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COLOR DOPPLER EVALUATION OF DEEP VEIN THROMBOSIS OF LOWER EXTREMITY

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Abstract:

Acute deep vein thrombosis (DVT) is a well-recognized contributor to increased morbidity and mortality following trauma and elective musculoskeletal procedures. Ultrasound has become a popular noninvasive modality for use in the detection of symptomatic acute DVT. The objects in present study were Doppler evaluation of acute DVT in lower limbs to study the distribution of thrombus, comparison of assessment of acute DVT by using color flow verses compression sonography, and simplification of technique by using parameters like probe compressibility and vessel diameter to diagnose acute DVT using B- Mode Ultrasonography & Doppler study.

Keywords: Color Doppler, Deep vein thrombosis, Lower extremity

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Introduction:

Acute deep vein thrombosis (DVT) is a well-recognized contributor to increased morbidity and mortality following trauma and elective musculoskeletal procedures. Ultrasound has become a popular noninvasive modality for use in the detection of symptomatic acute DVT.

In the last decade, ultrasonography (US) has become a primary and routine imaging method for the diagnosis of DVT of lower extremities.[1] It is most important and the commonly used imaging in diagnosing deep venous thrombosis (DVT).[1,2]

The aim of the study is to study the distribution of thrombus in acute lower extremity deep vein thrombosis; to study correlation with history to assess the factor prone to give rise to acute DVT; comparison of assessment of acute DVT by using colour flow verses compression sonography and simplification of technique by using parameters like probe compressibility and vessel diameter to diagnose acute DVT.

Material and Methods:

The study was carried out at Department of Radio diagnosis, in 100 acute DVT patients from September 2010 to October 2011. The study was carried out by USG machine of Siemens model MCMDO1AA by using linear transducer of 7.5 MHz to 10 MHz.

Criteria for selection of patients:

1. All patients having s/o acute deep venous thrombosis.

Criteria for exclusion of patients:

1. All patients having Arterial diseases or chronic deep venous thrombosis.

Material:

1. 100 acute deep venous thrombosis patients referred from orthopedic, medicine, general surgery, obstetrics and gynecology, radiotherapy and other departments.
2. USG machine of Siemens model MCMDO1AA and linear transducer.
3. Comfortable bed for patients.
4. Jelly.

Technique for lower extremity venous ultrasound examination

Patient position:

Clear visualization of lower extremity veins requires adequate distension of venous system. To this end the lower extremity must be dependent which may be accomplished by steeply elevating the head of the examination table or by examining the patient in the sitting position. The patient is examining room should be sufficiently warm to prevent vasoconstriction, which results in poor venous distension.

Step 1: The iliac segment identify the external iliac vein at the groin and follow it cephalad with long axis images. Locate the iliac bifurcation or its approximate position. Follow the common iliac vein cephalad to the inferior vena cava. If you lose track of the vein start at the inferior vena cava and follow the iliac vein inferiorly.

Step 2: The femoral segment use long axis images to identify the external iliac vein at the groin and follow it distally into the common femoral vein. Note the entrance of great saphenous vein. Check Doppler characteristics at the common femoral level. Identify the deep femoral vein and confirm its patency. Return to the groin and check vein compressibility with short axis images and intermittent from the femoral level to the adductor canal. Watch for superficial femoral vein duplication.

Step 3: The great saphenous vein confirm that the proximal portion of the great saphenous vein is patent with long axis color flow veins. Examine as much of the vein as is clinically indicated using short axis intermittent compression.

Step 4: The popliteal segment using long axis veins, locate distal portion of the superficial femoral vein as high as possible in the adductor canal. Follow the superficial femoral vein distal into the popliteal segment to the junction of the tibial trunks confirm the compressibility of the popliteal vein and the tibial trunks with short axis views and intermittent compression watch for popliteal vein duplication.

Step 5: The calf vein examining the posterior tibial veins in their entirety starting either at the popliteal space or at the ankle. Use short axis intermittent compression as the primary mode and supplement with long axis color flow images parallel to veins, examine the peroneal veins similarly. Examine the anterior tibial veins with long axis color flow images. Examine the gastrocnemius and soleal veins as clinically indicated, using long or short axis veins.

Results:

Age-wise distribution of cases:

Table 1 – Distribution of the patients

S.No.	Age Group (yrs)	No. of Patients	Percentage
1	0-9	0	0
2	10-19	5	5
3	20-29	12	12
4	30-39	26	26
5	40-49	24	24
6	50-59	13	13
7	>60	20	20
	Total	**100**	**100**

Majority of patients [83%] in our study were present in age group 30 yrs and above.

Table No.2 - Distribution of Cases According To Gender

Age group	Males	% of males	Females	% of females
0-9	0	0	0	0
10-19	3	3	2	2
20-29	8	8	4	4
30-39	16	16	10	10
40-49	14	14	10	10
50-59	9	9	4	4
>60	11	11	9	9
Total	**61**	**61**	**39**	**39**

In our study, majority of the males were of the age group 30-50 yrs. Majority of female patients were of age group 30-50 yrs.

Table NO. 3 - Distribution of patients as per cause of acute DVT

S. No.	Diagnosis	No. Of Patients	%
1	Post Trauma	17	17
2	Post Surgical	15	15
3	Neurologycal Patients (Cva, Tbm & Cauda Eqaina Syndrome)	16	16
4	Puerperal	5	5
5	Cancer Patients	5	5
6	Cardiac Patients (MI & CCF)	6	6
7	Varicose Veins	4	4
8	Snake Bite	4	4
9	Cellulitis	4	4
10	Idiopathic	24	24
	Total	**100**	**100**

Majority of patients in our study (30%) were post-traumatic and post- surgical

Table No.4 - Distribution of acute deep vein thormbosis in our study

Segment	Unilateral limb		Both limbs	Total
Inferior vena cava		4		4
	Right	**Left**		
Common iliac vein	3	1	2	4
External iliac vein	8	6	4	14
Common femoral vein	28	24	8	54
Superficial femoral vein	41	39	9	80
Deep femoral vein	14	10	5	24
Popliteal vein	31	36	4	71
Anterior tibial vein	12	11	1	23
Posterior tibial vein	24	20	2	44
Peroneal vein	5	3	1	8
Great saphenous vein	8	2	0	10
Short saphenous vein	2	2	0	4

Large thrombi involving many venous systems were more commonly seen in our study and the involvement of proximal deep veins was noted much more commonly than that of the distal veins. Bilateral disease was more commonly seen in proximal veins and the unilateral involvement was more common in distal veins.

Distribution according to b-mode sonographic findings:

All 100 patients were subjected to B-mode sonography and scanned on A) lumen diameter B) morphology of thrombus C) compressibility and D) collateral veins.

Table No.5 - Lumen Diameter

S. No.	Lumen diameter	No. of patients	%
1	Increased	97	97
2	Decreased	2	2
3	Normal	1	1
	Total	**100**	**100**

In acute DVT, lumen diameter was increased in 97% of patients in our study.

Table No.6 - Thrombus Echogenicity

S.No.	Thrombus morphology	No of patients	%
1	Completely anechoic	55	55
2	Anechoic to hyoechoic	45	45

Table no. 7 – According to compressibility

S.No.	Compressibility	No of patients	%
1	Non compressible	98	98
2	Compressible	2	2
	Total	**100**	**100**

In our study, we found that only 2% of thrombosed were compressible despite absence of color flow and increased lumen diameter.

Table no.8 - Collateral Veins

S.No.	Collateral veins	No. Of patients	%
1	Present	3	3
2	Absent	97	97
	Total	**100**	

In our study, only 3% of patients had detectable collateral flow

Table No.9 - Distribution according to colour flow mapping

All 100 patients were examined by color flow mapping.

S.No.	Indices	Present	%	Absent	%
1	Resting flow	0	0	100	100
2	Distal augmentation	0	0	100	100

In our study, we found that 100% of patients had absent resting flow and no evidence of color flow was seen on distal augmentation above the site of thrombosis.

Table No.10 - Distribution according to Phasic variation

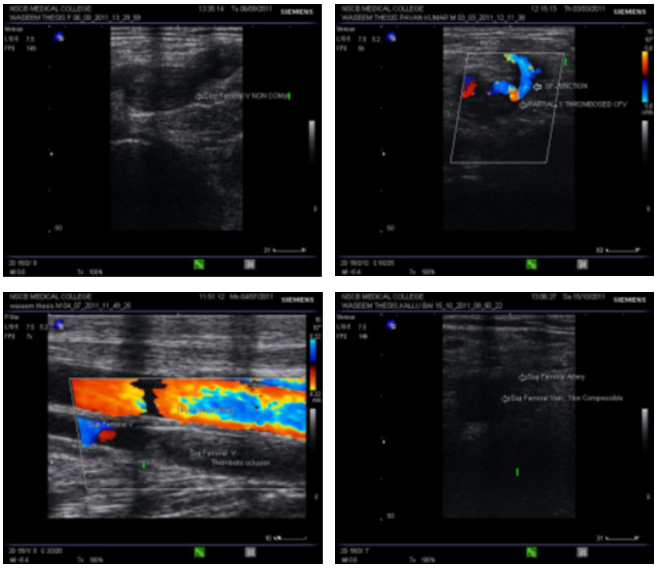
S.No.	Indices	Present	%	Absent	%
1	Phasic variation	0	0	100	100

In our study we found that distal to the site of thrombosis, there was no evidence of Phasic variation seen.

Table no. 11 – According to the reflux of valsalva

S.No.	Indices	Present	%	Absent	%
1	Reflux on Valsalva	0	0	100	100

In our study we found that distal to the site of thrombosis, there was no evidence of reflux on Valsalva seen.



Discussion:

Real-time imaging with B-mode ultrasound and the addition of pulse Doppler and color Doppler ultrasound provides objective anatomic information similar to that of venography as well as physiologic information of venous haemodynamics.

The relatively low cost, noninvasive nature, widespread availability, and proven high accuracy of ultrasound have led to its primary role in the diagnosis of venous thrombosis.

Acute Thrombosis:

The term acute thrombosis must be used with great caution, because the time frame implied by the term acute is ambiguous. As used herein, acute refers to a thrombus that is days to perhaps 1 or 2 weeks old. The Doppler findings include -

- **Low echogenicity:** Recently formed thrombi generate only low-level echoes and may be virtually anechoic. Thus they were difficult to visualize. The presence of such thrombi was indicated by flow void on Color Doppler images and lack of vein compressibility.
- **Venous distension:** The recently thrombosed vein was generally distended to an abnormally large size.
- **Loss of compressibility:** Lack of compressibility of the vein was perhaps the single most reliable finding for differentiating between thrombosed and normal veins. Thrombus can only be excluded when compression causes the vein to disappear completely. The primary diagnosis of deep vein thrombosis was based on the non-compressibility of vein lumen.
- **Free floating thrombus:** The proximal end of an acute thrombus may not adhere well to the vein wall and in such cases, the thrombus was said to float freely within the lumen.

Doppler Signal Abnormality:

When thrombus of any age substantially occludes the vein lumen:

- Flow augmentation was diminished or absent in veins proximal to the thrombosed segment.
- Flow was continuous rather than phasic distal to thrombosed segment.
- Valsalva response was diminished or absent.
- Collaterals enlarge rapidly during the acute phase of venous thrombosis and these were often visible on USG.

However localized partially occlusive thrombus may not affect flow signals. Flow signals may also be normal or nearly so, if large collateral veins circumvent the region of obstruction.

In our study majority of patients (83%) were of age group of 30 yrs and above because they were more prone to diseases like stroke, malignancy and road traffic accidents and 61 patients were males and 39 patients were females with male to female ration of 1.46:1 and comparing this with published literature by Wells et al[3] in which ratio of 1.5:1, we find no major difference in males and females as far as the incidence of acute DVT is concerned. In our country, males are prone to acute DVT since they are earning members and thus are prone to road traffic accidents and females are prone to acute DVT because they were common users of OCPs during child bearing age which is common risk factor of DVT in females.

In our study, the findings relative to location and extent of thrombus of involvement was as follows:

1. The right leg was involved in 41%, the left leg was involved in 49% and bilateral involvement was in 10%.
2. The veins most frequently involved in acute DVT were as follow:

Superficial femoral (SFV): 80%, Popliteal vein (PV): 71%, common femoral (CFV): 64%, Posterior tibial vein (PTV):44%, Antterior tibial vein (ATV):23%, Deep femoral vein (DFV): 24%, External iliac vein (EIV): 14%, Common iliac vein (CIV):4%, Peroneal vein (PeV): 8%, Inferior vena cava (IVC): 4%, Great SApheneous vein (GSV): 10% and small sapheneous vein (SSV): 4%.

3. In our study, isolated involvement of SFV in acute DVT was seen in only 4% of cases.
4. In symptomatic acute DVT, proximal involvement was seen in 93% patients, and in only 7% of patients there was isolated calf vein thrombosis. Bilateral involvement was more commonly seen in proximal DVT.

Comparing this with the study of Arie Markel et al[4] The findings relative to location and extent of involvement are as follows:

(1) The right leg was involved in 35% of patients, the left leg in 48%. Bilateral involvement was noted in 17%.

(2) The veins most frequently affected by deep vein thrombosis were as follows:

Superficial femoral in 74%, popliteal in 73%, common femoral in 58%, posterior tibial in 40%, deep femoral in 29%, greater saphenous in 19%, and the inferior vena cava in 2%; multisegment involvement was common.

(3) Total occlusion was present in 82% of the patients with deep vein thrombosis, and partial occlusion in 18%.

(4) Isolated occlusion of single veins was uncommon.

(5) The proximal (above-knee) area was involved in 95% of the cases with deep vein thrombosis, and the calf in 40% of the cases. Isolated calf deep vein thrombosis was found in 6% of the cases with right leg involvement and in 3% for the left.

(6) Total leg involvement (iliocaval, femoropopliteal, and calf) occurred in 10% of the patients. Our data confirm the fallibility of the clinical diagnosis of deep vein thrombosis. The frequent involvement of both limbs stresses the importance of not examining just the symptomatic limb. Proximal venous thrombosis (popliteal to inferior vena cava) is much more common than isolated calf vein thrombosis as a cause for symptoms and the referral for study.

According to S.C. Rose et al[5] Among symptomatic patients with acute DVT, 26 of 34 (76%) patients had an above-knee thrombus and only eight of 34 (24%) patients had a thrombus isolated to the calf.

In comparison, only three of 25 (12%) asymptomatic patients with DVT had an above-knee thrombus and 22 of 25 (88%) patients had a thrombus isolated to the calf veins (most involving only one venous segment). Failure to examine the calf veins, particularly in asymptomatic patients, would result in missing at least half of patients with DVT. This difference could be accounted by the fact that isolated calf vein thrombosis is usually asymptomatic. In our study being a tertiary government hospital, is approached by symptomatic patients belonging to low socioeconomic status.

According to Maki DD et al[6] of 2704 lower extremities studied with duplex sonography, acute deep venous thrombosis was isolated to the superficial femoral vein

in 60 (22.3%). The remaining 209 cases (77.7%) showed thrombus that extended into the common femoral or popliteal veins (or both). However in our study the percentage of patients with isolated superficial femoral vein thrombosis is only 3%. This could be because of good quality high frequency transducer used in our study and the larger proportion of symptomatic patients in our hospital.

In our study we found that on B-mode study, anechoic thrombus was present in 55% of patients and heterogenous (anechoic to hypooechoic) thrombus was seen in 45% of patients. On compression ultrasound loss of compressibility was seen in 98% of patients whereas in only 2% of patients the dilated vein was compressible. On color Doppler study resting flow was absent in 100% of patients. Hence, from our study we found that color Doppler facilitated a better sensitivity for diagnosis of acute DVT. Comparing this with the earlier studies:

In the study conducted by Baxter and coworkers[7], the sensitivity and specificity of color Doppler ultrasound for diagnosis proximal deep venous thrombosis in symptomatic patients was 100% and 100% respectively.

In the study conducted by Mattoos and coworkers[8], the sensitivity and specificity of color Doppler ultrasound for diagnosis proximal deep venous thrombosis in symptomatic patients was 100% and 98% respectively.

Elias and coworkers[9] reported the sensitivity and specificity of B-mode ultrasound for diagnosis proximal deep venous thrombosis in symptomatic patients was 100% and 98% respectively.

In our study, vein lumen diameter was increased in 97% of patients, decreased in 2% of patients and normal in 1% of patients.

According to Barbara S et al[10], veins with acute DVT were larger than normal veins. Likewise, veins with chronic DVT were smaller than normal veins. Because they found that the ranges of diameters of veins overlapped for different groups of veins, size alone is unlikely to provide compelling evidence for the diagnosis of acute versus chronic DVT, except at extreme diameters.

Diameters of veins as revealed by sonography should be interpreted in the context of other sonographic findings. Decreased luminal diameter in acute thrombosis in our study was due to acute thrombosis superimposed on chronic thrombosis.

Various retrospective and prospective studies were done by various examiners in an effort to find out accuracy of duplex ultrasound in detection of deep venous thrombosis.

A study conducted by Steven C Rose et al[11], in which 69 consecutive patients were studied who underwent both venography and color Doppler flow imaging. Color Doppler flow imaging results for detection of deep vein thrombosis above the knee (both iliac and femoropopliteal venous segments) were as follows: Sensitivity 96%, specificity 100%, positive predictive value 100%, negative predictive value 98%, accuracy 99%. Detection of deep vein thrombosis between the inguinal ligament and knee (common femoral, superficial femoral, deep femoral and poplitial veins) sensitivity 92%, specificity 100%, positive predictive value 100%, negative predictive value 96%, accuracy 97%. Color Doppler flow imaging results for detection of thrombus of thrombus in the infrapopliteal deep veins (tibioperoneal trunk and trunks and branches of the posterior tibial and peroneal veins) results were as follows: sensitivity 73%, specificity 86%, positive predictive value 79%, negative predictive value 83%, and accuracy 81%.

In our study we found common etiological factors causing acute DVT in decreasing order of frequency include post traumatic, chronic medical diseases (CVA, post myocardial infarction,CCF), post surgical, purperial, malignancy & insect bite.

In our study 54 % of total causes were secondary to trauma, recent surgery & chronic medical diseases.

On comparing with study done by Alberto Cogo et al[12] approximately 50% of cases of DVT were considered to be secondary to a major risk factor (immobilization, trauma, and/or recent surgery). Among additional risk factors, only increased age (over 60 years), male gender, malignant neoplasm, heart failure, systemic lupus erythematosus, and arteriopathy were independently associated with the risk of acute DVT.

Fancher TL et al[13], 2004 in their study found that immobility is also important in patients undergoing surgery. The combination of a long surgical operation and a prolonged period of bed rest will increase the risk of DVT.

Important internal risk factors which increase the likelihood of an individual person developing a DVT include age over 40 years, pregnancy, presence of cancer, hormone therapy (hormone replacement therapy, the oral contraceptive pill) and dehydration.

If patient has had previous DVT then he is always at a slightly increased risk of a further DVT, particularly soon after first DVT. This risk does decrease with time, but can be as high as 25% at 4 years. The risk of recurrence appears to be less in patients who develop a post-operative DVT.

Conclusion:

The objects in present study were Doppler evaluation of acute DVT in lower limbs to study -the distribution of thrombus, its correlation with history to assess the factor prone to give rise to acute DVT, Comparison of assessment of acute DVT by using color flow verses compression sonography, and simplification of technique by using parameters like probe compressibility and vessel diameter to diagnose acute DVT using B- Mode Ultrasonography & Doppler study.

It can be concluded that color Doppler is more sensitive & also facilitatesnlocalization of vessel. We are able to identify the morphology of thrombus according to echogenicity whether it is anechoic or hypoechoic as a criteria to determine the chronicity of thrombus which correlated with the duration of complaints of the patient.

Lumen diameter was found to be increased in acute DVT usually, more than twice the corresponding artery & on probe compression there was absent probe compressibility thus simplifying the technique of diagnosing acute DVT.

Thus, ultrasonography & color Doppler is better predictor of acute DVT because it is more sensitive & specific, non-invasive, painless, widely available, easy to use, and less expensive & has no ionizing radiations.

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