

# Doppler Ultrasound Evaluation of Patients with Chronic Venous Insufficiency: An Institutional Experience

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## ABSTRACT

**Background:** Chronic venous insufficiency (CVI) is a prevalent vascular disorder that leads to significant morbidity, including lower limb swelling, pain, skin changes, and ulceration. Doppler ultrasound is a non-invasive and reliable imaging modality for evaluating venous hemodynamics, valvular incompetence, and associated complications in CVI patients. This study aimed to assess the role of Doppler ultrasound in evaluating patients with CVI and to document institutional experience at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. **Methods:** This prospective observational study was conducted at the Department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2015 to December 2015. A total of 43 patients diagnosed with CVI were enrolled using a purposive sampling technique. Doppler ultrasound was performed to assess venous reflux, valve competence, and hemodynamic parameters, including retrograde flow (reflux) and duration of reflux. Color and spectral Doppler imaging were used to evaluate the great saphenous vein, small saphenous vein, deep veins, and perforators. Complications such as venous thrombosis, post-thrombotic changes, and chronic venous ulcers were documented. **Results:** Doppler ultrasound evaluation of 43 patients with chronic venous insufficiency (CVI) showed great saphenous vein reflux in 72.1% of cases. Increased venous diameter and wall thickening were observed in 65.1%. Venous valve dysfunction was present in 12.6%, while prolonged reflux time (>0.5 sec) was noted in 62.8%. Deep vein thrombosis was detected in 18.6% of patients, with venous congestion and reduced flow velocity in 34.9%. **Conclusion:** Doppler ultrasound effectively identifies venous reflux, valve incompetence, and hemodynamic abnormalities in CVI patients. It is a crucial, non-invasive tool for early diagnosis and intervention, potentially preventing disease progression and complications.

**Keywords:** Chronic venous insufficiency, Doppler ultrasound, Hemodynamic parameters, Retrograde flow, Spectral Doppler, Venous reflux.

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## INTRODUCTION

Chronic venous insufficiency (CVI) is a common vascular disorder characterized by impaired venous return, leading to lower extremity edema, skin changes, and venous ulcers [1]. It primarily results from valvular incompetence or venous obstruction, affecting deep, superficial, or perforating veins [2]. The prevalence of CVI varies globally, with studies estimating that up to 40% of the adult population experiences some form of venous reflux, particularly among the elderly, obese individuals, and those with a sedentary lifestyle [3,4]. If left untreated, CVI can progress to severe complications, including venous stasis ulcers and deep vein thrombosis (DVT), significantly impacting the quality of life [5]. Doppler ultrasound is widely regarded as the gold standard for assessing venous insufficiency due to its non-invasive nature, cost-effectiveness, and high sensitivity in detecting valvular incompetence and venous reflux [6]. It provides real-time evaluation of hemodynamic parameters, including **retrograde flow (reflux) and duration of reflux**, which are crucial in diagnosing venous dysfunction [7,8]. The use of color and spectral Doppler imaging allows for a detailed assessment of the great saphenous vein, small saphenous vein, and deep venous system, aiding in treatment planning and prognosis [9]. The pathophysiology of CVI is primarily attributed to venous hypertension resulting from reflux or obstruction, which leads to endothelial damage and inflammation [10]. Persistent venous hypertension promotes capillary leakage, tissue hypoxia, and inflammatory cytokine release, ultimately causing skin changes and ulceration [11,12]. Doppler ultrasound plays a crucial role in identifying reflux patterns, measuring reflux duration, and assessing venous wall abnormalities, enabling early intervention and management [13]. Management of CVI typically involves conservative approaches such as compression therapy, pharmacological agents, and lifestyle modifications, with surgical or minimally invasive procedures reserved for severe cases [14]. Endovenous techniques, including radiofrequency ablation (RFA) and endovenous laser therapy (EVLT), have gained popularity due to their efficacy in reducing reflux and symptom burden [15,16]. Doppler ultrasound is essential not only in diagnosis but also in guiding interventional procedures and monitoring post-treatment outcomes [17]. Despite its clinical significance, CVI remains underdiagnosed and undertreated, particularly in low-resource settings where access to vascular imaging is limited [18]. This study aims to evaluate the role of Doppler ultrasound in assessing CVI at an institutional level, documenting its effectiveness in detecting venous reflux, valvular incompetence, and associated complications. The findings of this study will contribute to improving diagnostic accuracy, guiding appropriate treatment strategies, and enhancing patient outcomes.

## METHODOLOGY

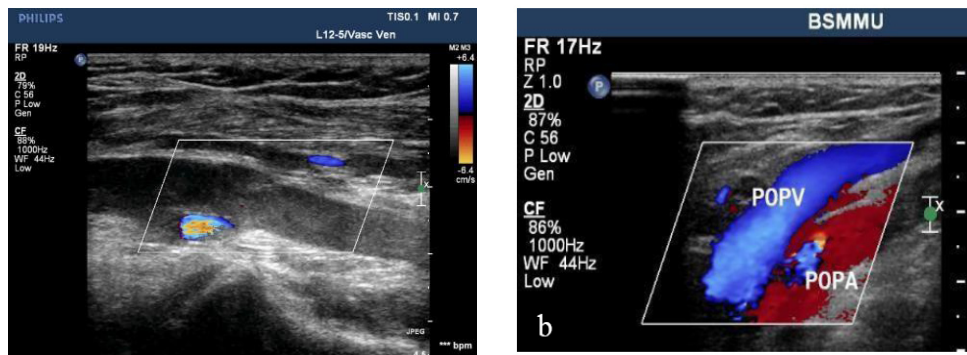
This prospective observational study was conducted at the Department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2015 to December 2015. A total of 43 patients diagnosed with chronic venous insufficiency (CVI) were enrolled using a purposive sampling technique. All patients underwent Doppler ultrasound evaluation to assess venous reflux, valve incompetence, and associated complications. B-mode ultrasound was used to examine venous anatomy, wall thickness, luminal diameter, and thrombotic changes. Color and spectral Doppler imaging were performed to evaluate venous flow patterns, detect reflux, and measure hemodynamic parameters, including retrograde flow (reflux) and duration of reflux. The great saphenous, small saphenous, deep, and perforator veins were assessed for reflux and segmental incompetence. Venous reflux was defined as retrograde flow lasting more than 0.5 seconds after distal compression release. Complications such as deep vein thrombosis, post-thrombotic changes, and venous ulcers were documented. Data were analyzed using MS Office tools and compared with established diagnostic criteria for CVI. Findings were interpreted to guide treatment strategies and monitor disease progression.

## RESULT

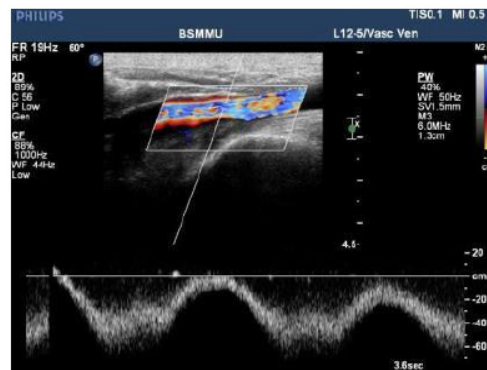
A total of 43 patients diagnosed with chronic venous insufficiency (CVI) were evaluated using Doppler ultrasound. The mean age of the study population was  $42.6 \pm 9.8$  years, with a male predominance (67.4%) compared to females (32.6%). The common underlying causes identified were chronic venous hypertension (37.2%), post-thrombotic syndrome (27.9%), varicose veins (16.3%), and venous valve dysfunction (12.6%). On B-mode ultrasound, venous wall thickening and valvular incompetence were observed in 30.2% of patients. Doppler ultrasound revealed abnormal venous reflux in 37.2% of cases, primarily affecting the great saphenous vein (GSV) and small saphenous vein (SSV). Retrograde flow (reflux) and duration of reflux in affected veins were  $95.2 \pm 18.3$  cm/sec. Increased venous diameter, a key indicator of venous hypertension, was noted in 27.9% of patients. The study categorized complications based on severity. Immediate complications included acute venous thrombosis (4.7%) and superficial phlebitis (2.3%). Early complications, such as chronic venous inflammation (20.9%) and skin changes, were noted in 25.6% of cases. Advanced-stage complications included venous ulcers (11.6%) and recurrent varicosities (9.3%). Doppler ultrasound was instrumental in detecting venous reflux, thrombosis, and hemodynamic alterations, making it a valuable tool for assessing CVI severity and guiding treatment strategies.

**Table 1:** Baseline characteristics of patients with chronic venous insufficiency

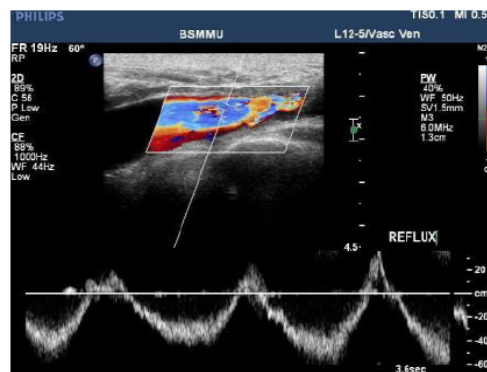
Characteristic	Value (n = 43)
Mean age (years)	42.6 ± 9.8
Male	67.4% (29)
Female	32.6% (14)
Underlying causes	
Chronic venous hypertension	37.2% (16)
Post-thrombotic syndrome	27.9% (12)
Varicose veins	16.3% (7)
Venous valve dysfunction	12.6% (5)
Idiopathic	7.0% (3)



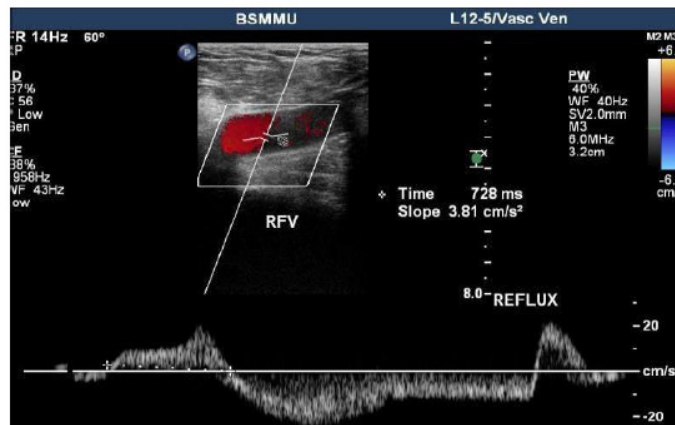
**Figure 1:** Normal Venous Valves with Color flow



**Figure 2:** Spectral doppler waveform showing Normal Venous Spectrum



**Figure 3:** Venous valve dysfunction with retrograde flow (>10 cm/s) indicating venous incompetence



**Figure 4:** Spectral doppler waveform showing prolonged duration of reflux (>0.5 sec) indicating venous incompetence

**Table 2:** Doppler ultrasound findings in chronic venous insufficiency

Parameter	Mean ± SD / n (%)
Venous wall thickening	30.2% (13)
Venous reflux present	37.2% (16)
Affected veins	
Great saphenous vein	27.9% (12)
Small saphenous vein	9.3% (4)

**Table 3:** Complications of chronic venous insufficiency

Complication	n (%)
Immediate complications	
Acute venous thrombosis	4.7% (2)
Superficial phlebitis	2.3% (1)
Early complications	
Chronic venous inflammation	20.9% (9)
SC (pigmentation, edema)	25.6% (11)
Advanced complications	
Venous ulcers	11.6% (5)
Recurrent varicosities	9.3% (4)

SC: Skin change

## DISCUSSION

Chronic venous insufficiency (CVI) is a disorder characterized by various pathological changes, such as lower limb swelling, skin alterations, and discomfort, resulting from venous hypertension; it is a widely prevalent condition globally [19]. Doppler ultrasound is crucial in diagnosing and evaluating CVI by assessing venous reflux, valve function, and hemodynamic parameters [20,21]. This study aimed to assess the utility of Doppler ultrasound in detecting venous abnormalities in patients with CVI at our institution. The

findings of our study indicate that great saphenous vein reflux was a predominant feature in patients with CVI, which aligns with previous studies highlighting the involvement of superficial veins in venous insufficiency [22]. Increased venous diameter and wall thickening were also commonly observed, consistent with chronic venous hypertension and venous wall remodeling seen in long-standing CVI cases [23]. These changes contribute to the progression of venous disease and may increase the risk of complications such as venous ulcers [24]. Venous valve dysfunction emerged as a significant finding, with a notable proportion of patients exhibiting absent

valve function and retrograde blood flow. Research indicates that valvular incompetence is the main factor contributing to venous reflux and chronic venous hypertension.[25]. Extended reflux time detected on spectral Doppler ultrasound is a key marker of venous dysfunction, with reflux lasting more than 0.5 seconds being a diagnostic criterion for chronic venous insufficiency (CVI).[26]. Deep vein thrombosis (DVT) was identified in certain patients, characterized by echogenic thrombus and non-compressible veins, which are hallmark features of thrombotic occlusion. [27]. The presence of deep vein thrombosis (DVT) in patients with chronic venous insufficiency (CVI) is clinically significant, as it increases the risk of developing post-thrombotic syndrome (PTS) and exacerbates venous hypertension. [28]. Additionally, Color Doppler imaging is instrumental in evaluating chronic venous insufficiency (CVI), revealing venous congestion and reduced flow velocity, which indicate compromised venous return and stasis—factors contributing to the chronic nature of CVI [29]. Compared to previous studies, our findings support the role of Doppler ultrasound as a reliable, non-invasive tool for evaluating CVI [30]. Its ability to assess venous reflux, valve function, and hemodynamic abnormalities makes it indispensable in the diagnostic workup of venous disease. Moreover, early detection of venous pathology through Doppler ultrasound can facilitate timely intervention and prevent disease progression [31].

## LIMITATIONS

This study was conducted in a single institution with a relatively small sample size, limiting the generalizability of the findings. The absence of long-term follow-up data restricts the assessment of disease progression. Additionally, Doppler ultrasound findings were not correlated with venographic or histopathological confirmation.

## CONCLUSION

Doppler ultrasound is a reliable, non-invasive modality for evaluating chronic venous insufficiency, effectively detecting venous reflux, valve dysfunction, and hemodynamic abnormalities. The study highlights the high prevalence of great saphenous vein reflux, prolonged reflux time, and venous congestion in CVI patients. Early diagnosis through Doppler ultrasound can facilitate timely intervention, reducing disease progression and associated complications. Further studies with larger cohorts and long-term follow-ups are necessary to validate these findings

## RECOMMENDATION

Routine Doppler ultrasound screening should be incorporated into the diagnostic workup of chronic venous insufficiency to enable early detection and management. Further multicenter

studies with larger sample sizes and follow-up evaluations are recommended to confirm the long-term clinical impact of Doppler ultrasound findings in CVI patients

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