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ROLE OF COLOUR FLOW DUPLEX SONOGRAPHY IN THE EVALUATION OF CHRONIC VENOUS INSUFFICIENCY OF THE LOWER LIMBS

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ABSTRACT

Background and objectives

Chronic venous insufficiency of the lower limbs is characterized by symptoms and signs produced by venous hypertension due to structural and functional abnormalities of veins as a result of underlying reflux or obstruction that may eventually give rise to lower extremity edema ,pigmentation pain ,ulceration . The main objective is to study the spectrum of findings on colour duplex sonography in patients with clinical suspicion of CVI and to identify the patients who can be taken up for varicose surgery by locating and ruling out DVT in them.**Methods :**A prospective study was carried out in 50 patients with clinical suspicion of chronic venous insufficiency. All the clinically diagnosed patients with CVI referred to Rajah Muthiah Medical college & Hospital were subjected to colour flow duplex examination using (3-12 MHz) linear array transducer.

Results : Of the total 50 cases, 42 cases showed positive doppler findings,8 cases were normal. Males predominated in our study (76%) and positive doppler findings were higher in them (78.57 %). Swelling (32%) and varicosities (24%) were the most predominant symptoms. Prolonged hospitalization was the most common predisposing factor in patients diagnosed to have DVT(27.8%) and occupational-prolonged standing (33.33%) factor were the commonest in patients with other causes of varicosities. The predominant involvement was unilateral (90.48 %) and left lower limb (61.9 %). GSV varicosity (75%) predominated in our study, with SFJ incompetence noted in 45%. Among the positive doppler cases (42),18 cases was diagnosed to have DVT. Thrombus was confined to femoro- popliteal segment in (83.33%) suggesting thrombus is more common in femoro- popliteal segment(proximal) than than in distal segment. Severe form of CVI with venous ulcer were noted in 8 cases of which 7 case(87.5%) showed underlying DVT. Suggesting that underlying DVT with deep venous reflux is seen in most severe forms of CVI and thus it should be excluded in to provide a safe and effective treatment.

Interpretation and conclusion It has been conclusively established that colour duplex sonography is safe, non invasive ,accurate,easily repeatable,widely available and cost effective in diagnosis of chronic venous insufficiency especially to exclude underlying DVT and thus helping in providing valuable information of therapeutic significance.

Keywords: Chronic venous insufficiency, lower limbs

1.INTRODUCTION

The term chronic venous insufficiency refers to the venous valvular incompetence in the superficial, deep and/or perforating veins. Incompetence of the vein valves permits reversal of flow and promotes venous hypertension in the distal segments. This form of venous dysfunction may be the result of recanalisation of thrombosed venous segments, pathological dilation of the vein or due to congenital absence of competent valves.[1]

Duplex ultrasound, complemented with colour flow imaging, has been validated as a sensitive and specific modality for the identification of superficial and deep vein thrombosis.[2-4]

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Image Characteristics Of Normal Veins :

B-mode characteristics:

The lumen of a normal vein[5] is echo free without colour Doppler, and the interior surface of the vein wall is smooth. The wall itself is so thin that it cannot be seen. The proper method for examining veins with colour Doppler is to first visualize the vein wall clearly and then to demonstrate that flow is present to the wall. Valves, which permit only cephalad flow, are numerous within extremity veins. In general, the number of valves increases from proximal to distal.

Compressibility:

Veins have thin walls, and the vein is held open primarily by the pressure of blood within the lumen. Thus, the vein

lumen can be obliterated with a small amount of extrinsic pressure. This simple observation is of great diagnostic importance, because the walls do not coapt when the lumen contains thrombus, even when the pressure applied is sufficient distort the shape of an adjacent artery. Vein Compressibility is best tested with the image plane transverse to the vein axis.[6] The pressure applied with the transducer to collapse a normal vein was sufficient to cause minimal dimpling of the skin (approximately $10^4 p_a$ of pressure).[7]

Vein size:

The major veins of the arm and thigh are somewhat larger in diameter than corresponding arteries. If the vein is substantially larger than the artery and the size does not vary with respiration, thrombosis should be suspected, because thrombus distends the vein lumen. Vein size may also be increased by backpressure from congestive heart failure, proximal venous obstruction, or venous reflux. Enlargement, therefore, should not be the sole criterion for the diagnosis of venous thrombosis. Small vein size may be a manifestation of a remote episode of venous thrombosis. If the patient is dehydrated or severely vaso-constricted, the veins may be smaller than normal.

Respiratory Changes :

The diameter of large veins increases with deep inspiration or with the Valsalva maneuver. Such respiration-related changes indicate that the venous system is patent proximal to the point of examination

Doppler characteristics of normal veins :

Five important features. It is spontaneous, phasic, ceases with the Valsalva maneuver, is augmented by distal compression and is unidirectional.[8]

Spontaneous Flow :

Flow is normally present in medium sized and large veins with the patient at rest, even if the extremity is dependent. The absence of spontaneous flow may result from thrombosis at the site of examination or from obstruction proximal or distal to that point. Flow is often not spontaneous in normal small veins, such as the paired tibial branches in the calf or the veins of the foot or hand.

Phasic Flow:

Normal venous flow is phasic, meaning that the velocity of flow changes in response to quite respiration and cardiac pulsation. Although respiratory waveforms disappear when patients hold their breath; doppler tracings continue to be multiphasic and cardiac phasic changes in velocity are evident in the colour-Doppler spectrum display and the audible Doppler signal. The Doppler spectrum and audible signal are the best media for assessing the phasic flow pattern, because subtle abnormalities are more apparent with these media than with colour-Doppler imaging. When the phasic pattern is absent, flow is described as continuous. This flow pattern is significant, for it to indicate the presence of substantial obstruction proximal, or sometimes distal, to the site of Doppler examination.

The phasic pattern may persist when thrombus does not substantially obstruct the vein lumen; therefore, the identification of a phasic flow pattern does not exclude thrombosis entirely but only excludes thrombus that occludes the vein lumen.

The Valsalva response:

Deep inspiration followed by bearing down (the valsalva maneuver) results in the abrupt cessation of blood flow in large and medium sized veins. The reason for decrease in lower limb venous doppler flow and for the loss of phasicity at the end of inspiration is due to increase in the intra-abdominal, intrathoracic and intra-atrial pressure.[9] This important response documents the patency of the venous system from the point of Doppler examination to the thorax. Although cessation of flow is visible on colour-Doppler images, the Valsalva response is best evaluated with the Doppler spectrum display or from the audible Doppler signal. A normal response may be observed if the vein lumen is only partially blocked.

Augmentation:

Manual compression of the extremity distal to the site of duplex examination increases, or augments venous flow. The resulting gush of blood is recorded as an abrupt increase in the Doppler frequency shift. The absence of this response indicates substantial obstruction distal to the site of Doppler examination. Delayed or weak augmentation indicates distal obstruction that is incomplete or is circumvented by collaterals. It must be noted that augmentation may be normal when a vein is only partially obstructed. The effects of augmentation are visible on colour-Doppler images, but the adequacy of augmentation is best evaluated with the Doppler spectrum, audible Doppler signals.

Unidirectional Flow :

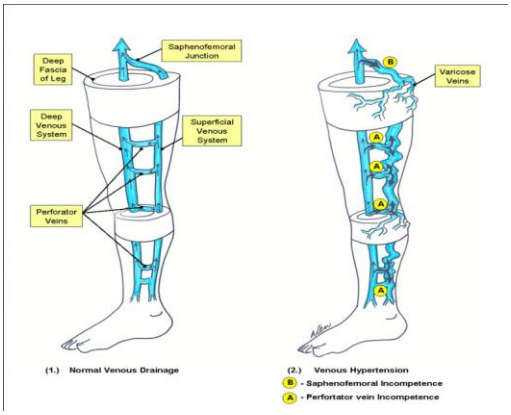
In the normal venous system blood flows only toward the heart, because the valves prevent flow in the opposite direction (retrograde flow). Normally functioning valves are described as competent, and valves that permit retrograde flow are described as incompetent. Valvular incompetence is diagnosed by demonstrating retrograde flow in response to the Valsalva maneuver or by manual compression proximal to the site of duplex examination. Reflux is most conveniently assessed with the colour-doppler image and may be documented with Doppler spectrum analysis.

Changes in the Major Veins

Varicose veins are the most common manifestation of CVI. It is believed that they are usually due to abnormal distensibility of connective tissue in the vein wall. Early work has suggested that veins from patients with varicosities are more distensible than those from patients with normal veins[10] indicating a probable systemic basis for

the abnormality. Varicosities usually start at points where superficial veins communicate with deep veins, particularly at the saphenofemoral and saphenopopliteal junctions and in the perforating system, because of valvular incompetence. Primary varicose veins result from venous dilatation without previous thrombosis. Secondary varicose veins are caused by valvular damage after deep vein thrombosis (DVT) and recanalization that gives rise to incompetent deep and perforating veins Poor venous drainage and resulting venous hypertension increase transmural pressure in postcapillary vessels, producing skin capillary damage, fluid exudation, edema, and tissue malnutrition, which favors inflammation, infection, thrombosis, and tissue necrosis with lipodermatosclerosis and eventual ulceration.[12,13]

Fig 1 : Schematic diagram of normal blood flow, varicose vein-reflux in the vein due to valvular incompetence.

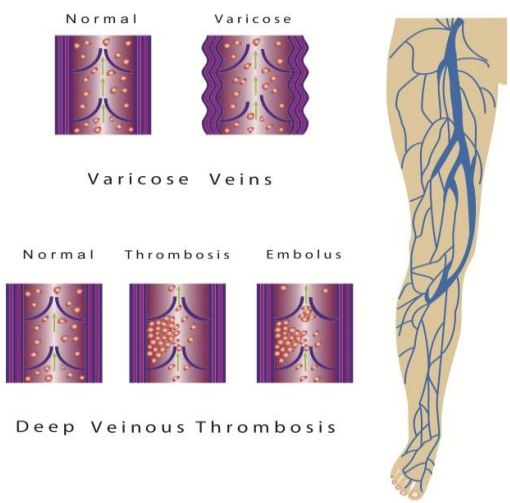


Reflux in deep veins can be due to past venous thrombosis and recanalization with destruction of venous valves, but it can also be idiopathic. Outflow obstruction can result from DVT without adequate subsequent recanalization and with poor development of collaterals. Less frequently, obstruction results from extramural venous compression[13] or from congenital agenesis or hypoplasia of the femoral or iliac veins.[14]

Venous recanalization occurs in 50% to 80% of patients several months or even years after DVT.[15-17]

Rapid recanalization after DVT is associated with a higher incidence of valve competency.[18] The chronic sequelae of DVT are most of ten ascribed to reflux rather than to obstruction.[19,20]

Fig. 2 : Schematic diagram showing development of CVI. The nterruption of venous blood flow caused by DVT lodged in valve resulting in CVI.



Colour Doppler findings in vein thrombosis

The distinction between acute and chronic thrombus is important because acute deep vein thrombosis has a greater potential to embolization. Acute clot is not well attached to vein walls and is more likely to progress proximally. Characterization of clot as acute or chronic also carries important therapeutic implications.

2.ACUTE THROMBOSIS:

1) Low echogenicity intraluminal material producing a flow void:

Recently formed thrombus has low echogenicity, is seen as large anechoic area on the grey-scale image [21]

2) Venous distension:

Increase venous diameter is a sign of acute clot[22]. The acutely thrombosed vein enlarges to twice the size of the corresponding artery in many patients. Exception is partial occlusion.

3) Loss of compressibility:

Excellent results for diagnosing venous thrombosis of any age have been reported on the basis of this criteria alone. The degree of force necessary to completely collapse the vein lumen may be greater when examining the calf veins than when examining the femoro-popliteal system. If the collapse of the vein is incomplete following compression, it indicates the presence of partially occluding thrombus.

4) Free floating thrombus:

Proximal end of acute thrombus may not adhere to the vein wall. In such cases the thrombus is freely floating in the venous lumen and has potential for pulmonary embolization. Unnecessary manipulation of such a vein is dangerous.

5) Doppler signal abnormalities:

- When the Doppler probe is directly over an obstructed vein, no spontaneous signal will be detected.
- If the probe is over a patent vein but distal to an obstruction, the signal may be absent or reduced and is often continuous, showing little respiratory variation.
- Although augmentation may be observed with partial venous occlusion, a strong response is usually not seen with complete venous occlusion. A weak response suggests partial thrombosis or complete occlusion with venous return via collaterals[23].
- Little or no increase in flow will be detected with limb compression when the probe is positioned cephalad to an obstruction, although the spontaneous flow pattern may closely resemble that found in normal limbs.
- Non-occlusive mural thrombus has a single eccentric flow lumen.[24]
- When the normal phasic pattern is absent in a vein it is called continuous flow. This flow pattern indicates substantial obstruction proximal or distal to the site of Doppler examination. The phasic pattern may persist when thrombus does not substantially obstruct the vein lumen and therefore identification of a phasic flow pattern does not exclude thrombosis.[25]

3.CHRONIC THROMBOSIS

1) Increased echogenicity:

The thrombus gradually becomes more echogenic. Older clots are more brightly echogenic than fresh clots. Heterogeneity observed during clot organization and recanalisation may be caused by clot fragmentation or penetration by capillaries and development of endothelium lined sinuses as seen at histologic examination.

Visualization of an echogenic band in the CFV, PV or both is considered to be a highly sensitive criterion for proximal vein thrombosis and has sensitivity of 99% and specificity of 52%.this is explained by the turbulent flow conditions which mimic thrombosis.

2) Incomplete compression:

This is due to intimal thickening in a recanalised vein or less commonly persistent venous occlusion by organized thrombus. In the former circumstance, the vein is seen to compress so that the recanalisedlumen is obliterated. However the outer vein walls do not coapt as a result of the interposed thickened intima.

3) Decreased thrombus size:

Detraction and lysis may reduce the size of the thrombus, as seen on serial examinations. Clot is more rigid on examination and may demonstrate irregular borders84.

4) Reduced vein size:

With retraction and lysis of the thrombus, the vein becomes less distended and returns to normal caliber or may be contracted.

5) Adherence of thrombus:

Free floating acute thrombus becomes attached to vein wall.

6) Resumption of flow:

With retraction and subsequent dissolution of the thrombus, obstruction to the flow may diminish, as revealed by colour Doppler examination. Veins with recanalised thrombuses tortuous eccentric flow channels filled with colour flow signal.

7) Collateral vessels:

They tend to be larger than during the acute phase. However not all thrombosed vessels recanalise. Some remain poorly occluded.

TABLE – 1: SEX DISTRIBUTION

Sex	Cases with suspected CVI (n = 50)	
	No.	Percentage
Male	38	76
Female	12	24
Total	50	100

TABLE 2: DISTRIBUTION OF CASES BY SYMPTOMS

SYMPTOMS	Cases with suspected CVI	Percentage
Swelling	16	32
Varicosity	12	24
Pain	8	16
Ulcer	7	14
Varicosity and swelling	3	6
Varicosity and pain	2	2
Eczema	2	2
TOTAL	50	100

We found that swelling (32%) was the most common presenting symptom, followed by varicosity (24%) as the second most common presenting symptom.

TABLE 3: DOPPLER ULTRASOUND FINDINGS

POSITIVE DOPPLER	42	84
NORMAL DOPPLER	6	12
OTHER CAUSES	2	4

Of the total 50 cases, positive Doppler was noted in 42 cases. 6 cases showed normal Doppler study. In2 of the patients other causes of symptoms were seen (cellulitis in 1, bakers cyst in 1).

TABLE 4 : ANATOMIC DISTRIBUTION OF THROMBI IN STUDY POPULATION WITH EVIDENCE OF THROMBI

	CFV	SFV	PV	ATV	EIV	CIV	SVS
No. of cases showing involvement	11	13	8	4	4	1	7
Percentage of cases showing involement	61.11	72.22	44.44	22.22	22.22	5.56	38.89

Predominant distribution of thrombi was seen in SFV (72.22%), followed by CFV (61.11%), Popliteal vein (44.44%) and ATV (22.22%). Thus, thrombus involvement is more common in proximal segments (femoropopliteal) than in distal segments (calf veins). Superficial venous thrombosis was seen in 7 cases (38.9%)

Fig. 3: Transverse colour flow image of normal vein showing compressibility

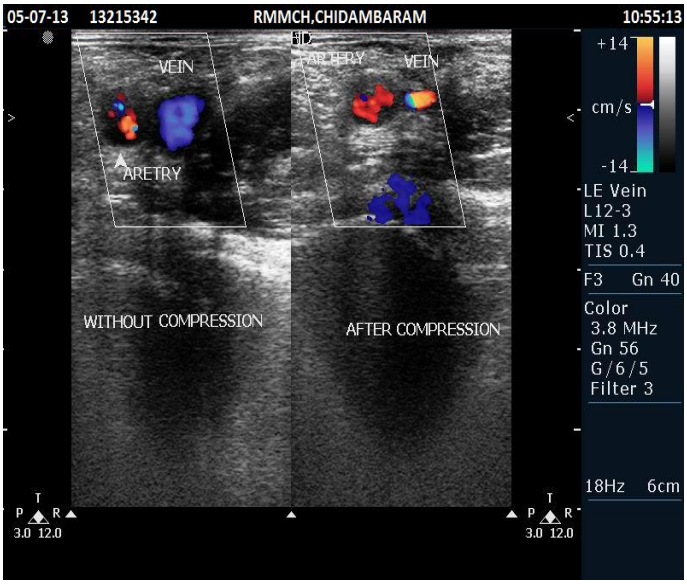


Fig 4: Longitudinal image of GSV opening into CFV , showing incompetent

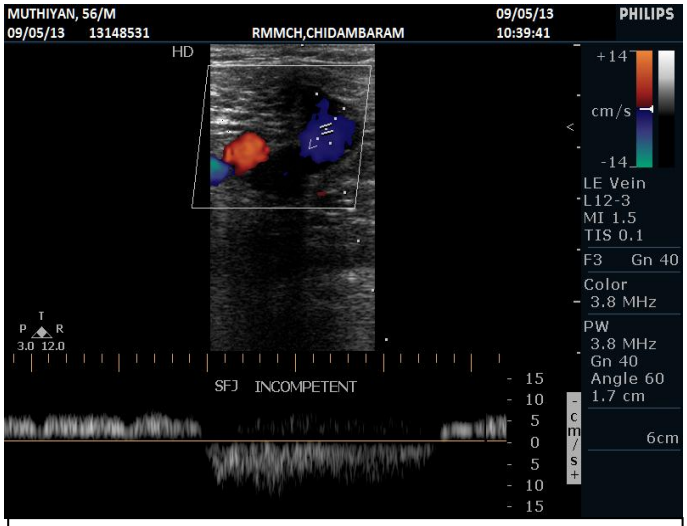


Fig. 5 : Transverse image of the common femoral vein thrombosis : showing lack of compressibility of common femoral vein with increased venous diameter and absence of spontaneous colour flow suggestive of thrombosis

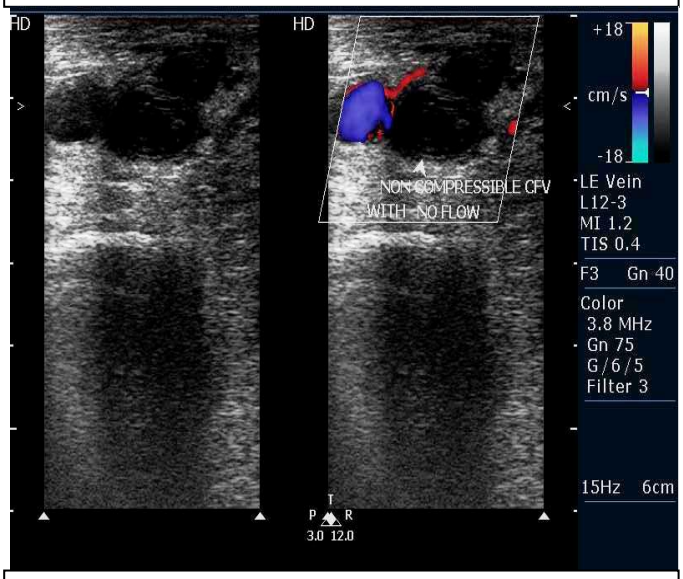


Fig. 6 : Transverse image of chronic popliteal vein thrombosis : showing dilated popliteal vein with partial filling of colour suggestive of thrombosis with partial recanalization

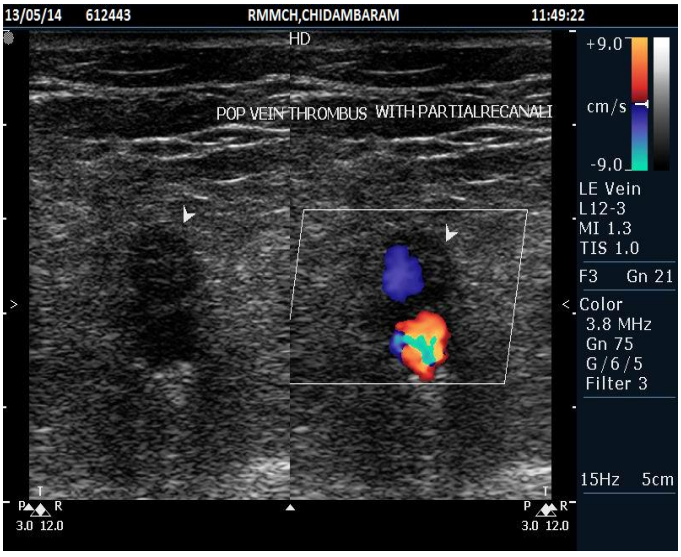


Fig .7 : Transverse image of midcalf perforator incompetence : showing flow passing from deep to superficial vein, on distal compression.

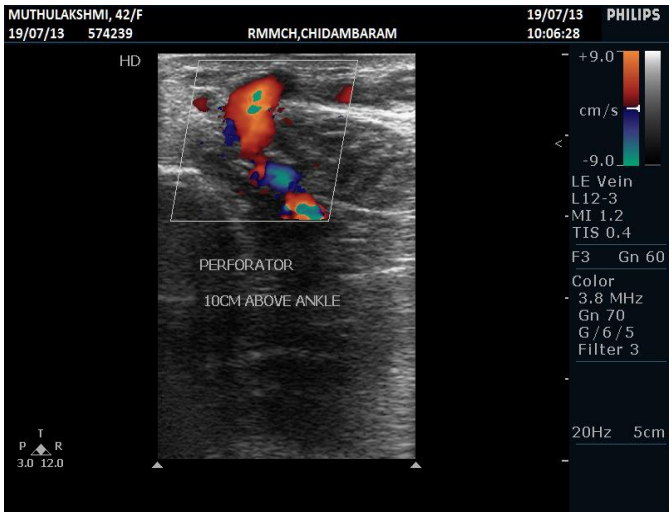
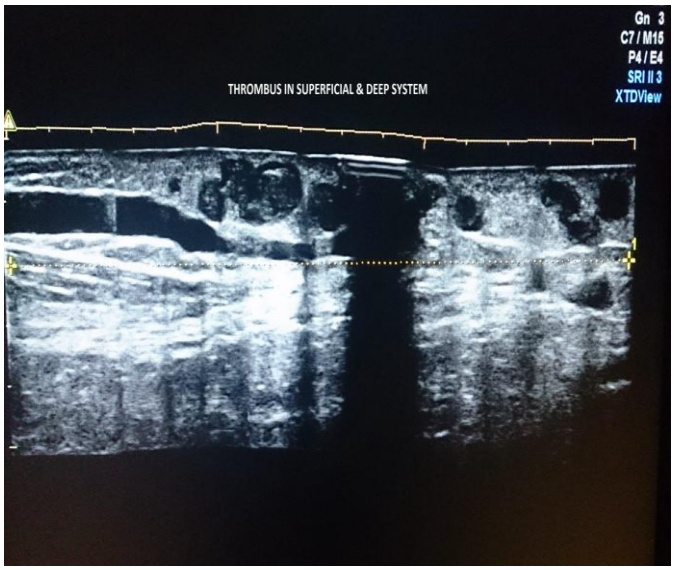


Fig 8 : Showing evidence of thrombus in both superficial and deep system with dilated, torturous superficial veins.



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