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Original Research Article

Role of Colour Flow Duplex Sonography in Evaluation of Chronic Venous Insufficiency in LowerLimbs with Surgical Correlation

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Conflict of interest: Nil

Abstract

Background: Chronic venous insufficiency (CVI) in the lower limbs occurs due to elevated venous pressure caused by structural and functional irregularities in veins, arising from underlying reflux or obstruction. The evaluation of varicose veins often relies on the widely available non-invasive method of Colour Duplex Sonography. Thus, the study aims to examine the efficacy of colour flow duplex imaging in diagnosing patients who present with clinical symptoms and signs indicative of chronic venous insufficiency.

Methodology: The study conducted at the Department of Radiodiagnosis in Chennai, from September 2018 to September 2020, aimed to diagnose venous insufficiency in 50 patients with lower extremity symptoms. Detailed clinical histories were taken, and Siemens ACUSON S 2000 ultrasound system with Virtual Touch™ software was used. Standard examinations, employing various probes and positions, were conducted. Compression techniques and color-coded imaging were utilized for a comprehensive evaluation of the venous system.

Results: The study included 50 patients, primarily aged 31 to 60, with 76% males and 24% females. Swelling (30%) and varicosity (24%) were the main clinical presentations. Prolonged standing (46%) was the leading cause of varicosity. Unilateral cases (80%) were more common than bilateral (20%), with left-sided incompetence at junctions and perforators being prevalent, especially below the knee.

Conclusion: The present study highlights the efficacy of color duplex ultrasound in diagnosing chronic venous insufficiency, with accurate correlation between Doppler and surgical outcomes, emphasizing its significance in guiding appropriate interventions.

Keywords: Chronic venous insufficiency, Colour Doppler ultrasound, Lower limb, venous incompetence, Venous Disorder.

Introduction

Chronic venous insufficiency (CVI), a medical condition, presents a spectrum of clinical manifestations ranging from varicose veins to venous ulcers. [1] CVI impacts 15-25% of the general population, predominantly affecting the lower limbs. [2] CVI is a condition characterized by the incompetence of venous valves in the superficial, deep, and/or perforating veins.

When these valves fail to function properly, it allows the reversal of blood flow, leading to increased pressure in the distal segments of the veins. This dysfunction can occur due to various factors, including the recanalization of thrombosed venous segments, pathological dilation of veins, or congenital absence of competent valves. [3] Clinical indicators include varicose veins, pain, swelling, and skin changes or ulcers, signifying the severity. Without timely intervention, CVI can lead to severe complications. It often involves venous leg discomfort, described as a dull ache, throbbing, or heaviness, especially after prolonged standing. This discomfort is relieved by actions that reduce venous pressure, such as elevating the leg, wearing compression stockings, or walking. [1] Clinical diagnosis is the cornerstone for identifying CVI, but Colour Doppler ultrasound has emerged as the preferred method to confirm this diagnosis. [4]

The introduction of Doppler technology has significantly transformed the diagnosis and management of CVI. The colour flow imaging in Doppler ultrasound offers a unique advantage by enabling visualization of the deep veins in the leg, which proves to be a valuable and desirable procedure for evaluating both the superficial and deep venous systems in the lower limb. [5] The duplex ultrasound, when enhanced with color flow

imaging, has been confirmed as a highly sensitive and specific method for identifying both superficial and deep vein thrombosis. In a normal vein, the lumen appears echo-free without any color on Doppler imaging. The interior surface of the vein wall is smooth, and the wall is so thin that it is not visible. [6-8] when examining veins with color Doppler, the correct approach involves first ensuring a clear visualization of the vein wall. This method helps in accurately assessing the venous system and detecting any abnormalities in blood flow patterns. [9]

Thus, the purpose of this study was to assess patients clinically symptomatic with CVI using colour duplex ultrasound. This evaluation aims to provide valuable information to assist in the subsequent management of these patients.

Materials and Methodology

The research was carried out over a period of two-years, from September 2018 to September 2020, at the Department of Radiodiagnosis in Sree Balaji Medical College and Hospital, Chrompet, Chennai. During this time frame, a total of 50 patients with lower extremity symptoms were referred to the department. The primary objective of the study was to identify, diagnose, and establish venous insufficiency as the underlying cause of these symptoms, utilizing the Doppler ultrasound technique.

Ethical approval was obtained from the Institutional Committee prior to initiating the study. Following the inclusion and exclusion criteria, a total of 50 patients having symptoms of lower extremity were referred to the department and enrolled in the research.

Criteria for Inclusion:

- Patients who showed clinical signs suggestive of chronic venous disease were included.
- Patients of all ages and both sexes were included in the study.
- Patients exhibiting symptoms such as pain, swelling, dilated painful tortuous veins, and leg ulcers.
- Patients scheduled to undergo varicose veins surgery at Sree Balaji College and Hospital.

Criteria for Exclusion:

- Patients with confirmed cases of deep vein thrombosis were excluded from the study.
- Patients with a history of recurring varicose veins.
- Patients suspected with arterial and lymphatic diseases of lower limbs.
- Pregnant women.

Methodology: A standardized protocol was followed for the assessment. Detailed clinical history was taken, emphasizing symptom onset, duration, and potential risk factors. Patients having symptoms such as pain, swelling, pedal edema, varicosities, and ulcers were enrolled in the study. Thorough reviews of previous treatment records and investigations were conducted.

The study utilized the Siemens ACUSON S 2000 ultrasound system from Siemens Medical Solutions, USA equipped with Virtual Touch™ tissue quantification software. The ultrasound examinations were conducted at a frame rate of 14 frames per second, with a soft tissue thermal index (TIS) of 0.8, bone thermal index (TIB) of 1.2, and mechanical index of 1.6. Both gray scale B-mode ultrasound and subsequent color Doppler imaging were employed. Standard examinations utilizing the linear probe were carried out to visualize the common femoral vein, superficial femoral vein, and popliteal vein, followed by the calf veins. Various positions, including supine, prone, and standing, were employed for a thorough evaluation.

The assessment involved using a curvilinear probe for the Common iliac vein and a high-frequency linear array probe for femoral and calf veins. The Valsalva maneuver and standing examinations identified venous incompetence. Compression techniques, including vein augmentation, detected obstructions and assessed patency. Superficial veins were specifically tested using compression.

In lower extremity venous imaging, veins were coded in blue and arteries in red. The approach included gray scale, spectral, and color flow examinations for a comprehensive evaluation of the venous system. Compression techniques were utilized to detect obstructions, and color-coded imaging distinguished veins in blue and arteries in red.

Results

The study found that more men were enrolled than women, with 38 males and 12 females participating. The patients' ages ranged from 19 to 68 years, with the majority falling into the 41 to 50 age group (30%). Around 80% of the patients were between the ages of 31 and 60. (Table 1)

The most common clinical presentation in the study was swelling (30%), followed by varicosity (24%). (Graph 1)

Unilateral varicose veins were more common than bilateral varicose veins in this study, with 80% of cases affecting one leg and 20% of cases affecting both legs. The most common type of varicose vein was great saphenous vein (GSV) varicosity, which was present in 54% of cases. (Table 2)

In present study, varicosity was most frequently attributed to prolonged standing, accounting for 46% of the cases. Idiopathic causes were identified

in 32% of the cases, following closely behind as the second leading factor. (Table 3)

The incompetence in the left SFJ (Saphenofemoral Junction) and SPJ (Saphenopopliteal Junction) was more prevalent compared to the right SFJ and SPJ. Additionally, some cases exhibited involvement on both sides, indicating bilateral issues In cases of incompetence, there were instances of bilateral and unilateral conditions categorized by their locations. Specifically, above the knee, there were two unilateral cases on the right and one on the left. Below the knee, there were eight unilateral cases on the left and three on the right.

At mid-calf level, there were six cases each of bilateral and unilateral conditions, and above the ankle, there were six unilateral cases on the left and three on the right.

Table 1: Demographic parameter of patients.

Sex	**Cases**	**Percentage**
Males	38	76%
Females	12	24%
Total	50	100%
Age group (In years)	**Cases with CVI (n = 50)**	
	No.	**Percentage (%)**
11 to 20	2	4
21 to 30	6	12
31 to 40	11	22
41 to 50	15	30
51 to 60	9	18
61 to 70	7	14

Table 2: Type of limb involvement and Varicosities in the case study of patients withevidence of CVI

Limb	**Cases**	**Percentage (%)**
Unilateral involvement	40	80
Bilateral involvement	10	20
Total	50	100
Varicosities		
GSV	27	54
SSV	15	30

Table 3: Pre-disposing factors for primary varicosity

Causes	**Cases**	**Percentage**
Prolonged standing	23	46
Unknown cause	16	32
Hereditary	6	12
Obesity	5	10
TOTAL	50	100

Table 4: Distribution of incompetent junction.

Incompetence	**Bilateral**	**Unilateral**	
		Right	**Left**
Sapheno-femoraljunction	3	5	18
Sapheno-poplitealjunction	1	2	5

Table 5: Distribution of incompetent perforators

Incompetence	**Bilateral**	**Unilateral**	
		Right	**Left**
Above Knee	0	2	1
Below Knee	3	8	14
Mid-Calf	6	6	14
Above Ankle	3	6	13

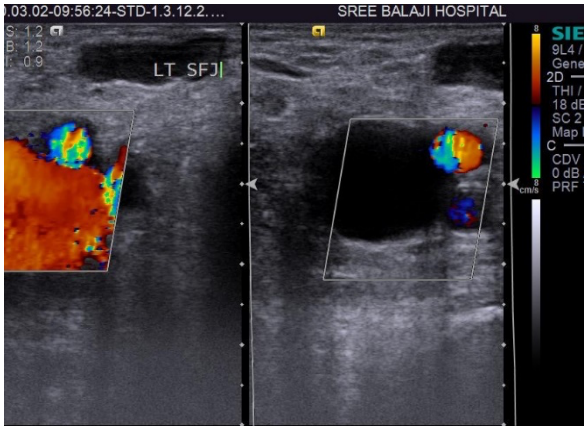


Figure 1: A transverse view displays the normal saphenofemoral junction, showing competency under the Valsalva maneuver.

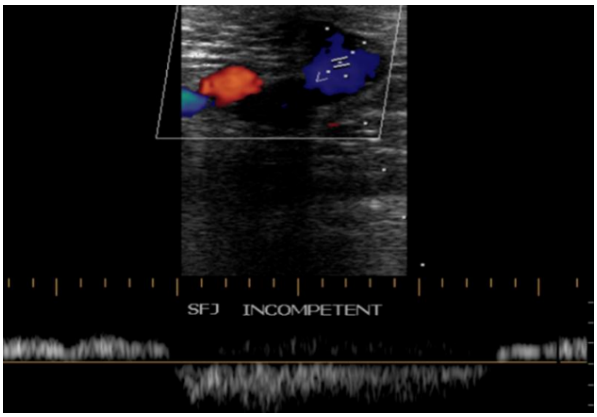


Figure 2: Longitudinal image: GSV opening into CFV, showing saphenofemoral junction incompetence with valsalva-induced reflux.

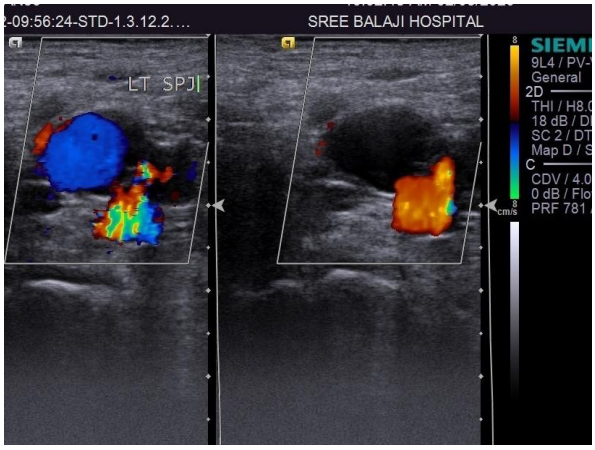


Figure 3: Transverse image displays a saphenopopliteal junction showing competent during the Valsalva maneuver.

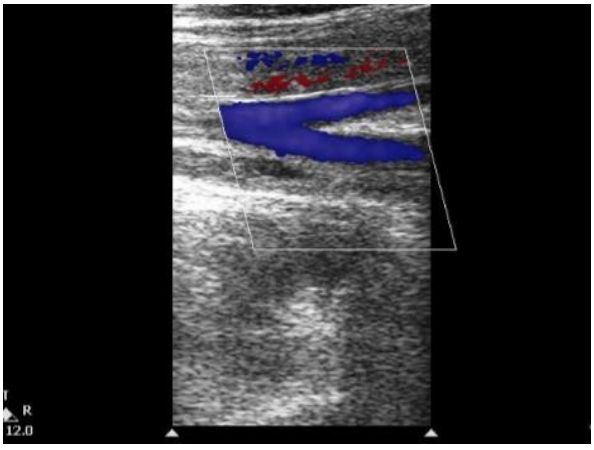


Figure 4: Longitudinal image shows normal confluence of superficial and deep femoral veins forming common femoral vein.

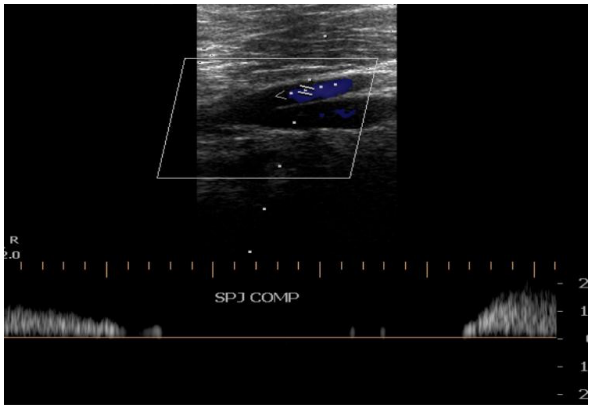


Figure 5: Longitudinal image shows SSV opening into Popliteal Vein, indicating competent saphenopopliteal junction with no reflux during Valsalva maneuver.

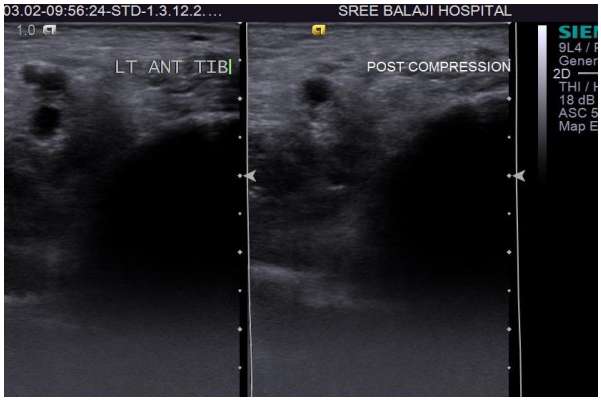


Figure 6: Transverse image displays normal compressibility of paired anterior tibial veins.

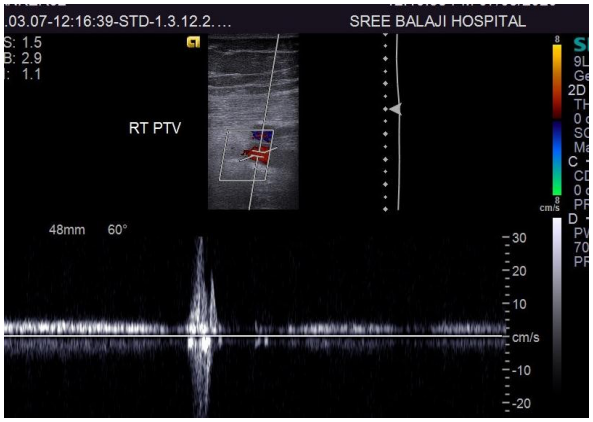


Figure 7: Longitudinal image demonstrates normal distal augmentation in the posterior tibial veins.

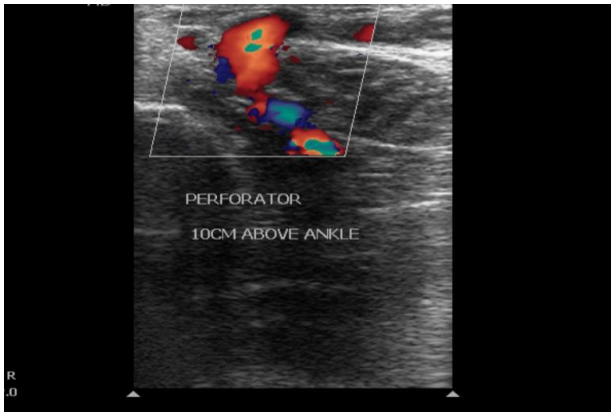


Figure 8: Transverse image reveals mid-calf perforator incompetence, indicating flow from deep to superficial vein.

Figure 9: Longitudinal image displaying varicosities along the great saphenous vein.

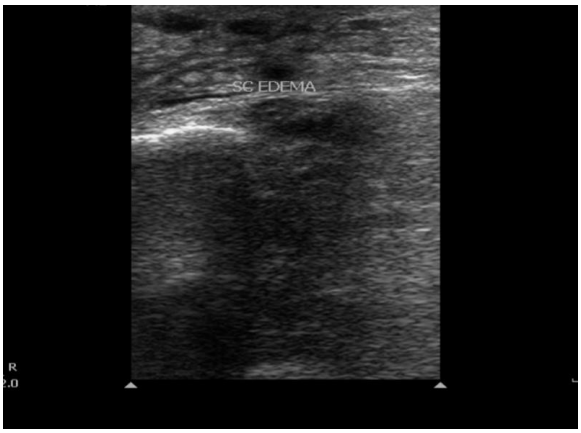
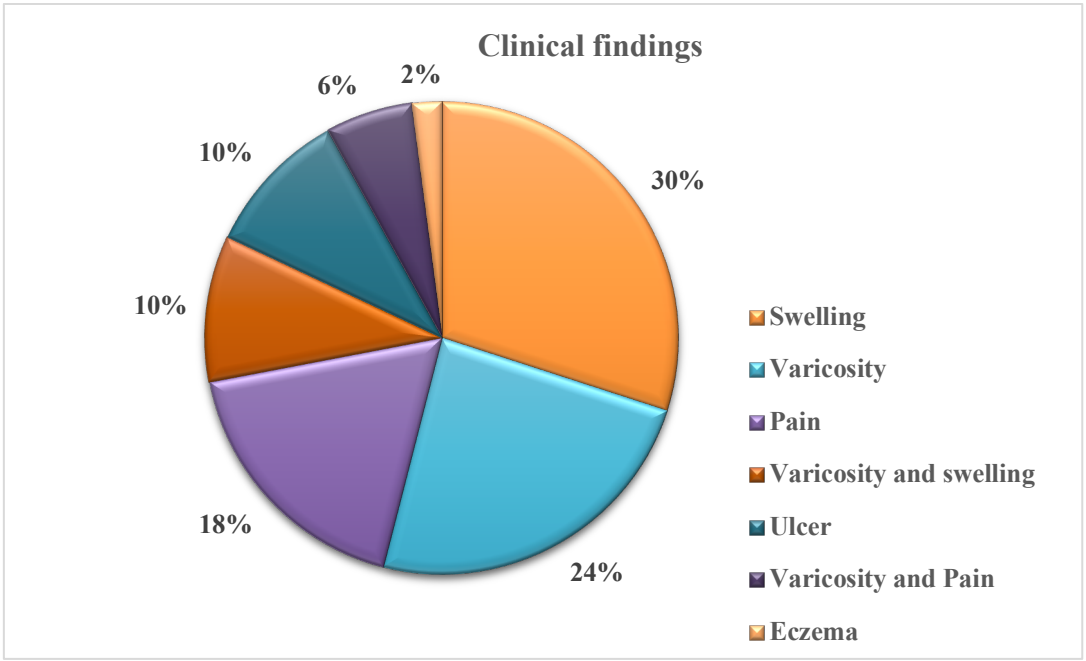


Figure 10: Longitudinal image displaying subcutaneous edema in the calf region.

Graph Legend:



Graph 1: Distribution of cases by clinical findings

Discussion

This study aimed to evaluate the role of color flow duplex in chronic venous insufficiency (CVI) and correlate the findings with surgical outcomes. It is particularly useful in diagnosing common abnormalities such as varicose veins, venous thrombosis, leg edema caused by venous insufficiency, and leg ulceration. [10] The study involved categorizing varicosities based on their causes, distinguishing between reflux and obstruction, and assessing valvular incompetence, alongside comparing these findings with surgical observations.

The study included patients with ages ranging from 11 to 70 years. Among the 50 cases examined, the highest number of patients (80%) were between 41 and 50 years of age. In randomized trial conducted by Belcaro et al. [11] concluded that the prevalence of CVI increases with age. This is most likely due to the loss of elasticity in vessels as individuals grow older.

Out of total 50 patients, 76% were male and 24% were female. The majority of cases 38 (76%) with suspected venous abnormalities consisted of males, while females contributed 12 cases (24%) of the studied population. This finding aligns with the research conducted by Azhar et al., [12] where they reported 82% male patients and 18% female patients in their study. The higher prevalence of males in the Indian population can be linked to work habits, particularly prolonged standing among individuals engaged in agriculture and industrial work. On the other hand, the lower incidence of females seeking medical advice and a generally more sedentary lifestyle contributes to their lesser representation in these demographics.

Swelling was the most common symptom, observed in 30% of cases, followed by varicosity in 24% of cases, and pain in 18% of cases. Additionally, 10% of patients presented with a combination of varicosity and swelling, while another 10% exhibited ulcers. Lastly, 6% of patients reported symptoms of both varicosity and pain. The prevalence of swelling and varicosity indicates the potential presence of underlying venous insufficiency, while the occurrence of pain and ulcers points towards more advanced stages of the condition. The findings were concurrent with the study conducted by Narra RK et al. [13] in which swelling was observed in 32% of patients, while varicosity was present in 24% of cases. Pain was reported by 16% of patients, and 14% had ulcers. Additionally, 6% exhibited both varicosity and swelling, and 4% had both varicosity and pain. Eczema was noted in 4% of patients. Similar findings were reported in the study conducted by Prassana K et al. [9]

Among the 50 cases with varicose veins, 80% of the cases had unilateral involvement, while 20% of the cases exhibited bilateral involvement. Additionally, 54% of the cases were associated with varicosities in the Great Saphenous Vein (GSV), and 30% of the cases were related to the Small Saphenous Vein (SSV). In the study conducted by Azhar et al., [12] 58.5% of the patients had varicose veins in the GSV alone, while 2.1% exhibited varicosities solely in the SSV. In another study, 47.6% had varicosities exclusively in the GSV, and only 0.6% had varicosities limited to the SSV. These findings were concurrent with both studies and indicates a higher prevalence of GSV varicosities.

Among the 50 cases examined, the most prevalent cause was prolonged standing, accounting for 46% of the cases. Prolonged standing, often associated with certain occupations, places increased pressure on the veins, potentially leading to varicosities. A significant portion, comprising 32% of the cases, fell under the category of unknown cause, indicating the complexity and multifactorial nature of varicose veins. Hereditary factors played a role in 12% of the cases. Obesity was identified as a contributing factor in 10% of the cases. Excess weight puts additional strain on the veins, impacting their ability to function properly and potentially leading to the development of varicose veins. While in another study conducted by Narra RK et al. [13], the most prevalent factors were prolonged hospitalization, affecting 27.8% of cases, and trauma, seen in 16.7% of cases. Among patients with other causes of varicosities, occupational demands and prolonged standing were widespread, contributing to 33.33% of cases. Additionally, hereditary factors played a role in 20.8% of these cases. These findings highlight the variations in the factors contributing to venous conditions, with occupational factors and hereditary elements playing significant roles in different patient populations.

The distribution of venous incompetence in patients, distinguishing between bilateral and unilateral occurrences, as well as specifying the affected sides at two significant junctions. In cases of incompetence at the Sapheno-femoral junction, 3 patients were bilateral, 5 were unilateral on the right side, and 18 were unilateral on the left side. Similarly, at the Sapheno-popliteal junction, 1 case was bilateral, 2 were unilateral on the right side, and 5 were unilateral on the left side. In a study conducted by Bashir et al., [14] a comparable trend was observed, with 41.7% of patients displaying incompetence at SFJ and 11.12% at SPJ.

In cases above the knee, there were 2 unilateral occurrences on the right side and 1 on the left. Below the knee, 3 cases were bilateral, 8 were

unilateral on the right, and 14 were unilateral on the left. At mid-calf level, 6 patients were bilateral, 6 were unilateral on the right, and 14 were unilateral on the left. Lastly, above the ankle, 3 cases were bilateral, 6 were unilateral on the right, and 13 were unilateral on the left. The findings of the study were in parallel with the study conducted by Sharma D et al. [10]

Conclusion:

Colour duplex sonography stands as a crucial, safe, and cost-effective method for evaluating venous disorders in the lower limbs. This non-invasive technique offers quick and accurate insights into the nature of venous pathology, including incompetence, venous reflux, and the presence of varicose veins. It not only aids in determining the type and level of incompetence but also provides detailed venous mapping, guiding surgical interventions effectively.

Unlike other methods like contrast-enhanced CT and MRV, colour duplex sonography is not only more affordable but also widely accessible. Its ability to visualize both deep and superficial venous systems and assess blood flow direction within each segment provides understanding of the condition. This modality significantly enhances the surgeon's success rate and ultimately improves the quality of life for patients affected by lower limb venous abnormalities.

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