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Original Research

CT venography versus Doppler ultrasound in evaluation of chronic venous insufficiency presenting with stasis dermatitis: A comparative study

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ABSTRACT:
Background: Chronic venous insufficiency (CVI) is a progressive vascular disorder resulting from venous reflux, obstruction, or both, leading to sustained venous hypertension and characteristic skin changes such as stasis dermatitis. Accurate evaluation of the superficial, deep, and proximal venous systems is essential for appropriate management, particularly in patients presenting with advanced disease. Duplex Doppler ultrasound is the primary diagnostic modality for CVI; however, its ability to assess deep and pelvic venous segments may be limited. Computed tomography venography (CTV) has emerged as a complementary imaging technique capable of providing comprehensive anatomical assessment of the venous system. Comparative data evaluating the diagnostic performance of these modalities in CVI patients with stasis dermatitis remain limited. **Aim:**To compare Doppler ultrasound and CT venography in the evaluation of chronic venous insufficiency presenting with stasis dermatitis, with particular emphasis on detection of venous reflux, deep venous involvement, venous obstruction, and proximal venous abnormalities. **Materials and Methods:**This prospective comparative study included 82 patients clinically diagnosed with chronic venous insufficiency associated with stasis dermatitis. All patients underwent Doppler ultrasound examination followed by CT venography of the lower limb and pelvic venous systems. Demographic characteristics and clinical manifestations were recorded. Imaging findings from both modalities were compared for venous reflux, superficial and deep venous involvement, venous obstruction, perforator incompetence, and proximal venous abnormalities. CT venography was considered the reference standard for comparative analysis. Statistical significance was assessed using appropriate tests, with a p-value <0.05 considered significant. **Results:**The majority of patients were aged 41–60 years (46.34%), with male predominance (58.54%) and bilateral limb involvement (56.10%). Doppler ultrasound demonstrated high sensitivity for detecting venous reflux (91.18%) with an overall diagnostic accuracy of 84.15%. CT venography detected a higher proportion of deep venous involvement (56.10% vs. 41.46%; p = 0.048) and venous obstruction (39.02% vs. 21.95%; p = 0.017) compared to Doppler ultrasound. Iliac vein and inferior vena cava involvement were significantly better visualized on CT venography (p < 0.001 and p = 0.006, respectively). **Conclusion:**While Doppler ultrasound remains an effective first-line modality for assessing venous reflux and superficial disease, CT venography provides superior detection of deep, obstructive, and proximal venous pathology in CVI patients with stasis dermatitis. The combined use of both modalities allows more comprehensive evaluation and may improve clinical decision-making in advanced venous disease.
Keywords: Chronic venous insufficiency; Stasis dermatitis; Doppler ultrasound; CT venography; Venous obstruction

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INTRODUCTION

Chronic venous insufficiency (CVI) represents a common, progressive disorder of venous return in the lower limbs in which venous hypertension develops from reflux, obstruction, or a combination of both. Over time, sustained ambulatory venous hypertension drives a cascade of microcirculatory dysfunction, capillary leakage, inflammation, and tissue remodeling that manifests clinically as edema, pain, heaviness, skin discoloration, eczema, lipodermatosclerosis, and ultimately venous ulceration.[1] The clinical burden is substantial because CVI is chronic, prone to relapse, and frequently presents late—after skin and subcutaneous changes have become established—making accurate anatomical and hemodynamic assessment essential for selecting appropriate therapy and preventing recurrent disease.[2]Stasis dermatitis (also termed venous

eczema) is a hallmark inflammatory dermatosis that reflects advanced venous hypertension and is often accompanied by edema and hyperpigmentation. It can mimic cellulitis and allergic contact dermatitis, leading to misdiagnosis, inappropriate antibiotic use, and delayed venous-directed care.[3] Beyond symptoms such as pruritus and scaling, stasis dermatitis is clinically important because it often coexists with deeper pathologies—particularly mixed superficial reflux and proximal outflow obstruction—that influence healing and recurrence risk. Consequently, modern evaluation of CVI presenting with stasis dermatitis increasingly emphasizes not only superficial reflux mapping but also identification of deep venous disease and proximal (iliac/iliocaval) lesions that may be clinically occult on examination.[4]Duplex Doppler ultrasound is widely regarded as the first-line imaging test in CVI because it is noninvasive, portable, repeatable, and capable of real-time physiologic assessment of reflux and flow patterns across superficial, perforator, and deep venous systems.[5] In routine practice, duplex ultrasound provides the foundation for interventional planning by localizing reflux sources (e.g., saphenofemoral junction, great saphenous vein, perforators) and documenting deep venous patency. However, duplex imaging faces technical limitations in obese patients, in those with extensive edema or dermatitis, and—most importantly—in evaluating pelvic and central venous segments where overlying bowel gas and depth reduce acoustic windows.[6] These constraints are clinically relevant in patients with stasis dermatitis, in whom missed deep venous obstruction can lead to incomplete treatment, persistent symptoms, and ulcer recurrence despite successful superficial ablation.Cross-sectional venous imaging has therefore gained attention as a complementary approach when duplex findings do not fully explain clinical severity or when proximal obstruction is suspected. Computed tomography venography (CTV) can delineate venous anatomy from calf to abdomen, demonstrate compressive lesions, collateral pathways, post-thrombotic changes, and venous wall abnormalities, and evaluate extrinsic causes of obstruction in a single examination.[4] Compared with operator-dependent ultrasound, CTV offers standardized depiction of iliac and inferior vena cava segments, which are pivotal in venous hypertension but often poorly characterized by ultrasound alone. Additionally, by providing three-dimensional context, CTV may better depict multifocal disease patterns—such as combined superficial reflux and iliac narrowing—that are particularly relevant in patients presenting with bilateral edema, long-standing hyperpigmentation, and active or healed ulcers.

MATERIALS AND METHODS

This comparative observational study was conducted at a tertiary care hospital to evaluate the diagnostic performance of CT venography and Doppler ultrasound in patients presenting with chronic venous insufficiency (CVI associated with stasis dermatitis). The study aimed to compare the ability of the two imaging modalities to assess venous anatomy, reflux, obstruction, and disease severity in the lower limbs.A total of 82 patients clinically diagnosed with chronic venous insufficiency and presenting with features of stasis dermatitis were included in the study. Patients of both sexes and varying age groups who were referred for radiological evaluation of lower limb venous disease were considered. All enrolled patients underwent both Doppler ultrasound and CT venography for comprehensive assessment.

Inclusion Criteria

Patients with clinical features suggestive of chronic venous insufficiency, including lower limb edema, skin hyperpigmentation, lipodermatosclerosis, venous eczema, or active/healed venous ulcers consistent with stasis dermatitis, were included. Only patients who were able to undergo both Doppler ultrasound and CT venography were considered eligible.

Exclusion Criteria

Patients with known hypersensitivity to iodinated contrast agents, impaired renal function contraindicating contrast administration, pregnancy, acute deep vein thrombosis, prior venous surgery or endovascular intervention, and those unwilling to participate were excluded from the study.

METHODOLOGY

Doppler Ultrasound Examination

All patients underwent color Doppler ultrasound of the lower limb venous system using a high-frequency linear transducer. The superficial, deep, and perforator venous systems were systematically evaluated. Parameters assessed included venous compressibility, presence of intraluminal thrombus, vein diameter, venous reflux (defined as retrograde flow lasting more than 0.5 seconds in superficial veins and more than 1 second in deep veins), valve competence, and perforator vein insufficiency. Hemodynamic assessment was performed with patients in standing and supine positions to accurately document reflux patterns.

CT Venography Protocol

CT venography was performed using a multidetector CT scanner following intravenous administration of iodinated contrast material. Imaging was acquired from the iliac veins to the ankle region during the venous phase. Axial images were reconstructed into multiplanar reformations and maximum intensity projection images for detailed evaluation. Parameters analyzed included venous patency, anatomical variations, extent and level of venous obstruction, collateral formation, vein caliber, wall thickening, and involvement of deep, superficial, and perforator veins.

CT venography findings were also used to evaluate pelvic and central venous segments not adequately visualized on Doppler ultrasound.

Outcome Measures and Comparative Parameters

The primary parameters compared between Doppler ultrasound and CT venography included detection of venous reflux, identification of venous obstruction, assessment of perforator vein incompetence, delineation of deep venous system involvement, and overall disease extent. Secondary parameters included visualization of proximal and pelvic veins, anatomical detail, and ability to classify disease severity. CT venography findings were considered complementary to Doppler ultrasound, particularly for central venous evaluation.

Statistical Analysis

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 21.0. Descriptive statistics were used to summarize demographic data and imaging findings. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean and standard deviation. Diagnostic performance of Doppler ultrasound was compared with CT venography using appropriate statistical tests, including chi-square test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The demographic characteristics of the study population are summarized in Table 1. Among the 82 patients evaluated, the majority belonged to the 41–60 years age group, accounting for 46.34% of cases, followed by patients aged over 60 years (36.59%). Younger patients aged between 21 and 40 years constituted a smaller proportion (17.07%). A male predominance was observed in the study population, with males comprising 58.54% of cases, while females accounted for 41.46%. Regarding laterality, bilateral lower limb involvement was more common, seen in 56.10% of patients, compared to unilateral involvement in 43.90%, indicating a tendency toward advanced or extensive disease at presentation.

The clinical manifestations of chronic venous insufficiency with stasis dermatitis are detailed in Table 2. Lower limb edema was present in all patients (100.00%), making it the most consistent clinical finding. Skin hyperpigmentation was observed in 82.93% of patients, reflecting chronic venous hypertension and prolonged disease duration. Venous eczema was noted in 65.85% of cases, while lipodermatosclerosis was present in 43.90%, indicating progressive skin and subcutaneous tissue changes. Active venous ulcers were identified in 26.83% of patients, whereas healed venous ulcers were observed in 21.95%, suggesting recurrent or longstanding venous disease in a significant proportion of the study population.

Table 3 compares the diagnostic findings of Doppler ultrasound and CT venography. CT venography detected venous reflux in a higher proportion of patients (82.93%) compared to Doppler ultrasound (75.61%); however, this difference was not statistically significant ($p = 0.241$). Similarly, superficial venous involvement was identified at comparable rates by both modalities, with no significant difference observed ($p = 0.741$). In contrast, CT venography demonstrated significantly higher detection of deep venous involvement (56.10%) compared to Doppler ultrasound (41.46%), with this difference reaching statistical significance ($p = 0.048$). Additionally, venous obstruction was identified more frequently on CT venography (39.02%) than on Doppler ultrasound (21.95%), a difference that was also statistically significant ($p = 0.017$). Although perforator vein incompetence was more commonly detected by CT venography, the difference did not reach statistical significance ($p = 0.342$).

The ability of both imaging modalities to detect proximal and pelvic venous abnormalities is presented in Table 4. Femoral and popliteal vein involvement was identified at similar frequencies by Doppler ultrasound and CT venography, with no statistically significant differences observed. However, CT venography demonstrated a markedly superior ability to detect iliac vein involvement, identifying abnormalities in 29.27% of patients compared to only 7.32% detected by Doppler ultrasound; this difference was highly significant ($p < 0.001$). Furthermore, inferior vena cava involvement was detected exclusively by CT venography in 9.76% of patients, while Doppler ultrasound failed to identify any cases, with the difference being statistically significant ($p = 0.006$). These findings highlight the advantage of CT venography in evaluating proximal and central venous segments.

The overall diagnostic performance of Doppler ultrasound relative to CT venography is summarized in Table 5. Doppler ultrasound demonstrated high sensitivity (91.18%) for the detection of venous reflux, with an overall diagnostic accuracy of 84.15%. In the assessment of venous obstruction, Doppler ultrasound showed high specificity (93.75%) but comparatively lower sensitivity (56.25%), indicating a tendency to miss obstructive lesions while reliably excluding their presence. For deep venous system assessment, Doppler ultrasound demonstrated moderate sensitivity (73.91%) and specificity (81.25%), with an accuracy of 76.83%. In evaluating perforator vein incompetence, Doppler ultrasound exhibited high sensitivity (88.00%) but lower specificity (69.23%), resulting in an overall accuracy of 80.49%.

Table 1: Demographic Characteristics of the Study Population (n = 82)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
21–40	14	17.07
41–60	38	46.34
>60	30	36.59
Gender		
Male	48	58.54
Female	34	41.46
Laterality of Involvement		
Unilateral	36	43.90
Bilateral	46	56.10

Table 2: Clinical Presentation of Chronic Venous Insufficiency with Stasis Dermatitis (n = 82)

Clinical Feature	Number of Patients (n)	Percentage (%)
Lower limb edema	82	100.00
Skin hyperpigmentation	68	82.93
Venous eczema	54	65.85
Lipodermatosclerosis	36	43.90
Active venous ulcer	22	26.83
Healed venous ulcer	18	21.95

Table 3: Comparison of Doppler Ultrasound and CT Venography Findings (n = 82)

Parameter	Doppler Ultrasound n (%)	CT Venography n (%)	p-value
Venous reflux detected	62 (75.61)	68 (82.93)	0.241
Superficial venous involvement	58 (70.73)	60 (73.17)	0.741
Deep venous involvement	34 (41.46)	46 (56.10)	0.048*
Perforator vein incompetence	44 (53.66)	50 (60.98)	0.342
Venous obstruction	18 (21.95)	32 (39.02)	0.017*

*Statistically significant ($p < 0.05$)

Table 4: Detection of Proximal and Pelvic Venous Abnormalities

Venous Segment Involved	Doppler Ultrasound n (%)	CT Venography n (%)	p-value
Femoral vein	30 (36.59)	36 (43.90)	0.361
Popliteal vein	24 (29.27)	28 (34.15)	0.512
Iliac veins	6 (7.32)	24 (29.27)	<0.001*
Inferior vena cava	0 (0.00)	8 (9.76)	0.006*

*Statistically significant ($p < 0.05$)

Table 5: Overall Diagnostic Yield of Doppler Ultrasound Compared with CT Venography

Diagnostic Parameter	Sensitivity (%)	Specificity (%)	Accuracy (%)
Detection of reflux	91.18	72.22	84.15
Detection of venous obstruction	56.25	93.75	78.05
Deep venous system assessment	73.91	81.25	76.83
Perforator vein assessment	88.00	69.23	80.49

DISCUSSION

In this cohort of 82 patients with chronic venous insufficiency (CVI) and stasis dermatitis, the predominance of older age (41–60 years: 46.34%; >60 years: 36.59%), male sex (58.54%), and frequent bilateral involvement (56.10%) suggests a symptomatic, late-presenting clinical spectrum rather than community-level disease. In contrast, Evans et al [1999] reported (population-based Edinburgh Vein Study; n=1566, age 18–64 years) an age-adjusted CVI prevalence of 9% in men and 7% in women, with trunk varices in 40% of men and 32% of women, and a clear increase of venous disease with age—highlighting how referral-based hospital samples, such as the present study, are enriched for more advanced and extensive disease.[7]The clinical profile in the current study (edema 100%, hyperpigmentation 82.93%, venous eczema 65.85%, lipodermatosclerosis 43.90%, active ulcer 26.83%, healed ulcer 21.95%) indicates substantial chronic venous hypertension and chronicity. Shankar et al [2017] (cross-sectional dermatology-based cohort; n=120) documented pigmentation in 61.7% and eczema in 80% of patients, with CEAP C6 (active ulcer) in 8.3% and C5

(healed ulcer) in 4.2%, and lipodermatosclerosis (C4b) around 3.3%, which is markedly lower than the 43.90% lipodermatosclerosis and higher ulcer burden observed here—supporting that the present series likely represents a more advanced subset (or more severe phenotypes) at imaging evaluation.[8]For reflux detection, CT venography identified reflux in 82.93% compared with 75.61% on Doppler ultrasound (p=0.241), while Doppler still showed high sensitivity (91.18%) and overall accuracy (84.15%) against CT venography in this dataset. Masuda et al [1992] demonstrated, using descending venography as the comparator, that duplex reflux duration >0.5 s correlated with venographic reflux with sensitivity 90%, specificity 84%, and accuracy 88%—figures that align closely with the high reflux sensitivity and solid accuracy seen for Doppler in the present study, reinforcing duplex ultrasound as a strong functional test for reflux even when cross-sectional imaging is added.[9]Although superficial venous involvement was detected at comparable rates by Doppler and CT venography in this study (no significant difference), CT can add high-quality 3D anatomic mapping that may strengthen pre-intervention planning and segmental localization. Whal Lee et al [2008] reported excellent 3D CT venography image quality in 76% of patients, visualization of the entire great saphenous vein in 99.5% of limbs, and (using CT features to predict duplex-defined GSV insufficiency) sensitivity 98.2% and specificity 83.3%; these data support why CT venography can approximate superficial insufficiency patterns anatomically, even though duplex remains the primary modality for dynamic reflux physiology.[10]Perforator evaluation in the current work showed Doppler ultrasound with high sensitivity (88.00%) but lower specificity (69.23%) and accuracy (80.49%) for perforator incompetence compared with CT venography, implying that Doppler may overcall incompetence in some contexts while still detecting most true cases. Meyer et al [2000] found duplex ultrasonography and ascending phlebography detected nearly identical numbers of insufficient Cockett perforators (Cockett III: 76 vs 76; Cockett II: 84 vs 82; Cockett I: 36 vs 37), concluding comparable diagnostic performance—consistent with the present study's high Doppler sensitivity, while also underscoring that test characteristics can shift with disease severity, operator technique, and the chosen reference standard.[11]A key differentiator in this study was CT venography's superior detection of deeper and more proximal pathology: deep venous involvement was higher on CT venography than Doppler (56.10% vs 41.46%; p=0.048) and obstruction detection was also higher (39.02% vs 21.95%; p=0.017), while iliac vein involvement (29.27% vs 7.32%; p<0.001) and inferior vena cava involvement (9.76% vs 0%; p=0.006) were essentially CT-driven findings. Lawson et al [2012] similarly positioned multidetector CT venography as an adjunct in complex/recurrent varicose veins and ulcers, reporting an AUC of 0.75 for iliac stenosis severity versus conventional venography and a 19% false-positive iliac stenosis rate on CT—together suggesting CT venography improves proximal visualization but still requires careful correlation and, in selected cases, confirmatory testing when intervention is planned.[12]When the present obstruction rate on CT venography (39.02%) is compared with cohorts focused on advanced CVI, the magnitude is directionally consistent but somewhat lower, likely reflecting differences in inclusion criteria and stenosis thresholds. Rossi et al [2014] (advanced CVI, CEAP C3–C6, treatment-failure cohort; 112 limbs) reported 57.1% had iliocaval obstruction ≥50% and 10.7% had >80% obstruction, with mean age 55.8 years and 35.8% history of DVT; the higher obstruction prevalence in that study may reflect their explicit grading of iliocaval stenosis severity and selection for refractory disease, whereas the present study's broader CVI/stasis-dermatitis sampling may dilute the proportion meeting high-grade obstruction criteria despite clear proximal disease detection advantages on CT.[13]Finally, the ulcer burden in this cohort (active 26.83% and healed 21.95%) provides a clinical anchor for why proximal outflow assessment matters: recurrent/healed ulcers often indicate long-standing venous hypertension where reflux alone may not explain severity. Marston et al [2011] evaluated CEAP C5–C6 patients and found iliocaval obstruction ≥50% in 37% and >80% in 23%, with risk enrichment in those with prior DVT and deep venous reflux; compared with the present study, the similar overall "obstruction present" signal (CT obstruction 39.02%) and the strong CT-only pickup of iliac/IVC disease (29.27% and 9.76%) support a practical interpretation that stasis-dermatitis patients—especially those with current or past ulcers—may benefit from systematic proximal venous evaluation beyond standard lower-limb duplex, to avoid missing clinically relevant outflow lesions.[14]

CONCLUSION

In conclusion, this study demonstrates that Doppler ultrasound remains a highly sensitive and reliable first-line modality for assessing venous reflux and superficial venous pathology in patients with chronic venous insufficiency presenting with stasis dermatitis. However, CT venography provides a significant diagnostic advantage in detecting deep venous involvement, venous obstruction, and proximal iliocaval abnormalities that are frequently under-recognized on ultrasound. The complementary use of CT venography is therefore particularly valuable in patients with advanced skin changes, bilateral disease, or disproportionate clinical severity. An integrated imaging approach can improve diagnostic accuracy and guide more comprehensive and effective management strategies in chronic venous insufficiency.

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