRUKTURA

S A Ž E T A K

U ovom istraživanju prikazani su nalazi pretraga kod bolesnika upućenih na doplerski ultrazvučni pregled perifernih i zdjeličnih vena zbog sumnje na trombozu dubinskih vena. Tijekom 48 mjeseci 2.610 pacijenata je pregledano dupleks doplerskim ultrazvukom. Bilo je 1.879 žena (72%) i 731 muškarac (28%), dobnog raspona 16–91 godina (srednja vrijednost 56,2). Korišteni su ultrazvučni uređaji Acuson 128 XP 10, ATL HDI 5000, GE Logiq 7 i GE Logiq 9, sa sondama u frekvencijskom rasponu od 2,5–14 MHz. Nalazi su svrstani u četiri glavne skupine: (1) tromboza dubinskih vena (TDV); (2) patologija uglavnom vezana uz površinske vene, bez TDV; (3) patologija okolnih struktura; (4) normalni nalazi. 562 pacijenta su imali TDV (21,5%). 1.108 bolesnika (42,5%) imali su patologiju površinskih vena bez TDV: posttrombotski sindrom, površinski tromboflebitis i varikozne vene. 390 bolesnika (14,9%) imali su patologiju okolnih struktura, koja nije vezana uz vene, a najčešće se radilo o poplitealnim cistama i hematoma mišića. Patologija nije nađena u 550 bolesnika (21,1%). Kod bolesnika upućenih na ultrazvuk zbog sumnje na trombozu dubokih vena često se nalazi patologija okolnih struktura, koja klinički oponaša TDV. Ove lezije treba prepoznati i dijagnosticirati ultrazvukom kako bi se izbjeglo pogrešno antikoagulantno liječenje.